UNIT 6 GLOBAL DISTRIBUTION OF BIODIVERSITY

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6.1 INTRODUCTION

The part of the earth where organisms (animals, plants, micro-organisms) live is called the biosphere. Distribution of species within biosphere is set by limiting barriers such as large water bodies, land areas and mountains, as well as unfavourable climate regime (light, rainfall, soil conditions). As a consequence of a combination of various physical, climatic and other barriers, plant and animal communities form different biomes. Thus a biome could be referred to as large ecosystem existing on a macro-scale. Ecologists call these large, distinct, easily differentiated formations or communities having distinct flora and fauna as biomes. Biomes are generally recognised by and named after the dominant plant species or community.

In this Unit we will describe the terrestrial biomes as well as the large aquatic biomes. Seldom the boundaries between two adjacent or neighbouring biomes are discrete or distinct instead they blend with the neighbouring biomes through a transition zone known as ‘ecotone’. This transition zone between two biomes generally has high species diversity and density as compared to any of the neighbouring biomes. In the present Unit we describe the major biomes of the world and also of the Indian region. We describe briefly the physical conditions and biodiversity of specific biomes. In the
Natural Resources: Biotic present unit you will study about biodiversity hot spots and reasons for variation in biodiversity occurrence across the globe. You will also study about the criteria for identifying biodiversity hot spots.

Objectives

After studying this unit, you should be able to:

- explain the concept of biomes;
- describe the major terrestrial and aquatic biomes of the world and of India;
- explain the relationship between climate of biomes;
- enumerate and analyse the wild life species that occur in the different biogeographic zones of India; and
- list global biodiversity hot spots and reasons for varied biodiversity in different ecosystem/countries and discuss the criteria for identifying global biodiversity hot spots.

6.2 TERRESTRIAL BIOMES OF THE WORLD

Figure 6.1 shows the major terrestrial biomes of the world. As we have said earlier the primary factors that influence the formation of these biomes are climatic, like precipitation, temperature, seasonal extremes and winds. However, topography and light are also important factors. Of all these, precipitation is the chief limiting factor that determines whether a biome would be a forest or a desert or a grassland. **If the average annual precipitation in the region is less than 25 cm the place would be a desert containing little vegetation.** This would be true regardless of average temperature, light and quality of soil. **If a region has moderate average precipitation, around 25-75 cm a year, grasslands would be formed. A region would be a forest if the average annual precipitation is more than 75 cm.** The combination of average temperature and average precipitation, however, decides the type of desert, forest or grassland present in a region.

**Box 6.1: Forests and their importance**

The word forest is derived from the Latin word ‘foris’ meaning outside, the reference being to village boundary fence and must have included all uncultivated and uninhabited land. Today a forest is any land managed for the diverse purpose of forestry whether covered with trees, shrubs, climbers etc. or not. The forest biomes include a complex assemblage of different kinds of biotic communities. Optimum conditions of temperature and ground moisture responsible for the growth of trees contribute greatly to the establishment of forest communities. The nature of soil, climate and local topography determine the distribution of trees and their abundance or sparseness in the forest vegetation. Forests may be evergreen or deciduous. They are distinguished on the basis of leaf into broad-leafed or needle-leafed coniferous forests in the case of temperate areas.

India is losing forests at an extremely rapid rate. The data released in mid 1984 by the National Remote Sensing Agency (NRSA) shows that India lost 1.3 million hectares of forests every year in the approximately seven year period between 1972-75 to 1980-82.

The NRSA study classifies the forest cover into three categories closed forests, open or degraded forests and mangrove forests.

For man, forests have been a source of recreation and the development of his culture and civilisation. Apart from the source of fuelwood, they are raw materials to various wood industries like pulp and paper, composite wood, rayon and other man-made fibres, matches, furniture, shuttles and sport goods. Indian forests also provide many other minor products such as essential oils, medicinal plants, resins and turpentines, lac and shellac, kattha and catechu, bidi wrappers, tasser silk, etc.
India and other tropical countries have particularly abundant timber and heartwood resources. Timber accounts for 25% of all photosynthetic materials produced on the earth and about half of the total biomass produced by a forest. Forests have great biological importance as reservoirs of genetic diversity apart from playing an important role in regulating earth’s climate.

Forests provide habitat, and food as well as protection to wildlife species against extremes of climate and help in balancing carbon dioxide and oxygen of the atmosphere. Forests enhance local precipitation and improve water holding capacity of soil, regulate water cycle, maintain soil fertility by returning the nutrients to the soil through litter. Forests check soil-erosion, landslides and reduce intensity of flood and droughts. Forests, being home of wildlife are important assets of aesthetic, touristic and cultural value to the society.

Fig.6.1: The terrestrial biomes of the world can be identified according to the climax vegetation. Note that the taiga and tundra are roughly like a belt around the globe, other biomes have a less continuous distribution

Now let us suppose you had the time and the resources to travel around the world and you plan to start your journey from the north pole towards the equator, let us see in a general way the biomes that you would encounter. You could start your journey of the biomes of the world from the blocks of ice floating on the sea about the north pole. This is a cold barren place. As you travel southwards you would reach arctic tundra where the sea meets the land which represents the northern most biome. As you travel further south towards the equator, the biomes you would pass through would be taiga (coniferous forests), temperate deciduous forests, deserts, grasslands and finally the tropical regions of the planet.

Let us study briefly the main characteristic of each major world biome. Starting with the tundra, which is the least complex of all biomes.

### 6.2.1 Tundra

The northern most biome on our planet is the arctic tundra. It is a treeless wet circumpolar band between the polar ice caps and the forests to the south. The
predominant plants are lichens, grasses, sedges and dwarf woody plants. Despite the lack of trees, animals are found on land, in air and nearby oceans. Similar communities are found at high mountains of all latitudes forming the alpine tundra. The climate is very cold with a short growing season. The soil is frozen for most part of the year and only the top 0.5 meter melts during the short summers in the arctic tundra (Fig. 6.2). The permanently frozen soil below is known as permafrost. In summer you might see huge herds of caribou, flocks of waterfowls and huge swarms of mosquitoes! With such a harsh climate it is not surprising that only a few kinds of plant and animal species are found here though, in the short growing season moss, lichens, some grasses and fast growing plants dominate the landscapes. Swarms of migratory birds invade the tundra in summer to raise their young and fly south as the summers come to an end. Some of the common permanent residents are musk ox, polar bear, grizzly bear, wolves, snowy owl, arctic hare, weasels, minks, etc. **Tundra is a very fragile ecosystem as the rate of organic matter decomposition is very slow.** On account of harsh climate plants grow very slowly and the tundra takes a long time to recover from any disruptions.

**Fig. 6.2: Arctic Tundra**

### 6.2.2 Coniferous Forests and Taiga

As you travel south from the tundra you will enter the circumpolar belt of coniferous forests which stretches across North America to Eurasia, this region is called taiga, a world derived from Russian word meaning ‘primeval forest’. **The taiga is a land of lakes, bogs and marshes.** The climate is cold with long winters and short summers. The dominant trees are conifers like spruce, pines and firs (Fig. 6.3) with needle like leaves, that can survive extremely cold winters. Typical animals found in this region include moose, wolves, lynx, bears, gray jays. Many of these rely on their stored body fat for survival during the cold months.

**Fig. 6.3: Taiga in summer**
6.2.3 Temperate Deciduous Forests

Going south of taiga you would reach the temperate regions of the planet (see Fig. 6.1). These regions experience moderate temperatures on average that change during four distinct seasons. They have long summers, not too severe winters and abundant precipitation spread over the whole year. These regions are dominated by broad leaved deciduous trees such as oak, hickory, maple, poplar, beech, sycamore, etc., that can survive the winter by dropping their leaves and going into a dormant state (Fig. 6.4). Temperate regions are the most productive areas of the world with the best agricultural lands. You would recall that the tundra soils are poor because of extremely slow rate of decomposition of matter but in the temperate regions the decomposition rate is controlled.

Fig.6.4: Temperate deciduous forests

6.2.4 Temperate Shrublands

These are areas where woody shrubs predominate rather then trees. In regions with a Mediterranean type of climate i.e., hot dry summers and cool wet winters, shrubs grow close together having typically leathery leaves. Remarkably similar shrublands are found in the coastal mountains of California in USA and in Chile; at the tip of Africa and south western Australia. However, in USA such communities are called chaparral (Fig. 6.5). Fires are of common occurrence and plants and animals have developed adaptations to these special habitat features.

Fig.6.5: Chaparral biome
6.2.5 Grasslands

In the northern hemisphere grasslands are found over large areas in huge plains. Such grasslands are known as prairie in North America, steppes in Asia and pampas in South America (Fig. 6.6). In Australia grasslands cover an area almost equal to the area of the desert in the country.

Fig.6.6: A grassland

Grasslands often fade away into deserts. Annual rainfall in areas dominated by grasslands is between 25-100 cm depending on temperature and seasonal distribution – (grasslands occur where rainfall is less to support forest and more than desert). Another factor that prevents penetration of forests into grasslands is the frequent occurrence of natural fires. Grasslands provide natural pastures for grazing animals. The soils under grasslands are rich and fertile. Most of our present day food plants (cereals) have evolved from wild grasses by the process of natural selection and it is one of the most important genetic stock for plant breeding research to develop new food species. Grasslands can be divided into three categories depending on the basis of relative height of grasses – tall grasses (1.5-2 m), mid grasses (30-60 cm), short grasses (3-16 cm). Grassland biomes generally support large number of herbivores, whereas carnivores are very few (coyotes, weasels, badgers, foxes, owls and rattlesnakes).

6.2.6 Deserts

In your tour across the temperate zone, you would find some regions lying between mountains and grasslands that are too dry and hostile to life. These are the deserts (Fig.6.7). If you continue to travel southwards as you approach 20° to 30° north and south latitudes you will encounter deserts. Deserts bring up the image of inhospitable places but actually they are quite varied. The world’s largest desert is the Sahara followed by the Great Australian desert. These have the driest environment with less than 30 cm rainfall (sometimes higher but, unevenly distributed). In deserts day temperatures are high, rainfall and humidity is low, but there are cool northern deserts too where winter snows are common e.g. Tibet and Bolinia. However, all deserts exhibit dramatic day and nigh temperature variation. The soil is sandy or salty.

Box 6.2: Cold Deserts

Cold deserts cover a vast area north of the Himalayan ranges forming an ecosystem with exceptionally low temperatures which may reach – 75°C and a mean annual rainfall of 500-800 mm. They occur in a plateau at 4,500 to 6,000 m and fall within the Trans-Himalayan Biogeographic Zone identified by Rodgers and Panwar (1988) which extends into the Tibetan plateau.
These cold deserts of the Indian sub-continent harbour a distinctive insect diversity, the most diverse wild sheep and goat community in the world, the Tibetan wild ass or kiang, the now rare snow leopard and the wolf are among many other species adapted to this exacting environment.

**Source:** Draft National Biodiversity Action Plan and Strategy of India.

The driest deserts are the Sahara where the rainfall is less than 2 cm per year. They support little life but the less extreme deserts have highly specialised life forms.

Three plant life forms are most adapted to the desert environment.

i) **Annuals** that avoid drought and grow when there is adequate moisture.

ii) **Succulents** – (e.g. cactus), that have adaptation for water storage and avoid water loss.

iii) **Hardy desert shrubs** – having short stem, number of branches and thick leaves.

The animals of deserts are primarily arthropods, reptiles, birds and mammals. Large animals are uncommon. Small rodents are the most common mammals, along with small foxes. Among the herbivores, insects are dominant. A number of insectivorous lizards are very common. However, most animals restrict their activity to early morning or after sunset.

Desert soils are rich in nutrients but water is a serious limiting factor. If water is supplied or made available to desert biomes, they can attain very good production because sunlight is abundant.

**Fig.6.7: A desert**

### 6.2.7 Tropical Savannas

Leaving the deserts as you approach the tropical regions of the earth you will enter the savanna biome, which is a combination of grassland with scattered or clumped trees. These special kinds of grasslands often border tropical rain forests. The climate is warm having 100-150 cm annual rainfall, with prolonged dry season in which fires are common. The rains are erratic.

These grasslands have scattered trees, that do not form canopy in any part of savanna (Fig. 6.8). Trees are up to 20 m height, with thick, deciduous or evergreen leaves. Grasses may attain height of 1-1.5 m and support a great variety of grazing animals.

The largest savanna is found in the African continent. They also occur in Australia and South America and cover nearly 8 percent of the earth’s land. The most prominent animals of this biome are large grazing animals such as giraffes, antelopes, elephants, buffalo and predators such as lions and cheetahs.
6.2.8 Tropical Deciduous Forests

Before reaching your final destination the equatorial regions, you would encounter the tropical deciduous or seasonal forests. These are also known as monsoon forests found in South East Asia, in Central and South America, Northern Australia, Western Africa and the Pacific. (Fig. 6.9)

Rainfall is high, sometimes higher than tropical rain forests but seasonal. There are pronounced wet and dry periods, and so are winter and summer seasons. The soils are brown in colour and rich in nutrients.

Vertical stratification in the vegetation is somewhat simple with a single understorey tree layer. The trees lose leaves in one season but ground vegetation remains evergreen. ‘Teak’ and ‘sal’ forests are good examples of this type of biome. Trees are of 20-30 m height, sometimes reaching a height over 40 m in this biome. Bamboo is also one of the climax shrubs in these areas.

6.2.9 Tropical Rain Forests

As you approach the equator the climate becomes increasingly hot and seasonal variation in climate decreases resulting in practically the same climate throughout the year. This tropical region abounds with life and thousands of species of plants and animals can be seen, though no species predominates. Tropical rain forests cover about 7 percent of the earth’s surface but house approximately 40 percent of the plant and animal species. Tropical rain forests are found on both sides of the equator in South East Asia, Africa, South and Central America, North East Australia.
Both temperature and humidity are very high and constant. Rainfall exceeds 200 cm a year and is distributed over the year. Soil is nutrient poor because in spite of the high rate of decomposition the nutrients do not remain in the soil. They are absorbed rapidly by plants or the rains wash them away thus making the soil virtually useless for agriculture. There is a distinct stratification of vegetation in rain forests. The dominant plants in these forests are tall, 25-30 meters high with slender trunks that branch only near the tops forming a dense canopy of leathery evergreen leaves. The canopy blocks out most of the light, therefore, the forest floor is fairly open. Whatever the time of the year, some trees are flowering and some bear fruit. Epiphytes and liana are very common (Fig. 6.10).

Wherever there is a gap in the canopy, a thick many layered ground vegetation consisting of bushes, herbs, shrubs, ferns, mosses etc., can be seen. An incredible number of animal species thrive in this biome, many of which have become adapted to life in the specific layers of the canopies and subcanopies. Amongst animal species insects and birds are particularly abundant. On a very small island of six square mile, Barro Colorado, of Panama, there are 20,000 species of insects! There are large varieties of coloured birds such as hornbills, parrots and toucans as well as monkeys and predatory cats that inhabit this most interesting biome.

Fig.6.10: Tropical rain forest

Now after studying about biomes, you can understand the altitudinal variation of the biomes. If you look at Fig. 9.11 you would realise that terrestrial biomes tend to be arranged according to particular latitudes in the northern hemisphere. Interestingly at any given geographical location you would find that the climate and vegetation change as the altitude changes. Therefore, we find that at the foot of a mountain there would be complex vegetation and as we go up the slopes of the mountain we find the vegetation becomes sparse till we reach the moss and lichen dominated tundra like regions at the top of the mountain (Fig. 6.11).

Fig.6.11: The altitudinal variation often mimics the latitudinal variation
SAQ 1
Define a biome and ecotone.

SAQ 2
Name the major types of biomes. How do the organisms (flora and fauna) differ in these biomes?

6.3 THE AQUATIC BIOMES

If you look up a world atlas you would notice that most of the earth’s surface is covered by the waters of the oceans (about 71%). Beneath the water surface is a fascinating world of a wide variety of habitats and living communities comparable in diversity to the terrestrial biomes but different enough from them to seem to belong to a different world altogether. The main factors affecting the type and numbers of organisms found in aquatic ecosystems are water salinity and depth to which sunlight penetrates, amount of dissolved oxygen and temperature of water.

Salinity levels are used to distinguish the waters on the earth into two categories, freshwater, and marine. We shall first consider the freshwater biomes.

6.3.1 Freshwater Biomes

Low levels of dissolved salts characterise the freshwater biomes. The salt content of fresh water is about 0.005 percent. The freshwater biomes consist of inland bodies of standing water like lakes, reservoirs, ponds and wetlands as well as the flowing waters of the streams and rivers. Their nature does not depend as much on global climate, but on the individual site where they occur.

A lake or a body of standing water can be divided into three zones according to penetration of sunlight in the water body i.e., littoral, limnetic and profundal. Each of these have their own physico-chemical features and characteristic array of living organisms (Fig. 6.12).

The littoral zone is the area where light penetrates to the bottom. Aquatic life in the littoral zone consists of free floating and rooted plants, many aquatic insects, snails, amphibians, fish, turtles and water birds.

The open water zone is called the limnetic zone. This represents the zone or depth of the water upto which sunlight can penetrate. Phytoplankton along with algal forms, various zooplankton species and fish abound in this zone. The deep water zone lying below the limnetic zone is called profundal zone. It is relatively cool and dark, having low dissolved oxygen content and is inhabited by fish which can tolerate such stressful conditions. The bottom of the lake is inhabited by bacteria, fungi, blood worms and other decomposers which live on dead plants, organic matter including remains of animals and their metabolic wastes.
Precipitation that does not evaporate or penetrate the soil remains on the soil surface resulting in run off which flows down from the mountains in the form of streams and rivers which ultimately discharge into the sea. The downward flow of the river comprises of three phases.

The first phase, when the stream with cold clear water rushes down steep slopes having high dissolved oxygen content. Most organisms which are adapted to cold temperatures and need high amounts of dissolved oxygen are found here. In the second phase the stream flows over gentle slopes and through wider valleys. Here the temperature of water is warmer and supports a wide variety of cold water and warm water fish that require slightly lower dissolved oxygen. At the point where river discharges into sea, the river may divide into many channels, forming the delta.

Rivers and brookes which are flowing fresh water bodies differ from lakes and ponds in three major aspects:

1. current is the major controlling and limiting factor,
2. land-water interchange is greater because of the smaller size and depth of moving water systems, and
3. oxygen is always abundant except in case of excessive pollution in river stretches.

Plants and animals living in streams and rivers are usually attached to surfaces. The free swimming animals are exceptionally strong swimmers.

The freshwater and its flora and fauna are utilised as a major communities for recreational purposes and for waste disposal as well as waterways for transport. In this manner we exert a significant impact on freshwater ecosystems.

### 6.3.2 Marine Biomes

The marine biomes consist of the earth’s oceans and its associated areas like the shorelines, islands, reefs and estuaries. The marine waters contain about 3.5 percent
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Salt, mostly sodium chloride and the organisms inhabiting these waters are profoundly adapted to these salty conditions. As landlivers we generally think of the earth as being mostly land and tend to forget that 71% of the surface of our planet is covered by oceans. In fact, often our planet is referred to as the ‘water planet’.

Oceans

The oceans play a major role in determining the climate and sustaining life on earth. Oceans help to redistribute the solar energy, through ocean currents and evaporation; they are huge reservoirs of carbon dioxide, oxygen and other minerals and help to regulate the ambient temperature and also help in maintaining atmospheric composition and serve as sources of various natural resources.

The world’s seas and oceans are all interconnected forming a World Ocean. The average depth of the ocean is 3.7 km. In some parts of the world the ocean is 11.5 km deep. Compare this with the height of Mount Everest that is 8848 m above sea level.

Fig. 6.13 shows a diagrammatic representation of the vertical and horizontal zonation in the marine environment.

Most marine life is found in the shallower regions of the ocean and seas along the continental shelves, coral reefs and oceanic islands. Life at greater depths is limited by darkness, cold temperatures and pressure. Animal life at great depths comprises mainly of scavengers and predators that feed on the detritus and dead organic matter. The food that supports the large and diverse communities of the ocean is produced in the open water by phytoplankton in upper regions of the ocean where sunlight can reach. The average depth of the lighted zone of the sea is 200 meters in clean areas.

The marine habitat faces destruction due to pollution and resource use. Shorelines and open waters are subject to human activities such as fishing, recreational use, real estate development, garbage and effluent disposal, oil spills, radioactive waste disposal and exploitation of marine natural resources.

Fig.6.13: Zonation in the ocean
Global Distribution of Biodiversity

Shorelines, Oceanic Islands and Reefs

Ocean shorelines include rocky coasts and sandy beaches that are particularly rich in diverse life forms. Rocky shorelines support a diversity of organisms that grow attached to some solid substratum. Sandy shorelines provide home to organisms that can live in burrows in sandy substratum.

Oceanic islands are interesting and somewhat specialised biomes. Islands which have broken away from the main continents have similarity of flora and fauna related to the continental source, volcanic and coral islands show results of chance colonization.

Coral reefs form in clear warm tropical seas and are particularly well developed in the South Pacific. They are formed by accumulation in calcareous skeletons of tiny colonial animals called corals over generations. Coral reefs usually form along the shallow submerged shelves and they are limited to a depth up to which sunlight can diffuse. Coral reef communities in terms of species diversity, number of organisms, brilliance of colours and interesting life forms are comparable with tropical forest communities.

Wetlands and Estuaries

Wetlands and estuaries are transitional biomes. Land that remains flooded either part of the year or permanently with fresh or salt water is known as wetland. The internationally accepted definition of wetlands is: Areas of fen, peatland or water whether natural or artificial, permanent or temporary, static or flowing, fresh, brackish or marine water, the depth of which does not exceed six metres. Bogs, swamps, marshes are covered by freshwater and found inland. These are known as island wetlands, those found on the coast and covered by seawater are known as coastal wetlands. Wetlands provide a variety of fish and wildlife and are major breeding, nesting and migration staging areas for water birds and shorebirds. Importance of wetlands cannot be underestimated as they act as traps and filters for water that move through them reducing flooding. As a result, sediments are deposited and chemical interactions in wetlands neutralize and detoxify substances in water and slow seeping of water into the ground helps to replenish underground water reserves.

Estuaries are enclosed or semi closed bodies of water formed where a river meets the sea forming an area of mixed fresh and sea water. Estuaries usually contain rich sediment forming mud flats. Estuaries are very productive areas with high species diversity. They are important nurseries for ocean fish including all economically important fish and molluscs. The estuaries extend inland to form the coastal wetlands. In temperate areas, coastal wetlands usually consist of mix of bays, lagoons and salt marshes, while in tropical areas we find mangrove swamps dominated by mangrove trees, the mangrove forests consist of evergreen, broad – leaf trees growing in brackish water in tropical areas.

SAQ 3

Name the areas of the marine biome and list their characteristics.

SAQ 4

Name two freshwater biomes. How do the organisms in them differ?

6.4 BIOGEOGRAPHIC REGIONS

Biogeographic regions are large areas that contain characteristic assemblages of animals and plants, delineated on account of natural barriers such as oceans, mountains and deserts. A biogeographic region is generally characterised by high levels of species endemism (i.e. species which are restricted to a specific region only).

**Box 6.3: Biogeographic realms**

Wallace in 1876 proposed six biogeographic regions based on distribution of animals: **Nearctic, Neotropical, Palearctic, Ethiopian, Oriental and Australian** (Fig. 6.14). Later Udvardy (1975) recognised eight biogeographic realms Nearctic, Palaearctic, Africo-tropical (formerly Ethiopian), Indo-Malayan (formerly Oriental), Oceanian, Australian, Antarctic, and Neotropical. South Asia represents several of these regions. For example the Indian subcontinent and Pakistan fall within the influence of the Palaearctic, Africo-tropical and Indo-Malayan, resulting in high regional biodiversity. Nepal links the Tibetan Plateau with the Indian Subcontinent, and forms a biogeographic corridor between China and India.


![Fig.6.14: The world’s zoogeographic regions](image)

Boundaries between biogeographic regions are called “biogeographic lines”. Examples are:

- Wallace’s line between Southeast Asia and Australia (between Sundaland and Wallacea), and
- Kangar-Pattini line between India and Myanmar.

The marine environment is three-dimensional with a distinct vertical zonation, each having its distinct associated species. Accordingly in a particular oceanic region, intertidal areas, the upper layers of the open ocean and the deep sea have very different assemblage by species.

**SAQ 5**

Define biogeographic realm.

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SAQ 6

What is Wallace’s line?

6.5 THE BIOGEOGRAPHIC ZONES OF INDIA AND THEIR BIODIVERSITY

The country has been divided into ten biogeographic zones: Trans-Himalayas, Himalayas, Indian Desert, Semi-Arid, Western Ghats, Deccan Peninsula, Gangetic Plains, North-East India, Islands, and Coasts. (Fig. 6.15). This classification was

Fig.6.15: The biogeographic zones of India. From: W. A. Rodgers and H.S. Panwar, 1988. Planning a wildlife protected area network in India. Vol. 1, Department of Environment, Forests and Wildlife, Govt. of India
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developed at the Wildlife institute of India by Rodgers & Panwar (1988) and it is being largely followed. What are these biogeographic zones? These represent the major species groupings. In addition, each of these ten zones indicates a distinctive set of physical, climatic and historical conditions. The Himalayas and Gangetic Plains are examples of two adjacent but obviously extremely different zones.

Table 6.1: Characteristics of biogeographic zones of India (Rodgers and Panwar 1988)

<table>
<thead>
<tr>
<th>Biogeographical Zone</th>
<th>Biotic Province</th>
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<tr>
<td><strong>A) Palaeoarctic</strong></td>
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<td>1) Trans-Himalayan</td>
<td>a) Ladakh</td>
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<td>(Tibetan)</td>
<td>b) N.W.Himalaya</td>
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<td>2) Himalayan</td>
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<td>d) Central Himalaya</td>
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<td>e) East Himalaya</td>
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<td><strong>B) Paleotropical: African</strong></td>
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<td>3) Desert</td>
<td>a) Kutch</td>
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<td>4) Semi-Arid</td>
<td>b) Thar</td>
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<td>a) Punjab</td>
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<td>b) Gujarat-Rajwara</td>
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<td><strong>C) Paleotropical: Indo-Malayan</strong></td>
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<td>5) Western Ghats</td>
<td>a) Malabar Coast</td>
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<td>6) Deccan Peninsula</td>
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<td>a) Deccan Plateau (South)</td>
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<td>1) Tamil Nadu plains</td>
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<td></td>
<td>d) Chhota-Nagpur</td>
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<td></td>
<td>1) Satpura-Maikal</td>
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<tr>
<td></td>
<td>2) Vidhya-Bagelkhand</td>
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<tr>
<td></td>
<td>e) Central Highlands</td>
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<tr>
<td></td>
<td>1) Sinhagad-Akolkar</td>
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<tr>
<td></td>
<td>2) Chhota-Nagpur</td>
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<td></td>
<td>3) Garhjat Hills</td>
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<td></td>
<td>f) Vidhyabagh</td>
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<td></td>
<td>1) Brahmaputra Valley</td>
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<tr>
<td></td>
<td>2) Assam Hills</td>
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</tbody>
</table>

Subspecies – A taxonomic subdivision of a species, with some less obvious morphological* differences from the other subspecies and often with a different geographical distribution or ecology, e.g., a species ‘A’ may have a number of subspecies $a_1,a_2,a_3$, and so on.

Variety – A taxonomic subdivision of a subspecies, consisting of individuals with uniform characters that have arisen either due to genetic isolation* or due to various cultivation practices.

Endemic species – species confined to a particular region, e.g., **Azadirachta indica** (neem) is endemic to Indian sub-continent.

Endangered species – A species is considered endangered when its numbers are so few and/or its habitat is so small that it may become extinct if not given adequate protection.
| 9) Coasts | a) West Coast  
b) East Coast |
|----------|-----------------|
| 10) Islands | a) Andaman Islands  
b) Nicobar Islands  
c) Lakshadweep Islands |

Our country, which occupies just two percent of the total land mass, harbours a rich biodiversity comprising of about five percent of the known biodiversity from the world over. The numerical figures of the familiar categories of living organisms would give you a feel of the ‘rich biodiversity’ that we have in our country. There are about:

- 81,000 species of animals, including
  - 50,000 species of insects, and
- 12,000 species of birds,
- 45,000 species of various other categories of plants, including
  - 15,000 species of flowering plants.\(^1\)

In addition, these species may have several sub-species which in turn may have countless varieties. All these make the wildlife in India one of the richest in the world. The prime reason for such a rich biodiversity is because of the availability of an extraordinary diversity of habitats in India: from the cold and arid high-altitude regions of the trans-Himalayas to the dense, tropical rain forests of south India; from the searingly hot Thar desert in the west to the lush mangrove forests of the eastern coastal areas; and several variations in between. In fact, an entire life time would be inadequate to see the entire range of habitats.

### 6.5.1 Zone 1: The Trans-Himalayas

This zone has an area of about 1,86,200 sq km\(^2\) and it covers mainly Ladakh and Lahul-Spiti. This zone is much more extensive than the area within India, because of its high altitude mountainous terrain which are between 4,500-6,000m. Taking the topography into account, the areas comes out to be around 2.6 million sq km.

#### The Wildlife of the Trans-Himalayas Zone

This zone represents an extremely fragile ecosystem, because of its harsh climatic conditions and the inhospitable terrain. There are three mountain ranges running across this zone in India: Zanskar, Ladakh and Karakoram. Each slope has its own major valley-slope system. Each of these three mountain ranges is very interesting from the biological point of view. To the east, the Ladakh and Zanskar ranges merge into the southern margin of the Tibetan Plateau and the beginning of an internal drainage marsh and lake systems (e.g., Tso Morari). Most of its areas in the north is above the snowline. Siachen Glacier, covering an area of about 1,180 sq km is a major constituent of this area. This, in fact is the largest such area outside the polar region.

The vegetation of Ladakh and Lahul-Spiti is largely a sparse alpine steppe. In addition, several endemic species also occur here. This area within India, alongwith Pakistan and Tibet, has the richest wild sheep and goat communities in the whole world. There are eight distinct species and sub-species of sheep, the familiar ones are: Urial or Shapu, Argali or Nayan, Marco Polo Sheep, Markhor (Fig. 6.16 a-d) and Blue Sheep. The flatter plateaux have a distinct grazing community comprising of Wild

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\(^1\) These figures are based on the survey of nearly 70% of the geographical area of the country surveyed so far, survey of remaining areas is continuing.

\(^2\) This area includes 83,808 sq km area of Jammu and Kashmir under illegal possession of Pakistan, and 41,500 sq km area occupied by China since 1962.
Natural Resources: Biotic

Yak, Tibetan Ass, Tibetan Gazelle, Ibex and Tibetan Antelope (see Fig. 6.17a-e). In addition to these herbivores, there is an equally distinctive set of carnivores including Snow Leopard, Indian Wolf, Pallas’s Cat, Fox and smaller animals like Marbled Pole Cat, Pika and Marmot (see Fig. 6.18a-d). Of these the Pallas’s Cat is endemic to this area. The lakes and marshes too, have a distinctive avifauna including the spectacular Black-necked Crane, which is a migratory bird. Avifauna refers to the birds of an area collectively.

Since this ecosystem has very low primary productivity, the various kinds of animal populations are found in considerable altitudinal migration. Many of the species concentrate in valley areas during winters. The increasing human intrusion is endangering the delicate ecological balance of this extremely fragile ecosystem.

Fig. 6.16: Sheep species found in the Trans-Himalayan zone, a) Urial (*Ovis orientalis*), b) Nayan (*Ovis ammon hodgsonii*), c) Marco polo (*Ovis ammon polii*), and d) Markhor (*Capra falconeri*)

Fig. 6.17: Some herbivores of the trans-Himalayan zone, a) Wild yak (*Bos grunniens*), b) Gazelle chinkara (*Gazella gazella*), c) Tibetan ass (*Equus hemionus*), d) Ibex (*Capra ibex*) and e) Tibetan antelope (*Pantholops hodgsoni*)
6.5.2 Zone 2: The Himalayas

The Himalayan mountain ranges in India stretch for over 2,000 km from arid Mediterranean areas in the west, to the wet Chinese-Malayan areas in the east. This zone covers an area of 236,300 sq km in India, and forms about seven percent of the country’s total land surface. The environment here is extremely harsh, as there are steep slopes, unconsolidated soils and intense rainfall. Moreover, the pressures of human habitation, and the demand for timber, firewood and food are intense. All these factors have led to rapid degradation of this ecosystem that has taken toll of the biological resources occurring here. There are more endangered species in the Himalayas than anywhere else in India.

The Wildlife of the Himalayan Zone

The Himalayan zone is one of the richest areas of India in terms of habitat and species diversity. It shares its boundaries with many other ecosystems. The wildlife is so diverse that we need to look at it along its altitudinal and longitudinal ranges, and also along east-west axis.

First let us look at the wildlife within the altitudinal and longitudinal range of Himalayas. These are:

i) The **lower sub-tropical foot-hills**. These have typical mixed deciduous community merging into Chir Pine (Fig. 6.19a) and then Ban Oak. The fauna consists largely of Sambar, Muntjac. Wild Boar (Fig. 6.20a-c). Black Bear, Goral (Fig. 6.20d) and Kalij Pheasants. Deciduous community refers to plants that shed their leaves seasonally.

ii) The **temperate areas**. These lie below 3,500 m. This zone has a complex mixture of vegetation types with forests of Maples (Fig. 6.19b) and Walnuts, Moru and Oak (Fig. 6.19c), and a variety of conifers such as the Blue Pine, Fir and Spruce (Fig. 6.19d-g). All these grow in an altitudinal sequence. The fauna consists of Musk Deer (Fig. 6.20e), serow (Fig. 6.20f), Koklas and Monal pheasants. In winters, the high altitude fauna such as Tahr (Fig. 6.20g) move to these areas.

iii) The **sub-alpine area**. This area has forest and scrub vegetation of Birch and Rhododendrons (Fig. 6.19h) interspersed with grasslands with several kinds of herbs. These communities merge into the alpine communities, with sparser cover to over 5,000 m, where only rocks and snow dominate. Here, Musk Deer, Serow and Tahr share the lower ranges with Bharal, and in the west Ibex are more common at higher levels. Along with altitude, the Pheasants of wooded areas give way to the Snowcock. The panther gives way to the Snow Leopard and Wolf. The Black Bear is replaced by Brown Bear.
On moving along the east-west axis characteristic communities can be seen as well. We divide this axis in three sub zones, i.e., the western, central and the eastern zones.

i) **The Western Zone**: This is a comparatively drier area with Deodars (Fig. 6.21a) and Blue Pines. In addition, there are vast expanses of grassy meadows. Several species of bovids are typical of this area. These include the Bharal, Ibex. Markhor, Goral, Serow and Tahr. The Tahr is now missing from Kashmir. The Hangul which is a sub-species of Red Deer is restricted to this area.
ii) **The Central Zone**: There is a poor representation of large herbivores. The Ibex, Markhor and Hangul populations have dwindled to nil. The Sikkim Stag is now thought to be extinct in the Indian territory.

![Image of Deodar, Orchids, and Paphiopedilum spicerianum]

Fig. 6.21: a) Deodars, *Cedrus deodara* predominates the western zone of Himalayas, b-c) Orchids constitute characteristic vegetation of the Eastern Himalayan zone, b) *Calanthe triplicata*, and c) *Paphiopedilum spicerianum*

iii) **The Eastern Zone**: The Brown Bear, Bharal and Tahr found in other areas are absent here. Mishmi Takin a herbivore, is found here (Fig. 6.22a). This area has a higher tree line, and supports arboreal forest animal at higher altitudes. The Binturong, Red Panda (Fig. 6.22b) and Lesser Cats are the characteristic eastern faunal elements found here. The Orchids are profuse (two examples shown in Fig. 6.21b,c) and the alpine areas have an abundance of dwarf Rhododendrons that are shrubby.

![Image of Takin, Binturong, and Red Panda]

Fig. 6.22: Some animal species of the Eastern Himalayas, a) Takin (*Budorcas taxicolor*), b) Binturong (*Ailurus fulgens*)

Endemism is high in nearly all groups of plants and animals found here. Though some species are widespread along the Himalayas, others have tiny restricted ranges. In addition to the endemic species there are quite a few endangered species also. As mentioned earlier, this area is regarded as a highly degraded ecosystem. Many large mammals are on the endangered species list. There are indications that the Sikkim Stag is lost from the Indian territory. All evidences indicate that the Tahr may have disappeared from Kashmir as may have the Western Tragopan. The populations of Markhor, Tahr and Serow have dwindled to low densities. The Hangul Stag is virtually restricted to a protected area only.
6.5.3 Zone 3: The Indian Desert

This zone is located in the western part of the country and is also known as the Thar desert. It covers west Gujarat and west Rajasthan. Parts of Punjab and Haryana were once a part of this desert, but the irrigated cultivation has changed the situation there. Biogeographically, the Thar is the eastwards extension of the Sahara-Arabian desert system spread through Iran, Afghanistan, Baluchistan to the India-Pakistan border. Because of the extreme seasonality of rainfall and extreme livestock pressures, it is a fragile ecosystem.

The Wildlife of the Indian Desert

The wildlife of the desert zone is peculiar not because of its great diversity of density, but because of the extraordinary ecological adaptations to the desert conditions. Several of the species are endemic to the Thar Desert. A distinct sub-species of Wild Ass is confined to the Rann of Kutch, its populations in Pakistan have dwindled away. Besides this, the Desert Fox, Desert Cat (Fig. 6.23a), Houbara Bustard and some Sand Grouse species are restricted only to the Thar area. This region also has exclusive breeding sites of birds like the Flamingoes (Fig. 6.24a) in the Indian sub-continent breed chiefly in the Rann of Kutch. In addition, there are many species, that are in the endangered species’ list. For example, the Chinkara, Blackbuck (Fig. 6.23b), Wolf, Caracal (Fig. 6.23c) and Great Indian Bustard (Fig. 6.24b), have significantly numbered populations in this zone. The plant communities are very peculiar. Within the Rann of Kutch, extensive areas are subjected to saline or brackish flooding every monsoon and there appears a typical salt marsh-salt bush plant community of halophytes. *Prosopis cineraria, Salvadora oleoides* are common trees of Indian deserts. Human habitation has modified much of the desert area, and as a result, exotic species as *Prosopis juliflora* (Fig. 6.25) are becoming increasingly widespread.

![Fig.6.23: a) Desert cat (*Felis libyca*), b) Blackbuck (*Antilope cervicapra*) male (?) and female (?) and c) Caracal (*Felis caracal*)](image)

![Fig.6.24: A Flamingo (*Phoenicopterus roseus*). Flamingoes breed exclusively in the deserts, b) The great Indian Bustard (*Choriotis nigriceps*), another bird species associated with the deserts](image)
6.5.4 Zone 4: The Semi-Arid

This zone with an area of 508,000 sq km occupies 15% of the total area in our country. The presence of several grass species and palatable shrubs in these areas has made them a favourite of a vast number of wildlife species. This zone shares common boundary with Western Gujarat and Rajasthan, Maharashtra; and includes areas of Punjab, Haryana and Madhya Pradesh.

The Wildlife of the Semi-Arid Zone

This zone has strong biological links with western Asia, primarily with Pakistan, Iran, Middle-east and Northern Africa. Many of the plants found here show African affinity, e.g., *Acacia* sp., *Anogeissus* sp., *Balanites* sp., *Capparis* sp., and *Grewia* sp. (see Fig. 6.26). One can see pure gregarious forests of *Anogeissus pendula* along the gentler slopes of Aravalli and associated hill ranges. This is the only area where it occurs in this form. Outside this area, *A. pendula* occurs in north Madhya Pradesh, mixed with teak.

![Fig.6.26: Plants of the semi-arid zone, a) Acacia leucophloea (Ronj), b) Acacia auriculiformis (Australian wattle), c) Anogeissus pendula (Dhoj, Siras), d) Capparis sepiaria (Kanthari), and e) Grewia tenax (Ramchana)](image-url)
The fauna consists of larger herbivores – Blackbuck, Chowsingha, Gazelle and Nilgai (Fig. 6.27a). The Sambar is restricted to the wooded hills and Chital to the moist valley areas. Amongst the carnivores, the Asiatic Lion is restricted to a small area in Gujarat whereas Cheetah is now extinct. Many of the species found here are in very low densities, and these are of conservation interest, e.g., Caracal, Jackal, Wolf, Sloth Bear (Fig. 6.27b), Blackbuck, Great Indian Bustard, Lesser Florican (Fig. 6.27c), Flamingoes and both resident and migratory species of waterfowl. The rivers and lakes too have prominent forms such as the Crocodile – Mugger and Gharial, and turtle populations. The largest population of Star Tortoise are seen in this zone.

Meghalaya is known for its botanical value, most of which are high altitude Oak forests of Shillong-Cherrapunji plateaux. The area near Tripura-Mizoram border has exceptional wildlife species diversity with four rare primate species: Hoolock Gibbon, Leaf Monkey and both Pig-tailed and Stump-tailed Macaque.

6.5.5  Zone 5: The Western Ghats

The Western Ghats represent one of the major tropical evergreen forest regions in India. The total area of Western Ghats is about 160,000 sq km. In the west, the zone is bound by the coast and in the east, it shares boundary with the Deccan peninsular zone. The tropical evergreen forests occupy about one third of the total area of this zone. In recent years, a large chunk of the forest cover has been lost and this zone is now of great conservation concern, more so because of its exceptional biological richness. About two-thirds of India’s endemic plants are confined to this region. However, the potential of many of these species is yet to be tapped. Besides harbouring diverse biological communities, the forests in this zone also play an important role in maintaining the hydrological cycle.

The Wildlife of Western Ghats

The Western Ghats have a stretch of about 1,500 km, encompassing a considerable gradient of temperature and rainfall, which produces several species associations. Longitudinally, the Ghats extend from sea-level in the west, rise abruptly to a highly dissected plateau up to 2,700 m in height and then descend, often equally abruptly to the dry Deccan plains below 500 k. This gradient produces a change from evergreen to semi-evergreen to moist deciduous to dry deciduous formations. This elongated mountain chain has been cut by wide valleys in a few places, preventing dispersal of less mobile species and encouraging local speciation. The major biogeographic barriers or forest gaps are the Moyar Gorge, Palghat Gap and Shencottah Gap.
separating the Nilgiri, Anamalai and Agastyamalai mountain blocks. After discussing the overall terrain of this zone let us discuss its plant life.

Out of the 15,000 odd species of flowering plants found in India, about 4,000 or 27% of the total, are found in this zone. And the Western Ghats constitute just 5% of the total land area! Of these 4,000 species, almost half of them (about 18,00 species) are endemic to this region.

We have mentioned earlier about the geographic variation in the 1,500 km stretch of this zone. Likewise, the evergreen forest formation is also not uniform down the length of the Ghats. The distinctive vegetation recognised by their dominant species are described in Table 6.2.

**Table 6.2: The major vegetation types occurring along the stretch of the western ghats**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Vegetation</th>
<th>The Affecting Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Briedelia – Syzygium – Ficus – Terminalia</td>
<td>Winter temperature and length of dry season</td>
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<tr>
<td>2.</td>
<td>Memecylon – Syzygium – Actinodaphne</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Persea – Holigarna – Diospyros</td>
<td></td>
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<tr>
<td>4.</td>
<td>Dipterocarpus – Mesua – Palaquium</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Cullenia – Mesua – Palaquium</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Montane ‘Shola’ forest</td>
<td>Higher altitudes</td>
</tr>
<tr>
<td>7.</td>
<td>Riverine/Swamp forest, <em>Myristica</em> (Fig. 6.28)</td>
<td>Water-logged valleys</td>
</tr>
</tbody>
</table>

Although these forests have great ecological similarity with the forests in North-east India and Andamans, they are very different in terms of species composition. Of the total 29 species of the timber family Dipterocarpaceae, 13 are found only in the Western Ghats and nowhere else. Of these, 4 species are highly localized endemics of conservation concern. One species, *Hopea jacobi* has not been recollected for more than half a century now. These species constitute an exceedingly important genetic stock for timber improvement.

Now let us have a look at the faunal elements of this zone. This zone has fairly good population of most of the vertebrate species found in Peninsular India, along with an endemic faunal element of its own. The only large mammals missing are the bovid group of Gazelle, Blackbuck, and Nilgai with associated lesser fauna, and the moist grassland fauna of Swamp Deer (Fig. 6.29a) and Buffalo.

Within the vertebrates, endemic taxa are found in all the groups. The proportion of endemic taxa in amphibians is exceptionally large, i.e., almost half the genera and most species are endemic. Some of them are extremely localised. Even the freshwater fish fauna is of interest as endemic taxa, and has affinity to the taxa in north-east India. These have been important in the formulation of Hora’s Satpura Hypothesis in the development of Indian biogeographic thought. Several reptiles and bird species are restricted to the Ghats. The Travancore Tortoise and Cane Turtle are two endangered taxa restricted to a small area of Central Western Ghats, also known as the Coorg-Travancore. There are 62 mammal genera in the zone, one of which, a rodent is endemic. There are several instances of linkage of biogeographic interest: with the Himalayas, e.g., the Tahr; with North-east India; and with Sri Lanka.

The well known species found exclusively in Western Ghats include the following:

Among Primates – Nilgiri Langur and Lion-tailed Macaque (Fig. 6.29b,c)
Rodents – Plataonchomys, the Spiny Dormouse of the southern ghats.
Natural Resources: Biotic

Squirrels – Several subspecies of Ratufa indica with separate forms in Maharashtra, Mysore, Malabar and Tamil Nadu Ghats. The Grizzled Squirrel is restricted to two localities in the drier Tamil Nadu forest.

Carnivores – Malabar Civet in southern evergreen forests, Rusty spotted Cat in northern deciduous forests.

Ungulates – Nilgiri Tahr (Fig. 6.29d) in Nilgiris to Agastyamalai montane grassland. Hornbills – Malabar Grey Hornbill (Fig. 6.29e).

In addition to the above endemic species, the other species found are: Tiger, Leopard, Dhole (Fig. 6.29f), Sloth Bear, Indian Elephant and Gaur (Fig. 6.29g).

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6.5.6 Zone 6: The Deccan Peninsula

This zone covers the largest area in India that amounts to about 43% of the total land mass, and about 1,421,000 sq km area. Though a large area of this zone has been greatly altered by humans, still some forest areas exist, particularly in Madhya Pradesh, Maharashtra and Orissa.
This zone has deciduous forest, thorn forests and degraded shrublands. There are small areas of semi-evergreen forests in the Eastern Ghats and, dry evergreen forests or thorn scrub on the coastal side of the plains of Andhra Pradesh and Tamil Nadu.

The Northern zone has forest dominated by the trees like Sal, especially in the Northeast, Teak (Fig. 6.30), and miscellaneous species – (Terminalia – Anogeissus – Chloroxylon). The southern half of the zone has dry, thorn forests having Acacia – Albizia amara and Hardwickia associations. The natural grasslands are rare.

The faunal species are widespread throughout the whole zone, e.g., Chital (Fig. 6.31a), Sambar, Nilgai, Chowsingha, Barking Deer, and Gaur. Some species such as the Blackbuck are restricted to dry open area. Small, relict populations of species also exist, e.g., Elephant (Bihar-Orissa, and Karnataka-Tamil Nadu) and Wild Buffalo (in a small area at the junction of Orissa, M.P. and Maharashtra). The Hard Ground Swamp Deer is now restricted to a single locality in M.P. The Gharial is restricted to a few rivers flowing to the Ganges and one area in the Mahanadi river. Amongst the carnivores, the Rusty Spotted Cat has few small populations in Central India. Low density populations of Wolf are seen in the drier areas. The Tiger, Leopard, Sloth Bear, Gaur, Sambar, Chital, Chowsingha, and Boar are present in sufficiently high densities, particularly in the deciduous areas.

Considering the flora elements, this zone exhibits many interesting features. The Central Hill Ranges mark the beginning of a temperate flora at higher altitudes, and the Eastern Ghats harbour some endemic forms, which include the birds like the Hill Myna (Fig. 6.31b), lesser vertebrates and invertebrates. The valuable, endemic plant resources such as the Red Sanders and Sandalwood are of immediate conservation concern. Similarly, there is also a need for conservation measures for the species – Moist Teak, Southern and Coastal Sal, Umbrella Thorn, and especially Orissa semi-evergreen communities and dry evergreen forest.

### 6.5.7 Zone 7: The Gangetic Plain

This zone has one of the most fertile areas in the world, and it supports a dense and growing human population. It covers an area of about 359,400 sq km. The original vegetation found in most of the area is no longer there, as a major portion of this area has been brought under cultivation. This zone is topographically homogeneous for hundreds of kilometers. The only natural vegetation and wildlife is found in the north, in the Shivalik Hills and the adjacent Bhabar and Terai-Duar tracts. This zone has a large number of lakes and seasonal swamps. These have usually escaped drainage. This area is the habitat for migrating waterfowl.

#### The Wildlife of the Gangetic Plains

Centuries ago, this area was rich in wildlife consisting of Rhinoceros, Elephant, Buffalo and Swamp Deer. With the passage of time, their populations declined and disappeared as more and more area was brought under agriculture. However, small relict populations of Nilgai, Blackbuck and Chinkara, interspersed with dense cultivation presently exist in the western areas. The northern Terai grasslands have populations of Swamp and Hog Deer (Fig. 6.32a) in a few places. The Rhinoceros, Bengal Florican, and Hispid Hare are found in low numbers in the Eastern Terai of Duras. The Sambar-Chital community if found in the Bhabar forests, with Goral in the areas with steeper slopes. These along with the Kaleej Pheasant shows the beginning of a transition to Himalayan conditions.

As mentioned earlier, this area is a major winter feeding ground for the migratory waterfowl which occurs in exceptional density and richness here. The wetlands and rivers also contain Crocodile – Mugger and Gharial populations, relict populations of Gangetic Dolphin (Fig. 6.32b) and a rich, fresh-water turtle community having over 20 species.
6.5.8 Zone 8: North-East India

North-East India represents the transition zone between the India, Indo-Malayan and Indo-Chinese regions as well as the meeting point of Himalayan mountains and Peninsular India. It is one of the most important zones in the Indian Subcontinent for its rich biological diversity and a large number of its species are endemic to this zone. It is not only the species of plants that are diverse, but also the animals exhibit a species richness not found anywhere else in the world. It has an area of about 171,423 sq km and includes the states of Assam, Manipur, Meghalaya, Mizoram, Nagaland, and Tripura. About 40% of this area is occupied by forests.

The diverse habitat conditions along with the long term geological stability have contributed to the development of endemic plant and animal groups. Many of the species contributing to the biological diversity of North-East India are restricted to the region itself, or to even smaller localised areas such as in the Khasi Hills.

The North-East alone has the original habitat that once was the common habitat of north India. The Brahmaputra valley of this zone contains unique natural vegetation – swamps, grasslands and fringing woodlands and forests. It is in these regions that the full richness of the large herbivore fauna typically found in such grass lands can be seen. The fauna consists of Rhinoceros, Buffalo, Swamp Deer, Hog Deer, Pygmy Hog and Hispid Hare. This area also contains the largest elephant populations. This is also the fly-way for waterfowl and other birds travelling between the warmth of the subcontinent and their summer grounds in Siberia and China. This zone is still poorly explored biologically and many species remain to be discovered and described. There is immense potential for greater biological values to be documented.

The North-Eastern units have biological affinity with the Indo-Chinese and Indo-Malayan areas to the east and south-east. Many species are shared and there is a gradual interchange from one region to the next. Brahmaputra river itself is a dispersal barrier for several species of animals as well as of plants. For example, Golden Langur (Fig. 6.33a), Hispid Hare and Pygmy Hog are restricted to the north bank; Hoolock Gibbon (Fig. 6.33b) and Stump-Tail Macaque are restricted to the south bank. Amongst evergreen forest, dominant canopy tree – *Mesua assamica* is found only on the north bank; *Dipterocarpus macrocarpus* and *Shorea assamica* are found only to the south.

Within the Assam Hills, two further gradients of variations exist: an altitudinal gradient, and a rainfall gradient.

1) An altitudinal gradient going from below 300 m at the southern foot of Meghalaya, and to 3200 m in the highest point in the whole province on the Burma border in Manipur. This altitudinal range encompasses tropical evergreen and semi-evergreen forest, tropical moist deciduous forest, subtropical hill forest and temperate forest communities. The higher reaches of Manipur virtually show a sub-alpine shrub community.

2) A rainfall gradient from exposed southern slopes, e.g., in south Meghalaya at Cherrapunji with average annual precipitation of over 11,000 mm, to sheltered rain-shadow slopes with precipitation below 1,500 mm p.a. Of the endemics, members of Magnoliaceae occur in restricted areas, whereas Balsiminaceae has wider distribution.

Meghalaya is known for its botanical value, most of which are high altitude Oak forests of Shillong-Cherrapunji plateaux. The area near Tripura-Mizoram border has exceptional wildlife species diversity with four rare primate species: Hoolock Gibbon, Leaf Monkey and both Pig-tailed and Stump-tailed Macaque.
6.5.9 Zone 9: The Islands

In this category we shall discuss the Andaman and Nicobar group of islands in the Bay of Bengal, and the Lakshadweepes in the Arabian Sea. The Andaman and Nicobar islands are a long group of 348 islands north-south oriented. They have a total land area of about 8,327 sq km, stretching for about 590 km. The Andamans are separated by shallow continental waters from the Burma-India coast, and the Nicobars are separated from the mainland – the Andamans, and also internally from each other by channels of about 800 m depth. These islands are actually the extensions of the Arakan Mountain range of Burma and they have several peaks over 500 m. The Barren and Narcondam Islands are volcanic, and are believed to be still active. The Andamans exhibit biogeographical affinity with Burma. And the Nicobar islands that are about 90 km from Sumatra show strong biogeographic closeness to South-east Asia. The Andaman and Nicobar Islands are one of India’s three tropical moist evergreen forest zones. These islands are isolated and show linkages to the east. Their endemic flora and fauna, not found anywhere in India, make them unique in many ways.

The Wildlife of the Andaman and Nicobar Islands

Before discussing the wildlife, we shall briefly look into its biogeographic locations. The Andaman group of islands include 324 islands covering about 6,491 sq km area. Most of the area is taken up by the ‘Great Andaman’ comprising 5 islands separated by creeks. These are: North, Middle, South Andamans; and Baratang and Rutland Islands. Little Andaman is some distance away to the south. The Nicobar group is much smaller with only 24 Islands. It has 3 major subdivisions the North Group; Teressa, Tilangchong, Kamorta; Little Nicobar and Great Nicobar.

The zone possesses a unique kind of plant and animal life exhibiting a high degree of endemism. One finds these islands with impoverished mammal fauna. This may be largely due to the isolation of Andaman and Nicobar islands and the small island size. Amongst mammals, species of rodents and bats dominate. Centuries back, pigs were introduced in these islands and these are now known as the ‘Andaman Pigs’. Besides these, some other species like the Spotted Deer, Hog Deer, Barking Deer, Goats, Elephant, Sambar, Leopard and Palm-Civet (Fig. 6.34a) are also present. Some of these species are flourishing very well on these islands, and are believed to be reducing the native fauna that includes certain ground nesting birds and common rat. The indigenous mammal species that need to be conserved include the Nicobar Macaque, also known as the Crab-eating Macaque, and a distinctive race of the widespread Long-tailed Macaque, the Nicobar tree-Shrew, and the Dugong (Fig. 6.34b) found commonly in the coastal waters off the Andamans and Nicobars.

The avifauna consists of 255 distinct taxa of birds, of which 112 are endemic to these islands. Some of the peculiar examples include a mound building bird found in low densities around sandy shores and littoral forests, and the Nicobar Megapode. It is highly endangered. Another interesting endemic avi-species is the Narcondum Hornbill that is restricted to 7 sq km volcanic island ‘Narcondum’ to the east of the Andamans. The Serpent Eagle, and the ‘Andamans’ or ‘Grey Teal’ – a gregarious Duck of brackish and fresh water forest pools, is again restricted to Andamans and is highly endangered. It has been seen that many endemic species are restricted to ‘dense evergreen forests’ like the Nicobar Pigeon, Andaman Wood Pigeon (Fig. 6.34c), Nicobar Parakeet and the Nicobar Crested Serpent Eagle (Fig. 6.34d). The conservation of these endemic species calls for immediate preservation of their original habitats.
Natural Resources: Biotic

Reptiles and Amphibia: A large number of reptile and amphibian species are endemic to the islands. Many of these species await to be discovered and the behavioural ecology of many of these birds remains to be understood. Some of the interesting reptile and amphibian species include the salt-water Crocodile that is now restricted only to a few creeks in the north, middle and Little Andaman and Great Nicobar, and on some off-shore islands. The islands have 4 species of Marine Turtle – Green, Ridley, Hawks Bill and Leather. Of these, the only nesting beach for Leather Turtle over half of the Green Turtle nesting area is in the Andaman and Nicobar Islands. The small population of Asiatic Box Turtle – a fresh water turtle, is a cause of concern.

The fish and coral life: The Andaman and Nicobar Islands show a variety of coastal variations such as the mangrove estuaries, sandy and muddy shores, coral reefs, lagoons, and marine cliffs. These waters are said to have the richest fish and coral communities in India. Several species of Dolphins are present and Whale sightings are frequent.

Plants: Out of the 15,000 species of flowering plants found in India, some 2,200 species are found in these islands (two such species are shown in Fig. 6.35). Over 200 are strict endemics. Further, 1,300 species are found nowhere else in India, and these show closeness to the species of Burma, Malaysia and the Indonesian region. It implies that about 10% of India’s 15,000 flowering plant species are restricted to the 8,000 sq km area of Andaman and Nicobar forests. Extensive data on the extent of forest cover in the region glaringly point out that the forest cover of Andamans has been reduced to half in the past 100 years. At this rate, about 20% of the total species, that is, about 400 species will disappear in coming times. And remember, these are found nowhere else in India!
The seven major categories of forest vegetation described by Champion and Seth\(^3\), (1968) are: Evergreen Forests; Semi-evergreen forests; Hill Top Stunted Evergreen Forests; Moist Deciduous Forest, Swamp Forest and Mangrove Forests. In addition, there are some non-forest plant communities found on the beach strands – fresh water ponds and rocky cliffs. The Barren Island – a volcanic island – has a grass-scrubland cover. Smaller islets have grass-spray sclerophyllous scrub. Many species of Andamans show affinities with Burma and North-East India. The Dipterocarpaceae is one such example with no affinity to its South Indian counterparts.

The Nicobars have affinities with Indonesia. They lack Dipterocarps, but have a high diversity of tree-ferns and Palms. The Orchid flora of Great Nicobar further lend support to their affinities with their Indonesian counterparts. Out of the 36 species recorded, 21 are known nowhere in India except this region. Twenty of these species are restricted to the forests, and one is found on open hill-top rocky grassland in the forest hills.

The great biological resources of the Andamans have prompted the authorities to develop permanent field stations of the Botanical and Zoological Surveys of India in Port Blair.

The Lakshadweep Islands or Arabian Sea Islands

These islands comprise of some 25 islets, forming three main groups: Amindivi Islands in the north; Laccadive or Cannanore Islands in the centre, and Minicoy Island – a solitary island of about 175 km towards the south. These islands are of coral origin and have a typical reef lagoon system. They have a total land area of about 109 sq km including reef, bar and islets. Only 10 islands have permanently settled populations consisting of more than 25,000 people. The population density works out to be high, about 870 people per sq km. Now most islands are planted with coconuts and not much natural vegetation is left. The major environmental threats to these fragile ecosystems include: the setting up of a cement factory that would use the fossil reef limestone commercial inshore fishing, and the demands put by tourism on the local resources.

Some of the smaller islands show a typical coralline rock-sand beach littoral vegetation of *Pandanus – Casuarina* and *Thespesia*. The reefs have excellent examples of tropical inshore marine ecosystems needing immediate protection. The shallow sea lagoons have marine angiosperm pastures that are Dugong’s feeding grounds. These islands are also major feeding grounds for Turtles and there are some Green Turtle nesting sites also. Several oceanic bird species have resting sites on uninhabited islets, e.g., Brown-winged Tern, Noddy Tern, White capped Noddy, Lesser Crested Tern and Sooty Tern. Some sea birds are so peculiar that they have chosen only two islets as their nesting sites. These are Pitti and Baliapani. Despite a ban on the collection of the eggs of these birds, people continue to illegally collect them.

6.5.10 Zone 10: The Coasts

India has a vast coastal stretch of about 5689 km (Srinivasan, 1969)\(^4\). On the west, the Arabian Sea washes the shores of Gujarat, Maharashtra, Goa, Karnataka and Kerala States. On the east, the Bay of Bengal washes the coasts of Sunderbans in West Bengal, Orissa, Andhra Pradesh and Tamil Nadu states. The southern promontory of Indian Peninsula is bathed by the Gulf of Manaar and Indian Ocean, along the coasts of southern portions of Tamil Nadu.


The Wildlife of Coasts

The geology of coasts is very varied and accordingly, five main communities have been described:

a) Mangroves – that have a variety of community types from seaward to landward facing areas of estuaries, lagoons and deltas.

b) Sandy beaches, including raised beaches and distinctive plant communities such as *Casuarina* – *Calophyllum* – *Pandanus*

c) Mud flats with a range of successional stages to completely terrestrial vegetation.

d) Raised corals and rocky coast lines.

(e) Marine angiosperm pastures.

Some of the interesting coastal wildlife species include: Dugong; Hump-back Dolphin of estuarine turbid waters; Estuarine or salt-water Crocodile; Olive Ridley, Green, Hawksbill, Leather and Loggerhead sea Turtles; the Estuarine Turtle – *Batagur barker* of Sunderbans and the huge Soft-shell Estuarine Turtle; *Pelochelys birbornii* off the Utkal-bengal Coast fish – mud skippers or semi-terrestrial Gobies, small Crabs in association with Anemones; avifaunal communities of mangrove, mud flats and lagoons. In the higher regions of mangroves, there are Spotted Deer, Pigs, Monitor Lizards, Monkeys, and the Sunderban Tiger.

India harbours some of the best mangrove swamps in the world, of which the largest stretch of mangroves in the country lies in the Sunderbans in West Bengal in an area of 4200 sq km. The predominant mangrove species are *Avicennia officinalis*, *Excoecaria agallocha*, *Heritiera formes*, *Rhizophora mucronata* (Fig. 6.36a) and *Xylocarpus granatum*. The region harbours a number of Molluscs, Polychaetes and Honeybees. The main species found in the west coastal regions in the states of Gujarat, Maharashtra, Goa, Karnataka and Kerala are: *Avicennia marinar*, *A.officinalis*, *Ceriops tegal*, *Salvadora persica*, (Fig. 6.36b), *Rhizophora mucronata*, *Sonneratia alba*, *Acanthus illiciolius* and *Heritiera littoralis*. Coastal mangroves also occur in the states of Orissa, Andhra Pradesh and Tamil Nadu on the eastern coast. The dominant species in this region include *Burguiera cylindical*, *B.Parviflora*, *Rhizophora mucronata*, *Phoenix palmosa*,*Avicennia officinalis*, *A.marina* and *Ceriops tagal*. In addition, a large variety of phytoplankton and sea weeds occur all along the coasts (two forms shown in Fig. 6.37).

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**Fig.6.36:** Two commonly seen plants found along the Indian coasts, a) A twig of *Salvadora persica*, commonly known as ‘Pilu’, b) *Rhizophora* sp. Note the two plantlets (arrows) germinated on the mother plant itself.
Associated with the coasts are the coral reefs. We shall consider them as part of the coastal ecosystems. The coral reefs are formed by the calcareous skeletons of stony coral polyps that house the corals, which are soft-bodied, radially symmetrical marine invertebrates. Each individual of a colony is called a polyp. Millions of coral skeletons cemented together over a period ranging from thousands to millions of years give rise to such reefs, which often reach great depths and even run continuously for hundred of kilometers at a stretch. The coral reefs too exhibit rich biological diversity. A variety of fishes also known as Coral Reef Fishes are found in this habitat.

Coral reefs are divided into three major types.

i) **Fringing reefs** are the most common type. They project seawards from the shore and surround island and the continental land masses.

ii) **Barrier reefs**, though similar to fringing reefs, are separated from the landmass by shallow lagoons.

iii) **Atolls** are common in the Indo-Pacific region. They rest on the summits of submerged volcanoes and they are usually oval or circular with a central lagoon.

**SAQ 9**

How many biogeographical regions are there in India?

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**SAQ 10**

Complete the table given below:

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<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Biogeographic Zones of our Country</th>
<th>The Physical conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
### 6.6 BIODIVERSITY HOT SPOTS

Hot spots are areas that are extremely rich in species, have high endemism and are under constant threat.

**Box 6.4: Biodiversity hot spots**

Myers (1988) identified 18 regions or “Hot spots” around the world. Interestingly, these areas contain nearly 50,000 endemic plant species, or 20% of the world’s plant species, in just 746,000 km², or 0.5% of the Earth’s total land surface. A subsequent study done by the World Conservation Monitoring Centre, U.K. identified 21 “hot spots”. A more recent study by Conservation International, which carries forward the work of Myers, has identified 25 global “biodiversity hot spots”. These 25 hot spots cover only 1.4 percent of the Earth’s land surface but contain about 44% of all vascular plants and 35% of vertebrates (excluding fishes), and 96% of the world’s most threatened primate species. Among the 25 hot spots of the world two are found in India extending into neighbouring countries – the Western Ghats/Sri Lanka and the Indo-burma region (covering the Eastern Himalayas) (Fig. 6.38). These areas are rich in floral wealth and endemism, not only in flowering plants but also in reptiles, amphibians, swallow tailed butterflies and mammals.

![Fig.6.38: Biodiversity hot spots in India extending into neighbouring countries](image)

Overall, 241 centres of Plant Diversity have been identified and Ethiopia represents one of the eight major centres of crop plant diversity in the entire world. More classes to have, the Indian sub-continent bears traces of having produced a considerable component of the major crops that are used in the world today. India has been named, among the world’s 12 Vavilovian Centre’s of origin and diversification of cultivated plants known as the “Hindustan Centre of Origin of Crop Plants” by Vavilov in 1951.

#### 6.6.1 Differences between Regions

Biodiversity is not uniformly distributed across the globe. Some areas are very rich in biodiversity, while others are less so. Comparison of species richness of different geographical regions of the earth indicates that species diversity increases in warm areas and decreases with increasing latitude. For example, amphibians are generally absent at high latitudes although a salamander species can be found in the Arctic circle. Reptile species diversity increases towards the subtropics and tropics, and the diversity of birds and mammals also increases towards the equator. As such, tropical areas have more species in a given land area than a similar sized area in the temperate zone. There is also some indication that gross genetic diversity is higher in some tropical species compared with related temperate species.

An endemic species is one that is restricted to a given area that can be a mountain top, a river, a country or continent according to usage.
Diversity is also greater in areas of high rainfall compared with drier areas, although the relationship between precipitation and diversity is not straightforward. However, the relationship is most apparent in areas of climatic extremes, such as arid areas where species diversity is relatively low. In terrestrial ecosystems diversity generally decreases with increasing altitude although in some tropical forests, diversity is higher at mid-altitudes—giving rise to what is called a “mid-altitude bulge”. In coastal aquatic environments biodiversity declines when salinity declines from normal sea water (i.e. salinity 35 ppt). In contrast, biodiversity declines in fresh water habitats when salinity levels are >2ppt. (parts per thousand).

6.6.2 Differences between Ecosystems

Some ecosystems possess relatively large number of species as compared to others. This is particularly true of tropical forests which exhibit a very rich-biodiversity. For example, the 13.7 km$^2$ area comprising the La Selva Forest Reserve in Costa Rica (a tropical forest) contains almost 1500 plant species, which is more than the total number of plant species found in the 243,500 km$^2$ area comprising the whole of Great Britain.

Tropical moist forests are believed to be the richest terrestrial ecosystems on earth. In the marine environment, coral reefs also possess extremely rich biodiversity. It is now suspected, however, that the richness of species diversity on sea floor may be equal or even greater than coral reefs.

6.6.3 Differences between Countries

Some countries are richer in biodiversity than others. Generally, the economically poor developing countries in tropical areas are richer in biodiversity than developed countries in temperate areas.

Countries that lie along the equatorial zone can have enormous numbers of species. Venezuela has 15,000 and 25,000 plant species; Brazil has as many as 55,000 flowering plant species; Tanzania has 10,000 and Indonesia has 20,000. In terms of examples of flowering plant diversity in the countries of South Asia, India has 7000 species which is over 45% of the Indian flora; Pakistan has 5700 species, Nepal has 6500 species and Sri Lanka although small in size has 3500 species of flowering plants which is the highest diversity per unit area for the Asian region. About a quarter of these species are also endemic to the country.

Small tropical oceanic islands have relatively fewer species due to their isolation, but they generally possess large number of endemics. Mauritius has a native flora of 878 higher plant species, of which 329 are endemic.

Countries rich in diversity are called mega diversity countries. India is among the world’s mega-diversity countries. The mega-diversity countries deserve special international attention for conservation of the earth’s biological diversity.

Box 6.5: India: A megabiodiversity country

<table>
<thead>
<tr>
<th>Why India is one of the mega-diversity countries. India has a rich and varied heritage of biodiversity:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 2 hot spots out of 25 global biodiversity hot spots listed by Myers are in India with its neighbouring countries i.e. Western Ghats/Sri Lanka and the Indo-Burma region (covering the Eastern Himalayas).</td>
</tr>
<tr>
<td>• The endemics of Indian biodiversity is high about 33% of the country’s recorded flora are endemic to the country. Of the 49,219 plant species, 5150 are endemic and distributed into 141 genera under 47 families corresponding to about 30% of the world’s recorded flora.</td>
</tr>
</tbody>
</table>

Green Nations

Plants, insects anything mentioned in a biology text book qualifies as a bioresource. Countries with vast bioresources are called Mega-Diverse.

Mega Diverse countries

Eighteen countries that control 70 percent of the world’s bioresources have got together: India, China, Zaire, Indonesia, Columbia, Mexico, Ecuador, Kenya, Peru, Venezuela, Costa Rica, Bolivia, Malaysia, Madagascar, Philippines, South Africa, Congo and conservation priority in the selection of countries is based on species richness and species endemism.
India has 26 recognised endemic centres that are home to nearly a third of all the flowering plants identified and described to date.

India has two major realms called the Palaeretic and the Indo-Malayan and three biomes i.e. tropical humid forests, tropical deciduous forests and the warm deserts/semi-deserts.

India has ten biogeographic regions.

India is one of the 12 centres of origin of cultivated plants.

### 6.7 CRITERIA FOR IDENTIFYING BIODIVERSITY HOT SPOTS

Conservation priority in the selection of countries is based on species richness and species endemism.

#### 6.7.1 Selection According to Species Richness

A simple method used to identify areas of high conservation priority is the selection of countries according to highest species richness. Among the top 12 countries identified this way based on the assessment of vertebrates, swallow-tailed butterflies and higher plants are Mexico, Columbia, Ecuador, Peru, Brazil, Zaire, Madagascar, China, India, Malaysia, Indonesia and Australia. It is estimated that 70% of the species diversity in the world is found within these countries.

This method, however, involves species inventory within a geopolitical boundary, and fails to take into account the uniqueness of the fauna and flora of each country or region in question. As a result, there is considerable overlap of species between adjacent regions (or countries) that are prioritised for conservation action. For example, most mammalian species listed for Ecuador are also found in Peru. If both countries are prioritised for conservation, therefore, the same species will be conserved in both.

#### 6.7.2 Selection According to Endemic Species Richness

An alternative approach has been to identify areas with the highest number of endemics or species with a restricted geographical range. Assessments of this nature have been very often done at a country level (single country endemics) rather than in some identifiable region in a country (site or area endemics). It is relevant that single country endemic species are given high conservation priority at the global level because they are unique. If such species are lost, they can never be replaced. Here again, prioritising is done at the country level.

Myer’s work on identification of global hot spots is an important step towards determining areas where conservation requirements are greatest, and where the potential benefits from conservation measures should be maximised at a global level.

The essential criterion to be met with in qualifying as a global “hot spot” is the

i) presence of at least 0.5% of 1,500 of the world’s 300,000 vascular plant species as endemics.

ii) the threat criterion which decrees that a hot spot should have lost 70% or more of its natural vegetation,

iii) the presence of mammals, birds, reptiles and amphibians and their endemism serve as a back-up to further facilitate comparison among the “hot-spots”.

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Some of these hot spots span two or more countries as exemplified by the Western Ghats/Sri Lanka hot spot.

Although the hot spot analysis is as yet for terrestrial areas, efforts are under way to identify conservation priorities for marine species. Other efforts for priority setting for areas of conservation value have been carried out via Birdlife International’s Endemic Bird Areas and IUCN/WWF International’s Centres of Plant Diversity and Endemism.

SAQ 8
Why India is considered as one of the megadiversity countries?

SAQ 9
Explain the criteria in prioritization of global biodiversity hot spots.

6.8 SUMMARY
In this unit, you have studied that:

- Biomes are climatically distinct regions having specific plant and animal species. Very broadly the biomes of the world can be divided into terrestrial and aquatic.
- There are 10 major terrestrial biomes and these are named after the dominant vegetation of the region.
- The northern most extremely cold land biome is the tundra which is dominated by low lying cold resistant plant species. The taiga is a biome dominated by coniferous trees and is found like a circumpolar belt on the continents in the northern hemisphere. Temperate shrublands occur in coastal regions marked by winter rainfall and summer droughts and are dominated by evergreens adapted to these conditions. Grasslands occur where the rainfall is more than deserts but less to support forests. Deserts have hot days and cold nights with very little rainfall. The tropical regions with maximum plant and animal species are the tropical rainforests where high temperate and rainfall permit plants to grow throughout the year.
- The aquatic biomes of the world can be classified as fresh water and marine according to the salinity of the water. The fresh waters biomes are the stream, rivers and lakes and animals and plant species are adapted accordingly.
- The marine biomes consist of the oceans, coastal regions and islands. The distribution of animals and plants is limited by availability of light and nutrients. Some specialised marine biomes are the coral reefs, estuaries and wetlands.
- The Indian subcontinent has a lot of variation in climate, soil type and therefore, in vegetation. This is the reason why all the biome types of the world find a representation here.
- India has been divided into ten biogeographic zones viz; Trans-Himalayas, Himalayas, Indian Desert, Semi-arid, Western Ghats, Deccan Peninsula, Gangetic Plains, North East India, Islands and Coasts. Each of these zones has certain geographical as well as biological peculiarities. Some of the biological elements are characteristically found in certain zones only and no where else.
Natural Resources: Biotic

- Biodiversity hot spots are areas that are extremely rich in species, have high endemism and are under constant threat. Today, there are 25 hot spots in the world; 2 of which are found in India extending into neighbouring countries. The Western Ghats/Sri Lanka and the Indo-Burma region (covering the Eastern Himalayas).

- India is among the world’s mega diversity countries because of various reasons, viz. 2 hot spots, 26 recognised endemic centres, two major realms, three biomes and ten biogeographic regions.

- High conservation priority of countries is according to highest species richness and highest endemism.

6.9 TERMINAL QUESTIONS

1. List the factors that affect the distribution of biological diversity.

2. Which of the biomes that you learnt about would you expect to find in your country? Discuss the main differences in biodiversity (abundance and species richness) that you would expect to find in similar sized areas of the following types of biomes:
   - Rain forest
   - Coniferous forest
   - Hot deserts
   - Savanna

3. Make a table listing the physical conditions and the plants and animals (list species where possible as well as different groups of animals and plants) in:
   - tropical rain forest
   - tropical monsoon forest
   - temperate deciduous forest
   - taiga or the northern coniferous (boreal) forest
   - chaparrals (evergreen scierophylls forest)
   - tundra
   - savanna grassland
   - temperate grassland
   - tropical hot desert
   - mid latitude desert

As far as possible list species in your country for biomes that occur there.
4. Which biome in your opinion would have the largest number of:

- reptile species
- amphibian species
- large herbivorous mammals
- bird species
- endemics (at the national level)
- insects

5. What broad group of animals would you expect to do best in both a desert as well as a tropical rain forest? State why?

6. Which of the Conservation International’s 25 hot spots are nearest to where you live?

7. Circle the correct responses in the following multiple-choice questions:

i) According to the Wallace the species in the:

   a) Nearctic Region is similar to those in the Neotropical Region.
   b) Palearctic Region is similar to those in the Ethiopian Region.
   c) Oriental Region is similar to those in the Indian subcontinent.

ii) Which response is false out of the following?

   a) Tropical moist forests are the most diverse ecosystems on earth at the phyletic level.
   b) Coral reefs are almost as diverse in terms of species as tropical forests.
   c) The deep sea is very high in species that are not yet discovered.
   d) The deep sea floor may prove to equal tropical forests in species richness in the future with more data coming in.

iii) Countries differ in terms of biodiversity. Generally:

   a) Developing countries in the tropics are poorer in biodiversity than developed countries in temperate areas.
   b) Countries in equatorial areas will have higher biodiversity than countries at high latitudes.
   c) Small tropical oceanic islands have very high biodiversity.
   d) Small oceanic islands have small floras and low endemism.
iv) A biodiversity hot spot is best defined as an area with:
   a) High endemism and high species diversity coupled with threats to the habitat.
   b) A large number of threatened species whatever the extent of overall biodiversity.
   c) Extremes of daytime temperate.
   d) “Mega diversity” in terms of species.

v) In your opinion the best way of conserving the earth’s biodiversity is to conserve species in the countries:
   a) Identified as mega diversity countries.
   b) With the highest number of single country endemics.
   c) With the highest number of species that are of commercial importance.
   d) That are rich in species though poor in endemics.