CHAPTER 5

Basic Ecological Concepts

Ecology is derived from a Greek word oikosâ€™ which means home.â€™ Ecology involves the study of organisms in relation to their environments. It is the study of plants and animals in their natural homes (habitats). It involves observing how they live, the relationship between them and the way they are affected by their surroundings (environments).

It may also be described as the study of structure and function of nature. Ecology is concerned mainly with populations, communities, ecosystems and the biosphere. It is a branch of biology that demands leaving the classrooms, conducting field study and working in the laboratory.

Ecological Concepts

In ecology, we make use of some important concepts. Some of these are discussed briefly below.

Environment

This is what the layman calls the surrounding. It is the totality of external factors, living (biotic) and non-living (abiotic) factors, which affect an organism. It may also include internal factors such as body fluids of the organism.

Biosphere

This is the part of the earth (i.e. soil, air and water) that supports life. This includes seas, oceans, fresh water and land habitats.

Lithosphere

This consists of certain parts of the earthâ€™s crust on or in which plants and animals live.

Hydrosphere

This is the aquatic part of the biosphere, e.g. rivers, lakes and oceans.

Atmosphere

The atmosphere surrounds the earth. It is the air we breathe. It consists of three main gases:
nitrogen (78%), oxygen (20.9%) and carbon (IV) oxide (0.03) and some

other gases (0.97).

Habitats

This is an area occupied by a biotic community. It is any environment in which an organism lives naturally. There, many similar organisms tend to gather and live together. It is an area where physical and chemical constituents and requirements needed to sustain life are similar. It is where the life of an organism is sustained. A habitat is always affected by environmental factors. Habitats can be terrestrial, e.g. forest, deserts, fields, farms, or grass lands, or aquatic, e.g. seas, oceans, lagoons, freshwater, ponds, puddles, lakes, gutters and streams.

Community

This consists of all organisms occupying a particular area or space. Example: a pond community includes the plants, animals and micro organisms within that pond at that period.

Ecological niche

An ecological niche refers to an organismsâ€™ physical space and its functional role in the community. It refers to an organismsâ€™ position in a food web and its relation to other biotic and abiotic factors. Every organism in a community is adapted to a given habitat. No other organism shares the role with the organism at the same time.

Population

It is the total number of organisms of the same kind living together in a habitat at a particular time. Examples include the populations of cockroaches or rats in a kitchen.

Biome or biotic community

A biome is the biggest community of organisms. Each biome has characteristic plants and animals which are more or less unique to itself and these are controlled by various climatic factors. Each community differs from the other, e.g. the sea community is different from the seashore community. The pond community differs from the desert community. The major biomes in West Africa are tropical swamp forest, rain forest, savannas and semi-desert.

Ecosystem

An ecosystem may also be called an ecological system. It is the basic functional unit in nature. It consists of all living factors and their interactions with the non-living factors of the environment. Each component influences the properties of the others and each is necessary for the maintenance of life on earth. Interactions between living and non-living components include circulation of materials, feeding and reproduction. An ecosystem can be natural or artificially created as in the laboratories. The size of an ecosystem varies greatly. It can be big or small. Examples of ecosystems are a rotten log, a

bush, or a school field, a pond or an ocean.

Components of an Ecosystem

The two main components of the ecosystem are the abiotic (non-living) and the biotic (living) factors.

Abiotic components

These are the non-living factors. They are the basic elements and compounds of an environment on which an organism lives. They consist of organic and inorganic substances and the climatic factors.

(i) Organic substances include food materials such as carbohydrates, proteins and lipids which the biotic components feed on.
(ii) Inorganic substances e.g. carbon(IV) oxide water, oxygen and nitrogen.
(iii) Climatic factors e.g. light, temperature and rainfall.
(iv) Edaphic factors –the soil, texture and topography.

Biotic components

These are the living things in the ecosystem. They include the producers, consumers, the decomposers and man.

Producers – They are green plants in water and on land. They are autotrophic, i.e. they synthesize food from simple inorganic substances through photosynthesis.

Consumers – These are animals which feed on the producers. They are heterotrophic organisms. There may be primary, secondary or tertiary consumers in a community.

Decomposers – They are saprophytes, bacteria and fungi. These break down parts of dead plants and animals. They release useable nutrients to the soil. These nutrients are used by producers to make more food for members of the community.

The biotic factors also include the effects of all organisms on the environment of any habitat in a community. Man for instance, is the main biotic factor that influences the other biotic factors because of his various activities e.g. agriculture, fishing, hunting, forestry, bush burning and urbanization in any habitat. Other animals also affect the biotic factors because of their various activities, e.g. burrowing (rabbits), grazing (cattle), pollination (insects and birds) and pest action of some insects. Other biotic factors include shade from plants, soil aeration, support from trees and shrubs, nesting and reproductive areas, dispersal of seeds and fruits.

Table 5.1. *Major local biomes in Nigeria*

Biome	State
1. Swamp and estuarine vegetation	Lagos, Ogun, Ondo, Ekiti, Edo, Delta, Rivers, Cross River, Akwa Ibom, Bayelsa.

2. Tropical rain forest	Ogun, Oyo, Osun, Ondo, Ekiti, Edo, Kwara, Imo, Ebonyi, Enugu, Anambra, Cross River
3. Southern guinea savanna	Kwara, Kogi, Oyo, Osun, Abuja, Benue, Niger, Nassarawa, Plateau, Taraba, Adamawa
4. Northern guinea savanna	Sokoto, Plateau, Bauchi, Zamfara, Kano, Katsina, Niger, Gombe, Taraba, Adamawa
5. Sudan/Sahelian vegetation	Sokoto, Kebbi, Katsina, Kano, Jigawa, Borno, Yobe, Kaduna, Gombe
6. Semi-desert/desert	Boundaries of Sokoto, Katsina, Jigawa, Kano, Kaduna, Yobe, Borno, Bauchi, Gombe

Biotic Communities in Nigeria

There are two distinct seasons in Nigeria ~dry and rainy seasons. Temperature is always high. Rainfall is usually high in the south and much lower northwards. The distinct differences in the quantity of rainfall in various parts of the country has led to different biomes or zones of vegetation. The main biomes in Nigeria are the mangrove and freshwater swamp forests and tropical rain forest in the South. Northwards, there are the southern guinea savanna, northern guinea savanna, sahel and desert vegetation see *Table 5.1*

Swamp or estuarine vegetation

This biome is characterised by heavy rainfall almost throughout the year. The commonest plants are the mangrove trees especially the red mangrove *(Rhizophora racemosa)* and the white mangrove *(Avicennia nitida)*. Coconuts *and Raphia* palms, *Paspalum* grass and a salt tolerant fern and herbs are also common. The soil is sandy and very salty. The animals which thrive in this environment include *Tilapia*, grey mullet and striped angler-fish, bloody clam (Arca), oysters, barnacles, lagoon crabs, mud skippers, hermit crabs, monkeys, kingfishers and warblers. The states which border the coastline such as Lagos, Ogun, Ondo, Edo, Delta, Rivers, Ekiti, Akwa Ibom, Bayelsa and Cross Rivers States have this vegetation.

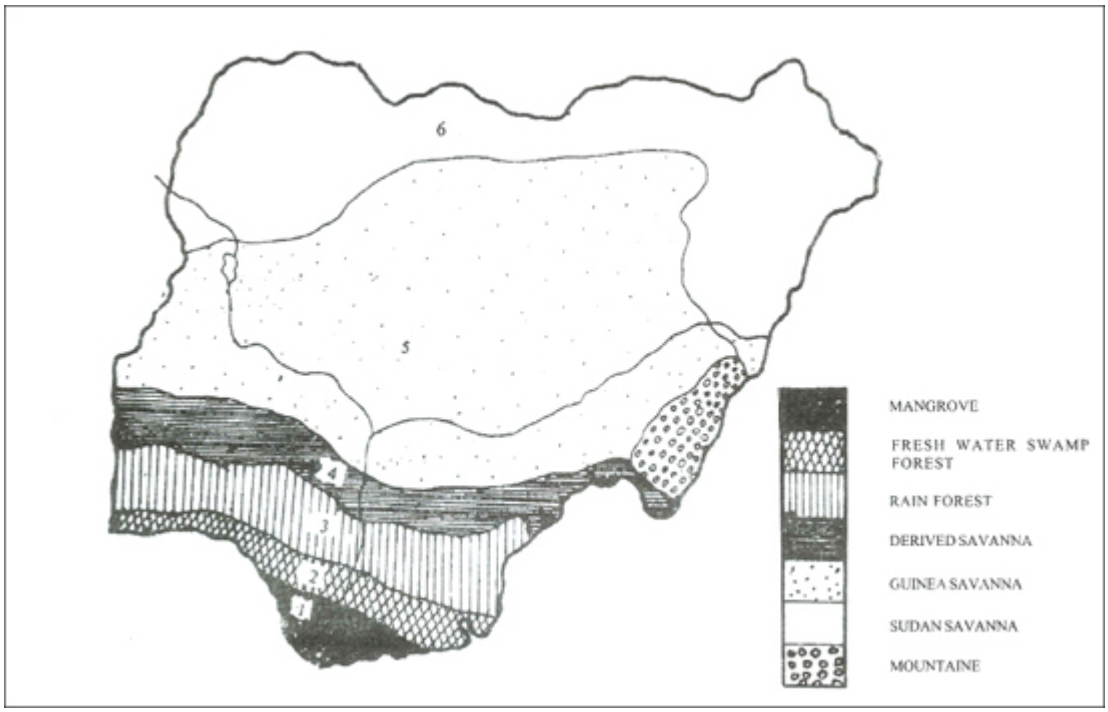

Fig. 5.1 Major biomes of Nigeria

Rainforests

These are found in parts of Oyo, Osun, Ogun, Ondo, Ekiti, Kwara, Kogi, Edo, Delta, Cross River, Akwa Ibom, Enugu, Anambra and Imo and Ebonyi states. These states have high humidity of 70% and above. Rainfall is not less than 125.0cm each year. Rain falls for generally most months in the year and there is no distinct dry season. The vegetation consists mainly of very tall, evergreen and deciduous trees shrubs. The trees are not fire-resistant. A typical rain forest is now scarce, but examples abound in the forest reserves.

Common trees in this biome include mahogany and timber trees such as iron wood, opepe, Benin, Sapele pink and white. All of them are evergreen emergents. In the dry forest, there could be found decidous emergent trees, e.g. obeche, *kola* and *iroko*. The animals that are common in the forest include nocturnal and arboreal types, e.g. mona mangabeys, poto, monkeys, lemurs, squirrels, striped and flying duiker, rodents and pangolins. Birds of the biome include hornbills, parrots and owls. Tree frogs, tree snakes and chameleon also abound in the forest.

Savanna

This is a grassland that merges with the northern fringes of the rainforest. This biome occurs where annual rainfall is less than 125cm per annum. Such vegetation can be divided into southern guinea, northern guinea and sahel savanna. It is characterized by grassland mixed with some decidous trees and shrubs. Often, bush fires consume most of them. The biome covers about 45% of Nigeria.

Southern Guinea Savanna

Rainfall is between 50cm and 125cm, the dry season is not more than six months and is not so intense. It covers a large proportion of the middle beltâ€™states such as Niger, Kwara, Kogi, Plateau, Adamawa, Taraba, Benue, Nassarawa and Abuja. Many of the trees are deciduous and are fairly fire-resistant. They have broad, small leaves. There is a great variety of trees and tall perennial grasses within this zone. Typical trees are the locust bean *(Parkia), Khaya* and shea butter trees. The southern part of this savanna tends to be a fringing forest or transitional woodland. Large herbivores like zebras, antelopes as well as large carnivores such as lions, leopards and cheetahs are found here.

Northern Guinea Savanna

The annual rainfall is less than 50cm and the dry season is more than six months. These factors affect the vegetation which is not as luxuriant as the southern guinea savanna. Trees here are shorter than those of the southern guinea. They are about 10-15 metres high with their crowns almost touching one another. They cast shade which suppresses grass cover. Mature woodland is rare. This might be due to farming and fires which are common in this biome. Typical trees are *Terminalia, Khaya* and *Syzyguim*. Fan palms are found in the wet fringing forest. Grasses are more abundant here than in the southern guinea savanna. Many grazing and browsing animals are also found here.

Sudan Savanna

This biome lies very close to the north of the guinea savanna. Rainfall is less than in the northern guinea savannah. It has a longer dry season of about seven months. Lowest monthly relative humidity is less than 28%. Much of the land is covered by sand and short grasses. Shrubs and woody climbers are common. Trees which are just about 5 to 6 metres in height as well as taller, mature Sudan drought resistant trees such as *Euphorbia*, silk cotton trees, and baobab trees, can be found in this vegetation zone.

Desert

Rainfall is very low. Temperature is usually too low at night and not high during the day. Humidity is very low and below 25% in the driest months. The soil is exposed with very little plant cover. There are few trees and shrubs dotted all over the biome. The biome supports very little plant and animal life, most of which are adapted for surviving scarcity of water and intense heat.

Population Studies

Population is the collection of similar organisms of the same species living in a community or a given habitat. The characteristics of population include its frequency, density and percentage cover, growth rate and dispersal.

(i) Population density: is the number of a particular species of

organism in relation to a unit or quadrat area.

(ii) Population frequency: It is how many times an organism occurs within a given area of quadrat.

(iii) Percentage cover: It is how much space an organism occupies in a given area when expressed in percentage.

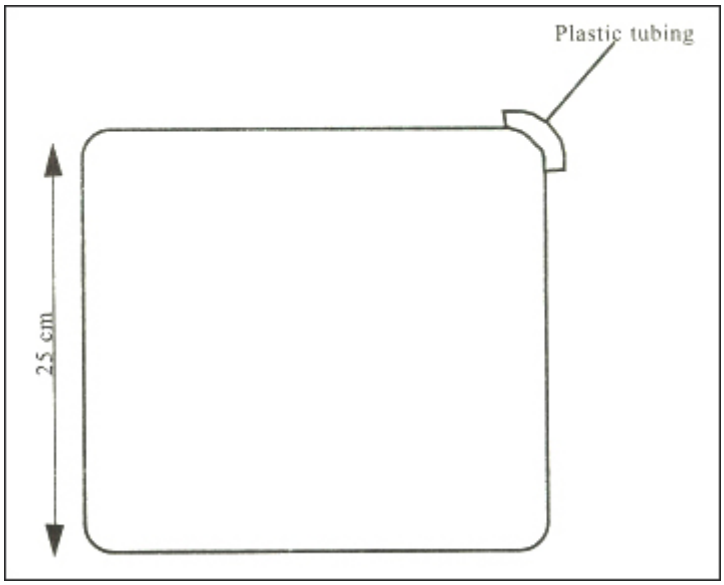

Fig. 5.2 A quadrat

(iv) Population growth rate or form: This is the net result of natality and mortality in the habitat.

Population of a place is always changing, be it that of plants or animals. Usually, it is not easy to study all the organisms in a habitat at any given time. This is because the exercise can be tedious or cumbersome. Instead, a common, useful strategy employed for population studies is the sampling method (e.g. quadrat sampling method).

Sampling Method: This is a method which involves the random selection of portions of a chosen habitat. This is a practical aspect of ecology. It involves field-study like going out to a nearby bush or lawn, pond, river, grassland, forest, seashore or lagoon front.

To study population of plants in a terrestrial habitat, quadrat sampling method is used. A quadrat *(Fig. 5.2)* is a square or rectangular wire, wooden, plastic or metal frame. The quadrat may be a temporary or a permanent one.

Sampling of Population

1. Go out to a pre-selected habitat already measured with a measuring tape (under the supervision of your teacher).
2. Your teacher will divide the area into manageable plots for you to work with in groups.
3. Throw a quadrat randomly, several times (about 50 times) in the selected habitat. Alternatively, several quadrats may be randomly thrown in the habitat.
4. Note the distribution of the various plants and animals in the

quadrat.

5. Count the number of individual types of plants and animals in each quadrat in the plot.
6. Record such counts in a chart with the names of the organisms at once.

1. To determine the density (i.e. population size per unit area) of a particular organism in a quadrat on a habitat, the following steps may be taken:

(a) Frequency of an organism i.e. total number of times an organism occurs in all the quadrats thrown in the habitat say 200 times.

(b) Number of tosses = 40

(c) Average number of organism per quadrat toss
= 200 = 5
40

(d) Area of quadrat = 1.00m.^{2}

(e) Density of organism = 5 per m.^{2} The formula used for estimating population density is

$$\text{Density} = \frac{\text{quadrat sample}}{\text{Area of quadrat sample}}$$

or Average frequency
Area of quadrat

i.e. Number of organism
Number of quadrat

2. To estimate the total number of any organism in the whole habitat (i.e. population), use this formula.
(Population = Density Ã— Area of habitat).

For instance, if the area of a habitat is 12.50m^2 and the population density is 4/m^2, then the total population can be calculated thus:
Estimated population = 4 Ã— 12.50
= 50

Estimation of population of insects

Select randomly some portions of a habitat of between 5cm and 10cm, using a square or rectangular quadrat 15cm Ã— 15cm or 1m Ã— 1m. By means of a hand net or a sweep net, catch as many insects (e.g. grasshoppers or butterflies) as possible from each sample plot.

Count the number of each type of species. Find the average number of each species.

Volume Sampling

This is used in an aquatic habitat to find/estimate the total number of a species in a given habitat. For example, to find the total number of tadpoles in a pond or stagnant water. First stir the water, then take a

known volume of the water, count the number of tadpoles, return the water and the tadpole to the pond, stir and take the same volume again, count the number of tadpoles and return. This should be repeated several times consecutively. The average number of tadpoles per volume is determined. This is then used to calculate the total number of tadpoles in the pond.

Dominance

This is the term used for the most commonly or frequently occuring organism in a community. For instance, in a savanna biome, grasses are the most dominant plants, while big, tall trees are dominant in the rain forest biome. In a vegetable farm, a particular vegetable may be so numerous (dominant) that one hardly notices the existence of a few other types of plants e.g. weeds.

A dominant species can be determined by measuring, using the **transect sample** method. A transect is a line taken at random across a habitat in any one direction at a time. Organisms of a particular species occuring along the transect, that actually touch the line are counted and recorded. The relative abundance of each species is calculated and the most numerous is said to be dominant.

In any given habitat, two species or more may be co-dominants.

Factors that affect population

Population of organisms in a habitat is dynamic. Dynamic in the sense that it is ever changing. Certain factors may lead to its increase or decrease. The factors which lead to population increase include dispersal (immigration), and abundance of food. Those factors which decrease population include mortality and emigration.

Factors that may lead to increase in population

(a) *Natality* new organisms may be produced through reproductive activities (birth). Organisms with high fecundity, i.e. ability to lay numerous eggs and exhibit necessary adaptation, tend to increase in population e.g. cockroach.

(b) *Dispersal* (immigration) Many animals can move from one place to another. When animals move into other habitats, the population there increases, e.g. cattle egret moving from the northern parts of Nigeria to the southern parts with cattle in the months of November to January. The methods of dispersal in animals include the use of locomotory organs to swim, walk, crawl or fly. Some plants and animals are dispersed by attaching themselves to moving objects, by drifting in water or air currents. Plants are also dispersed through man and with the aid of specially developed structures such as floss and wing-like features.

(c) *Abundance of food:* Animals tend to migrate to where plenty of food is available. Human beings move away from dry lands to fertile lands. For example, cattle from Chad and Niger are brought into Nigeria where people believe plenty of food is available.

Factors that may reduce population

(a) *Mortality* – The rate at which individuals in a community die may cause mortality. Death may be due to disease, illness and accident.

(b) *Emigration* Several individuals may leave a community and go to other areas. This may be due to breeding habitats as in birds and fish. It may be due to scarcity of food (i.e. during drought) or natural disasters such as flood, famine, war or pest infestation.

Ecological factors

Factors which can cause changes in any habitat (aquatic or terrestrial) are called *ecological factors*. There is a wide range of them. They may be broadly classified as *biotic* and *abiotic* ecological factors. Some of these factors are common to all habitats and others are habitat-specific. Biotic factors are the plants, animals and man in a habitat. Abiotic factors include physical, chemical and climatic factors.

Ecological factors common to all habitats include (a) rainfall; (b) temperature; (c) light duration and intensity; and (d) wind (direction and speed), pressure, and hydrogen-ion concentration (pH).

Those factors common to aquatic habitats include (a) salinity or concentration of dissolved mineral salts in the water; (b) dissolved gases (especially oxygen and carbon(IV) oxide; (c) tidal movement; (d) transparency or turbidity; and (e) currents (tides and waves).

Ecological factors common to only terrestrial habitats are relative humidity, edaphic and topographic factors.

Topographic factors have to do with the physical feature of the soil. These include soil elevations such as lowlands, valleys, hills and mountains, the type of drainage, as well as degree of exposure to agents of erosion or weathering. These factors determine the types of plants and animals in a habitat. For instance, the base of a hill may support very sparse vegetation.

Edaphic (soil) factors are related to the soil type and texture, soil, mineral salt and moisture content. These also determine the types of plant that can be found in the habitat. The different types of soil (loam, sand and clay) support different types of vegetation.

Importance of some ecological factors to population

Oxygen

Many organisms take in oxygen during respiration. It is abundant on land, so it is not a critical factor there. However, in an aquatic habitat, oxygen has to be dissolved before it can be absorbed by aquatic organisms. When very little oxygen is available in the water, then it becomes a critical factor. With this, aerobic respiration cannot take place effectively. All aerobic organisms would not have enough energy and they may soon die off.

Light

It is a very important factor in both terrestrial and aquatic habitats. Its

intensity, wavelength and duration are of immense interest in the study of plant ecology. Light to the ultimate source of energy for all organisms. In intense light, green plants carry out photosynthesis and store the food formed. It is this food that man and animals depend on. Light also regulates daily and seasonal activities of plants. For instance, animals such as goats and hawks feed during day, while others like bats and owls feed at night. Termites swarm at dusk when bird predators are not around.

Light-controlled seasonal activities in animals include fish and bird migration, changes in feathers of some birds and haircoats of some mammals as well as diapause (resting stage) in some insects.

Flowering and fruiting in many plants as well as etiolation of seedlings, depend on the availability of light. The opening of flowers at certain times of the day to agents of pollination is also light-controlled. For instance, the morning glory or moonflower opens around 6pm. for moths to pollinate it, while the sunflower opens around mid-day for butterflies to pollinate it. Where the duration, intensity and wavelength of light are adequate, there is the tendency for populations of plants and animals to increase. This is because the green plants will manufacture food and this will be fed upon by the animals.

Rainfall

Rainfall is the main source of water in the biosphere. It is therefore an important factor for plants, animals and man. It soaks the soil and excess of it drains into rivers, lakes and water basins of the land.

It is a critical factor for organisms that live in terrestrial habitats and sometimes fresh waters. This is because, available water may be insufficient or it might dry up if there is drought or if rain does not fall regularly. Water from rain is used for photosynthesis and other physiological activities by plants. Many animals drink water and use it for several metabolic processes e.g. amphibians (toads and frogs) depend on water for their reproduction. Rainfall is not a critical factor in saltwater, but prolonged absence may lead to increase in salinity of the habitat. Yet, animals can tolerate salinity only to a certain extent.

Generally, the quantity of rainfall in Nigeria and world-wide determines to a large extent, the type of vegetation of each habitat or biome. For instance, where rain falls abundantly throughout the year, the vegetation is the dense rain forest e.g. parts of Ondo and Delta states. Where rainfall is low and far in-between, e.g. many parts of Borno and Sokoto States, the (Sudan Savanna) vegetation is sparse with very few trees and some grasses.

Temperature

Temperature is an important abiotic factor to plants and animals especially in terrestrial habitats. There are fluctuations in temperature of a habitat within each day. While temperature may be high in the afternoon, it may be much lower at night or in the morning. Similarly, temperature varies from one season to another. It tends to be higher

in the dry season than it is in the wet season. In the temperate lands, seasonal variations in temperature has resulted into distinct seasons of winter, summer, spring and autumn. Temperature may fall below 0Â°C in winter and rise above 20Â°C in summer.

The variations have various effects on the distribution and density of plants and animals in a given habitat. For instance, poikilothermic animals e.g. reptiles and amphibians hide away in crevices, cracks, holes or under stones when the temperature is very high. They come out when the temperature is lower. High temperature can lead to desiccation, wilting or drooping of some plants such as grasses, weeds and crops on the farms. Areas with grasslands are usually associated with areas with high temperature.

Temperature affects terrestrial habitats more than aquatic habitats. Temperature variation is not very pronounced in tropical waters. Aquatic habitats usually experience a vertical variation in temperature as the depth increases, the temperature decreases. Animals vary in their ability to tolerate wide variations in temperature.

Wind

It is an important climatic factor for both aquatic and terrestrial habitats. The speed and direction of wind have distinct effects on plants and animals. For instance, high wind speed increases the rate of transpiration, in plants and evaporation of surplus water on the ground and in puddles.

Wind is an agent of spore, seed and fruit dispersal, e.g. cotton seed and *Mucor* spores. Wind is also a strong agent of weathering. This is especially so in exposed lands with little plant cover such as in the hot deserts. Many flying animals (insects, birds and rodents) are also affected by the speed and direction of wind.

Hydrogen ion concentration (pH)

A pH of 7.0 is neutral, a pH of 17 is acidic and a pH above 7 is alkaline. The factor is important for terrestrial and aquatic organisms. It is closely related to the presence of a certain amount of carbonates in a medium. Where they are present, they act as a buffer and tend to neutralise any acidity. In the soil, the acidic or basic feature may be due to the origin of the soil, quantity of water in the soil and abundance of organic and inorganic matter in the soil. Plants thrive under various pH. Certain plants can thrive only in acidic or alkaline or neutral medium. However, most tropical soils are acidic in nature. This soil acidity can be reduced by adding slaked lime and or nitrogen fertilizers.

Relative humidity

This is a measure of the amount of moisture in the atmosphere. It is usually damp during the rainy season and dry during the dry season in the tropics. Humidity is a very important ecological factor for both plants and animals, especially during the dry season.

Humidity may determine whether or not a species can survive in a

given habitat. If the atmosphere is not damp, the plant and animal body tends to dry out. If the situation is prolonged, it may lead to desiccation in plants. Man may sweat profusely when the atmosphere is dry and hot. High humid condition leads to turgidity in plant cells while plasmolysis results at low humidity.

Both plants and animals have developed features which adapt them to changes in humidity. This is especially so for plants, most of which are sessile. Hence, leaf fall, reduction of leaves to thorns, rolling of leaves, development of wax or thick cuticle on leaves, stomata on the under surfaces of leaves are adaptations of plants to reduce water loss.

Relationship between soil-types and water-holding effects of soil on vegetation

Soil is the outermost layer of the earthsâ€™ crust in which plants are normally fixed by their roots. Many small animals live inside it too. The soil is formed by continuous weathering of rocks by extremes of temperature, rain, wind, snow and frost. This has taken thousands of millions of years. The soil consists of various sizes of rock particles, humus, air, water, mineral salts and living things.

Soils are of utmost importance to man. This is because man uses vast areas of it for growing the crops he feeds on. The type of soil directly affects the growth of plants. The properties of a particular soil type may influence the type of plants found in a given rainfall belt. The commonest types of soil in Nigeria are sandy soil, clayey soil and loamy soil. These soil types vary in their characteristics and each of them determines the type of vegetation found on them.

Loam retains the greatest amount of water that plants can use. It has adequate air spaces for respiration of roots. It provides the richest quantities of plant nutrients. A flower garden is a common example of a loamy soil. The plants which grow in it are more luxuriant than plants in other parts of the habitat.

Sandy soil has plenty of air spaces needed for respiration of roots but this property is a disadvantage in other respects. The large air spaces prevent the retention of rain water and it also encourages the washing away or non-retention of soil nutrients. Therefore, sandy soil does not support luxuriant vegetation.

Clayey soil, which consists of fine particles, has very little air spaces, thus making it difficult for plants to respire properly in it. Clayey soil, because of its compactness, is often water-logged, heavy, wet and difficult to work on. All these prevent good growth of plants.

These soil characteristics help to explain why all areas in the same rainfall belt may not have the same type of vegetation.

Sandy soil

Sandy soil has large rock particles mostly above 0.02mm diameter. Sand fraction is 70% or more and clay less than 20%. There are very large air spaces between the particles. The soil is loose, light and easy

to work on.

Soil water or rain drains well and quickly in sandy soil. It retains little rain water that falls on it. It dries up quickly in hot weather. Water is not easily absorbed and it does not rise to a high level by capillarity. Useful chemicals are washed out of it when it rains. Therefore, it is poor in dissolved mineral salts. As a result, it is not very fertile.

Because of its large particles and air spaces, sandy soil contains plenty of oxygen needed for respiration. Sandy soil can be improved by adding humus and manure to the surface. Humus enriches the soil, binds sand particles together and holds onto water when it rains. Manure keeps the soil warm and prevents it from drying.

There are very sandy soils in northern Nigeria. From Lagos to Calabar, the sandy soils are heavily leached by high rainfall. Wild plants and grasses grow best in sandy soils.

Clayey Soil

This soil contains more than 30% clay and less than 40%) sand. It consists of very fine particles which are usually less than 0.002mm in diameter. The particles hold together tightly, such that there is little room for air in between the particles (poor aeration). Hence, few organisms can survive in clayey soil.

Water does not drain well in clayey soils. Clay particles hold on to water and are easily waterlogged. Hence, the soil remains sticky and wet. Water can rise to a high level by capillarity. Rain runs off its top. It is hard when dry and it can crack. To improve clay soil, one should construct additional drainage, add sand and lime to it. This will break up the soil, aerate and drain it. Lime also causes the particles of clay to clump together into soil crumbs and it neutralizes the soil acids.

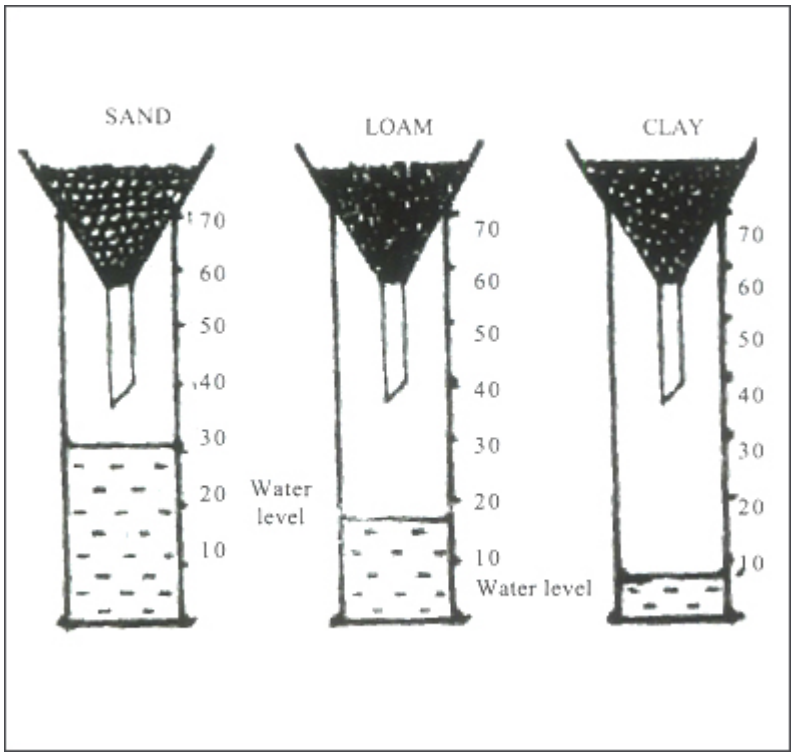

Fig. 5.3 Demonstration of water-holding capacities of sand, loam and clay

Clayey soil is not very common in West Africa. However, around the flood plains of Lake Chad, some deposits may be found. Clayey soil is plentiful in Anambra and most southern states of Nigeria.

Loamy Soil

It contains 40–47% sand, 20–30% silt; 12% humus; 8% lime and 10-30% clay. It has particles of intermediate size mixed with some sand and clay. It is the best form of soil for agricultural purposes. Since it consists of a mixture of humus, coarse and fine rock particles, it has good qualities of both sand and clay. It can retain sufficient water needed by plants or crops and ensures good movement of air.

Humus

All decaying plants and animals (organic matter) which make the soil black form humus. This type of soil is a constant source of fresh mineral salts. It holds water well and allows more air into the soil.

Experiment 5.1 *To show variations in the water retention ability of soil types*

Method

1. Place a funnel over each of the measuring cylinders.
2. Plug the funnel in each with cotton wool.
3. Put the filter paper cones into the funnels.
4. Next, add equal quantities of dry soil samples into the funnels.
5. Pour equal volumes of water, say, 50cm^3 on the soil samples.
6. Allow water to drain through.
7. Leave the set-up until the water stops dripping from the funnels.

8. Calculate the amount of water in each measuring cylinder by reading off from the cylinder.
9. Record your observations.

Results: The observations are tabulated below.

Table 5.2

Type of Soil	Volume of water added (cm^3)	Volume of water drained (cm^3)	Volume of water retained (cm^3)
Clay	50	5	50 - 5 = 45
Loam	50	10	50 - 10 = 40
Sand	50	20	50 - 20 = 30

Conclusion: Sand is the most porous, while clay is the least. Clay retains water most, followed by loam and the least is sand.

The above experiment can be extended to find out the rate of drainage of water through the various soil samples.

Equal volume of water (say 50cm^3). should be poured on the wet soil samples (which has stopped dripping). The starting time should be noted, so also the time when dripping stops. The rate of drainage of water through each soil sample is obtained by dividing the amount of water that drained through by the time taken to drain through.

Effect of Soil Water on Vegetation

The water which is normally available to plants (vegetation) in a particular habitat is called capillarity water. The volume of water retained by either clay, sandy or loamy soil depends on its characteristics e.g. size of the rock particles, the quantity in it as well as the level of the land and rainfall.

It has been found that loam will support the best form of plant growth while clay or sand can only support very few plant life. For instance, thick forests or trees do not normally grow in either clayey or sandy soils.

Simple Measurement of Ecological Factors

Many of the ecological factors can be measured with the aid of standard or improvised instruments. *Table 5.3* shows the equipment used for measuring some of the ecological factors.

Table 5.3 *Instruments for measuring ecological factors*

Instrument	Use
1. Photo (light) meter	Light intensity on land
2. Hydrophotometer	Light intensity in water
3. Wind vane	Direction of wind
4. Anemometer	Speed/velocity of wind

5. Rain gauge	Amount of rainfall
6. Wet and dry hygrometer	Relative humidity
7. Barometer	Pressure
8. Minimum and maximum	Lowest and highest temperature of the day
9. Weekly thermograph	Long period recording of temperature and relative humidity
10. Colorimeter or pH indicator	Acidity or alkalinity of substances e.g. soil or solution
11. Secchi disc	Transparency or turbidity
12. Tape	Height of a tree
13. Floating material or cork	Speed of current or water and stopwatch flow
14. Depth gauge or deep meter	Depth of running or standing water
15. Wave action	Tide
16. Sweep (insect) net	For catching insects
17. Plankton net	For catching plankton (plants and animals)
18. Fish/prawn/toad/ dragnet	For catching fish, prawn, tadpole.

Some of these ecological instruments e.g. windvane, rain gauge, secchi disc, cork and depth gauge can be improvised. For instance, depth gauge, which is used for the measurement of water level, can be made from a thick strong wood or flat metal. This should be painted white with gloss paint and marked with black gloss paint. The marks should be in metres. It is usually fixed at a very convenient point in the water. Depth gauge can be seen in any water works reservoir.

Depth of the water can be read easily by mere observation. Variations can be noticed as the rains stop and dry season begins.

Windvane –This is used to measure the direction of the wind. Usually the windvane has the 4 cardinal points (W - West; N –North; S –South and E –East). Above these, there may be an arrow-head, a cock or a flag to indicate the direction of the wind. The direction of the wind is that point which the arrowhead or indicator faces. For instance, if the arrow-head faces W,â€™ it means the wind is blowing towards the West.

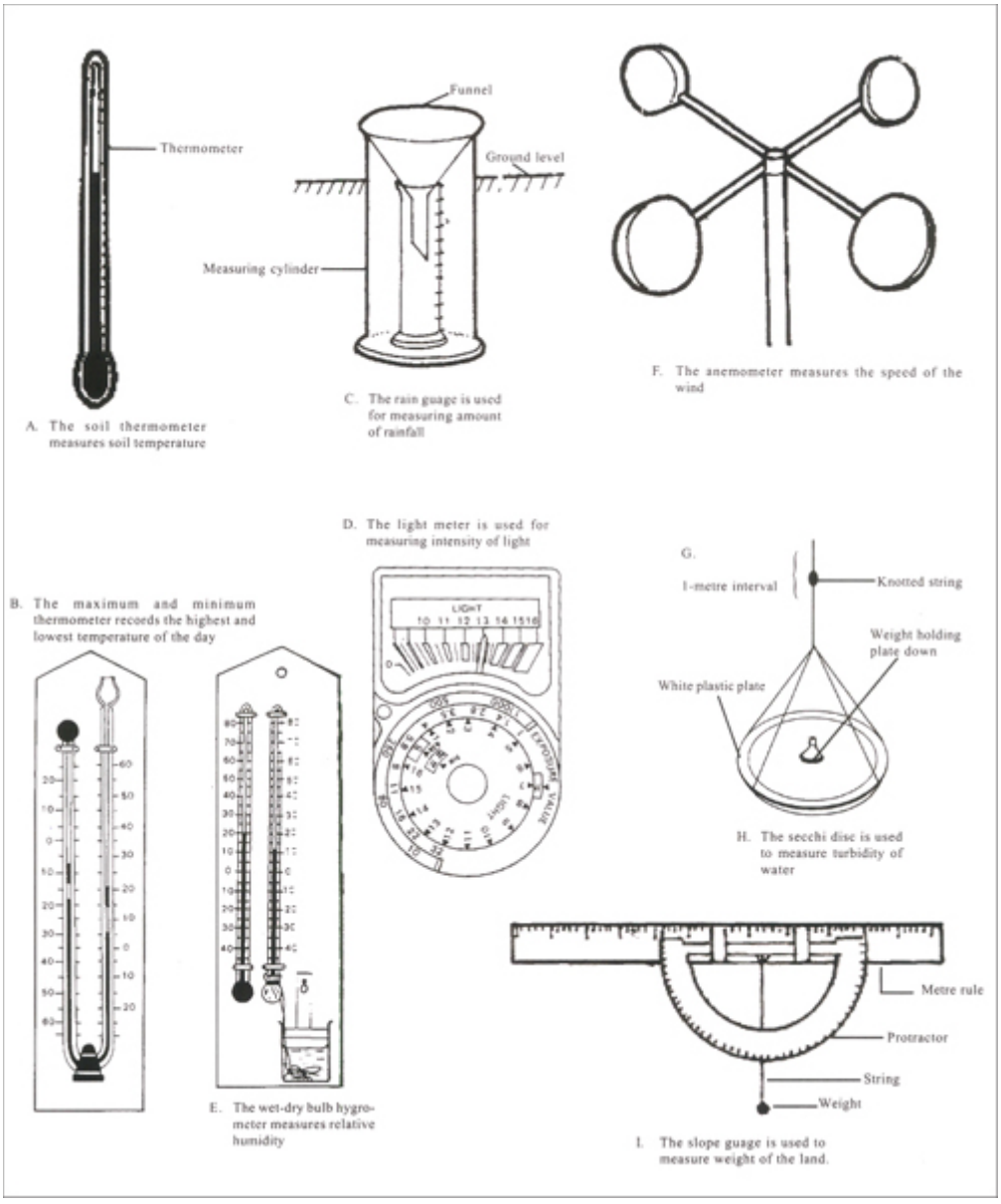

Fig. 5.4 Some instruments for measuring ecological factors

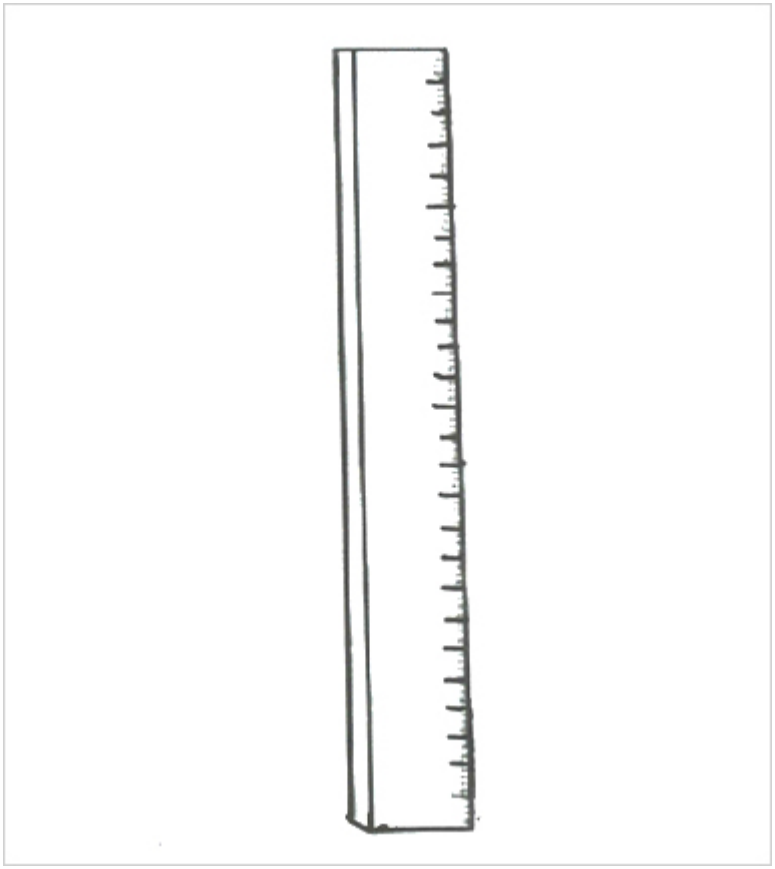

Fig. 5.5 A depth gauge

Measurement of humidity

There are two methods for measuring humidity:

(1) The use of Cobalt chloride paper.

(2) Use of hygrometer.

Cobalt chloride paper. When dry, the paper is blue but when moist it turns to pink, Hang a cobalt chloride paper outside a room and record the time it takes to turn pink.

The results may be tabulated as below:

Table 5.4

Time	Comment
1 minute	Very high humidity
1 minutes	High humidity
2 minutes	Moderate humidity
5 minutes	Low humidity
Above 5 minutes	Very low humidity

Hygrometer: It is used for measuring relative humidity. The hygrometer consists of two thermometers, one is like the ordinary thermometer while the other ends in a wet bulb. This is kept in a muslin that is dipped in water. This imparts a cooling effect on this thermometer that reads a lower temperature. The drier the air, the greater the loss of water from the wet bulb and the lower the

temperature read from it when compared with the other thermometer. Relative humidity is usually read in percentages from special tables.

Table 5.5

Percentage	Interpretation
1. Below 50%	Very low humidity
2. 50 –70%	Low humidity
3. 70 –80%	Moderate humidity
4. 70 –90%	High humidity.
5. 90% and above	Very high humidity

Measuring rainfall: The instrument used for measuring rainfall is the rain gauge. It consists of a tin container with an inner funnel and a measuring cylinder. The rain gauge is usually partly buried in the ground where there are no obstructions such as trees or buildings. Any rain that falls is collected by the funnel of the container. The water thus collected is measured in the measuring cylinder, which is marked in millimetres. This represents rain which could have covered the ground if it did not percolate.

Light intensity: It is measured with the aid of a lightmeter or photometer. Intensity is read off directly from the instrument using Lux units. The greater the intensity, the higher the readings on the meter and the greater the rate of photosynthesis by green plants.

Wind speed: This is measured with the aid of an anemometer. The speed of the wind is shown in metres per second. The higher the wind speed, the higher the values.

Suggested practicals

1. *Study of an ecosystem*

(a) The class is divided into groups of equal number of students

(b) Choose several terrestrial habitats one group should study an ecosystem, i.e.
   (i) a bush or school farm.
   (ii) a rotten log of wood e.g. a fallen palm tree.

(c) Measure the sizes of the ecosystems.

(d) Draw a map or diagram of the ecosystem.

(e) Identify and name 4 plants

(f) Identify and name 4 animals

(g) Show the distribution of these organisms on your map.

2. *Rainfall graphs*

(a) Graphs or histograms of rainfall and temperature are provided.

(b) Interpret the graphs by stating the possible geographical location of the towns shown on the graphs.

(c) Point out the months with the highest and lowest quantity of

rainfall.

3. *Soil identification*

(a) Bring different types of soil to the class.

(b) Using the criteria of colour, texture, nature when wet or dry, malleability and behaviour on sedimentation, identify the soil types.

Summary

1. Ecology is the study of whole plants and animals in relation to their environments.
2. Some ecological concepts were defined. They include habitat, population, community, biomes and eco system.
3. Ecosystem is the basic functional unit in nature. It consists of both abiotic (non-living) and biotic (living) components.
4. Local biomes of Nigeria - are the recognized vegetational zones. These include swamp, estuarine, tropical rainforest, savanna lands and desert fringes.
5. Sampling method for studying population. This is the random selection of parts of a given habitat. In the process, population size and density as well as dominant species can be estimated.
6. Dominant species are particular organisms which occur most frequently in a community.
7. Population density is the population size per unit area.
8. Factors which affect population making it unstable - may increase or reduce the number of organisms of the population. These factors include birth, death, migration in and out of the habitat.
9. Ecological factors are factors which can cause changes in the habitat, be it aquatic or terrestrial. These factors include physical, chemical (abiotic) as well as biotic factors.
10. Terrestrial habitats include land or soil and all the biomes e.g. forest, savanna or desert.
11. Aquatic habitats include all water habitats whether fresh water e.g. rivers, or salt water e.g. oceans and lagoons.
12. Ecological factors include rainfall, temperature, light, wind, pressure, salinity and currents.
13. Equipment that are useful for measuring ecological factors include, rain gauge, thermometer, photometer, windvane, barometer, deep meter and Secchi disc.
14. The three commonest types of soil are sand, clay and loam.
15. Each soil type has peculiar features. These make it support different qualities in the growth of plants.

Objective questions

1. Which of the following statements about sandy soil is wrong?
   A. It has a low water retaining capacity.
   B. There are large airspaces between soil particles.

C. Water cannot rise by capillarity to a high level.
D. Mineral salts are present only in small quantities.
E. Soil particles form a good crumb structure.

2. The instrument used for measuring the speed of wind is called
A. a windvane
B. a hygrometer
C. a rain gauge
D. an anemometer.
E. a thermometer.

3. In ecology, the term community refers to
A. a group of living organisms which do not interbreed.
B. an association between two species in which only one benefits.
C. a group consisting of all the organisms living in a habitat.
D. living organisms interacting with the physical factors of the environment.
E. different populations living together and interacting with each other.

4. The treatment of a poor soil with lime supplies
A. calcium
B. sulphur
C. nitrogen
D. potassium
E. phosphorus

5. Which of the following biomes is not found in Nigeria?
A. Desert
B. Tropical forest
C. Shrub
D. Savanna.
E. Swamp

Essay Questions

1(a) Mention two ecological factors which are common to both terrestrial and aquatic habitats.

(b) Describe how these two factors can affect plants and animals in a habitat.

(c) Name two ecological factors that are peculiar to an aquatic habitat.

(d) Name two ecological factors that are peculiar to a terrestrial habitat.

2. What is (a) population? (b) ecosystem? How would you estimate the population density and frequency of a named plant species in a terrestrial habitat?

3. Describe the main features of the local biomes of Nigeria.
4. Name 10 ecological instruments and state the use of each.