

3: Community ecology:.....Page 32-36

3-1: Principles of community structure:..... Lecture10

Biotic communities consist of all the plants and animal populations inhabiting a given area . They represent a higher order of biological organization than populations . As with populations , it is again important to think of communities in terms of structure and function . Structure , refers to spatial distribution of different populations within a community (species diversity) . Function , refers to the interactional processes (relationships between producers , consumers and decomposers) , energetic relationships , and patterns of change within communities (succession).

Biotic communities occur in a very diverse forms . For example ; arctic tundra , grasslands , deserts , northern coniferous forests , tropical forests , oceans , streams , rivers , ponds , lakes and estuaries . Major terrestrial communities , each characterized by certain types of plants and distinctive life forms , are known as " biomes " . Regional climates interact with regional biota and soil to produce these large , easily recognizable community units (Fig . 20).

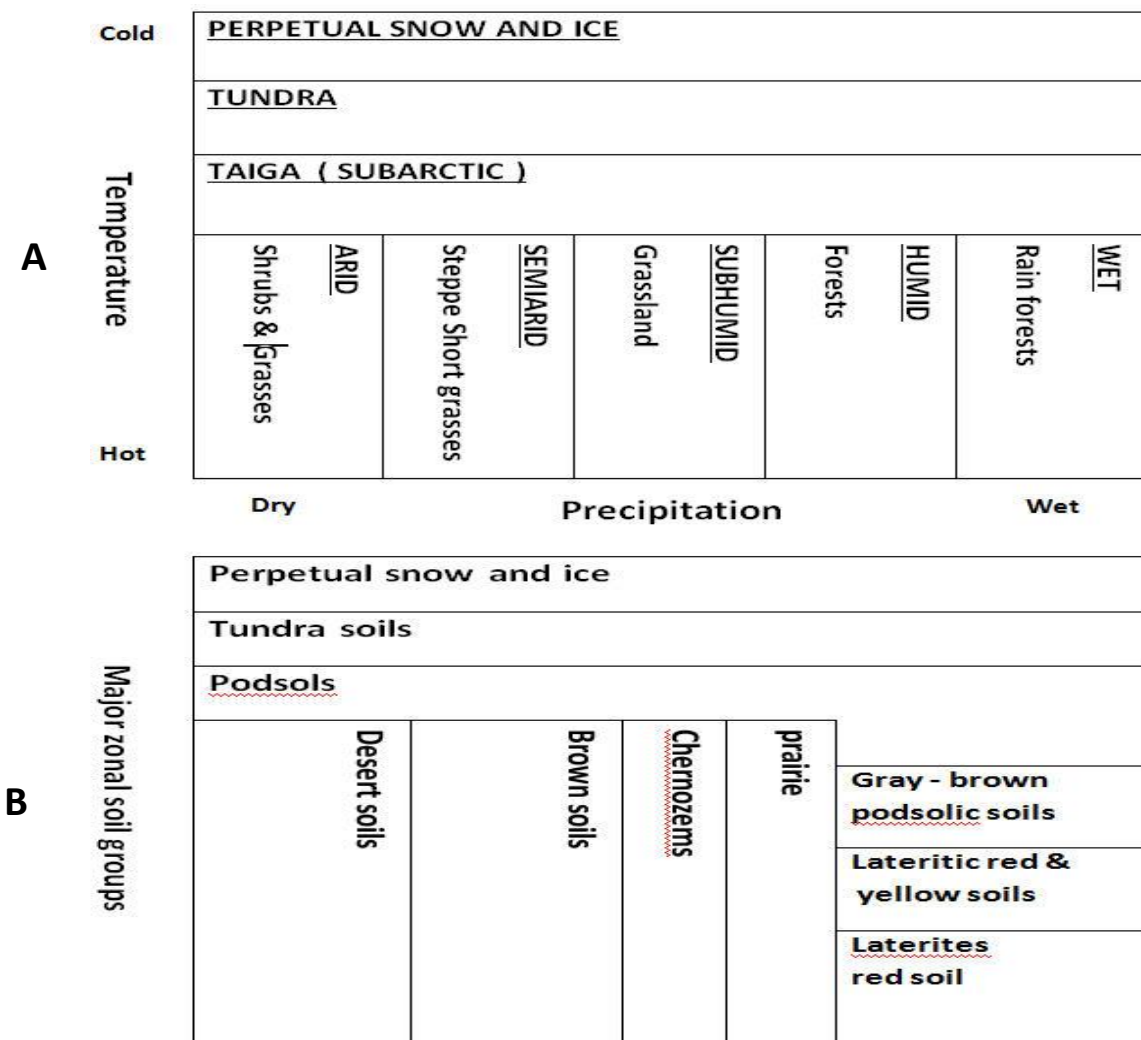


Fig . 20 : The interrelation of climate (underlined) & vegetational formations (A) and major zonal soil groups (B) .

Species diversity :

An important ecological principle is that species diversity of biotic communities generally increases in proceeding from polar regions to the equatorial tropical regions . For example , cold temperate forests often have less than 10 species of trees ; warm temperate forests often have 20 - 30 species, whereas the tropical forests usually have over 100 species of trees .This principle is true also for almost every plant and animal species , for example polar regions have less than 80 species of breeding birds , temperate regions have 100 - 200 and tropical regions have 500 - 1300 .

Indices of species diversity:

Species diversity is consider as a measure of diversity between biotic communities . Species diversity is a function to the number of species occurred , the number of individuals of each species and the total number of individuals of all species occurred within a community .

Several diversity indices are known in ecology , some of which become complicated due to difficulty in counting species or individuals of some natural communities .

1 - Simpson's measure of diversity

$$D = 1 - \frac{\sum ni (ni-1)}{N(N-1)}$$

Where D = Diversity measure

ni = number of individuals of each species

N = total number of individuals of all species

2 - Marglef's index of diversity

$$I = \frac{S-1}{\text{Log } N}$$

Where I = Index of diversity

S = number of species

N = total number of individuals of all species

3 - Shanon's index of diversity

$$I = - \sum Pi \text{Log } Pi$$

Where I = Index of diversity

OR
$$I = - \sum \frac{ni}{N} \text{Log } \frac{ni}{N}$$

Pi = Percentage of the individuals of each

Species to the total number of individuals of all species $(\frac{ni}{N})$

ni = number of individuals of each species

N = total number of individuals of all species

Factors affecting species diversity :

- 1 - The severity of the physical and chemical conditions in a given ecosystem . **It becomes reasonable to believe in the theory that " those environments with severe physical and chemical conditions will have the least diversity "** . Thus , we would expect deserts , ocean depths , polar regions and polluted environments to have the least diversity in their biotic communities .
- 2 - Size of environment and its topography . It is well known for example , that larger island contains more species than smaller island when both occurred under the same climate conditions . Similarly, island contains usually less species number than those occurred in the neighboring continental mainland.

Succession:

Biotic communities change with time as their plant and animal communities change . This process is known as " succession " , and it involves a sequence of community types from pioneer stages to mature or climax stages . One of the best ways to understand succession is to discuss the sequential growth and development of biotic communities on a cleared forests .

The following example is just for information

If a deciduous forest is cut , and the land cleared to the soil , a succession of plants will invade and grow on the exposed soil . The first plants which invade are those capable of seeding in quickly on disturbed land or capable of exposure to direct sunlight . This depends upon seeds from surrounding plant communities , as well as the characteristics of the soil and climate .

As soon as the first plants germinate , the community increases largely in physical complexity . the surface of soil has now shaded areas with new conditions of light and moisture . This enables other seeds to grow and new species become established . Pioneer animals also arrive , including ants , beetles and flying insects . Birds begin to fly over the new community searching for seeds and insects . Mammals may arrive also from adjacent communities . Each animal entering the area adds organic nutrients . Within a year or two a complex community has arisen . As plants grow , they continuously modify the light and moisture conditions on the surface of the ground . Thus initial pioneers of plants which correlated with direct sunlight , are now less favored than those which are more shade - tolerant . Hence , woody shrubs emerge above the herbaceous layer and compete more successfully for the ambient light . The shade developing beneath the herbaceous and shrubby layers permits the growth of tree species such as oaks which could not tolerate the initial exposure to sun and wind . This represents the first beginning of the forest .

Further succession continues to involve all the dynamic processes of plant and animal competition. Over a period of years , the initial invaders and pioneers begin to drop out . Trees mature and begin to take over the dominance in the community . The forest may now be 40 - 50 years old , reaching a height of 50 - 60 feet . By 70 - 80 years , the forest may be approaching relative maturity with tall trees of 60 - 80 feet , and deep shade . The climax stage may be approached in 80 - 100 years , when it becomes a stable community .

3-2: Major terrestrial biotic communities , the biomes:

1 - Arctic tundra :

Arctic tundra is the biotic community occupying the northern latitudes , generally above 60° north latitude . The dominant plants are lichens and arctic grasses.

The animal community is simplified into a relatively few species of birds , mammals and flying insects . The dominant mammals are the caribou , snowshoe hare , lemming and arctic fox .

The most important feature of tundra is its sudden productivity during a brief summer .This productivity is very great in both plant and animal life , which extends far beyond the limits of the tundra itself , through migration of several animals towards tundra during summer .

2 - Northern coniferous forest:

This is a forest belt at latitudes below tundra, generally between 50 - 60° north latitude . Plant community is dominated by spruces , firs , pines and hemlock ,with ground cover of lichens , grasses and cold - adapted herbs. Animal populations are more diverse than tundra , typical mammals are the snowshoe hare , lynx, squirrels , wolf , woodland caribou , deer and black bear .

Northern coniferous forests represent the great trading regions for wood , fur and mineral freshwaters in the world .

3 – Grasslands:

These are great plain areas with 10 - 30 inches of rainfall , which is generally less than most forested regions . The plant community is dominated by grasses in addition to a great variety of herbs , particularly legumes , such as trefoil . In all , a grassland or prairie flora may contain over 120 species in more than 10 families . The , the annual production of organic material in grassland is great ,organic accumulation is rapid ,and a thick layer of humus is produced . Thus , grasslands soils are among the thickest and richest in the world , where the roots of the grasses penetrate up to 6 feet in these rich soils .The animal populations of grasslands are also rich and varied. Among the mammals , for example the ungulates and rodents have great populations .

Grasslands , represent some of the greatest agricultural areas of the world for cattle, corn , and wheat farming .

4 – Deserts:

Deserts are arid biomes with usually less than 10 inches of rainfall per year . Deserts usually occur in areas of high pressure , rain shadows of mountains or high altitudes and they represent approximately 18 % of the world's land surface .

The predominant plants of deserts are succulent species with waxy surfaces, such as cacti ,or deciduous shrubs with thick waxy leaves . The growing season is very short , occurring suddenly after rains .

The animal community of deserts is confined , of course , to areas with plant life , and it is dominated by burrowing and nocturnal rodents , reptiles, insects and arachnids , such as scorpions and spiders. Most of these animals have remarkable water conservation adaptations . For example , many insects and arachnids have waxy coats and reduce water loss through the cuticle , whereas some desert rodents such as kangaroo rat utilize metabolic water , that is , they require no free water .

Deserts can be productive by more than irrigation , because although desert agriculture requires water as primary limiting factor , but excessive soil minerals , salinity and lack of organic material may also be limiting . Desert represent also the most constant resource of solar energy for future generating of electric power .

5 - Tropical rain forests:

These forests occur between 23° 27 ' N and S latitudes in areas with more than 80 inches of rainfall per year , and with one or more dry seasons per year .

The important characteristics of the tropical rain forest are ; the relative climatic stability , the richness and diversity of species and it represents a typical stratified community . Such forests are often very high and consist of 3 - 4 layers of trees , as follows :

- 1 - Ground layer of less than 20 feet .
- 2 - Intermediate layer of about 50 - 75 feet .
- 3 - A canopy layer of about 150 - 200 feet above the ground .
- 4 - Giant trees (emergents) , extending above the canopy to elevations of 250 feet .

Tropical rain forests have provide man with economic resources , such as Burmese teak , and Sandalwood. They are important also in the total oxygen balance of the world .