Topic: Phytogeography

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Phytogeography (from Greek *phytón* = "plant" and *geographía* = "geography" meaning also distribution) or **botanical geography** is the branch of biogeography that is concerned with the geographic distribution of plant species and their influence on the earth's surface. Phytogeography is concerned with all aspects of plant distribution, from the controls on the distribution of individual species ranges (at both large and small scales, see species distribution) to the factors that govern the composition of entire communities and floras.

Phytogeography, Climate, Vegetation and Botanical Zones of India

According to Campbell (1926), the main theme of plant geography is to discover the similarities and diversities in the plants and floras of the present and past found in widely separated parts of the earth.

Wulff (1943) states that Phytogeography is the study of distribution of plant species in their habitats and elucidation of origin and history of development of floras.

According to Croizat (1952), Phytogeography is the study of migration and evolution of plants in time and space.

Major Divisions of Phytogeography:
There are two major divisions of Phytogeography:
(i) Descriptive or Static Phytogeography

(ii) Interpretive or Dynamic Phytogeography

Descriptive Phytogeography:
This deals with the actual description of floristic or vegetational groups found in different parts of the world. Early plant geographers described floras and attempted to divide earth into floristic and botanical zones.

Interpretive or Dynamic Phytogeography:
This deals with the dynamics of migration and evolution of plants and floras. It explains the reasons for varied distribution of plant species in different parts of the world. It is a borderline science involving synthesis and integration of data and concepts from several specialized disciplines like ecology, physiology, genetics, taxonomy, evolution, palaeontology and geology. Good (1931), Mason (1936), Cain (1944) and some others have pointed out the factors involved in the distribution of plants.

Lowerence (1951) has suggested the following thirteen modern principles of Phytogeography which are classified into four groups:
I. Principles concerning environment:
1. The distribution of plants is primarily controlled by climatic conditions.

2. There has been variation in climate during geological history in the past which affected migration of plants.

3. The relations between land masses and seas have varied in the past. The large land masses split up to form new land masses or continents which separated and reoriented. Land bridges between continents acted as probable routes for migration of plant and animal species. The land bridges became submerged in sea with the passage of time and the possibility for migration of plants and animals from one continent to another disappeared for ever.

4. Soil conditions on plains and mountains of different land masses show secondary control on distribution of vegetation. Halophytes, psammophytes, calcicols, calcifobs etc. have developed because of edaphic conditions.

5. Biotic factors also play important role in distribution and establishment of plant species.

6. The environment is holocentric, i.e., all environmental factors have combined effects on the vegetation of a place (Ale & Pank, 1939).

II. Principles concerning plant responses:

7. Range of distribution of plants is limited by their tolerances. Each plant species has a range of climatic and edaphic conditions. Therefore, tolerance of a large taxon is the sum of tolerances of its constituent species.

8. Tolerances have a Genetic basis. The response of plants to environment is governed by their genetic makeup. Many of the crops through breeding and genetic changes have been made to grow in wider range of environmental conditions. In nature, hybrid plants have been found to have wider range of tolerances than their parents.

9. Different ontogentic phases have different tolerances. Different developmental stages of plants show different degree of tolerances, as for example seeds and mature plants are more tolerants to temperature and moisture variations than their seedlings.

III. Principles concerning the migration of floras and climaxes:

10. Large scale migrations have taken place. The fossils and palaeoecological evidences reveal that large scale migrations of plants and animals have taken place during Mesozoic era and Tertiary periods.

11. Migration resulted from transport and establishment. In the process of migration plants are dispersed to new habitats through their propagules such as spores, seeds, bulbils etc., and there they are established if environmental conditions are favourable. Plants grow and reproduce there and progeny perpetuates through ecological adjustments.

IV. Principles concerning the perpetuation and evolution of floras and climaxes:

12. Perpetuation depends first upon migration and secondly upon the ability of species to transmit the favourable variations to the progenies.

13. Evolution of floras and climaxes depends upon migration, evolution of species and environmental selections.

Distribution:

On the basis of area of the earth surface occupied by the plants, the various taxa are categorized as under:

1. Wides.

2. Endemics.

3. Discontinuous species.

1. Wides:
Plants widely distributed over the earth in definite climatic zones and the different continents are referred to as wides. Cosmopolitan is applied for wides but, in fact, no plant is cosmopolitan in real sense of the term. Taraxacum officinale and Chaenopodium album are the common examples of the wides. Plants of tropical regions are called Pantropical. The plants of very cold climate may not only be found in the arctic regions but also in alpine zone of mountains in tropical and subtropical regions. These are called arctic-alpine plants.

2. Endemics:
A taxon whose distribution is confined to a given area is said to be endemic to that area. The taxon may be of any rank, although it is usually at a family level or below, and its range of distribution may be wide, spanning an entire continent, or very narrow covering only a few square metres. The concept of endemism is important because in the past the formulation of biogeographic regions was based on it.

The limits of a region are determined by mapping the distributions of taxa; where the outer boundaries of many taxa occur, a line delimiting? a biogeographic region is drawn. Major regions are still determined as those that have the most endemics or stated another way, those that share the fewest taxa with other regions. As regions are further broken down into subdivisions, they will contain fewer unique taxa.

This has been criticized because it assumes that species ranges are stable, which they are not. An alternative method of determining biogeographic regions involves calculating degrees of similarity between geographic regions. The concept of endemic distribution of plants was put forth by A.P. de Candolle (1813). Engler (1882) suggested two categories of endemic forms; Palaeo-endemics which are survivors of ancient forms and indigenous or native forms which are confined to a particular ocahty. According to area of distribution, the species may be continental endemics (restricted to a continent, endemic to a country, provincial, regional or local endemics (restricted to valley, hills, islands, etc.).

Now the endemic species have been grouped into the following categories:
(i) Relics or Palaeoendemics:
They are the survivors of once widely distributed ancestral forms, for example, Ginkgo biloba (restricted to China and Japan), Sequoia sempervirens (confined to coastal valleys of California, U.S.A.). Agathis australis, Metasequoia (Confined to Single valley in China). These species are called Palaeoendemics or epibionts. A great majority of the endemic species belonging to this type have many fossil relatives. They are also called living fossils. Because of little variability the endemics are adapted only to a particular environment and even if they reach new areas, they fail to establish themselves in new environment.

(ii) Neoendemics:
The other endemics may be modem species which have had not enough time for occupying a large area through migration. They are called neoendemics. There are several such genera which are widely endemic or few species of which are endemic. Neoendemics show good variability and have many biotypes, grow in diverse habitats and have wide tolerance for habitats.

Some of the well known endemic genera in Indian flora are Mecanopsis (Papaveraceae) Chloroxylon swietenia (Flindersiaceae, formerly Rutaceae). Catenaria and Butea (Papilionaceae) Caesulia (Compositae), Petalidium (Acanthaceae), etc. Eletteria repens (Zingiberaceae) Piper longum (Piperaceae), Piper nigrum (Piperaceae), Ficus religiosa (Moraceae), Shorea robusta (Dipterocarpaceae), Venda caerulea (Orchidaceae), Salmalia malabarica (Bombacaceae) Eleusine coracana (Grammeae) are the well known endemic species of Indian flora.

There are some special terms to designate the quality of these endemics, viz. Local endemics which are found in small land features, progressive endemics which tend to spread with time retrogressive endemics in which case the area of distribution is contracting and micro-endemics (i.e., the endemics of lower groups).

Pseudo endemics:
These endemics arise due to mutation in existing population at a particular place. These pseudo endemics or mutants may or may not persist for long in the particular area where they originate. Endemism results from the failure on the part of species to disseminate its seeds fruits spores or propagules because of existence of great barriers like mountains, oceans and large deserts. The oceanic islands which are isolated from rest of the world by large expanses of water abound in endemic species and water barrier checks the migration of those species outside their original habitat.

3. Discontinuous Distribution:
When plants occur at two or more distant places of the world which are separated by overland's or oceans hundreds or thousands of kilometres apart. Such a distribution is called discontinuous or disjunct distribution. Three genera Nothofagus, Jovellona and a for example are found in parts of South America, South Africa and Australia which are -paraded by vast oceans.

The significant phytogeographical causes for discontinuous distribution are as follows:
(i) The species might have evolved at more than one place and they failed to migrate outside their original habitats because of barriers.

(ii) The species which were once widely distributed in the past disappeared from certain areas and are now surviving in some distant pockets.

(iii) The climate may also be a factor for discontinuity in distribution of species. Plants having specific climatic requirements are found in widely separated areas with similar environmental conditions, as for example, plants of arctic regions are also found in alpine zone of high mountains in tropics and subtropics. Salix and Silen species show discontinuous distribution in arctic-alpine regions.

Theories of Discontinuous Distribution:
1. Theory of Land Bridge:
According to this theory, land bridges occurring in between the separated continents are believed to have helped in the migration of various taxa from one continent to the other. Uniform distribution of plants and animals in different parts of the world during Palaeozoic era is believed to have been due to those land bridges. With the passage of time the land bridges became submerged in sea and the connections between the various continents snapped beyond the dispersal capacity of organisms resulting thereby the discontinuity in the distribution.

2. Theory of Continental drift:
The theory of continental drift was propounded by Wegner (1912 1924) According to him the whole land- mass of the world was a single super continent during Palaeozoic era. He named it as Pangaea. That super continent was surrounded by sea on all the sides which was named Panthalassa. During Mesozoic, Pangaea split up into two large landmasses; Laurasia in the north and Gondwanaland in south.

The two landmasses were separated by Tethys Sea. Du Toit (1937), however, suggested that Laurasia and Gondwanaland existed from the very beginning. The two large landmasses having characteristic flora and fauna broke up into new landmasses called continents. Laurasia gave rise to Eurasia, Greenland and North America and similarly Gondwanaland gave rise to South America, Africa, India, and Polynesia, Australia Antarctica etc.

About 135 million years ago reorientation of continents began. The continents were drifted apart by the oceans. This is called Continental Drift. The occurrence of Dinosaurs and many fossil plants lend support to the existence of Laurasia and Gondwanaland. With the separation of continents the distribution areas of several plant and animal species got separated and gave rise to discontinuous distribution areas.

Factors Affecting Distribution of Species:
Several factors are known to affect the geographical distribution of plant species, some of which are as follows:
1. Geological history and distribution,

2. Migration, and

3. Ecological amplitude.

1. Geological history and distribution:
The place where a species first originated is called its centre of origin. Evolution of species is a slow but continuous process. Some of the species in present day flora are quite old while a great majority of them are recent in origin.

The process of species differentiation involves:
(i) Hybridization between the related species as well as mutation and

(ii) The natural selection of the hybrid and mutant populations.

In the selection process not all the hybrids and mutants are selected by nature and only the fittest individuals which find the habitat conditions within their ecological amplitudes are selected and the individuals least fit are eliminated. Changing climate has also played important role in the origin of new species. In the course of evolution several old species became extinct, some of which can be found even today as fossils. The fossils provide direct evidence for the existence of various taxa in the past.

Age and Area Hypothesis:
This hypothesis was proposed by J. W. Willis (1915) on the basis of his extensive studies of geographical distribution of certain plant species in tropics. On the basis of his findings Willis postulated that the species which evolved earlier occupy greater areas than those which appeared later in the evolutionary sequence. According to this hypothesis, the frequency of a species over an area is directly proportional to its age in scale of evolution and age of species is directly related with the area of its distribution.

Thus a small area of distribution of a species will indicate its relative young age. Willis has quoted several examples such as Impatiens, Primula, Gentiana, Rhododendron in support of his hypothesis. Genus Coleus may be quoted here as an example in support of this hypothesis. There are two species of Coleus namely C. elongatus and C. barbatus.

The former species is endemic while the latter is widely distributed. On the basis of areas under distribution of these species Willis considered C. elongatus less evolved and derived from C barbalins. Willis has also pointed out that the majority of endemics are found to be members of large and successful genera. The age and area hypothesis, however, is not universal and it has been criticized by many.

2. Migration:

The newly evolved species starts migration to new areas and side by side it undergoes further evolutionary changes. The dispersal of germules and propagules is brought about by several agencies like wind, water, glaciers, insects, animals, even man. The dispersal is followed by ecasis. Migration may be adversely affected and sometimes even totally stopped by some factors called migration barriers. Barriers in the dispersal of species may be classified as ecological or environmental and geographical.

The climate, an ecological barrier, plays important role in distribution and establishment of species. Unsuitable climatic condition or change of climate in particular area forces the species to migrate from one place to another and the failure of some species to migration leads them to gradual extinction. Besides climate, there are geographical barriers, as for example, high mountains, vast oceans or deserts.

The fresh water plants, for example, cannot be dispersed across oceans if their propagules are suitable only for fresh water dispersal and similarly germules or propagules of land plants from one country cannot reach other country separated by vast oceans and mountains. Species are called natives of the place of occurrence if they originated there. Outside the area of its origin, the species is referred to as exotic. Exotic species reach new area through migration. If any species is introduced intentionally in new area by man then it is called introduced species.

3. Ecological amplitudes and distribution:

Environmental conditions not only influence the life and development of plants but also determine the presence or absence, vigour or weakness and relative success or failure of various plants in a particular habitat. Each plant species of a community has a definite range of tolerance towards physical and biological environment of the habitat. This is referred to as ecological amplitude. The presence of species at a particular place, no doubt, indicates that the environmental conditions of that habitat are within its ecological amplitude but the absence of a species from one place does not necessarily indicate that the environment is not suitable for that species.

The ecological amplitude is governed by genetic set up of the species concerned and thus different species have different ecological amplitudes which may sometimes overlap only in certain respects. Further, some species may occur at different geographical regions as and when the conditions fall within their ecological amplitudes. As for example, some plants of temperate region say conifers, may also be found in alpine zone of high mountains in tropical and subtropical regions.

The other consideration in ecological amplitude as a factor in plant distribution is its change with time. In sexually reproducing plants the hybridization between related species results in offspring's with new genetic composition. With the change of environment the plant species also make adjustments with new environment by shifts in their ecological amplitudes facilitated by changes in the genotype. Within a species there may occur several genetically different groups of individuals (populations) which are adjusted to particular set of ecological conditions.

These populations are called ecotypes or ecological races or ecological populations. In Euphorbia thymifolia, for example, there are two major populations-one is calcium loving or calcicole and the other type is calcium hating or calcifuge. Similarly ecological races of Xanthium strumarium and Ageratum conyzoides differ in the photoperiodic requirements. The existence of ecotypes within the species widens the area of its geographical distribution.

Botanical Zones of India

Vegetation of any place is modified by the environmental factors; climate, geology and biotic factors.

The great area of Indian subcontinent has wide range of climate and corresponding diversity in the vegetation.

India has been divided into the following botanical zones by D. Chatterjee (1962) Fig. 11.4:

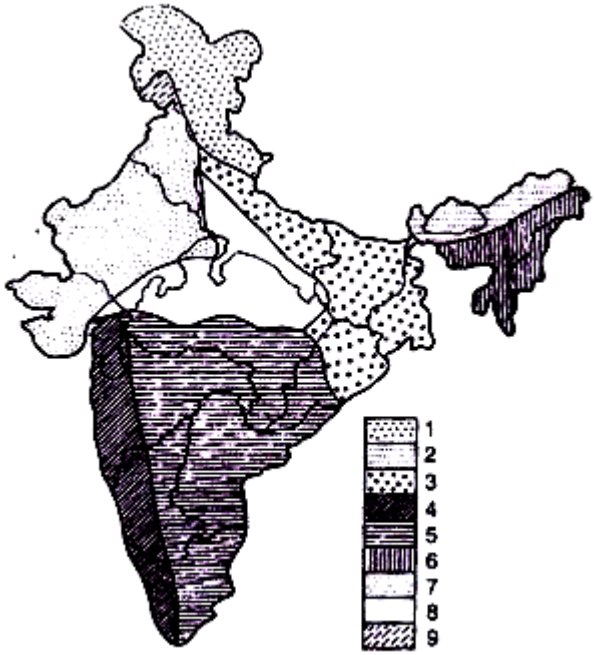

Fig. 11.4. Botanical zones of India.

(1) Western Himalayas,

(2) Eastern Himalayas,

(3) Indus plain,

(4) Gangetic plain,

(5) Central India,

(6) Deccan,

(7) Western coasts of Malabar,

(8) Assam, and

(9) Bay Islands of Andaman and Nicobar.

1. Western Himalayas:

The northern part of our country is bounded by highest ranges of Himalayas and is one of the important botanical regions of the world with climate and vegetation ranging from truly tropical near the low altitudes to temperate arctic types at the high altitudes. The northern mountain division can phytogeographically be divided into western, central and eastern zones.

Western Himalayas consist of north Kashmir, south Kashmir, a part of Punjab, H.P., Garhwal and Kumaon. This zone is wet in outer southern ranges and slightly dry in inner northern zone. The average annual rainfall in this

region is from 100 to 200 cm. Snowfall occurs in this region during winter season. The region may be divided into three subzones (Fig. 11.5).

(i) Submontane zone or lower region or tropical and subtropical belts (up to about 1500 metres altitude from the sea level).

(ii) Temperate zone (from 1500 metres to 3500 metres altitude),

(iii) Alpine zone (above 3500 metres and up to the line of perpetual snow).

(i) Submontane or lower region or tropical and subtropical belts:
It includes outer Himalayas, particularly region of Siwaliks and adjoining areas where annual average rainfall is over 100 cm. This zone ranges between 300 and 1500 metres above sea level. In this zone, forests dominated by timber trees of Shorea robusta are common. Other important tree species are Salmalia malabaricum, Butea monosperma. Acacia catachu and Zizyphus species.

In the swampy areas, Dalbergia sisso (Shisham), Ficus glomerata, Eugenia jambolana are of common occurrence. In west dry regions sal trees are replaced by xeric plants particularly Zizyphus, Carissa, Acacia, and thorny Euphorbias. At higher elevation, around 1000 to 1500 metre altitude, cheer (pine) forests are also found at certain places. The common species of pine are Pinus longifolia and Pinus roxburghii. Ground vegetation is scanty.

(ii) Temperate zone:
It commonly ranges at the altitudes from 1500 to 3500 metres above the sea level. Oaks are dominant along with Populus, Rhododendron, Betula and Pyrus. Pinus excelsa, Cedrus deodara, Picea, Abies, Cupressus and Taxus baccata are found in the heavy rainfall region (between 1600 and 1800 m). Herbs are also common in this region. Common herbs are Ranunculus hirtila, Polygonum, Pedicularia, Potentilla argyrophylla. Primula, Delphinium, Clematis, crucifers and many members of asteraceae.

In cultivated drylands of Punjab, wheat and barley are main crops. In Kashmir, Betula (birch), Salix (cane), Populus (poplar) are of common occurrence. Besides these, Quercus semicarpifolia, Q. dilatata, Aesculus indica (chestnut) and many conifers are commonly met within this region. In west Kashmir rice cultivation is common Sar or saffron (Crocus sativus), apples, peaches, walnut, almonds and other fruits are important economic plants of Kashmir region.

(iii) Alpine zone:
Above the altitude of 3500 metres and up to snowline (about 5000 m) is alpine zone. The vegetation consists of evergreen conifers and some low and broad leaved trees. The vegetation of this region is characterized by cushion habit, dwarf nature and gregarious habit. In lower alpine region, shrubby forests are common which may be (a) Birch—fir forest which is fairly dense and is mixed with evergreen shrubby Rhododendron at higher level and (b) Birch— Rhododendron forests in which silver fir, Betula, Rhododendron and Juniperus are common. In the upper alpine region, prominent herbaceous plants are the species of Primula, Polygonum, Gentiana, Cassiope, Meconopsis, Saxifraga, Potentilla, Geranium, Aster, Astragalus etc. which form alpine meadows. At about 5000 metre altitude and above snow perpetuates round the year and plant growth is almost nil. This altitude is called snow line or ice line.

Populations of Draba, Braya, Cortia, Leontopodium go on increasing with the increase in altitude. Species of Ephedra, Juniperus, Berberis are also found scattered. Poa, Stipa and Fectuca are common grasses of alpine zone.

2. Eastern Himalayas:

Eastern Himalayas extend from Sikkim to upper Assam, Darjeeling and NEFA. Vegetation of this region differs from that of western Himalayas. The chief differences are due to changed environmental factors as heavy monsoon rainfall, less snowfall and high temperature and humidity.

This region can also be divided into:

(i) Tropical submontane zone

(ii) Temperate or Montane zone, and

(iii) Alpine zone (Fig. 11.5).

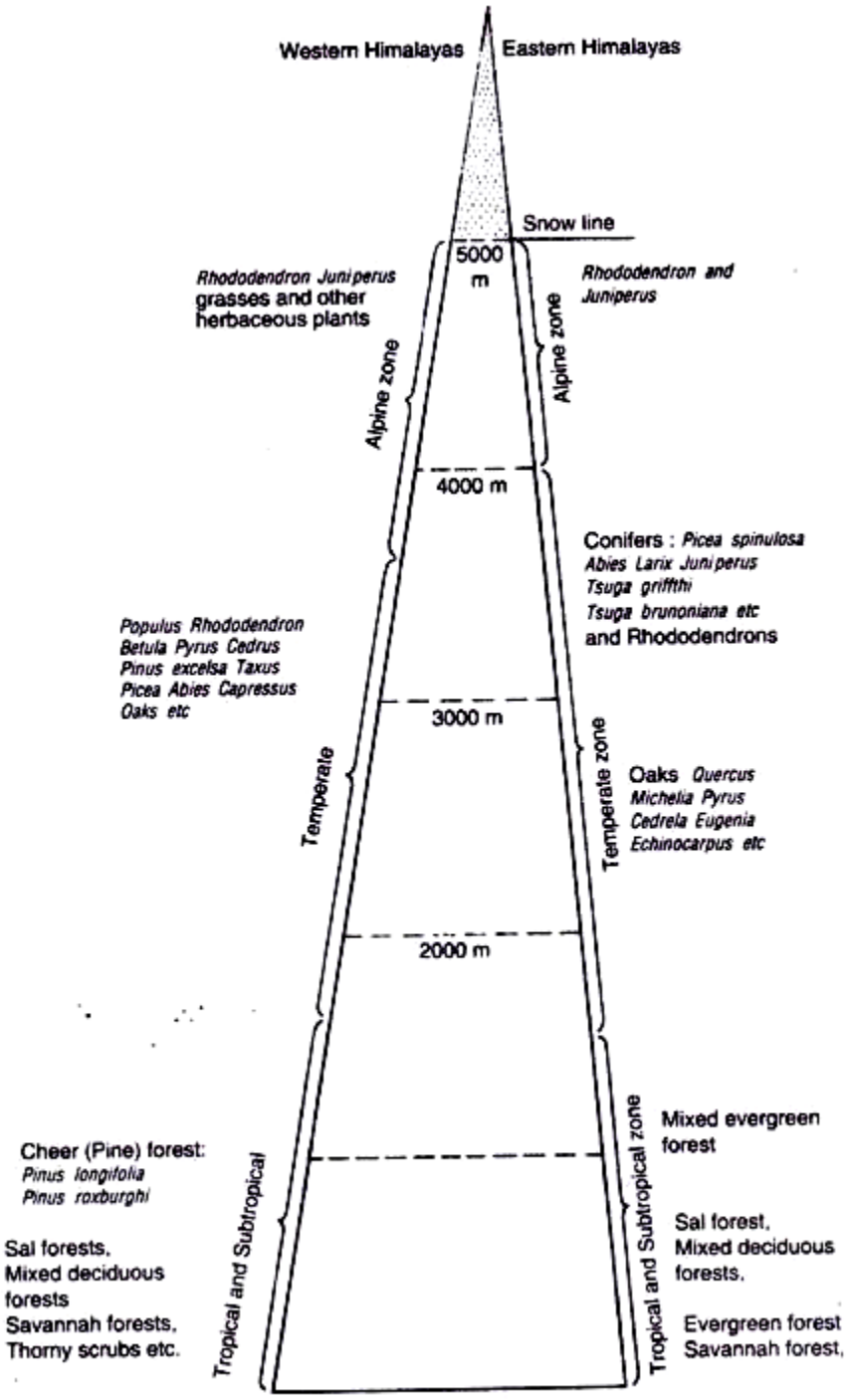

Fig. 11.5. Main types of vegetation at different altitudes in the Western and Eastern Himalayas.

(i) Tropical or Submontane Zone:

The tropical subzone characterized by warm and humid conditions extends from plain up to the altitude of about 1800 m. In this zone mostly sal forests, and mixed deciduous forests consisting of important plants, such as Sterculia, Terminalia Anthocephalus cadamba and Bauhinia are common. In the savannah forests, common plants are Albezzia procera, Bischofia, Salmelia, Dendrocalamus. Evergreen forests of Dillenia indica, Michelia champaca, Echinocarpus, Cinnamon, etc. are common.

(ii) Temperate or Montane Zone:
It may be further divided into upper and lower zones Lower temperate zone is the region between 1800 and 3000 metre altitudes. In the lower temperate zone, Oaks (Quercus). Michelia, Pyrus, Cedrela, Eugenia, Echinocarpus are common plants. In upper temperate zone (3000-4000 metre altitude), conifers and Rhododendrons are common. Important conifers of this region are Picea spinulosa, Abies, Larix, Juniperus, Tsuga griffithi, Tsuga brunoniana, etc.

(iii) Alpine Zone (from 4000 metres up to snow line):
Climate is humid and extremely cold. The vegetation in the alpine zone is characterised by complete absence of trees and predominance of shrubs and meadows. Important plants of this zone are Rhododendron and Juniperus. Eastern Himalayan vegetation is considered to be one of the richest vegetational units in the world and consists of several species of plants which are native of foreign countries, such as, China, Japan, Burma, Malaya and European countries.

3. Indus Plains:
It includes part of Punjab, Rajasthan, Cutch, Delhi, a part of Gujarat. Some part of this plain is now in Pakistan. The climate of this zone is characterised by dry hot summer, and dry cold winter. Rainfall is usually less than 70 cms, but in certain regions it is as low as 10-15 cms. The soil of a wide area except cultivated land, is saline. Much of the land has become desert due to excessive dryness.

Vegetation is mainly bushy and thorny Acacia arabica, Prosopis spicigera, Salvadora Capparis decidua are very common plants of this region. Salsola phoetida and Lunakh grass are found mostly in saline soils. Other plants of this botanic province are Anageissus, Eugenia, Mango, Dalbergia sisso, Albizzia lebbek, Zizyphus nummularia, etc.

Historical evidences indicate that the area was covered by dense forest some 2000 years ago, but gradual destruction of vegetation cover either by biotic agencies or by any other agency led to the development of desert in this plain. Saccharum munja, Cenchrus ciliaris, Prosopis spicigera. Acacia leucophloea, A. Senegal are the important plant species which are grown for checking the spread of desert.

4. Gangetic Plains:
This is one of the richest vegetational zones in India. This zone covers flat land of a part of Delhi, whole of U.P., Bihar, and West Bengal and also a part of Orissa. Rainfall in this zone is from 50 cm to 150 cm. A great part of the land is under cultivation. The common crop plants are wheat, barley maize. Sorghum (jowar), Bajra, urad, Moong (Phaseolus mungo), Cajanus cajan, til (Sesamum indicum), sugarcane. Pea (Pisum sp.), gram (Cicer arietinum), potato, Brassica, rice.

In western part of U.P. annual rainfall is from 50 cm to 110 cm. Dry deciduous and shrubby forests are common in this part. Important plants of south-western part of U.P. are Capparis, Saccharum munja, Acacia arabica. In the north-western part of U.P. near Himalayas foothills Dalbergia sisso. Acacia arabica are most common plants.

In eastern gangetic plain, the conditions are cold and wet (annual rainfall, 150 cm in West Bengal). In this part evergreen forests are common. In central part, the annual rainfall is about 100 cm to 150 cm. The vegetation consists mainly of deciduous trees. Sal trees are dominant. Other common trees are Terminalia tomentosa, T. belerica. Acacia species, Bauhinia, Diospiros (Biri Ka patta or tendu) Eugenia sp., neem trees (margosa), Madhuca indica (Mahua), Cordia myxa (Lasora), Tamarindus, Mango (Mangifera indica). Ficus etc.

In Bihar and Orissa hills, Rubus, Potentilla, Fragaria (Rosaceae), Pyrus etc. are common. Mangrove vegetation is common in tidal regions in West Bengal near Sunder-ban, and Orissa. Rhizophora mucronata, R. conjugata,

Sonneratia, Ceriops roxburghiana and Acanthus ilicifolius, Kandelia rheedii, Bruguiera gymnorhiza are common mangrove plants in those regions.

5. Central India:

Central India covers Madhya Pradesh, part of Orissa (now Odisha), Gujarat and Vindhya. The areas are hilly. The average rainfall per annum may be 100-170 cm. Some places are at the altitudes of 500-700 m from the sea level. Biotic disturbances are very common in this botanical province which have led to the development of the thorny vegetation in open areas. In this region teak (Tectona grandis) and sal (shorea robusta) forests are very common. Other trees are Terminalia tomentosa, Bauhinia, Mango, Phyllanthus, Ficus glomerata, etc. Among common shrubs are Mimosa rubricaulis, Desmodium, Acacia sp., Zizyphus rotundifolia and other.

Entire forest vegetation of central India may be divided into:

(i) Sal forests

(ii) Mixed deciduous forests

(iii) Thorny forests.

At Sarguja (M.P.) many species have been reported to occur. Some of them are Pyrus, Barberis asiatica, Rubus, elipticus, etc.

6. Deccan:

This region comprises whole of the southern peninsular India including Satpura and southern part of Godawari River. Average annual rainfall in this region is about 100 cm.

It may be divided into the following two subdivisions:

(i) Deccan plateau

(ii) Coromandel coast.

In Deccan plateau teak forests containing Diospiros, Acacia, Prosopis spicigera. Santalum a hum (chandan tree) and Cedrda toona are common. On rocks, Capparis, Euphorbias, Phyllunthus are common. Teak, Pterocarpus, Borassus, Foenix silvestris are also common in this area In Chhota Nagpur plateau, important species are Clematis natans, Barberis, Thallictrum and also many members of Annonaceae, Rosaceae, Compositae, Araliaceae, Apocynaceae, Lauraceae, Amaranthaceae, Orchidaceae. Some ferns also common.

In Coromandel coast vegetation consists largely of some halophytic species.

7. Western Coast of Malabar:

This is small botanical province covering Cape Comorin to Gujarat and Western Ghats .This is a region of heavy rainfall.

In this zone, four types of forests are common:

(i) Tropical forests (occur at 700 m altitude).

(ii) Mixed deciduous forests (found at the altitude up to 1600 m).

(iii) Temperate evergreen forests (occur above 1200 m altitude), and

(iv) Mangrove vegetation.

In tropical evergreen forest the trees are tall and they have root buttresses. Important species are Cedrela toona Dipterocarpus. Mangifera indica, Sterculia alata, Artocarpus hirsuta. In the mixed deciduous forests, important plants are Terminalia tomentosa, Terminalia peniculata Tectona grandis, Dalbergia, Lagerstroemia lanceolata and bamboo species, particularly Dendrocalamus and Bamboosa arundinacea. On the Nilgiri hills sub-tropic and temperate conditions exist. Important plants of Nilgiri vegetation are Rubus, Rhododendron arboreum, Barberis, Thallictrum Ranunculus, Fragaria, Potentilla. Many other herbs along with many grasses are also common.

Temperate forests commonly called as "sholas" contain Gardenia obtusa, Michelia nilgirica Eugenia species are also common. In Malabar, plants belonging to family Dipterocarpaceae' Tihaceae, Anacardiaceae, Meliaceae, Myrtaceae, Piperaceae, Orchidaceae and many ferns are common. The west coast of Malabar region receives very high rainfall. In the coastal region mangrove plants grow luxuriantly.

8. Assam:

This botanical province is very rich in vegetation and covers valley of Brahmaputra, Naga hills and Manipur. This is the region of heaviest rainfall. Cherapunji is one of the rainiest place in the world where annual rainfall often exceeds 1000 cm. Excessive wetness and high temperature in this zone are responsible for the development of dense forests. Broad leaved, tall evergreen angiosperms and some conifers are very common in the forests.

Common plants occurring in this region are Ficus, Artocarpus, Michelia champaca, Sterculia alata. Morus species. Besides these bamboos canes, climbers, and green bushes are also common. Prominent plants in the northern forests of this zone are Alnus nepalensis, Betula. Rhododendron arboreum. Magnolia, Michelia and Prunus. Sal also occurs at Garo hills. Orchids and fern species are very rich in this zone.

9. Bay Islands of Andaman and Nicobar (India):

Islands:

These are represented by the Andaman and Nicobar islands in the east and Lakshadweep islands in the west. The Andaman and Nicobar islands are a group of more than 300 islands, which support many characteristic plants and animals. The forests range from tropical evergreen to moist deciduous and even mangroves. The Lakshadweep group of islands comprise 36 major Islands, which together from an area of 32 sq km. Many varied marine fauna are present here that include turtles, crabs, molluscs and fishes. Beautiful coral reefs are also present in this part of India.

These bay islands represent elevated portions of submarine mountains. Climate is humid in the coastal region. In Andaman, beech forests, evergreen forests, semi-evergreen forests deciduous forests and mangrove vegetation are of common occurrence. Rhizophora Mimusops, Calophyllum, etc. are common plants in mangrove vegetation. In the interior evergreen forests tall trees are common. Important species of trees are Calophyllum, Dipterocarpus, Lagerstroermia and Terminalia etc. Some part is under cultivation. The important crops are paddy and sugarcane.

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