COURSE GUIDE

BIO 308
BIOGEOGRAPHY

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INTRODUCTION

BIO 308: Biogeography is a one-semester, 2 credit- hour course in Biology. It is a 300 level, second semester undergraduate course offered to students admitted in the School of Science and Technology, School of Education who are offering Biology or related programmes.

The course guide tells you briefly what the course is all about, what course materials you will be using and how you can work your way through these materials. It gives you some guidance on your Tutor-Marked Assignments.

There are Self-Assessment Exercises within the body of a unit and/or at the end of each unit. The exercise(s) is/are an overview of the unit to help you assess yourself at the end of every unit.

WHAT YOU WILL LEARN FROM THIS COURSE

This course contains fifteen (15) units which cover a generalised survey of the plant and animal kingdom based mainly in the study or similarities and differences in the external features, ecological adaptation of plant and animal forms.

Plants and animals consist of different forms: from the simple forms to the complex forms. At the end of this course, you would have acquainted yourself of the different forms of the plant and animal kingdom, especially their external features and ecological adaptation.

COURSE AIMS

The aim of this course is to provide a generalised survey of the floristic and zoogeographic regions of the world with reference to tropical and temperate flora based mainly on the study of the similarities and differences in the dispersal and colonisation of land by plants and animals ecological adaptations of plants and animals forms.

COURSE OBJECTIVES

In addition to the aim of this course, the course sets an overall objective which must be achieved. In addition to the course objectives, each of the units has its own specific objectives. You are advised to read properly the specific objectives for each unit at the beginning of that unit. This will help you to ensure that you achieve the objectives. As you go through each unit, you should from time to time go back to these objectives to ascertain the level at which you have progressed.

By the time you have finished going through this course, you should be able to:

- explain the different floristic and zoogeographic regions of the world
- compare tropical and temperate flora
- recognise the patterns of dispersal and colonisation of land by plants and animals
- describe the island biogeography
- recognise relationships between vegetation, soil types and climate and relationship between plant distribution and world fauna.

WORKING THROUGH THIS COURSE

In this course, you are advised to devote your time in reading through the material. You would be required to do all that has been stipulated in the course: study the course units, read the recommended reference textbooks and do all the unit(s) self-assessment exercise(s) and at some points, you are required to submit your assignment (TMAs) for assessment purpose. You should therefore avail yourself of the opportunity of being present during the tutorial sessions so that you would be able to compare knowledge with your colleagues.

COURSE MATERIALS

You are to be provided with the two major course materials. These are:

- Course Guide
- Study Units

The course comes with a list of recommended textbooks. These textbooks are supplement to the course materials so that you can avail yourself of reading further. Therefore, it is advisable you acquire some of these textbooks and read them to broaden your scope of understanding.

STUDY UNITS

This course is divided into 3 modules with a total of fifteen units which are divided as follows:

Module 1

Unit 1 Fundamentals of Biogeography and Ecosystem
Unit 2 Tropical and Temperate Flora and Fauna

Unit 3 Classifications and Types of Biogeography
Unit 4 Floristic Regions of the World
Unit 5 Holarctic Kingdom

Module 2

Unit 1 Paleotropical Kingdom
Unit 2 Neotropical Kingdom
Unit 3 South African Kingdom
Unit 4 Antarctic Kingdom
Unit 5 Zoogeography

Module 3

Unit 1 Zoogeographical Provinces
Unit 2 Island Biogeography
Unit 3 Relationship between Vegetation and Climate
Unit 4 Relationship between Soil Type and Vegetation

TEXTBOOKS AND REFERENCES

You will find some recommended textbooks for this course. You may wish to purchase them or any other textbook that you may find useful for the course.

ASSESSMENT

There are two aspects of assessment in this course; the tutor marked assignments and the written examination/end of course examination.

You are advised to be sincere in working on the exercise. In tackling the assignments, you are expected to apply information, knowledge and techniques gathered during the course. The assignments must be submitted to your tutor/facilitator for formal assessment in accordance with the deadlines stated in the presentation schedule and the assignment file. The work you submit to your tutor for assessment will count for 30% of your total course work. At the end of the course you will need to sit for a final or end of course examination of about three hours duration. This examination will count for 70% of your total course mark.

END OF COURSE EXAMINATION AND GRADING

The end of course examination has a value of 70% of the total course guide. The examination will consist of questions, which will reflect the

type of self-testing exercise and tutor-marked assignment problems you have previously encountered. All areas of the course will be assessed.

Use the time between finishing the last unit and sitting for the examination to revise the whole course. You might find it useful to review your self-test, TMAs and comments on them before the examination from all parts of the course.

COURSE MARKING SCHEME

ASSESSMENT	MARKS
Assignments 1 – 4	Four assignments, best three marks of the four count at 10% each – 30% of Course marks
End of course examination	70% of overall course marks
Total	100% of course materials

PRESENTATION SCHEDULE

Your course materials have important dates for the early and timely completion and submission of your TMAs and attending tutorials. You should remember that you are required to submit all your assignments by the stipulated time and date. You should guard against falling behind in your work or studies.

TUTOR- MARKED ASSIGNMENT (TMAs)

The TMA is a continuous assessment component of your course. It accounts for 30% of the total score. You will be given four (4) TMAs to answer. Three of these must be answered before you are allowed to sit for the end of course examination. The TMAs would be given to you by your facilitator and returned after you have done the assignment as of before. Now TMA questions are through electronic system known as E-TMA. These comprise of eighty (80) questions. TMAs 1, 2, 3 and 4 comprise twenty (20) questions each respective fully.

Assignment questions for the units in this course are contained in the assignment file. You will be able to complete your assignment from the information and material contained in your reading, references and study units. However, it is desirable in all degree level to demonstrate that you have read and researched more into your references, which will give you a wider view point and may provide a deeper understanding of the subject.

Make sure that each assignment reaches your facilitator on or before the deadline given in the presentation schedule and assignment file. If for any reason you cannot complete your work on time, contact your facilitator before the assignment is due to discuss the possibility of an extension. Extension will not be granted after the due date unless there are exceptional circumstances.

TUTORS AND TUTORIALS

There are hours of tutorials provided in support of this course. You will be notified of the dates, time and location of these tutorials as well as the names and phone number of your facilitator, as soon as you are located a tutorial group.

Your tutor facilitator will mark and comment on your assignments, keep a close watch on your progress on any difficulties you might face and provide assistance to you during the course. You mail your tutorial marked assignment to your facilitator before the scheduled date (at least two working days are required.). They will be marked by your tutor and returned to you as soon as possible. With e- examination, it is no more applicable.

Do not delay to contact your facilitator by telephone, e-mail and discuss problems if you need assistance.

The following might be circumstances in which you would find assistance necessary. Contact your facilitator if:

- You do not understand any part of the study units or the assigned readings.
- You have difficulty with the self-test or exercises.
- You have a question or problem with an assignment or with the grading of an assignment.

You should endeavour to attend the tutorials. This is the only chance to have face to face contact with your course facilitator and to ask questions which are answered instantly. You can raise any problem encountered in the course of your study.

To gain much benefit from course tutorials, prepare a question list before attending them. You will learn a lot from participating in active discussion.

I wish you success in the course and hope that you will find it both interesting and useful.

MAIN COURSE

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MODULE 1

UNIT 1 FUNDAMENTALS OF BIOGEOGRAPHY AND ECOSYSTEM

CONTENTS

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

3.1 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 colonised 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 only 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 Lutley Sclater (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
- the historical developments in biogeography
- the branches and aim of the study of biogeography.

6.0 TUTOR-MARKED ASSIGNMENT

i. Describe the different types of biogeography.
ii. Explain the importance of the study of biogeography.

7.0 REFERENCE/FURTHER READING

Taggart, S. (2004). Biology: *The Unity and Diversity of Life.* (10^{th} ed). 933 pp.

UNIT 2 TROPICAL AND TEMPERATE FLORA

CONTENTS

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

a) 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).

b) 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*.).

c) Differences 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.

3.3 Tropical and Temperate Fauna

TROPICAL ANIMALS

S/N	Animals	Features
1	**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 butterflies that 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

11	**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
1	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 birds
4	China	Giant pandas, red pandas

Others include Slugs, banana slug, *Nucifraga columbiana*, *Dendeagapus obscurus*, *Ixoreus naevis*, 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
- the flora and fauna in these regions
- the differences between the organisms in the regions.

6.0 TUTOR-MARKED ASSIGNMENT

i. State the differences between tropical flora and temperate flora
ii. 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 COLONISATION OF PLANTS AND ANIMALS

CONTENTS

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
- write 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.

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.

1. **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.

    a) **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.

- **Panama Corridor**: 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.

b. **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 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.

2. **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.

3. **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.

4. **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.

5. **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:

1. **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.

2. **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 broad-leaved 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.

3. **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.

4. **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

- ❖ Animal species are distributed in areas where they are most adapted.
- ❖ Different barriers act differently for different species depending on their modes of locomotion and dispersal.
- ❖ Poikilotherms generally spread slowly as compared to homeotherms (birds and mammals).
- ❖ 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.

- ❖ Parasites generally disperse with their hosts and predators along with prey.
- ❖ Majority of birds do not face any physical barriers due to their ability to fly over them.
- ❖ Low temperature prevents tropical animals to migrate northwards and polar and temperate animals to migrate southwards.
- ❖ For aquatic animals land is the barrier while for terrestrial animals sea, rivers and lakes are physical barriers.
- ❖ 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
- the means and factors that affect animal dispersal
- the distribution of animals.

6.0 TUTOR-MARKED ASSIGNMENT

i. State the mechanisms of animal dispersal
ii. What are the agents that facilitate plant dispersal.

7.0 REFERENCE/FURTHER READING

Taggart, S. (2004). Biology: *The Unity and Diversity of Life.* (10^{th} ed). 933 pp.

UNIT 4 FLORISTIC REGIONS OF THE WORLD

CONTENTS

1.0 INTRODUCTION

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 subkingdoms 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 · Madrean

3.2 Paleotropical Kingdom

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

3.3 Neotropical Kingdom

Caribbean · Guayana Highlands · Amazonian · Brazilian · Andean

3.4 South African Kingdom

Cape

3.5 Australian Kingdom

Northeast Australian-Southwest Australian, Central Australian

3.6 Antarctic Kingdom

Fernandezian · Chile-Patagonian · South Subantarctic Islands · Neozeylandic

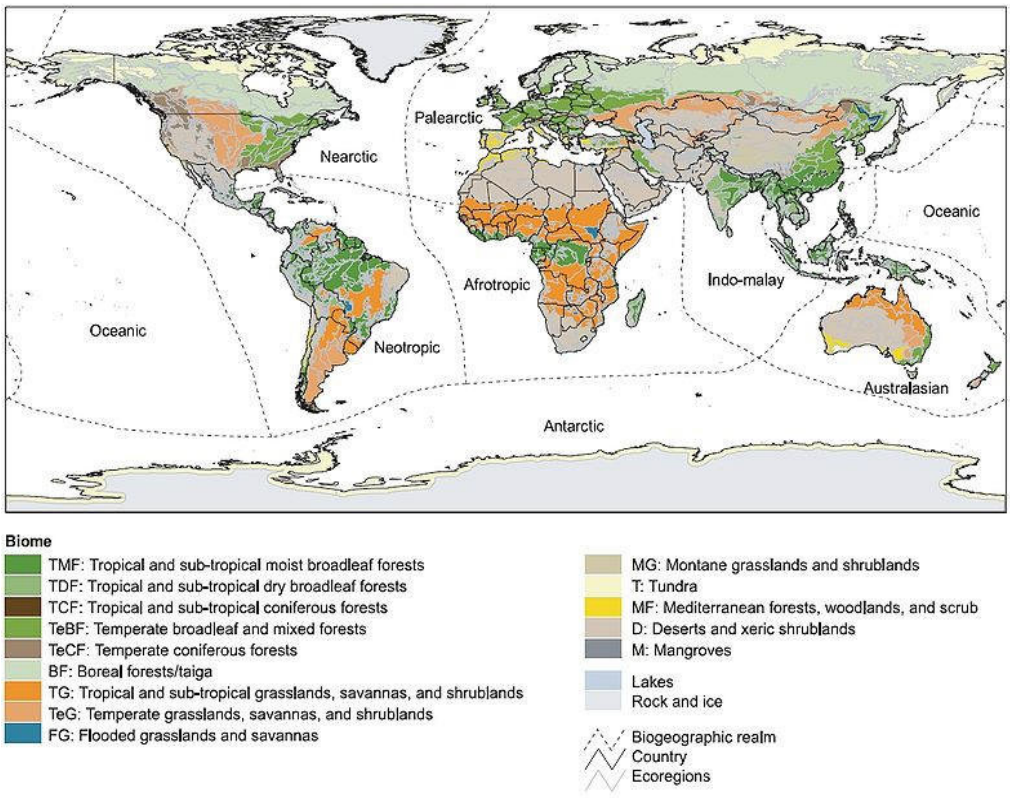

Fig. 1: World Map Showing the different Floristic Kingdoms and Regions

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 TUTOR-MARKED ASSIGNMENT

i. 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,* (10^{th} ed). 933 pp.

UNIT 5 HOLARCTIC KINGDOM

CONTENTS

1.0 INRODUCTION

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 subdivisions 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 Subkingdom: Circumboreal Region, Eastern Asiatic Region, North American Atlantic Region, Rocky Mountain Region.
Tethyan Subkingdom, Macaronesian Region, Mediterranean Region, Saharo-Arabian Region, Irano-Turanian Region.
Madrean Subkingdom : 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, Alnus*

viridis, *Vaccinium vitis-idaea*, *Arctostaphylos uva-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. *Ranunculus sabinei, Papaver polare, Salix arctica, Colpodium vahlianum, Colpodium wrightii, Puccinellia angustata*).

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, Ulex europaeus, Genista anglica, Deschampsia setacea*).

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, 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, Soldanella carpatica, Rosa abietina, Saxifraga muscoides, Trifolium saxatile, Chaerophyllum villarsii, Heracleum carpaticum, Syringa josikaea, Valeriana tripteris, Campanula zoysii, Campanula carpatica, Pulmonaria filarzkyana, Leontopodium alpinum, Narcissus poeticus, Narcissus angustifolius, Gymnadenia albida, Carex carvula, Calamagrostis villosa*).

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. *Ramonda nathaliae, Ramonda serbica, Picea omorika, Pinus heldreichii, Pinus peuce, Rheum rhaponticum, Aesculus hippocastanum, Forsythia europaea, Lathraea rhodopea, Wulfenia baldacci, Solenanthus scardicus, Amphoricarpus neumayeri, Narthecium scardicum, Dioscorea balcanica*).

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. *Abies nordmanniana, Epimedium pubigerum, Quercus pontica, Quercus hartwissiana, Betula medwedewii, Betula megrelica, Corylus colchica, Corylus pontica, Paeonia wittmanniana, Hypericum bupleuroides, Hypericum xylosteifolium, Rhododendron ungernii, Rhododendron smirnovii, Epigaea gaultherioides, Primula megaseifolia, Cyclamen adsharicum, Andrachne colchica, Trapa colchica, Staphylea colchica, Hedera colchica, Astrantia pontica, Heracleum mantegazzianum, Seseli rupicola, Rhamnus imeretinus, Osmanthus decorus, Trachystemon orientalis, Rhamphicarpa medwedewii, Gentiana paradoxa, Scabiosa olgae, Campanula mirabilis, Campanula lactiflora, Inula magnifica, Lilium ponticum, Ruscus colchicus, Dioscorea caucasica, 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. *Betula raddeana, Papaver oreophilum, Corydalis pallidiflora, Corydalis emanuelii, Cerastium kasbek, Cerastium argenteum, Cerastium multiflorum, Minuartia inamoena, Silena lacera, Gypsophila acutifolia, Dianthus fragrans, Sobolevskia caucasica, Draba bryoides, Draba elisabethae, Draba supranivalis, Draba molissima, Draba ossetica, Primula bayernii, Saxifraga subverticillata, Sedum stevenianum, Geranium renardii, Oxytropis owerinii, Genliana grossheimii, Gentinana septemfida var. lagodechiana, Gentiana marcowiczii, Veronica caucasica, Campanula andina, Centaurea amblyolepis, Lilium monadelphum, Galanthus latifolius, Ornithogalum magnum, Colchicum laetum, Asphodoline tenuior, Gagea helenae, Calamagrostis caucasica*), many endemic species and genera shared with the Euxinian Province (e.g. *Agasyllis, Sredinskya, Rhododendron caucasicum, Vaccinium arctostaphylos, 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, Diplotaxis cretacea, Sisymbrium wolgense, Syrenia talievii, Pyrus rossica, Hedysarum cretaceum, Hedysarum ucrainicum, Erodium beketowii, Linaria cretacea, Linaria macroura, Scrophularia cretacea*). Northern European Province (parts of Finland, Sweden, Norway and Russia), without endemic genera, with but few endemic species (e.g. *Corispermum algidum, Castilleja schrenkii*).

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. *Callianthemum sajanense, Eranthis sibirica, Aquilegia borodinii, Delphinium mirabile, Delphinium inconspicuum, Aconitum krylovii, Aconitum altaicum, Anemone baicalensis, Ranunculus sajanensis, Gymnospermium altaicum, Betula kelleriana, Stellaria martjanovii, Stellaria imbricata, Stellaria irrigua, Silene turgida, Aphragmus involucratus, Erysimum inense, Euphorbia alpina, Euphorbia altaica, Euphorbia tshuiensis, Rhodiola algida, Sedum populifolium, Chrysosplenium filipes, Caragana altaica, Vicia lilacina, Lathyrus frolovii, Lathyrus krylovii, Linum violascens, Scrophularia altaica, Schizonepeta annua, Valeriana petrophila, Brachanthemum baranovii, Echinops humilis, Saussurea serratuloides, Saussurea sajanensis, Allium pumilum, Carex tatjanae, 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, Draba baicalensis, Saxifraga algisii, Potentilla adenotricha, Astragalus trigonocarpus, Oxytropis heterotricha, Mertensia serrulata*).

Northeastern Siberian Province (parts of Russia), with one endemic genus (Gorodkovia) and many endemic species (e.g. *Corydalis gorodkovii, Androsace gorodkovii, Saxifraga anadyrensis, Potentilla anadyrensis, Potentilla tollii, Helictotrichon krylovii, Poa lanatiflora*).

Okhotsk-Kamchatkan Province (parts of Russia), with one endemic genus (Redowskia) and many endemic species (e.g. *Abies gracilis, Picea kamtschatkensis, Delphinium ochotense, Aconitum ajanense, Aconitum ochotense, Corydalis redowskii, Stellaria peduncularis,*

Arenaria redowskii, Lychnis ajanensis, Sorbus kamtschatcensis, Oxytropis ajanensis, Oxytropis tilingii, Sambucus kamtschatica).

3.3 Tethyan Subkingdom

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" μακάρων νῆσοι makárōn nêsoi, 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)
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 have 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 northwestern 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

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	Ionopsidium	Bivonaea
Euzomodendron	Hutera	Vella
Boleum	Didesmus	Morisia
Guiraoa	Malope	Drosophyllum
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
Aphyllantes		

The genera Aubrieta, Sesamoides, Cynara, Dracunculus, Arisarum and Biarum are nearly endemic. Among the endemic species prominent in the Mediterranean vegetation are the 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, Vitex agnus-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 shrublands 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 Macaque, and the Iberian Lynx.

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-broadleaf forests	Lebanon, Israel, the West 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 forests	Croatia, France, Italy, Malta

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

a) **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.

b) **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.

c) **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 Larrea tridentata (Creosote bush).

d) **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 subkingdoms. Each subkingdom 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
- subkingdom, provinces and regions of the Holarctic Kingdom
- plants that are endemic in this kingdom.

6.0 TUTOR-MARKED ASSIGNMENT

i. State the regions of each of the subkingdoms of the Holarctic kingdom.
ii. State the ecozones of the holarctic region.
iii. Give seven ecoregions of the Holarctic kingdom stating the type of plants found each ecoregion and the countries where such ecoregion is found.

7.0 REFERENCE/FURTHER READING

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

MODULE 2

UNIT 1 PALEOTROPICAL KINGDOM

CONTENTS

1.0 INTRODUCTION

This unit looks at the general features of the Paleotropical kingdom which comprises the tropical areas of Africa, Asia and Oceania. It also describes the subkingdoms of the paleotropical kingdom.

2.0 OBJECTIVES

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

- describe the paleotropical kingdom
- explain the subkingdoms in the Paleotropical kingdom.

3.0 MAIN CONTENT

3.1 General Description of the Paleotropical Kingdom

The Paleotropical Kingdom (Paleotropis) is a floristic kingdom comprising tropical areas of Africa, Asia and Oceania (without Australia). Its flora is characterised by about 40 endemic plant families, e.g. Nepenthaceae, Musaceae, Pandanaceae, Flagellariaceae. Part of its flora, inherited from the ancient supercontinent of Gondwana or exchanged later (e.g. Piperaceae with pantropical distribution and but

few warm temperate representatives), is shared with the Neotropical Kingdom, comprising tropical areas of Central and South America. Moreover, the Paleotropical flora influenced the tropical flora of the Australian Kingdom.

3.2 The Subkingdoms of Paleotropical Kingdom

The Paleotropical Kingdom is subdivided into five floristic subkingdoms about 13 floristic regions. The floristic subkingdoms of the paleotropical kingdom are as follows: African Subkingdom, Madagascan Subkingdom, Indo-Malesian Subkingdom, Polynesian Subkingdom and Neocaledonian Subkingdom

a) **African Subkingdom**: This contains 10 endemic families and many endemic genera. The 10 endemic families include Dioncophyllaceae, Pentadiplandraceae, Scytopetalaceae, Medusandraceae, Dirachmaceae, and Kirkiaceae. The subkingdom is made up of the Guineo-Congolian Province, the Usambara-Zululand Region and the Sudano-Zambezian Region (including tropical Asia west of the Gulf of Khambhat) Karoo-Namib Region.

b) **Madagascan Subkingdom**: This contains 9 endemic families, more than 450 endemic genera, and about 80% endemic species. It ceased to be influenced by the African flora in the Cretaceous, but underwent heavy influence of the Indian Region's flora. Mainly up of the Madagascan Region.

c) **Indo-Malesian Subkingdom**: This contains 11 endemic families (including Degeneriaceae, Barclayaceae, Mastixiaceae) and many endemic genera. It is made the Indian Region, the Indochinese Region, the Malesian Region and the Fijian Region.

d) **Polynesian Subkingdom**: This subkingdom contains no endemic families and many endemic genera. The flora is mostly derivative from that of the Indo-Malesian Subkingdom. It contains the Polynesian Region and the Hawaiian Region.

e) **Neocaledonian Subkingdom:** This contains several endemic families (including Amborellaceae, Strasburgeriaceae) and more than 130 endemic genera (including. Exospermum and Zygogynum). The flora is partially shared with the Indo-Malesian Subkingdom and the Australian Kingdom. It contains the Neocaledonian Region.

4.0 CONCLUSION

The Paleotropic floristic kingdom is found in the tropic areas of Africa, Asia and Oceania. It is made of five subkingdoms with forty endemic plant families.

5.0 SUMMARY

In this unit, you have learnt the parts of the world that the paleotropical kingdom can be found. You have also learnt the subkingdoms of the Paleotropical kingdom and the types of organisms that are endemic in the kingdom.

6.0 TUTOR-MARKED ASSIGNMENT

i. State the floristic regions in each subkingdom of paleotropical kingdom.
ii. What are the peculiar features found in the paleotropical kingdom?

7.0 REFERENCE/FURTHER READING

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

UNIT 2 NEOTROPICAL KINGDOM

CONTENTS

1.0 INTRODUCTION

The neotropical kingdom is sometimes described as the tropical area of South America. It has more tropical rainforests than any other kingdom hence with high biodiversity. It is divided into four floristic regions and has many endemic plants and animals.

2.0 OBJECTIVES

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

- identify the general nature of the neotropical kingdom
- describe the ecological regions in the neotropical kingdom
- list the plants and the animals endemic in the neotropical kingdom.

3.0 MAIN CONTENT

3.1 General Description of the Neotropical Kingdom

In biogeography, the Neotropic or Neotropical zone is one of the eight terrestrial ecozones. This ecozone includes South and Central America, the Mexican lowlands, the Caribbean islands, and southern Florida, because these regions share a large number of plant and animal groups. It is sometimes used as a synonym for the tropical area of South America, although the ecozone also includes temperate southern South America. The Neotropical Floristic Kingdom excludes southernmost South America, which instead is placed in the Antarctic Kingdom.

The Neotropic includes more tropical rainforest (tropical and subtropical moist broadleaf forests) than any other ecozone, extending from

southern Mexico through Central America and northern South America to southern Brazil, including the vast Amazon Rainforest. These rainforest ecoregions are one of the most important reserves of biodiversity on Earth. These rainforests are also home to a diverse array of indigenous peoples, who to varying degrees persist in their autonomous and traditional cultures and subsistence within this environment. The number of these peoples who are as yet relatively untouched by external influences continues to decline significantly, however, along with the near-exponential expansion of urbanisation, roads, pastoralism and forest industries which encroach on their customary lands and environment. Nevertheless amidst these declining circumstances this vast "reservoir" of human diversity continues to survive, albeit much depleted. In South America alone, some 350–400 indigenous languages and dialects are still living (down from an estimated 1,500 at the time of first European contact), in about 37 distinct language families and a further number of unclassified and isolate languages. Many of these languages and their cultures are also endangered. Accordingly, conservation in the Neotropic zone is a hot political concern, and raises many arguments about development versus indigenous versus ecological rights and access to or ownership of natural resources.

3.2 Major Ecological Regions of Neotropic Kingdom

The WWF subdivides the ecozone into bioregions, defined as "geographic clusters of ecoregions that may span several habitat types, but have strong biogeographic affinities, particularly at taxonomic levels higher than the species level (genus, family)."

a) Amazonia Region

The Amazonia bioregion is mostly covered by tropical moist broadleaf forest, including the vast Amazon rainforest, which stretches from the Andes Mountains to the Atlantic Ocean, and the lowland forests of the Guianas. The bioregion also includes tropical savannah and tropical dry forest ecoregions.

b) Eastern South America Region

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Eastern South America includes the Caatinga xeric shrublands of northeastern Brazil, the broad Cerrado grasslands and savannas of the Brazilian Plateau, and the Pantanal and Chaco grasslands. The diverse Atlantic forests of eastern Brazil are separated from the forests of Amazonia by the Caatinga and Cerrado, and are home to a distinct flora and fauna.

c) Orinoco Region

The Orinoco is a region of humid forested broadleaf forest and wetland primarily comprising the drainage basin for the Orinoco River and other adjacent lowland forested areas. This region includes most of Venezuela and parts of Columbia.

d) Southern South America Region

The temperate forest ecoregions of southwestern South America, including the temperate rain forests of the Valdivian temperate rain forests and Magellanic subpolar forests ecoregions, and the Juan Fernandez Islands and Desventuradas Islands, are a refuge for the ancient Antarctic flora, which includes trees like the southern beech (Nothofagus), podocarps, the alerce (*Fitzroya cupressoides*), and Araucaria pines like the monkey-puzzle tree (*Araucaria araucana*). These magnificent rainforests are endangered by extensive logging and their replacement by fast-growing non-native pines and eucalyptus.

3.3 Endemic Animals and Plants in Neotropical Kingdom

Animals: Thirty-one bird families are endemic to the Neotropical ecozone, over twice the number of any other ecozone. They include rheas, tinamous, curassows, and toucans. Bird families originally unique to the Neotropics include hummingbirds (family Trochilidae) and wrens (family Troglodytidae).

Mammal groups originally unique to the Neotropics include:
Order Xenarthra: anteaters, sloths, and armadillos
New World monkeys,
Caviomorpha rodents, including capybaras and guinea pigs, and chinchillas
American opossums (order Didelphimorphia) and shrew opossums (order Paucituberculata).

Forty-three fish families and subfamilies are endemic to the Neotropical ecozone, more than any other ecozone (Reis et al., 2003). These fish taxa include more than 5,700 species, and represent at least 66 distinct lineages in continental freshwaters (Albert and Reis, 2011).

Some fish groups originally unique to the Neotropics include:

Order Gymnotiformes Neotropical electric fish
Family Characidae tetras and allies
Family Loricariidae armoured catfishes
Subfamily Cichlinae Neotropical cichlids

Subfamily Poeciliinae guppies and relatives.

Examples of groups that are entirely or mainly restricted to the Neotropical region include New World Monkeys, Sloths, Tinamous, Hummingbirds, Toucans, Ovenbirds, Antbirds, Tanagers, Caimans, New World Coral Snakes, Poison Dart Frogs, Gonyleptidae.

Plants: Plant families that originated in the Neotropic include Bromeliaceae, Cannaceae, and Heliconiaceae. Plant species originally unique to the Neotropic include: Potato (*Solanum tuberosum*), Tomato (*Solanum lycopersicum*), Cacao tree (*Theobroma cacao*), source of cocoa and chocolate, Maize (*Zea mays*), Lima bean (*Phaseolus lunatus*), Cotton (*Gossypium barbadense*), Cassava (*Manihot esculenta*), Sweet potato (*Ipomoea batatas*), Amaranth (*Amaranthus caudatus*), Quinoa (*Chenopodium quinoa*).

4.0 CONCLUSION

This floristic kingdom used to be home to some well known crop and cash crops that are found in many parts of the world today. It contains some endemic plant and animal species located in four different floristic regions. It spreads to different continents of the world.

5.0 SUMMARY

In this unit, you have learnt the nature of the Neotropical kingdom and the subdivisions of the kingdom. You have also learnt the different plant and animal species that are endemic in the Neotropical region.

6.0 TUTOR-MARKED ASSIGNMENT

i. Compare the features that are found in each neotropical floristic regions with those in the other regions within the kingdom.

7.0 REFERENCE/FURTHER READING

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

UNIT 3 SOUTH AFRICAN KINGDOM

CONTENTS

1.0 INTRODUCTION

The South African floristic kingdom is mainly known as the Cape floristic region. It is located in South Africa and it has some plants and animals peculiar to it.

2.0 OBJECTIVES

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

- describe the South African Kingdom and its location
- describe the endemic plants and animals in the floristic kingdom.

3.0 MAIN CONTENT

3.1 General Description of the South African Kingdom

The Cape Floristic Region is a floristic region located near the southern tip of South Africa. It is the only floristic region of the Cape (South African) Floristic Kingdom, and includes only one floristic province, known as the Cape Floristic Province.

The Cape Floristic Region, the smallest of the six recognised floral kingdoms of the world, is an area of extraordinarily high diversity and endemism, and is home to more than 9 000 vascular plant species, of which 69 % are endemic. Much of this diversity is associated with the fynbos biome, a Mediterranean-type, fire-prone shrubland. The economic worth of fynbos biodiversity, based on harvests of fynbos products (e.g. wildflowers) and eco-tourism is estimated to be in the region of R77 million a year. Thus, it is clear that the Cape Floristic

Region has both economic and intrinsic biological value as a biodiversity hotspot.

3.2 Location and Description

The Region covers the Mediterranean climate region of South Africa in the Western Cape in the southwestern corner of the country, and extends eastward into the Eastern Cape, a transitional zone between the winter-rainfall region to the west and the summer-rainfall region to the east in KwaZulu-Natal.

3.3 Flora: Fynbos in the Western Cape

Most of the region is covered with fynbos, a sclerophyllous shrubland occurring on acid sands or nutrient poor soils derived from Table Mountain Sandstones (Cape Supergroup). Fynbos is home to an amazing diversity of plant species including many members of the Protea family (Proteaceae), Heath family (Ericaceae), and Reed family of restios (Restionaceae). Other vegetation types are strandveld, a soft coastal scrubland found mostly on the west-facing coast of the Western Cape Province, on tertiary sands. Renosterveld is a grassy shrubland dominated by members of the Daisy family (Asteraceae - particularly renosterbos (Elytropappus rhinocerotis)), graminoids and geophytes, occurring on the base-rich shaley soils of the coastal forelands. Small pockets of Afromontane forest (Southern Afrotemperate Forest) can be found in humid and sheltered areas.

Ecology

The World Wildlife Fund divides the Cape floristic region into three ecoregions, the Lowland fynbos and renosterveld, Montane fynbos and renosterveld and the Albany thickets. The fynbos ecoregions are designated one of the Global 200 priority ecoregions for conservation. Conservation International declared the Cape floristic region to be a biodiversity hotspot.

4.0 CONCLUSION

The South African Kingdom is also known as the Cape region because that is the only floristic region in the kingdom. It, however, has three ecoregions. It is smallest floristic kingdom and has different plant families endemic in it.

5.0 SUMMARY

In this unit, you have learnt about the nature of the South African kingdom also known as the cape floristic region. You have also learnt about the flora of the kingdom.

6.0 TUTOR-MARKED ASSIGNMENT

List the types of vegetation/flora that can be found in the Cape Region.

7.0 REFERENCE/FURTHER READING

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

UNIT 4 AUSTRALIAN KINGDOM AND ANTARCTIC KINGDOM

CONTENTS

1.0 INTRODUCTION

In this unit, you will learn about the Antarctic floristic kingdom. The Antarctic kingdom is found south of latitude 40^0S. It has about 50 genera of plants original to it with three regions.

2.0 OBJECTIVES

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

- give a general description of the Antarctic Kingdom
- explain the different subkingdoms and regions of the Antarctic kingdom.

3.0 MAIN CONTENT

3.1 General Description of Antarctic Kingdom

The Antarctic Floristic Kingdom (also Holantarctic Kingdom) is a floristic region first identified by botanist Ronald Good (and later by Armen Takhtajan), which includes most areas of the world south of 40°S latitude. The Antarctic plant kingdom includes the continent of Antarctica, Patagonia (southern Chile, southern Argentina, Tierra del Fuego), most of New Zealand, the New Zealand Sub-Antarctic Islands, and all islands of the Southern Ocean south of 40°S latitude, including Gough Island, the Kerguelen Islands, and the Falkland Islands. Tasmania is omitted since its plant species are more closely related to those found in the Australian Floristic Kingdom. Many plant species of

Antarctica, temperate South America and New Zealand were very closely related, despite their disjunction by the vast Southern Ocean. The flora of this kingdom dates back to the time of Gondwana, the southern supercontinent which once included most of the landmasses of the present-day Southern Hemisphere, though it has been influenced by the flora of the Holarctic Kingdom since the Tertiary.

About 50 genera of vascular plants are common in the Antarctic plant kingdom, including Nothofagus and Dicksonia. Takhtajan also made note of hundreds of other vascular plant genera scattered about and isolated on islands of the Southern Ocean, including Calandrinia feltonii of the Falkland Islands, Pringlea antiscorbutica of the Kerguelen Islands, and the megaherb genera of the New Zealand Sub-Antarctic Islands.

There are about 11 families of plants that are endemic to this kingdom: Lactoridaceae, Gomortegaceae, Hectorellaceae, Halophytaceae, Francoaceae, Aextoxicaceae, Tribelaceae, Griseliniaceae, Misodendraceae, Alseuosmiaceae and Donatiaceae.

3.2 Subdivisions

The Antarctic floristic kingdom is subdivided into four floristic regions, and subdivided even further into sixteen floristic provinces. Most of the provinces lie within, or very near the Antarctic convergence zone.

3.2.1 Fernandezian Region

This is often included within the Neotropical Kingdom. It contains an Endemic family: Lactoridaceae. There are 20 endemic genera including Thyrsopteris, Nothomyrcia, Selkirkia, Cuminia, Juania, Robinsonia, Rhetinodendron, Symphyochaeta, Centaurodendron, Yunquea, Hesperogreigia, Podophorus, Pantathera and Megalachne. Species endemism of vascular plants is very high (about 70%). It is made up of the Fernandezian Province.

3.2.2 Argentina-Chile-Patagonian Region

This contains the following endemic families: Gomortegaceae, Halophytaceae, Malesherbiaceae, Tribelaceae, Francoaceae, Aextoxicaceae, and Misodendraceae. There are many endemic genera (including Leptocionium, Saxegothaea, Austrocedrus, Pilgerodendron, Fitzroya, Peumus, Boquila, Lardizabala, Philippiella, Austrocactus, Holmbergia, Berberidopsis, Niederleinia, Lebetanthus, Ovidia, Quillaja, Kageneckia, Saxifragella, Zuccagnia, Tepualia, Magallana, Gymnophyton, Laretia, Mulinum, Talguenea, Schizanthus, Melosperma, Monttea, Hygea, Mitraria, Sarmienta, Chiliotrichum, Melalema,

Nassauvia, Tetroncium, Gilliesia, Leontochir, Leucocryne, Schickendantziella, Solaria, Lapageria, Conanthera, Tecophilaea, Tapeinia, Fascicularia, Ortachne, and Jubaea) and species.

It is made up of the Northern Chilean Province, the Central Chilean Province, the Argentine Pampas Province, the Patagonian Province and the Tierra del Fuego Province.

3.2.3 Neozeylandic Region

This contains an endemic family: Ixerbaceae which is an endemic monogeneric family of one species, *Ixerba brexioides*. The Ixerbaceae is the only endemic New Zealand vascular plant family. There are 50 endemic genera in the region (including Loxsoma, Pseudowintera, Hectorella, Entelea, Hoheria, Corokia, Alseuosmia, Carmichaelia, Lophomyrtus, Neomyrtus, Plectomirtha, Stilbocarpa, Kirkophytum, Coxella, Lignocarpa, Scandia, Dactylanthus, Myosotidium, Parahebe, Negria, Rhabdothamnus, Teucridium, Oreostylidium, Pachystegia, Haastia, Leucogenes, Phormium, Rhopalostylis, Lepidorrhachis, Hedyscepe, Howea, Sporadanthus, Aporostylis, Desmoschoenus), very high species endemism, especially among Pinophyta.

The provinces in the region include the Lord Howe Province, the Norfolkian Province, the Kermadecian Province, the Northern Neozeylandic Province, the Central Neozeylandic Province, the Southern Neozeylandic Province, the Chatham Province and the New Zealand Subantarctic Islands Province.

4.0 CONCLUSION

The artarctic kingdom contains about 30 genera of plant. It is located in the Antarctic region and other parts of the world like New Zealand and the Patagonia. It is made of four flouristic regions and about sixteen flouristic provinces.

5.0 SUMMARY

In this unit, you have learnt the:

- nature of the Antarctic Kingdom
- subdivisions of the Antarctic kingdom
- type of plants that is endemic in the region.

6.0 TUTOR-MARKED ASSIGNMENT

i. State the locations of the artactic kingdom.
ii. Give four regions of the Antarctic regions and five genera of plants endemic in each region.

7.0 REFERENCE/FURTHER READING

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

UNIT 5 ZOOGEOGRAPHY

CONTENTS

1.0 INTRODUCTION

This unit looks at zoogeography which is the branch of science that deals with animal distribution. It gives a general overview of zoogeography and explains the zoogeographical regions.

2.0 OBJECTIVES

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

- classify the zoogeographical regions of the world
- identify the basics of zoogeography.

3.0 MAIN CONTENT

3.1 General Concept of Zoogeography

Zoogeography deals with the study of distribution of land animals and those living in freshwater. Marine animals cannot be confined to any one region as the seas are interconnected and the only possible barrier for them can be climate. Hence most of the animal distribution studies are based on the land vertebrate fauna that also includes freshwater fishes and amphibians, which due to osmotic problems cannot cross salt water to reach from one land mass to another, although land makes only about 29% of the earth's surface and land vertebrates only 2% of the entire animal kingdom. Theoretically zoogeography is the study of all animals that includes invertebrates of which insects constitute the largest group. Earlier studies involved almost exclusively the bird fauna, which being gifted fliers can cross all kinds of barriers and some of them do reach from one end of the globe to another.

Fascination for zoogeographical studies arose from the Darwinian philosophy that animals lived where evolution made them most adapted to live in. But a cursory look reveals that elephants, zebras, giraffes, lions and a large number of African animals can live equally comfortably in South America and so can do the tropical American monkeys, jaguars, Llamas, sloths, armadillos, anacondas and a large number of birds in Africa but they are limited to their regions. Alligators can live almost in any tropical habitat but are confined to the New World and China, whereas crocodiles occur in the tropics of all continents. Given the opportunity, marsupials will do well in any other continent but are restricted to Australia and one of them, opossum, does exist in the New World. No placental mammal existed in Australia and New Zealand until recently when we carried our pets and sheep along and some of them escaped and became wild to disturb the ecological balance that existed for millions of years. Lungfishes and ostriches inhabit widely separated continents of South America, Africa and Australia. Camels are found in the deserts of Middle East to Mongolia and India but one species reaches as far away as South America. Similarly, four species of tapirs live in South America but one species has gone to far eastern Sumatra and nowhere in between where climate is quite suitable for it to live. Limbless amphibians also show similar distribution. Such peculiarities in the distribution of animals triggered more detailed studies to find out why animals could not be distributed in all places where climate and other environmental conditions are conducive.

Zoogeographic provinces are regions of distinctive fauna. They are based on the taxonomic or phylogenetic relationships of animals and not the adaptations of animals to specific environments. One way of looking at this is to think of the fauna of each province as constituting the gene pool available to the forces of natural selection to adapt animal life to the variety of habitats present in the particular region. The gene pool (i.e. the taxa represented) is different in each province.

Following the concept of a ***region*** as used in geography, each province maintains a level of homogeniety within its borders and clearly differs from adjacent areas. The boundaries between zoogeographic provinces are drawn according to the ***distribution of vertebrate taxa*** (in particular, *families*). Slater, who is commonly acknowledged as the developer of this system of drawing regions according to fauna, based his regions on the taxonomic relationships of birds; but the same regional limits work well enough for fishes, amphibians, reptiles, and mammals.

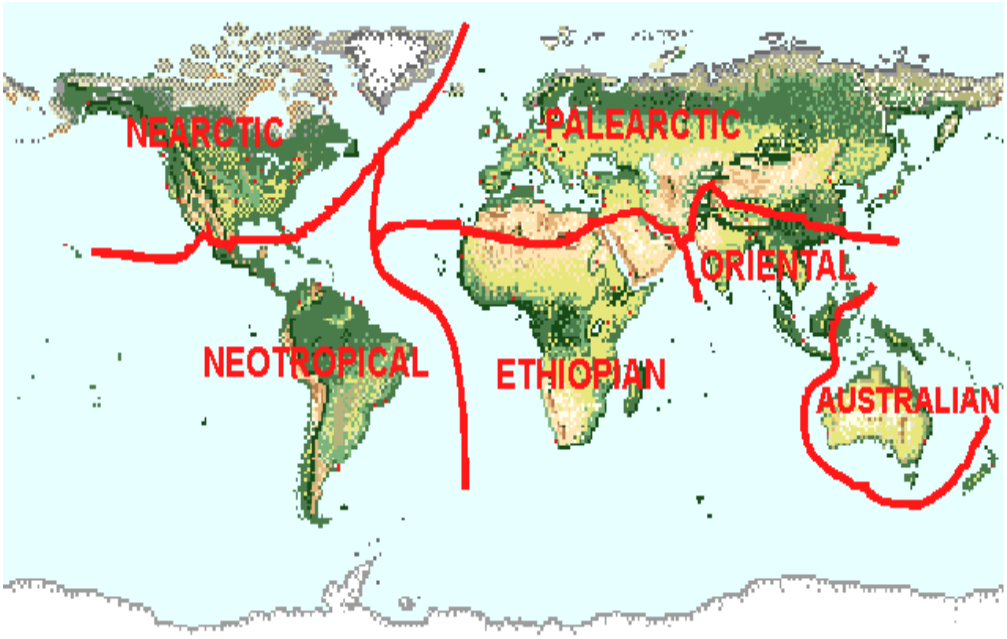
The data used to delineate regions were compiled long before continental drift was even considered. Furthermore, they represent only taxa extant in the 19th century. Paleontological advances, particularly in

the 20th century, have added new information on the distribution of vertebrate families that negate some of the assumptions of Slater, Wallace and others. Nonetheless, the basic notion and the names of the zoogeographic provinces are still in use today.

The exact locations of boundaries of any region are often problematic, and this is certainly true for zoogeographic provinces. The boundary between the Oriental and Australian provinces, for example, has been redrawn several times; the most famous version is known as Wallace's Line, which falls between Borneo and Sulawesi and between the tiny islands of Bali and Lombok. The latter pair of islands is separated by a mere 20 miles, but for the most part they are inhabited by different families of mammals and even birds with all the powers of flight.

3.2 Zoogeographic Regions

Below are some comparative data for the six zoogeographic regions. The total number of families and the number of endemic families pertain to all mammals, except bats. The number of families shared refers to those families found only in the respective two zoogeographic regions and excludes more widespread families like the Canidae, which has reached all continents except Antarctica (although entry into Australia is generally considered a result of its introduction by people and not natural dispersal processes).



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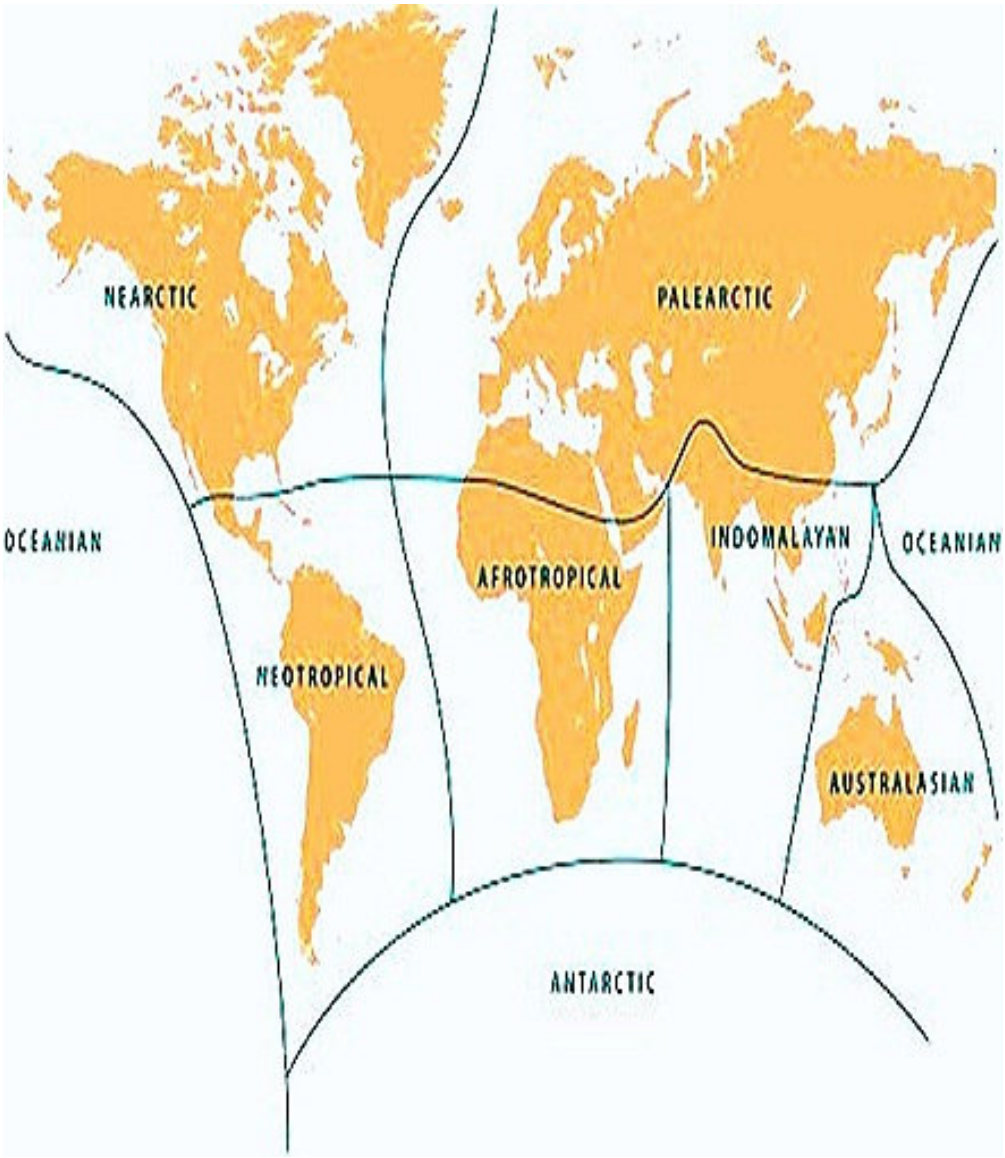

a) **Palearctic Zoogeographic Province**: 28 families of animals are found in this province; 2 are endemic (the mole rats, and another rodent group, the seleviniids). 22 families of animals in this province are shared with the Ethiopian while 19 families are shared with the Oriental. Many in common with the Nearctic (to the degree that the same genera and in some cases the very same species are found in both regions).

b) **Nearctic Zoogeographic Province**: This contains 24 families of animals; 4 are endemic (pronghorn, mountain beaver, pocket gophers, pocket mice). Most are widely distributed, especially in the Palearctic. 4 families in this province are shared with the Neotropical, but each is represented in Nearctic by only one species (armadillo, opossum, porcupine and peccary).

c) **Neotropical Zoogeographic Province:** This contains 32 families; 16 are endemic (10 are caviomorph rodents; 3 are in the nearly endemic order Edentata-sloths, anteaters, and armadillos; 1 is a marsupial; and 2 are monkeys). 4 families shared with the Nearctic (each represented in the Nearctic by only one species) 1 shared with the Palearctic (Camelidae), and 1 shared with the Oriental (Tapiridae).

d) **Ethiopian (Afrotropical) Zoogeographic Province:** 38 families; 12 endemic (including giraffes, hippopotamus; aardvark, elephant shrews, otter shrews, hyraxes, golden moles, and several rodents). 22 families shared with the Palearctic 8 shared with the Oriental (in many cases the same genera are found in both regions).

e) **Oriental Zoogeographic Province:** 30 families; 4 endemic families (2 primates-flying lemurs; tree shrews; hairy hedgehogs; spiny dormice). There is one endemic order (spiny dormice) in the province. 19 familie in this provinces are shared with the Palearctic, 8 shared with the Ethiopian (e.g., elephants, rhinoceroses, great apes) and 1 shared with the Neotropical (Tapiridae).

f) **Australian Zoogeographic Province:** 9 families; 8 are endemic (6 are marsupials, 2 are monotremes-a subclass of mammals). The one non-endemic family is shared with the Palearctic (the only placental mammal, a mouse).

4.0 CONCLUSION

The study of zoogeography helps to understand the regions of animal distribution. It also helps to give knowledge on the different types of animals endemic in various zoogeographical regions.

5.0 SUMMARY

In this unit, you have learnt that:

- animals are found in different regions called zoogeographical regions
- the zoogeographical regions of the world.

6.0 TUTOR-MARKED ASSIGNMENT

Differentiate between the phytogeographic and zoogeographic kingdoms.

7.0 REFERENCE/FURTHER READING

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

MODULE 3

UNIT 1 ZOOGEOGRAPHICAL REGIONS

1.0 INTRODUCTION

This unit will describe the zoogeographical regions one after the other. The animals will be classified accordingly. Classification of families of both animals and births will be made also in their various regions.

2.0 OBJECTIVES

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

- relate animals to regions they belong
- state the characteristic features of each zoogeographical region.

3.0 MAIN CONTENT

3.1 Palaearctic Region

This is the largest of the six regions is covering an area of 14,000,000 square miles. In this region Europe, Asia, North of Himalayas and Northern parts of Africa. It lies on Longitudes 10°W to 170°W and latitudes 25°N to 80°N covers a total area of approximately 46 million $km^{2.}$

This region shows wide range of temperature fluctuations. It also shows wide range of fluctuation in the amount of rainfall. It includes polar arctic region. On its Northern side it shows temperate conditions. Eastern Asia shows deciduous forests and in the Northern region 'Steppe' grass lands are present. The region also shows wide fluctuations in physical and climatic features. So, it supports good fauna.

i) Sub Regions of Palaearctic Region

a) **European Sub-region** : Northern and central Europe, Black sea and caucasus rare included in it. It is represented by 85 families of vertebrates. Amphibians and Reptiles are represented with six families each. Myogale, only one genus of mammal is present. Bird like Tits, wagtails, mammals like wolf and moles are common in this sub-region.

b) **Mediterranean Sub-region:** Remaining parts of Europe; Africa and Arabian portions are included in it. 124 families of terrestrial vertebrates are present. Birds like Upupa and Pastor; mammals like elephant scurew, Hyena and porcupine are seen in this sub-region.

c) **Siberian Sub-region:** Northern Asia, Himalayas are included in it. 94 families of vertebrates are included in it. Families of Musk deer and Moles are confined to this sub-region.

d) **Manchurian Sub-region**: Mangolia, Japan, Korea, and Manchuria are included in it. Mammals like, Tibetan Languor, Great Panda, Tufted deer, Chinese water deer are common.

ii) **Fauna of the Palaearctic region**: This region is supported by good fauna. Fishes, Amphibians, Reptiles, Birds and Mammals are represented.

Fishes: Most of the fishes show greater affinity to North America. Paddle fishes in China, Cyprinus, Anabas and Sucker fish (Echenis) are present.

Amphibians: Frogs like Discoglossus, Bufo, Hyla, Rhacophorus, Salamanders like Proteus, Megalobatrachus, and a number of tailed amphibians are seen in palaearctic and Nearctic regions.

Reptiles: Snakes like Natrix, Dasypettis, T,rphlos, lizard like Monitor, tortoise like Testudo are common. True pit vipers, Colubrids are most commonly seen. '

Birds: Birds like Hawks, Cukoos, rails, finches, crows are present which are migratory. Nearly 37 species of birds are present. Parrots are absent.

Mammal: Camel, deer, wolf, horse, pig, hedgehog like mammals are common, Fruit bats, panthera bear are also present. The common mammalian fauna includes Deer, Beavers, Dog, Cat, Squirrels, Rabbits, Mice, Bats and moles.

3.2 Nearctic Region

This cuts across North America, Mexico north of the tropics, and Greenland. It lies along Longitudes 168°W to 15°W and latitudes ~20°N to 85°N with a total area of approximately 21 million km^2. It shows great variations in climatic conditions and temperatures. In the North Greenland, frozen ice is seen. It has range of mountains which extended from North to South. In the South west of North America deserts are present.

Sub- Regions of Nearctic Region

a) **California Sub-region** : A part of North America Nevadaand Cascade ranges and part of British Columbia are included in it Nearly 86 families of vertebrates like Haplodotidae Anielhade Vampires and Free tailed bats are seen in this sub region

b) **Rocky Mountain Sub-region**: It includes mountains of East California with nearly 107 families of terrestrial vertebrates. Goats, Haplocerus, Prairie dogs and Lizards are commonly seen.

c) **Alleghasy Sub-region**: It includes rocky mountain sub- region, Lakes of Eastern parts of U.S.A. Vampire bats, Star nosed moles, Opossums, Turkeys and Carolina parrots are present.

d) **Canadian Sub- region**: It includes remaining parts of North America and Greenland. Bison, Gluttons, Polar bears, arctic fox, Reindeer are commonly seen. ‘

Fauna of the Nearctic region: This includes Fishes, Amphibians, Reptiles, Birds and Mammals.

Fishes: Cat fishes, Garpike, Paddle fishes, and Cyprinidonts are commonly present.

Amphibians: Amphiuma, Salamanders, Bufo, Amblystoma, Hyla, and Rana are seen in this region.

Reptiles: Rich number of Reptiles like, Musk turtle, Trionyx, Emydines, *Alligators ophiosaurs*, and vipers like *Pituophis couophis* and Chilomeniscus are present.

Birds: Nearly 39 families of birds including Pelicans, Heron, Humming birds, Woodpeckers, l9ycatchers, Mocking birds, Larks and Sand- pipers are present.

Mammals: Mammals like Squirrels, Moles, Rabbits, Beavers, Cats, Bats, Deers, Bears, Weasels, Opossum, Porcupine and Armadillo are present. Nearly 24 families are seen in this region.

3.3 Neotropical Region

This includes tropical Mexico, Central America, South America and adjacent islands (Galapagos, Falklands), and the West Indies. It lies along Longitudes 112°W to 35°W; latitudes 20°N to 57°S. Total area of this region is approximately 8.2 million km^2. This region includes S. America, Central America, Mexico and West Indies. This region shows tropical conditions. The southern part of South America shows temperate zones, because of these varied environmental conditions Luxuriant forests, Deserts, Plains and Rivers are common. In the Amazon region thick forests are present. They are all evergreen forests while grassy plains are present in Argentina. This region shows Andes Mountains. Because of these conditions good vegetation is seen and rich fauna is present.

This region is divided into 4 sub-regions: Chillian sub region, Brazilian sub region, Mexicon sub-region and West Indies sub-region.

1) **Chillian Sub-region**: It includes West Coast of South America. It contains Ands mountain ranges Bolivia =, Peru, Argentina. It includes 3 toed Ostrich called Rhea Americana, Clams, Oil birds are common.
2) **Brazilian Sub-region**: It includes tropical forests of South America. It shows evergreen forests. Plains are also seen Rivers are present hence more vegetation is seen. It supports rich fauna. In this region American Monkey, Blood sucking bats (Vampire) Armadillos are common. ‘
3) **Mexican Sub-region**: North of Isthmus of Panama is called Maxton sub-region. This region shows Rocky Mountains. It is showing subtropical conditions. In this region Tapiers, Mudterrapins etc., are common.
4) **West Indies or Antillean Sub-region**: The region contains West Indies, islands. Trinidad and Tobago are not included in this region. These islands contain mountains. In this sub-region the Vertebrate fauna is poor.

Fauna in Neotropical region: In this region many endemic species are present, and 39 families are recognised.

Fishes in Neotropical region: In this region many fresh water fishes are present. The important features of the regions are the absence of Carps. In this region Cat fishes; Trygonids, Edi fishes are present.

In South American region one Dipnoi fish is present Lepidosiren is called South American Fresh water Lung fish.

Amphibians in Neotropical region: In this zone 14 families of Amphibians are present which include *Pipa pipa*, Hyla, Bufo, Rana etc. Caecelians are also represented in this region by Siphanophis, and Rainotrema with Urodeles being very few.

Reptiles in Neotropical regions: The reptiles of the sub-region will resemble those of Ethiopian and Oriental zone. The reptiles in the region include Crocodiles, Alligator, many turtles, and tortoises (which are common in the region), etc. 15 families of lizards are represented out of which 5 families are reported in this region. Examples include Helodermidae (Poison lizard), Andidae, Crcosauridae etc. In this region many snakes are present. Coral snakes, Pit vipers, Typhiops and many other snakes are present.

Birds in Neotropical: Avian fauna of this region is striking and peculiar. Hence South America is called Bird continent. Birds in the region include *Rhea Americana* (3 toed ostrich) - American Ostrich, Tinamus (Flightless bird is Endemic to this region), Ducks, Pigeons, Patrots, Swifts, Wood peckers, King fishers, Starks. Ant thrushers, Tree creepers, Oil birds are endemic to this region only.

Mammals in Neotropical region: 32 families are available. Nearly 10 families are endemic to this region. Examples include Hapalidae, Cebidae etc. families of New World monkeys. Armadillos, sloths, Ant eaters, Didelphis etc., are also seen in this region. Other mammals like Tapiers, Uamas, Deer, Squirrels, Rabbit, and Armadios are common in this region. In this region, Hyenas (*Aye-aye*), Hedge-hog and native horses are absent.

3.4 Afrotropical (Ethiopian) Region

This includes Africa south of the Sahara and Indian Ocean islands Madagascar, Comoro Islands, Seychelles, and Mascarene Islands). Latitudes 20°N to 35°S. Total area is approximately 21 million km^2. This Ethiopian region is divided into four sub regions namely: East African sub region, West African sub region, South African sub region, and Malagasy sub region.

East African Sub-region: This region includes Tropical Africa and tropical Arabia are present, because of high temperature desert conditions are available. Sahara desert is included in the region. In this region desert animals are included. Giraffe, Zebra, Camel, Ostrich etc., are common.

West African Sub- region: This region shows thick forest. River Congo is included in this region. This region shows heavy rainfall. It has rich flora which supports good fauna. Gorilla, Gibbon, Great Apes, Elephants, Panthers, Lions are present while Pittedae family of Birds are common.

South African Sub- region : This Southern part of the African continent is included in this region. It shows peculiar fauna like Secretory birds, African moles, Rats, Bandicoots, and South African lung fish (Protopterus).

Malagasy Sub- region: It includes Madagascar and nearby islands. Darlington separated this Madagascar from Ethiopian region. In this region Chameleons are more popular.

Fauna of Ethiopia Region

Mammals: *Aye aye* (Hyaena), Galeopithicus, *Gorilla gorilla*, Chimpanjee, Gibbon, *Equs equs* (Horse), Elephant, *Panthera tigris* (Tiger), *Panthera leo* (lion), Assionomyx (Leopard), Camelus (Camel), Deer, Sus (Pig), *Equs acinus* (Donkey).

Birds: The most important birds of this region are two toed Ostrich-Struthio camelus. Others include Horn bills, Heron, Pigeons, Parrot, Cuckoos, Storks, Finches etc. In this region some exclusive birds are present. They are: Ostriches, Pittedae, . Hammer headed birds, Mouse birds etc.

Reptiles in Ethiopian region: Crocodiles and Reptiles are very numerous. Examples are: Testudo, Trionyx, Chameleon which is the characteristic of this region and Geck (a flying lizard). In this region many Snakes are present such as: Rattle snakes, Cobras, Vipers, Pythons and Typhiops etc.,(common in this region).

Amphibians: This fauna is distinctive and is represented by Cicaelians, Anura. Rhacophorus, Hyla, Microhyla, Xenopus (Clawed Toad) which is exclusively in this region, Cicaeans (which are abundant). Tailed amphibians are absent.

Fishes in Ethiopian region: Fish fauna is diverse is diverse in this region. Examples include Protopterus (African fresh water lung fish), Sharks, Tuna fishes, Cat fishes, Cyprinids, Electric fishes which are common in this region.

3.5 Indomalayan (Oriental) Region

This is found in Southeast Asia and adjacent islands south of the Himalayas though the Indonesian Archipelago, Philippines, and Borneo to "Wallace's Line" between Bali and Lombok. It has a total area ~9.6 million km^2. This region includes Indian sub-continent Ceylon Burma Philippines. Formosa and Scathe China, form the North of this region Himalayas are present. On the West of it Arabian Sea is present. In the South east corner physical boundary is absent.

This region includes 4 sub regions. This region shows tropical and temperate zones. In the North East Asia rain forest is present towards the west desert is present. The remaining part shows plains and rivers hence this region shows different types of conditions. Hence more vegetation is present and more fauna is seen. The 4 sub regions in this region are Indian sub-region, Ceylon sub-region, Indo-China sub-region, and Indo-Malayan sub-region.

Indian Sub-Region: It includes North India and Central part. It starts from the root of Himalaya and extend up to Malabar Coast. This region shows plains and deserts. It shows temperate and tropical conditions. In this region Antelopes, Peacock, Indian Bison, Black Elephant, Equas and some important snakes are present.

Ceylonian Sub-Region: It includes Ceylon, Small Indian Peninsula. It shows Loris, Elephants, Equas, Rat, bandicoots and snakes.

Indo-China Sub-Region: It includes China south of Palaerctic region. It includes Gibbons, Lemurs, Rhinoceros, Salamanders, Disc tongued frogs are present.

Indo-Malayan Sub- Region: It includes Malayan peninsula and surrounding Islands. This region supports 132 families of fauna Gibbon, Rhinoceros, Badger, Broad bills etc. are very common in this region.

Fauna of Oriental Region: The fauna of Oriental region shows resemblances that of Ethiopian region. The fauna in the oriental region include:

Fishes: Fish fauna of Oriental region resemble that of Ethiopian region. Oriental fish fauna is dominated by Carps and Cat fishes. Notopteridae, Anabantklae, Syngnathus, and Cypsilurusetc.,

Amphibians: Tailed Amphibians are very rare, only one genus is represented *Tylptotriton verrucosus*. Anura and Apoda Amphibians are more. Rana species, Hyla, Rhacophorus, Bufo, Discoblastidae members, lcthyophis, Uraeotyphlus, Gegenophis etc. are some of the amphibians found in the oriental region.

Reptiles: Many reptiles are seen in this region. This fauna is dominated by lizards, snakes, turtles and Crocodiles. The other reptiles found in the region include Gvialis, Gecko (Flying Lizard), Chameleon, Varanus (Indian Monitor Lizard), Python, Typhlops, Testudo, Cobra etc. In this region Xenopeltidae, Uropeltidea forms are exclusive.

Birds: In this region 66 families of birds are included. These include Honey Guides, Wood Pecker, Horn bill, Pea- cock etc.

Mammals:This region includes 30 mammalian families. Shrews, Rabbit, Canis, Cat, Aye-aye (Hyaena), Sues, Equas Rhinoceros, Great apes like Orangutan, Gibbon Gorilla, Chimpanzee Alirus (Himalayan Pander), Camel etc., are the major mammals in the region. In this region tree shrews, flying lemurs, Indian Bisons are exclusive.

3.6 Australian Region

Australian region contains Australia, Newzealand, New Guinea and nearby Islands in the Pacific ocean Walice" includes Celebas islands in Australian region. The realm is sub divided into four sub regions: a) Australian subregion, b) Austromalayan Subregion, c) Polynesian Subregion and d) Newzealand Subregion.

a) **Australian Subregion**: It includes Australia and Tasmania. This region is located towards Southwest of Pacific ocean. In this region very peculiar fauna is seen. It is because this part is separated from the main land by a big stretch of Ocean. It shows tropical and temperate climate. In this subregion 34 genera of marsupials included. Hence it is called "Home of Marsupials**".** Tailed Amphibians are-reported in this region. Flightless birds like Emus are included in this region.

b) **Austromalayan Subregion**: This region includes Malayan Archepelago islands, New Guinea, Solmon Islands etc., Dendrolagus, Dayrus etc., Marsupials are present while Crowned Pigeons, and Fly river Turtles are common.

c) **Polynesian Subregion** : This region includes Polynesian Islands. In this region fauna is poor. Tooth build Pigeons are common.

d) **Newzealand Subregion** : In this subregion Newzealand is included. In this subregion snakes are absent while flightless birds (kiwi) are present Hence these people are called Kiwis. Rats and bats are common and Sphenodon a living fossil is confined to this region only.

Fauna of Australian Region

Mammalian Fauna in Australian region: These include Ornithorhynchus (Duck billed Platypus), Macropus (Kangaroo), Dasous (Tiger Cat), Dendrologous, Pteropus (Flying fox), Paramoles (Marsupial Bandicoot), Echidna(Spiny ant eater), *Rattus rattus* (Rat), *Equs equs* (Horse), and *Equs acinus* (Donkey), Sus (Pig).

Avian Fauna in Australian region: In this region flightless birds are common. Such include Apteryx (Kiwi); present only in Newzealand, Dromaeus (Emu) New Guinea, and Casso wails- present in Australia. The other birds can be seen in this region are Pigeon (Columba livia), Duck, Crane, Crow, *Passer domesticus* (Sparrow), Tooth billed Region.

Reptiles in Australian Region: the major reptiles found in this region include Varanus (Monitor Lizard), Trionyx, *Testudo elegans*, *Caretta caretta*, Chameleon, Calotes versicolor, Mabuya etc. In Newzealand snakes are absent; Sphenodon is seen only in this region.

Amphibians: Tailed Amphibians, Frogs and Apodans are common in Australian region. Rana species, *Hyla arbouria*, *Micro hyla*, Rhachophorus, Alytes etc., Amphibians are common.

Fishes in Australian region: In this region the most important fish is a lung fish. Ceratodous is seen in this region. It is called **"**Australian Lung Fish**".** In this region many other fresh water and marine fishes are present. Examples include Scoliodon, Macarell, Cynoglosus, Catla catla, Anabas, Saccobranchus.

Invertebrates in the Australian Region: "Trigonia" a fresh water bivalved Molluscan is seen.

4.0 CONCLUSION

The different zoogeographical regions have been shown in this unit. Each zoogeographical region has subdivisions (sub regions). Some animals are endemic in certain regions while some are absent in certain regions.

5.0 SUMMARY

In this unit, you have learnt the:

- different zoogeographical regions
- subdivisions in each zoogeographical region
- animals present, endemic and absent in each zoogeographical region.

6.0 TUTOR-MARKED ASSIGNMENT

i. Distinguish between the types of mammals found in the various zoogeographical regions
ii. Give the characteristics features of each zoogeographical region.

7.0 REFERENCE/FURTHER READING

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

UNIT 2 ISLAND BIOGEOGRAPHY

CONTENTS

1.0 INTRODUCTION

Island biogeography is a term used to describe locations that are isolated from other location. Such isolation may be due to difficult access to the locations and hence little interaction with other locations. The concept and the theory of island biogeography will be explained in this unit.

2.0 OBJECTIVE

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

- describe the concept of island biogeography and the theory of its explanation.

3.0 MAIN CONTENT

3.1 Concept of Island Biogeography

Island biogeography is a field within biogeography that attempts to establish and explain the factors that affect the species richness of natural communities. The theory was developed to explain species richness of actual islands. It has since been extended to mountains surrounded by deserts, lakes surrounded by dry land, fragmented forest [Sahney *et al*., 2010] and even natural habitats surrounded by human-altered landscapes. Now it is used in reference to any ecosystem surrounded by unlike ecosystems. The field was started in the 1960s by the ecologists MacArthur and Wilson [1967] who coined the term theory of island biogeography, as this theory attempted to predict the number of species that would exist on a newly created island.

For biogeographical purposes, an "island" is any area of suitable habitat surrounded by an expanse of unsuitable habitat. While this may be a traditional island—a mass of land surrounded by water—the term may also be applied to many untraditional "islands", such as the peaks of mountains, isolated springs in the desert, or expanses of grassland surrounded by highways or housing tracts. Additionally, what is an island for one organism may not be an island for another: some organisms located on mountaintops may also be found in the valleys, while others may be restricted to the peaks.

3.2 Theory of Island Biogeography

The theory of island biogeography proposes that the number of species found on an undisturbed island is determined by immigration and extinction. And further, that the isolated populations may follow different evolutionary routes, as shown by Darwin's observation of finches in the Galapagos Islands. Immigration and emigration are affected by the distance of an island from a source of colonists (distance effect). Usually this source is the mainland, but it can also be other islands. Islands that are more isolated are less likely to receive immigrants than islands that are less isolated.

The rate of extinction once a species manages to colonise an island is affected by island size (area effect or the species-area curve). Larger islands contain larger habitat areas and opportunities for more different varieties of habitat. Larger habitat size reduces the probability of extinction due to chance events. Habitat heterogeneity increases the number of species that will be successful after immigration.

Over time, the countervailing forces of extinction and immigration result in an equilibrium level of species richness.

Modifications

In addition to having an effect on immigration rates, isolation can also affect extinction rates. Populations on islands that are less isolated are less likely to go extinct because individuals from the source population and other islands can immigrate and “rescue” the population from extinction (rescue effect).

In addition to having an effect on extinction, island size can also affect immigration rates. Species may actively target larger islands for their greater number of resources and available niches; or, larger islands may accumulate more species by chance just because they are larger (target effect).

3.3 Influencing Factors on Island Biogeography

These include:

- Degree of isolation (distance to nearest neighbour, and mainland)
- Length of isolation (time)
- Size of island (larger area usually facilitates greater diversity)
- The habitat suitability which includes:
- Climate (tropical versus arctic, humid versus arid, etc.)
- Initial plant and animal composition if previously attached to a larger land mass (e.g. marsupials, primates)
- The current species composition
- Location relative to ocean currents (influences nutrient, fish, bird, and seed flow patterns)
- Serendipity (the impacts of chance arrivals)
- Human activity.

4.0 CONCLUSION

Island biogeography explains the richness of species in natural communities. The concept has been explained by several theories which have been modified over the period. The species richness is affected by certain factors like human interference, climate, current species composition amongst others.

5.0 SUMMARY

In this unit, you have learnt the:

- factor that influences species richness in a natural community
- theories that explain island biogeography.

6.0 TUTOR-MARKED ASSIGNMENT

With reference to a named location, state the factors that make such location described biogeographically as an island.

7.0 REFERENCES/FURTHER READING

MacArthur, R. H. & Wilson, E. O. (1967). The theory of island biogeography. http://books.google.com/books?

Albert, J. S. & Reis, R. E. (2011). *Historical Biogeography of Neotropical Freshwater Fishes.* University of California Press, Berkeley. 424 pp.

UNIT 3 RELATIONSHIP BETWEEN VEGETATION AND CLIMATE

CONTENTS

1.0 INTRODUCTION

The growth and the nature of plants in an area depend largely on the climatic situation of a given area. The relationship between climate and vegetation is examined in this unit.

2.0 OBJECTIVES

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

- explain how climate affects vegetation
- evaluate how vegetation affects climate
- describe with particular reference to Nigeria, the interaction between climate and vegetation.

3.0 MAIN CONTENT

3.1 Relationship between Climate and Vegetation

Generally, the climate of a place or a region influences the type of vegetation to be found in such region. Moisture content, availability of nutrient in the soil depends on the climatic conditions of an area. These in turn determine the type of vegetation that can be found in a given place .Köppen's climate classification system was among the firsts attempts to establish quantitative relationships between climate and vegetation on a global scale. Holdridge used three climatic variables (predictors) - annual precipitation, bio-temperature (temperature above 0°C), and ratio of mean annual potential evapotranspiration to mean total annual precipitation - to separate 38 climatic “life zones” from each other.

On a global average, of 100 units of energy entering the global climate system, 46 are absorbed by the surface and 31 are exchanged in the form of sensible and latent heat. Vegetation influences the absorption of energy by the surface via modification of the surface albedo as well as via alteration of energy partitioning between sensible and latent heat. Additionally, vegetation modifies the surface roughness length. These processes are accounted for by soil-vegetation-atmosphere transfer schemes (SVAT) which serve as land surface modules within atmospheric general circulation models (GCMs).

In regions with strong zonal atmospheric circulation, like the northern middle latitudes, the effect of local vegetation changes on the regional climate may be smaller than the effects due to such changes in remote regions. At the same time, changes in vegetation cover affect not only the region with altered vegetation, but also neighbouring regions. The local effect is most pronounced for temperature, as vegetation changes directly affect the local radiative budget.

Changes in vegetation also alter the evaporation. However, changes in air moisture content may result in quite remote effects due to the long-distance transport of moisture. For example, in Europe there is a general reduction in precipitation towards the continent's interior as the transport of moisture from the Atlantic Ocean declines with distance to the ocean. A substantial fraction of precipitation re-evaporates via plant transpiration. The significance of water recycling on a way of moisture transport increases for continental regions. Thus, changes in regional climate depend on both remote and local changes in vegetation.

3.2 Climate-vegetation Interaction in Sahara/Sahel Region

The dependence of vegetation on climate in subtropical deserts and semideserts can in a first approximation be expressed in terms of precipitation because the vegetation productivity is strictly limited by low water availability. Vegetation does not completely cover the land surface. The drier the climate is, the scarcer is the vegetation and the greater is the fraction of bare soil. The physical characteristics of bare soil (albedo, roughness, and water conductivity) differ from those of vegetation cover. That, in turn, creates a basis for the influence of vegetation on climate.

Low precipitation results in little vegetation cover, and the surface albedo is determined by bare ground with a high albedo. This positive feedback supports a desert that is self-sustaining. On the other hand, if there is more precipitation, there is more vegetation; this is darker than sand so the albedo is lower, the surface temperature is higher, and the gradient in temperature between land and ocean increases, amplifying

monsoon circulation and upward motion over the desert. As a result, the summer rainfall in the region increases. Another positive vegetation-precipitation feedback active in the region is based on an ability of vascular plants to transpire water from the soil, enhancing evapotranspiration in comparison with bare ground.

3.4 Nigerian Vegetation: Case Study of Relationship between Vegetation and Climate

Nigeria has a tropical climate with sharp regional variances depending on rainfall. Nigerian seasons are governed by the movement of the intertropical discontinuity, a zone where warm, moist air from the Atlantic converge with hot, dry, and often dust-laden air from the Sahara known locally as the harmattan. During the summer, the zone of intertropical discontinuity follows the sun northward. As a result, more and more of the country comes under the influence of moisture-laden tropical maritime air. As summer wanes, the zone shifts southward, bringing an end to the rainy season. Temperatures are high throughout the year, averaging from 25° to 28°C (77° to 82°F). In the higher elevations of the Jos Plateau, temperatures average 22°C (72°F). Northern Nigeria typically experiences greater temperature extremes than the south.

Rainfall varies widely over short distances and from year to year. Parts of the coast along the Niger Delta, where the rainy season is year-round, receive more than 4,000 mm (160 in) of rain each year. Most of the country's middle belt, where the rainy season starts in April or May and runs through September or October, receives from 1,000 to 1,500 mm (40 to 60 in). Within this region, the Jos Plateau receives somewhat more rain, due to its higher elevation. In the dry savanna regions, rainfall is especially variable over distance and time. The region along Nigeria's northeastern border receives less than 500 mm (20 in) of rain per year, and the rainy season lasts barely three months.

Climate (particularly rainfall) has an important influence on the distribution of vegetation in Nigeria. There are ten main vegetation zones: the Sahel, Sudan and Northern Guinea zones. Jos Plateau, Montane forest and grassland, Rain forest, Oil palm bush, Southern Guinea zone, Swamp and Mangrove forest. These major zones have different vegetation types which can be further subdivided into coastal forest and mangrove, deltaic swamp forest, swamp forest and wooded savanna, secondary forest, mixed leguminous wooded savanna. *Isoberlinia* savanna, *Afzelia* savanna and semi-deciduous forest, plateau grass savanna, mixed Combretaceous woodland, wooded savanna, mixed wooded savanna, floodplain complex, *Sorghum* grass savanna,

Burkeo Africana savanna, wooded tropical steppe and moist lowland forest.

Vegetation also varies dramatically at both the national and local level in relation to climate, soil, elevation, and human impact on the environment. In the low-lying coastal region, mangroves line the brackish lagoons and creeks, while swamp forest grows where the water is fresh. Farther inland, this vegetation gives way to tropical forest, with its many species of tropical hardwoods, including mahogany, iroko, and obeche. However, only in a few reserves-protected from the chainsaw and the farmer-is the forest's full botanic diversity intact. Elsewhere, forest is largely secondary growth, primarily of species like the oil palm that are preserved for their economic value.

Immediately north of the forest is the first wave of savanna: the Guinea, or moist, savanna, a region of tall grasses and trees. The southern margins of the Guinea savanna-which has been so altered by humans that it is also called the derived savanna-were created by repeated burning of forest until only open forest and grassland were left. The burnings decimated important fire-sensitive plant species and contributed to erosion by removing ground cover. Tropical forest is giving way to the Guinea savanna at such a rate that the only forests expected to survive the next generation are in reserves. Beyond the Guinea savanna lies the drier Sudan savanna, a region of shorter grasses and more scattered, drought-resistant trees such as the baobab, tamarind, and acacia. In Nigeria's very dry northeastern corner, the semidesert Sahel savanna persists. Throughout these drier savannas, drought and overgrazing have led to desertification-the degradation of vegetation and soil resources.

4.0 CONCLUSION

The interaction between vegetation and climate has been explained in this unit. The climate of an area generally influences the type of vegetation to be found in such area and the type of plants and the activities influence the climatic conditions to found in an area. Nigerian vegetative distribution shows a clear example of the interaction between climate and vegetation.

5.0 SUMMARY

In this unit, you have learnt that:

- climate and vegetation influence each other
- the climatic factors like temperature and temperature affect the growth of plant and the type of vegetation to be found in an area

while vegetation affects climatic factor like humidity

- the vegetation distribution in Nigeria is a typical example of how climate affects vegetation.

6.0 TUTOR-MARKED ASSIGNMENT

i. Explain how rain fall and temperature affect vegetation of an area.

ii. Describe the vegetative zone of Nigerian linking such to the level of rainfall.

7.0 REFERENCE/FURTHER READING

Woodward, F. I., *Climate and plant distribution* (Cambridge University Press, 1987). 174 pp.

UNIT 4 RELATIONSHIP BETWEEN SOIL TYPE AND VEGETATION

CONTENTS

1.0 INTRODUCTION

This unit introduces you to the close relationship between soil type and vegetation.

2.0 OBJECTIVE

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

- describe the relationship between soil type and vegetation.

3.0 MAIN CONTENT

3.1 Influence of Vegetation on Soil Type

A close relationship between soil type and vegetation tends to develop as soils begin to form. Vegetation plays an important part in the formation of soils from solid rock. The acids released by the roots of some plants act to breakdown the rock on which the soil is forming. The vegetation on a soil is particularly important in supplying the soil with precious organic matter. There is often a close relationship between the vegetation and the soil, the vegetation supplying its dying remains to the soil and the soil converting them into nutrients so the vegetation can continue to survive and develop in years ahead. Different types of vegetation give rise to different forms of organic matter in soils. The different soil processes and the potential plant influence on them are shown below.

S/N	Soil process	Defining soil characteristic	Potential plant influence on process
1	Sorption	Temperature (*T*)	Low, shading
		Kd of adsorption, pH	High, root exudates
		Solution ionic strength (μ)	None to low
2	Desorption/dissolution	*T*	Low, shading
		Kd of desorption, pH	High, root exudates
		μ	None to low
3	Mineralisation/ immobilisation	Volumetric water content (*q)*	High, transpiration
		T	High, shading
		Organic matter quality	High
		Enzyme concentration	High, phosphatase exudation
4	Mass flow	Hydraulic conductivity,*q*	High, transpiration effect on *q*
		Bulk density (*r)*	Low to medium, root action
		Pore-size distribution	Low to medium, root action
		Solution concentration (*Cl)*	Low to medium, root exudates
5	Diffusion	Impedance	High, transpiration effect on *q*, root action on soil structure
		Kd	Low to medium, root exudates
		Q	High, transpiration
		r, pore-size distribution	Low to medium, root action
		Cl	Low to medium, root exudates

Growth of plants and activities of plants also depend on the nature of soils. Soil types with high sandy particles have low water retention capacity with high porosity. With the high porosity, such soils have little retention of nutrients hence support little vegetation. In the case soils with high level of fine particles, water retention is very high and the

pore spaces are easily filled with water. This reduces gaseous exchange between the atmosphere and the soil making the soil to be more or less in aerobic in nature. Such soils support few plants as organic matter accumulation is usually poor. In soil types with high clay particles, positively charged minerals are usually retained by the particles. Plants usually exchange hydrogen ions for such nutrients. However, since the clay particles do not usually retain negatively charged ions like nitrates, soil types with high clay contents have low nitrogen contents and do not support plants with high nitrogen demands. Loam soil types sufficiently retain water and nutrients while still allowing for enough drainage to provide air spaces in the soil. Such soil type allows for growth of plants.

The humus content of soils also affects the growth of plants. Humus has the capacity to absorb and swell with water and shrink as water is gradually released from it. These alternating swelling and shrinking aerate the soil. Also as decomposers work on the humus, nutrients are released to the soil which is taken up by plants. Generally, soil types with10-20% are favourable to plant growth while soil types with less than 10% or more than 90% humus are not good for plant growth.

4.0 CONCLUSION

The different ways that soil type affects vegetation and vice versa have been highlighted in this unit. While the nature and actives of plants affect soil processes, the type of soil influences and determines the type of vegetation found in an area.

5.0 SUMMARY

In this unit, you have learnt how the nature and type of soil influence the type of vegetation in an area and how soil processes are affected by vegetation.

6.0 TUTOR-MARKED ASSIGNMENT

i. Explain how plants affect soil formation processes.
ii. How do soil particle sizes affect the water and nutrient availability to plant.

7.0 REFERENCE/FURTHER READING

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