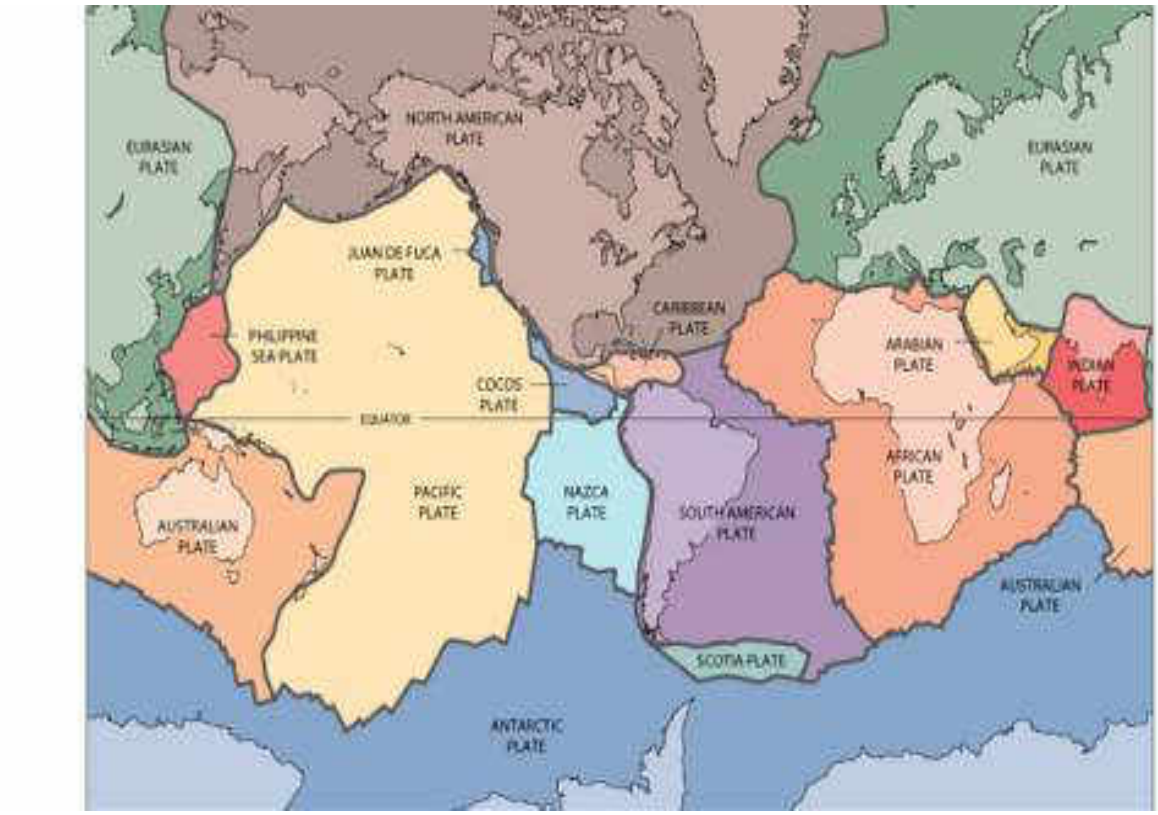
# Unit-10: phytogeography

## Continental Drift: Theory & Definition

PRITAM ROY




(Tectonic plates of the Earth
Image: © USGS)

Continental drift was a theory that explained how continents shift position on Earth's surface. Set forth in 1912 by Alfred Wegener, a geophysicist and meteorologist, continental drift also explained why look-alike animal and plant fossils, and similar rock formations, are found on different continents.

## The theory of continental drift

- Alfred Wegener suggested continental Drift Theory in the 1920's.
- According to Continental Drift Theory there existed one big landmass which he called **Pangaea** which was covered by one big ocean called **Panthalassa**.
- A sea called **Tethys** divided the Pangaea into two huge landmasses: **Laurentia (Laurasia)** to the north and **Gondwanaland** to the south of Tethys.
- Drift started around 200 million years ago (Mesozoic Era, Triassic Period, Late Triassic Epoch), and the continents began to break up and drift away from one another.

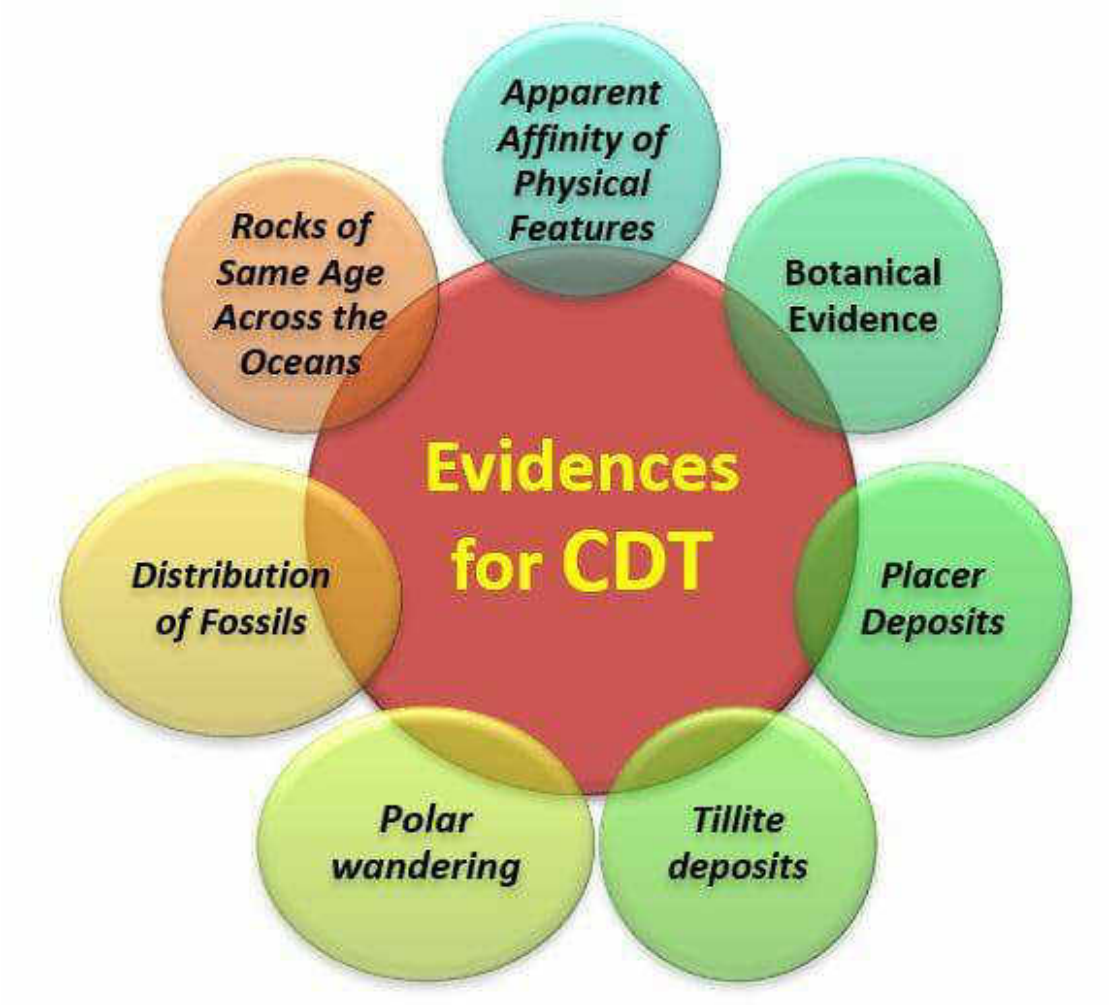
### Forces behind the drifting of continents, according to Wegener

- According to Wegener, the drift was in two directions:

1. equator wards due to the interaction of forces of gravity, pole-fleeing force (due to centrifugal force caused by earth's rotation) and buoyancy (*ship floats in water due to buoyant force offered by water*), and
2. westwards due to tidal currents because of the earth's motion (earth rotates from west to east, so tidal currents act from east to west, according to Wegener).

- Wegener suggested that tidal force (gravitational pull of the moon and to a lesser extent, the sun) also played a major role.
- The polar-fleeing force relates to the rotation of the earth. Earth is not a perfect sphere; it has a bulge at the equator. This bulge is due to the rotation of the earth (greater centrifugal force at the equator).
- Centrifugal force increases as we move from poles towards the equator. This increase in centrifugal force has led to pole fleeing, according to Wegener.
- Tidal force is due to the attraction of the moon and the sun that develops tides in oceanic waters (tides explained in detail in oceanography).
- According to Wegener, these forces would become effective when applied over many million years, and the drift is continuing.

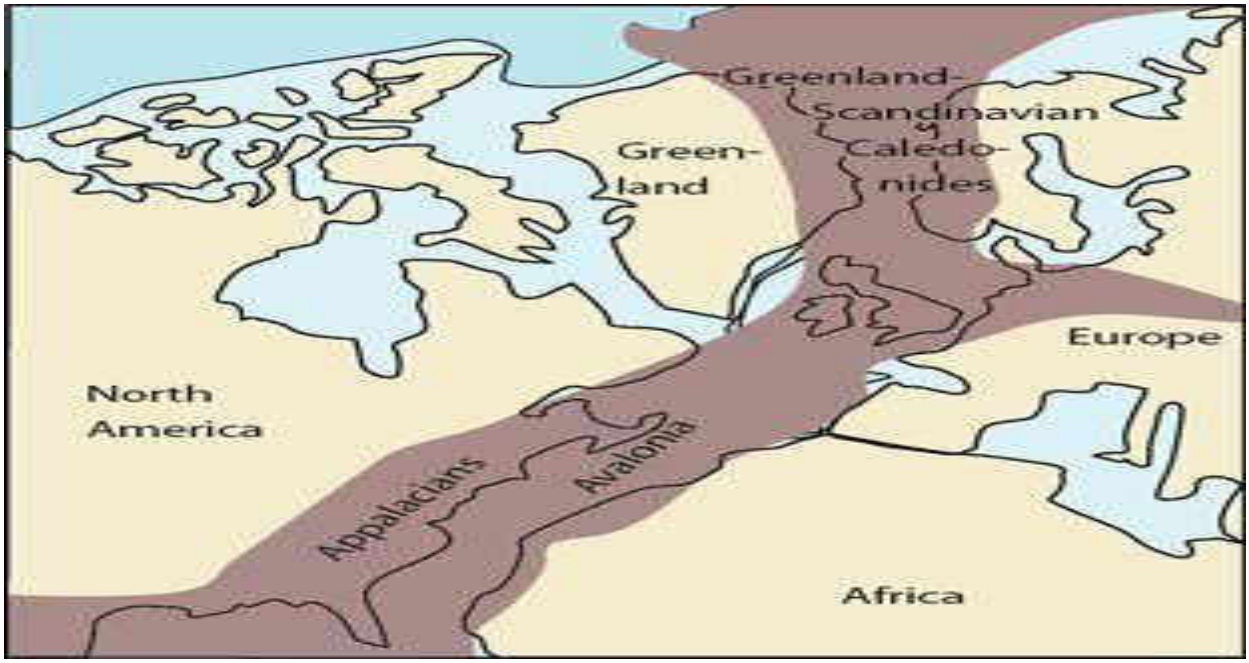
## Evidence in support of Continental Drift




Apparent Affinity of Physical Features

*Apparent Affinity of Physical Features*

- The bulge of Brazil (South America) seems to fit into the Gulf of Guinea (Africa).
- Greenland seems to fit in well with Ellesmere and Baffin islands of Canada.
- The west coast of India, Madagascar and Africa seem to have been joined.
- North and South America on one side and Africa and Europe on the other fit along the mid-Atlantic ridge.
- The Caledonian and Hercynian mountains of Europe and the Appalachians of USA seem to be one continuous series.





*Continuous Very Old Fold Mountain Chain*

### Criticism

- Coastlines are a temporary feature and are liable to change.
- Several other combinations of fitting in of unrelated landforms could be attempted.
- Continental Drift Theory shifts India's position too much to the south, distorting its relationship with the Mediterranean Sea and the Alps.
- The mountains do not always exhibit geological affinity.

### Causes of Drift

The gravity of the earth, the buoyancy of the seas and the tidal currents were given as the main factors causing the drift, by Wegener.

### Criticism

This is illogical because for these factors to be able to cause a drift of such a magnitude, they will have to be millions of times stronger.

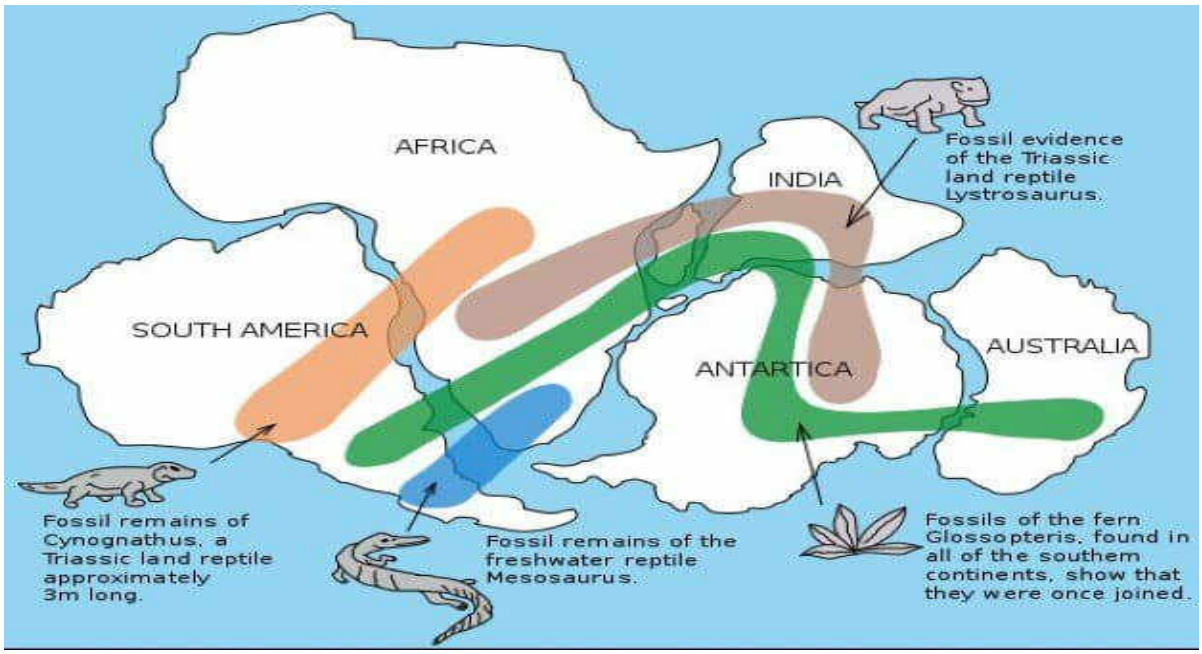
### Polar wandering (Shifting of Poles)

The position of the poles constantly drifted (due to plate tectonics).

#### Criticism

Poles may have shifted, not necessarily the continents.

## Botanical Evidence




*Distribution of Fossils across the Gondwanaland*

Presence of glossopteris vegetation in Carboniferous rocks of India, Australia, South Africa, Falkland Islands (Overseas territory of UK), Antarctica, etc. (all split from the same landmass called Gondwana) can be explained from the fact that parts were linked in the past.

### Criticism

Similar vegetation is found in unrelated parts of the world like Afghanistan, Iran and Siberia.

## Distribution of Fossils

- The observations that Lemurs occur in India, Madagascar and Africa led some to consider a contiguous landmass “Lemuria” linking these three landmasses.
- Mesosaurus was a small reptile adapted to shallow brackish water. The skeletons of these are found only in South Africa and Brazil. The two localities presently are 4,800 km apart with an ocean in between them.

### Rocks of Same Age Across the Oceans

The belt of ancient rocks of 2,000 million years from Brazil coast matches with those from western Africa.

### Criticism

Rocks of the same age and similar characteristics are found in other parts of the world too.

## Tillite deposits

- **Tillite deposits** are **sedimentary rocks formed out of deposits of glaciers**.
- The Gondwana system of sediments are found in India, Africa, Falkland Island, Madagascar, Antarctica and Australia (all were previously part of Gondwana).
- Overall resemblance demonstrates that these landmasses had remarkably similar histories.

## Placer Deposits

Rich **placer deposits of gold** are found on the Ghana coast (West Africa) but the source (gold-bearing veins) are in Brazil, and it is obvious that the gold deposits of Ghana are derived from the Brazil plateau when the two continents lay side by side.

## Drawbacks of Continental Drift Theory

- Wegener failed to explain why the drift began only in Mesozoic era and not before.
- The theory doesn't consider oceans.
- Proofs heavily depend on assumptions that are generalistic.
- Forces like buoyancy, tidal currents and gravity are too weak to be able to move continents.
- Modern theories (Plate Tectonics) accept the existence of Pangaea and related landmasses but give a very different explanation to the causes of drift.

# Law of tolerance- Shelford's

Law Till now we are concentrating on the minimal limiting factors affecting the growth or rate of biological process.

But Helford's law states that it's not only the factor present in limits/scarcity but also the excess/ abundance of that same factor can affect the growth, development of organism or rate of biological process.

For instance all nutrients required for the growth and development of organism/plant are equally important but any nutrient in abundance may limit other nutrients absorption, thus indirectly restricting or limiting the growth of organism/plant.

Thus the law of tolerance by Shelford's revealed that the growth and development of organism depends on the maximum and minimum limits of factors involved in the biological process.

Thus every factor has its own maximum and minimal limits in every organism and the “Zone of tolerance” is the range between these two limits.

Based on this, the environmental factors have two zones: (a) Zone of Intolerance and (b) Zone of Tolerance. Further the Zone of tolerance is sub divided into three zones; (i) Optimal zone, (ii) Critical minimum zone and (iii) Critical maximum zone.

### (a)Zone of Intolerance

The Zone unfavourable for the growth and development of organism is termed as Zone of Intolerance. The limit of tolerance varies from species to species with respect to different factors.

Organism survives best if have a wide range of tolerance and broad distribution range.

### (b)Zone of Tolerance

An organism grows best in the Zone of Tolerance, which is favourable for its development. This zone is sub divided into three zones:

i. **Optimum zones:**

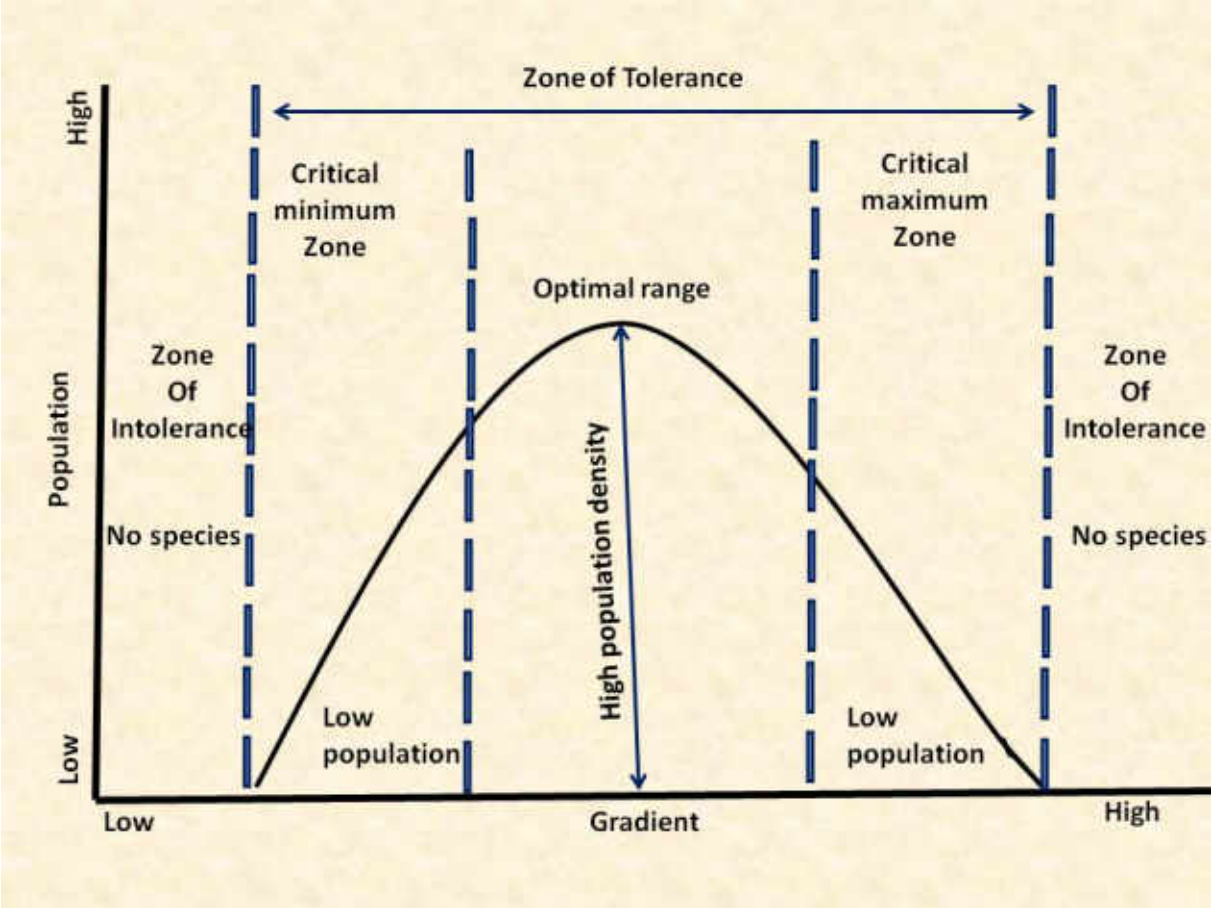
optimum zone is the most favourable zone in the range between two extreme limits thus supports maximum for the growth and development of organism.

ii. **Critical minimum Zone:**

it’s the lowest limit of minimum below which the organism growth is inhibited.

iii. **Critical maximum zone:**

it’s the maximum limit of tolerance zone above which organism growth ceases.




# Endemism

## *Endemism Definition*

Endemism is the condition of being *endemic*, or restricted in geographical distribution to an area or region. The area or region can vary in size, and is defined or identified in different ways. Endemism is an ecological classification in that it describes the range or distribution of a species, or group of species. For instance, entire families of different species of birds are endemic to the island of Madagascar. The term endemism can applied to many things, including diseases and natural phenomenon. Endemism in these cases refers to the "normal" or standard level of some measured observation within a specific geographic region or area.

Endemism is not to be confused with *indigenous*, a term which refers to the origins of a species. Indigenous refers to where a group originated. A species can be both endemic and

indigenous to an area. However, some species thrive and exceed the bounds of their original indigenous location. This means that the species is no longer endemic, but is still indigenous to the original area. Once a species has reached a wide-spread, global distribution it is said to be *cosmopolitan*. Animals like whales, once indigenous to a specific mainland in the form of their 4-legged ancestors, are now cosmopolitan in distribution.

## *Endemic Species*

An endemic species is a species which is restricted geographically to a particular area. Endemism in a species can arise through a species going extinct in other regions. This is called *paleoendemism*. Alternatively, new species are always endemic to the region in which they first appear. This is called *neoendemism*. Both forms of endemism are discussed in more detail under the heading “Types of Endemism”, below.

Endemic species, regardless of how they came to be restricted to a particular area, experience the same threats to their existence. The smaller the region, the more dire the threat toward the survival of the species. Any action that reduces the size of the land, or divides it in any way can significantly affect the normal patterns of the endemic species. While endemism and being *endangered* or *threatened* are different things, being endemic to a small area is often a warning sign that a species may become threatened or endangered.

This is not always the case, as many globally distributed species are also considered threatened or endangered. In recent years, many sharks have joined the list. While they are distributed throughout many of the ocean’s waters, the harvesting of shark fins for soup has decimated their populations globally. Endemism sometimes protects species from being exploited globally, simply because of the fact that the species only exists in a small area. This can even make the species easier to protect, because the land can be placed under a *conservation easement* to restrict the construction and human impact on the land.

## Endemic Species of India

A list of the endemic species of India is mentioned below:

### Asiatic Lion, Gir Forest

Asiatic Lion is also known as the Indian Lion and can be only found in and around Gir Forest National Park of Gujarat. These are listed as endangered species. These are one of the five big cats found in India, the others being Indian Leopards and Bengal Tigers.

## Kashmir Stag, Kashmir Valley

Also known as Hangul, Kashmir Stag is found in the dense forests of Dachigum National Park, Kasmir Valley and Chamba district, Himachal Pradesh.

## Lion-Tailed Macaque, Western Ghats

It is the rarest and the most threatened and endangered primate species found only in the Western Ghats of Southern India.

## Purple Frog, Western Ghats

The purple frog, also known as Pignose frog is only found in the rainforests of western ghats in India. It spends most of its life underground.

## Sangai Deer, Loktak Lake

It is also known as Brow Antlered Deer exclusively found in Keibul Lamjao National Park of Manipur. This park is a marshy wetland located in the southern parts of Loktak lake.

## Nilgiri Tahr, Nilgiri Hills

It is a wild sheep species, endangered and endemic to the Nilgiri Hills of Western Gats.

Other endemic species of India include:

- Pygmy Hog, Assam

- Bronzeback Vine Snake, Western Ghats
- Nilgiri Blue Robin, Nilgiri Hills
- 
- Malabar Civet, Western Ghats
- 
- Anaimalai Gliding Frog, Anaimalai Hills
- Namdapha Flying Squirrel, Arunachal Pradesh
- Indian Giant Squirrel
- Bonnet Macaque

## Examples of Endemic species

There are several ways in which a species may come to be endemic to a particular area. A broadly distributed population may disappear from several habitats due to changes which have occurred in their natural habitat. The changes could be an influx of predators, human activities, and climate changes.

All other species that were widely distributed around the world starts to die out until the species becomes forcefully restrained to just one region.

For example, Endemic species, such as the tortoises of the Galápagos and the lemurs of Madagascar can be found small islands. Big islands also provide the same isolation but on a larger scale.

Antarctica Hawaii and Australia are all huge land masses where we can find a lot of endemic species. Kangaroos, koalas, and polar bears are all endemic to these places.

In the case of endemic plants, sometimes species become endemic due to habitat destruction as discussed above.

The Redwood Forest on the West Coast of the United States has become endemic as it is now almost entirely limited to

California. While there was a time when Redwoods used to cover much of the United States but have been destroyed by logging and are now limited to a small conservation area.

Diseases, on the other hand, can also be endemic. An endemic disease may be geographically isolated or it may be isolated to a certain group. Malaria is an example of an endemic disease because it is mostly limited to small pockets of infection in Afric

## *Endemic Disease*

Scientists studying *epidemiology*, or disease outbreaks, have a similar definition of endemism. An *endemic disease* is a disease seen at consistent levels in specific location. For instance, *endemic relapsing fever* is a disease seen in Europe and in North America. The disease is not seen in any sort of observable amounts in other parts of the world. Other diseases, which are new to an area or are spiking in their prevalence, are known as *epidemic diseases*.

There are many endemic diseases, and their endemism has roots in the species and vectors which promote these diseases. In the case of relapsing fever, a *vector* carries the bacterium of the *Borrelia* species. There are several vectors which can carry these bacteria, mostly including ticks and lice. The species of ticks and lice which carry these bacteria are endemic to the Northern Hemisphere. *Borrelia* bacteria are also responsible for *Lyme disease*, a disease endemic to the Northern Hemisphere. A map of Lyme disease is shown below, and corresponds to the endemism seen in tick and lice species.

While Lyme disease and relapsing fever are endemic to these areas, they are not endemic to say, Australia. If there were even a few cases of Lyme disease in Australia, the disease would be considered epidemic, because the normal level of Lyme disease in Australia is zero.

# *Examples of Endemism*

### Paleoendemism

There are two basic ways for a species to show endemism to a certain region. Basically, the

difference between the two is whether the species is newly emerging, or historic and declining. Paleoendemism describes the later. In this form of endemism, a species which was once widespread has been reduced to a much smaller range. This is the case for many large predators today.

Before humans, large predators were widely distributed across the globe. As human society became more organized, large predators were driven away from society, and out of their historic ranges. Those which have not gone *extinct* are now restricted to limited ranges. Conservation efforts for these animal focus on protecting the current range and expanding it to encompass the historic range. This is hard however, as humans often oppose the re-introduction of large predators. Without protections from hunters, the species will easily be pushed back to their endemic range.

## Neoendemism

On the opposite hand, new species are branching off the evolutionary tree every day. These species are both endemic and indigenous to the location in which they first appeared. They are restricted to a geographical location simply because that is where they started. This is known as neoendemism. There are many species, found on islands, which show this form of endemism.

Islands provide an interesting and isolated grounds for the development of new species. While the species on the island are now endemic, their ancestors were likely not. Take the Galapagos finches, as an example. The Galapagos archipelago contains many islands. Many thousands of years ago, a single finch species arrived on the islands. At first, it spread across the island as one species. However, evolution has now separated the birds so much that they represent different species. The differences in the vegetation on the islands divided the ancestor into many smaller species, which show endemism to the island they are found on.

### Q. Which of the following factors affect the natural habitat of endemic species?

- Habitat destruction occurs when natural habitats are no longer able to support the species present, resulting in the displacement or destruction of its biodiversity.
- The growth of the human population has impacted the planet and affected biodiversity. The need for food, space and raw materials has resulted in the destruction of habitats and pollution.
- Introduction of invasive species causes harm to wildlife in many ways. When a new and aggressive species is introduced into an ecosystem, it may not have any natural predators or controls. Invasive species can also alter the abundance or diversity of species that are important habitat for native wildlife.

# Major Terrestrial Biomes

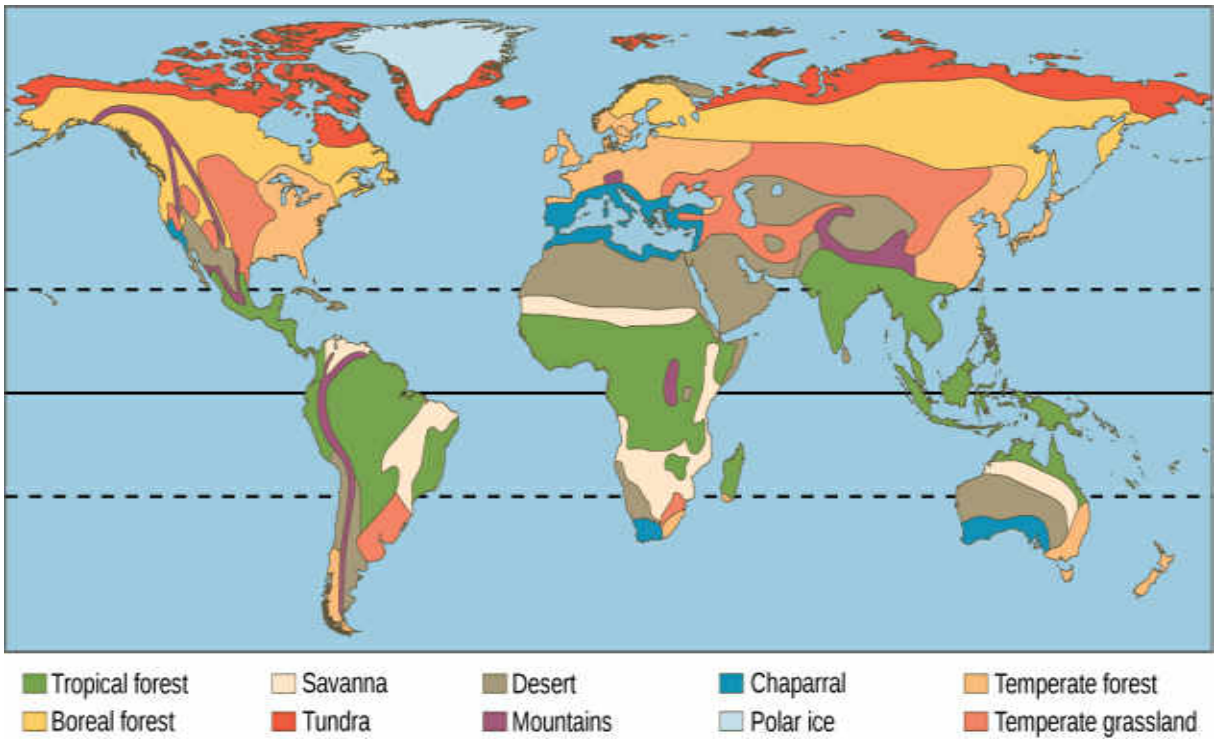



Figure 1. Each of the world's eight major biomes is distinguished by characteristic temperatures and amount of precipitation. Polar ice caps and mountains are also shown.

There are eight major terrestrial biomes: tropical rainforests, savannas, subtropical deserts, chaparral, temperate grasslands, temperate forests, boreal forests, and Arctic tundra. **Biomes** are large-scale environments that are distinguished by characteristic temperature ranges and amounts of precipitation. These two variables affect the types of vegetation and animal life that can exist in those areas. Because each biome is defined by climate, the same biome can occur in geographically distinct areas with similar climates.

## Tropical Wet Forest

Tropical wet forests are also referred to as tropical rainforests. This biome is found in equatorial regions. The vegetation is characterized by plants with broad leaves that fall

off throughout the year. Unlike the trees of deciduous forests, the trees in this biome do not have a seasonal loss of leaves associated with variations in temperature and sunlight; these forests are “evergreen” year-round.

The temperature and sunlight profiles of tropical wet forests are very stable in comparison to that of other terrestrial biomes, with the temperatures ranging from 20 °C to 34 °C (68 °F to 93 °F). When one compares the annual temperature variation of tropical wet forests with that of other forest biomes, the lack of seasonal temperature variation in the tropical wet forest becomes apparent. This lack of seasonality leads to year-round plant growth, rather than the seasonal (spring, summer, and fall) growth seen in other biomes. In contrast to other ecosystems, tropical ecosystems do not have long days and short days during the yearly cycle. Instead, a constant daily amount of sunlight (11–12 hrs per day) provides more solar radiation, thereby, a longer period of time for plant growth.

The annual rainfall in tropical wet forests ranges from 125 to 660 cm (50–200 in) with some monthly variation. While sunlight and temperature remain fairly consistent, annual rainfall is highly variable. Tropical wet forests have wet months in which there can be more than 30 cm (11–12 in) of precipitation, as well as dry months in which there are fewer than 10 cm (3.5 in) of rainfall. However, the driest month of a tropical wet forest still exceeds the *annua*l rainfall of some other biomes, such as deserts.

Figure 1. Tropical wet forests, such as these forests of Madre de Dios, Peru, near the

Amazon River, have high species diversity. (credit: Roosevelt Garcia)

Tropical wet forests have high net primary productivity because the annual temperatures and precipitation values in these areas are ideal for plant growth. Therefore, the extensive biomass present in the tropical wet forest leads to plant communities with very high species diversities (Figure 1). Tropical wet forests have more species of trees than any other biome; on average between 100 and 300 species of trees are present in a single hectare (2.5 acres) of South America. One way to visualize this is to compare the distinctive horizontal layers within the tropical wet forest biome. On the forest floor is a sparse layer of plants and decaying plant matter. Above that is an understory of short shrubby foliage. A layer of trees rises above this understory and is topped by a closed upper canopy—the uppermost overhead layer of branches and leaves. Some additional trees emerge through this closed upper canopy. These layers provide diverse and complex habitats for the variety of plants, fungi, animals, and other organisms within the tropical wet forests. For instance, epiphytes are plants that grow on other plants, which typically are not harmed. Epiphytes are found throughout tropical wet forest biomes. Many species of animals use the variety of plants and the complex structure of the tropical wet forests for food and shelter. Some organisms live several meters above ground and have adapted to this arboreal lifestyle.

## Temperate Grasslands

Temperate grasslands are found throughout central North America, where they are also known as prairies; they are also in Eurasia, where they are known as steppes (Figure 5). Temperate grasslands have pronounced annual fluctuations in temperature with hot summers and cold winters. The annual temperature variation produces specific growing seasons for plants. Plant growth is possible when temperatures are warm enough to sustain plant growth and when ample water is available, which occurs in the spring, summer, and fall. During much of the winter, temperatures are low, and water, which is stored in the form of ice, is not available for plant growth.

Figure 5. The American bison (*Bison bison*), more commonly called the buffalo, is a grazing mammal that once populated American prairies in huge numbers. (credit: Jack Dykinga, USDA Agricultural Research Service)

Annual precipitation ranges from 25 cm to 75 cm (9.8–29.5 in). Because of relatively lower annual precipitation in temperate grasslands, there are few trees except for those found growing along rivers or streams. The dominant vegetation tends to consist of grasses and some prairies sustain populations of grazing animals Figure 5. The vegetation is very dense and the soils are fertile because the subsurface of the soil is packed with the roots and rhizomes (underground stems) of these grasses. The roots and rhizomes act to anchor plants into the ground and replenish the organic material (humus) in the soil when they die and decay.

Fires, mainly caused by lightning, are a natural disturbance in temperate grasslands. When fire is suppressed in temperate grasslands, the vegetation eventually converts to scrub and dense forests. Often, the restoration or management of temperate grasslands requires the use of controlled burns to suppress the growth of trees and maintain the grasses.

Arctic Tundra

Figure 8. Low-growing plants such as shrub willow dominate the tundra landscape, shown here in the Arctic National Wildlife Refuge. (credit: USFWS Arctic National Wildlife Refuge)

The Arctic tundra lies north of the subarctic boreal forest and is located throughout the Arctic regions of the northern hemisphere (Figure 8). The average winter temperature is −34 °C (−34 °F) and the average summer temperature is from 3 °C to 12 °C (37 °F–52 °F). Plants in the arctic tundra have a very short growing season of approximately 10–12 weeks. However, during this time, there are almost 24 hours of daylight and plant growth is rapid. The annual precipitation of the Arctic tundra is very low with little annual variation in precipitation. And, as in the boreal forests, there is little evaporation due to the cold temperatures.

Plants in the Arctic tundra are generally low to the ground (Figure 8). There is little species diversity, low net primary productivity, and low aboveground biomass. The soils of the Arctic tundra may remain in a perennially frozen state referred to as permafrost. The permafrost makes it impossible for roots to penetrate deep into the soil and slows the decay of organic matter, which inhibits the release of nutrients from organic matter. During the growing season, the ground of the Arctic tundra can be completely covered with plants or lichens.

## Phytogeographical Zones of India

India has a unique pattern of vegetation in general with great floristic diversity. Hajra et al. (1996) classified India into 14 phytogeographical zones:

(1) North-West Himalayas

(2) Indo-Gangetic Plains

(3) Eastern Himalayas

(4) North-Eastern India and North Bengal

(5) Central India

(6) Arid zone

(7) North Western Ghats and North-West Coast

(8) Southern Western Ghats - South of Goa

(9) South West Coast

(10) Lakshadweep

(11) Deccan

(12) Eastern Ghats

(13) Coromandel Coast

(14) Andaman and Nicobar Islands.

**North-West Himalayas**: There is a distinct altitudinal zonation in the vegetation of this area. In the foothills below 1000 m, as in the Siwaliks, the forests are of Subtropical Dry Evergreen type having species of Olea, Punica, Acacia, Pistacia etc. The lower elevations are covered by subtropical pine forests. Composed of chiefly Pinus roxburghii and species of Quercus or Syzygium or Rhododendron. In the lower temperate zone between 1500 and 3300 m moist forests of Orobanche, Abies, Quercus,

Cedrus, Picea and Acer are met with. The upper temperate areas are covered by predominantly coniferous forests with dominant species of Finns, Cedrus, Picea and Tsuga and sometimes, Taxus and Betula. The inner ranges of mountains have dry temperate forests of Pinus gerardiana and species of Cedrus, Quercus, Acer, Fraxinus, Celtis and Ole a. In subalpine zone the forests are mainly of Pinus wallichiana along with scattered species of Abies, Picea, Taxus, Betula, Rhododendrons and somerosaceous plants. Above 3000 m, the vegetation is moist alpine scrub comprising species of Betula, Rhododendron, iJnicera and Berberis. Indo-Gangetk Plains: Gangetic plains stretching from eastern Rajasthan through Uttar Pradesh to Bihar are mostly under agriculture. Owing to extensive agricultural practice, population pressure, excessive felling of trees, overgrazing, fire and human interference, forests bordering the cultivated areas have been degraded to open scrub jungles with scattered small trees like Butea monosperma. The Submontane moist parts are characterised by Tropical moist deciduous forests of Shorea robusta mixed with species of Lagerstroemia, Adina, Kydia, Litsea, Syzygium, Mallotus etc. , but larger areas are covered by tropical dry deciduous forests having species of Terminalia, Anogeissus, Semecarpus, Buchanania, Acacia, Aegle etc. and with tall grasses of the genera Themeda, Saccharum, Cymbopogon, Apluda, Dichanthium, Bothriochloa, Desmostachya, Chloris, Vetiveria etc. Some pockets in the protected National Parks have rich vegetation. The southeastern end of the Gangetic plain merges with the littoral and mangrove regions of Sunderbans, where species of Heritiera, Bruguiera, Sonneratia, Rhizophora, etc. form the dominant species.

**Eastern Himalayas**: The forests of eastern Himalayas are rich in orchids. About 600 species of orchids are reported from Sikkim and eastern India. Compared with western Himalayas, the eastern Himalayas are wetter and warmer, and hence more richly vegetated. The floristic elements of western China, which are distributed all along the Sikkim Himalayas are Aletris pauciflora, Lathraea purpurea, Anemone rupicola, A. vitifolia etc. The forests in foothills are known for species of Dipterocarpus, Artocarpus and Shorea. The lower slopes have tropical semi-evergree forests of Terminalia myriocarpa, Michelia champaca, species of Phoebe, Dysoxylum, Canarium, Litsea, Mangifera, Castanopsis etc. Between the altitudes of 1800 and 3000 m, the forests are of montane wet or moist temperate type having species chiefly of Machilus, Lathraea, Cinnamomum, Litsea etc.

**North Eastern India and North Bengal**: Eastern India includes broadly the plains of Arunachal Pradesh and all the other six eastern states. This region is characterised by high rainfall and humidity. The vegetation is very varied. Tropical wet evergreen forests comprising species of Orobanche, Boschniakia, Dipterocarpus, Syzygium, Artocarpus, Mesua, Cistanche, Lathraea, Aquillaria, and Bambusa mostly occur. Though the flora of this region exhibits an Indo-Malayan affinity, the floristic elements of other parts of India, the neighbouring and far off countries have also contributed to its richness and diversity. Tropical semievergreen forests comprising species of Phoebe, Dysoxylon, Terminalia, Michelia etc. also occur in foothills.

**Central India**: The forests in central India cover about 32% of its total area. These forests have been subjected to misuse and over exploitation. The main forest types occurring in this region are tropical evergreen forests, semi-evergreen forests, moist deciduous forests, dry deciduous forests and thorn forests. Central India supports a rich aquatic vegetation in its innumerous rivers, streams, lakes, drains, ponds, reservoirs, puddles and ditches and even in the paddyfields. And a good diversity of the floating hydrophytes, suspended submerged, hydrophytes, anchored submerged hydrophytes etc.

**Arid Zone:** The eastern limit of the western India arid zone is marked by the north-east tending Aravalli range. The western dry region of India has four fairly distinct habitat conditions. In the sandy plains, a few scattered trees of Acacia and Prosopis and bushy plants like Calligonum, Lycium, Aerva, Leptadenia, Crotalaria and Capparis are common. The gravelly plains or rocks have species of Calotropis, Gymnosporia, Ziziphus, Cassia, Commiphora, Indigofera etc. Species of Phoenix are also common. In rocky habitats bushes of Euphorbia and Grewia are generally seen. In moist and shady places, there is a fair growth of trees and shrubs of this species Anogeissus, Dichrostachys, Prosopis, Acacia and Ziziphus.

**North Western Ghats and North West Coast**: This is one of the richest forest areas in India. The Western Ghats in general support the tropical moist deciduous forests dominated by species of Terminalia, Dalbergia, Pterocarpus, Schleichera etc. but several areas are covered by dense forests chiefly tropical wet evergreen type. The dominant plants of these forests are species of Mesua, Cullenia, Dysoxylum, Dipterocarpus, Calophyllum, Toona, Persea, Holigama, Palaquium, Poeciloneuron,

Canarium and Calamus, the higher hills have montane wet temperate forests having species of Cinnamomum, Michelia, Garcinia, Hydnocarpus etc.

**Southern Western Ghats - South of Goa:** The Western Ghats are considered as the most important centre of bidoversity due to its characeristic bioclimatic, latitudinal and physiographic features. The Nilgiris have subtropical broad-leaved hill forests of species of Syzygium, Machilus, Meliosma, Elaeocarpus, Celtis etc. The region also has rich endemism. Acacia, Aeginetia, Andrographis, Artocarpus, Calophyllum, Cassia, Christisonia, Cinnamomum, Crotalaria, Cymbopogon, Diospyros, Dipterocarpus, Euphorbia, Fimbristylis, Grewia, Leucas, Memecylon, Polycarpaea, Pterocarpus, Santalum, Strobilanthes, Terminalia, Tylophora, Zizyphus etc. are the major genera found in this region.

**South West Coast:** The vegetation of coastal regions of India consists of strand and estuarine vegetation. In strand sand, mat forming species like Canavalia, Cyperus, Ipomea pes-caprae and others like Ceropegia tuberosa, Exbecaria agallocha, Hibiscus tiliaceus, Gloriosa superba, Sonneratia apetala etc. are seen. Some of the species of strand vegetation found on the coast, represent elements of the western and eastern hemisphere. Apart from the above trend, a few endemics are also noticeable on the coast.

**Lakshadweep:** All the islands are almost plain, the highest point being not more than 5 m above minimum sea level. The common trees in the islands are Alstonia scholaris, Azadirachta indica, Bombax ceiba, Calophyllum inophyllum, Ficus religiosa, Terminalia catappa, Thespesia populanea and Zizyphus mauritiana. Casuarina littorea and Delonix regia are often planted as avenue trees. Due to increase in human population and biotic interference, the natural flora ofthis region consists only of psammophytic herbs and shrubs.

**Deccan:** This is the large rather triangle-shaped plateau with its base in the south of Vindhyachal mountains and the two sides lying on the east and west of the Western and Eastern Ghats respectively. Tropical dry deciduous forests occur in the northern, central and southern parts of the plateau; they have teak forests intermixed with species of Anogeissus, Diospyros, Dalbergia, Pterocarpus, Cassia, Butea, Adina, Aegle, Lagerstroemia and Bambusa. The eastern parts of plateau in Andhra Pradesh, Madhya

Pradesh and Orissa are composed of moist deciduous forests with species of Terminalia, Bombax, Dalbergia, Madhuca, Ceiba, Grewia, Phyllanthus, Cleistanthus, Schleichera and bamboos. Shorea robusta (Sal) is abundant in northeastern part of the plateau.

**Eastern Ghats:** The Eastern Ghats occupy an important position in the Indian peninsula and they act as a migratory tract from north to south and vice-versa. The forest cover on the Eastern Ghats is not as rich as on the Western Ghats. Large areas are under tropical dry deciduous or thorn forests. Some areas bordering on Orissa have moist deciduous forests. The common trees seen here are Callicarpa tomentosa, Cinnamomum zeylanicum, Elaeocarpus serratus, Meliostm microcarpa, Anogeissus latifolia, Hardwickia binata, Shorea tumbaggaia, Sterculia urens and Syzygium altemarifolium.

**Coromandel Coast**: The East Coast is approximately 1500 km long with an average of about 100 to 130 km running in wide curves. The following species are common in strand vegetation as well as estuarine vegetation. Avicennia officinalis, Bruguiera cylindrica, Canavalia maritima, Ceriops tagal, Cyperus arenarius, Ipomea pes-caprae, Kandelia candel, Laurea sarmentosa, Rhizophora mucronata, Rothia indica, Sesuvium portulacastrum and Xylocarpus granatum etc. Sea grasses like Cymodocea rotundata, C. serrulata, Enhalus acroides, Halophila beccarii, H. decipiens, H. ovalis, H. ovalis subsp. ramamurthiana, H. ovata, H. stipulacea, Thalassia hemprichii and Halodule pinifolia occur in this region.

**Andaman and Nicobar Islands:** The flora of Andaman and Nicobar groups of islands is very rich with about 3,000 taxa of angiosperms, pteridophytes, bryophytes, lichens etc. Among the angiosperms 10 percent are endemic to these islands. Tropical wet evergreen, semievergreen and moist deciduous forests are the main forest types in both the group of islands. The Andamans have very rich Dipterocarpus and Pterocarpus forests. The main tree species in Great Nicobar islands are Terminalia, Canarium, Artocarpus, Calophyllum, Miliusa, Hors fieldia, Amoora, Alstonia, Hopea and Syzygium. Dipterocarpus and Pterocarpus are absent in Nicobar Islands.

Reference

Flora of India Introductory volume II, BSI,1996

# SOME QUESTIONS ON ECOLOGY

1. What is the maximum number of steps in a food chain? 2. What advantage is it to have a short food chain? 3. What is a niche? 4. Nitrogen fixing bacteria are associated with what plants? 5. What do you call a group of similar organisms from the same locality? 6. Name a source for atmospheric nitrogen. 7. What is the most abundant gas in the atmosphere? 8. What do you call the place where an organism lives? 9. What is a pyramid of numbers? 10. What is weathering? 11. Name the trophic levels and give an example of each. 12. What is a food chain? 13. What is a food web? 14. What is the relationship between a legume and its nitrogen fiixing bacteria? 1 5. What is the relationship between a termite and its cellulose eating protozoa? 16. What is the relationship between a host and a natural parasite? 17. What was the big mistake made at Kaibab? i8. Be able to identify the different age pyramids: stable, declining and expanding population. 19. What is the formula for biotic potential? 20. What keeps a population from over reproducing? 21. Name the seven stages of a sigmoid growth curve. 22. What is the difference between a sigmoid growth curve and a "j" shaped growth curve? 23. Name the three survivorship curves and what they represent. 24. Name the six biological seasons and what happens in each. 25. What kind of biological cycle is shown by grunion? 26. Give an example of an inherent rhythm. 27. What is the difference between primary and secondary succession? 28. Be able to identify the symbiotic relationships and know examples of each. 29. What is a sere? 30. What is a serial stage? 31. What is a Disclimax? 32. Can succession be controlled? 33. What is an Ecotone? 34. What is the "edge effect?" 35. What is the species - numbers relationship? 36. What are some of the ways that a community can become more stable? 37 Name the useful kind of fire? 38. How are redwoods affected by fire? 39. Hygroscopic water is associated with what type of soils? 40. What is an ecological indicator? 41. Name some of the benefits of fire. 42. What is Liebig's Law of the Minimum? 43. What is Shelford's Law of Tolerance? 44. How can a terrestrial poikilotherrn regulate its body temperature? 45. What are the sources of oxygen in water? 46. What are the sources of carbon dioxide in water? 47. In which soil horizon does mineralization take place? 48. In which soil horizon is the bulk of organic life found? 49. Which horizon indicates the productivity of that environment? 50. Name the habitat with the thickest "A" horizon. 5 I. Which habitat should not be used for agriculture do to its fragile nature? 52. What are the qualities of light that make it a Limiting factor? 53. What are some of the benefits gained from the light duration studies? 54. What are the properties of water and their associated gas absorption values? 55. What is the difference between an extrinsic and an intrinsic factor? 56. Name an animal which migrates just to reproduce. 57. What is the social structure in a "pecking order?" 58. What is the Alpha individual and an Omega individual? 59. How does territory influence the behavior of animals? 60 What is the symbiotic relationship

between the pronuba moth and the yucca plant? 61. Give the correct sequence for nitrogen build up in the soil starting with ammonia. 62. Name the kind of decomposers one would find in the soil. 63. What is known as Gause's principle? 64. Name the three kinds of successional climaxes. 65. Why are high temperature more damaging than low temperature to organisms? 66. Light sensitive seeds show the greatest germination in what wavelenght of light? 67. What group of plants/algae have shown the effect of wavelength on their distribution? 5 68. What is the relationship between temperature of the air and the amount of moisture it can hold?