NATIONAL OPEN UNIVERSITY OF NIGERIA

SCHOOL OF SCIENCE AND TECHNOLOGY

COURSE CODE: ESM 424

COURSE TITLE: FRESH WATER ECOLOGY

FRESH WATER ECOLOGY

INTRODUCTION

This course discusses the basic issues that relate to Fresh water ecology, the branch of ecology that deals with uncontaminated fresh water bodies. The course thus begins with an introductory lesson which attempts to define and explain the basic concepts of ecology, and its various branches. The lesson also examines the scope of fresh water ecology. The course continues with other lessons which will focus on the structure and characteristics of fresh water ecology as well as the interactions which take place between the various organisms in a fresh water ecosystem. The course also examines the structure of aquatic plants and animals micro invertebrates, salinity and eutrophication, the influence of human activities on aquatic ecosystems, affluent control in fresh water ecology, as well as the management of fresh water ecosystems.

Students are therefore expected to acquaint themselves with the basic knowledge and understanding of the subject of Fresh Water Ecology, as a branch of ecology, and be able to explain the relevance of the course, and its applications in contemporary scientific and technological endeavours.

Exercises are provided at the end of each lesson to enable students assess themselves on the main issues covered in that lesson.

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LESSON ONE

INTRODUCTION TO FRESH WATER ECOLOGY

Fresh Water Ecology is a branch of ecology which deals with fresh water ecosystems. For us to have an understanding of the subject there is a need to first understand the meaning of ecology.

Ecology is a branch of environmental science which focuses on the examination of living organisms in the natural environment. It is concerned with how organisms interact with the environment and each other, and the e complex and interconnected systems which influence life on Earth. Ecology has a number of sub disciplines, which deal with specific topics of interest, such as the relationship between humans and the natural environment.

Researchers in ecology study individuals, populations, communities, and entire ecosystems. At each level, there are more things to learn about. The natural environment is usually heavily interconnected such that researchers can focus on a single population of plants or animals, for example, and find much fodder for study, ranging from how that population shapes the physical environment to how other organisms interact with it Ecologists are often interested in looking at entire ecosystems, and studying all of the organisms which live in them and influence them. Each ecosystem is characterised by unique plant and animal species which have adapted to the environment and each other, and studying this can provide scientists with information about the history of that ecosystem, and the evolutionary roots of the animals which live there. Ecology can also be studied in urban environments.

Marine Ecology

The study of ecology is not limited to the terrestrial environment; marine environments, lakes, and streams can also provide a great deal of food for thought and inspiration for study. The marine environment in particular is not very well understood, with researchers constantly finding that there is more to learn about the ocean, the creatures which live there, and its underlying geography and geology. For example, for centuries people assumed that the bottom of the ocean was inactive and bleak, but in the 20th century, researchers discovered areas of biological activity around hydrothermal vents, with organisms which had adapted to the dark, high pressure, low oxygen environment of the deep sea.

Fresh Water Ecology

Freshwater ecology is a specialized subcategory of the overall study of ecology that is concerned with the study of fresh water organisms and their environment. By studying the plants and animals in a body of water as well as the components of the water itself, a scientist specializing in freshwater ecology can discover vital information about the health and needs of a freshwater system.

Rather than study the vast world of saltwater like marine ecologists, scientists that work in freshwater ecology concentrate on the ecosystems of bodies of non-brackish water, such as lakes, ponds, and streams. Some may also work in wetland environments where the water is primarily fresh. The information that freshwater ecologists gather can be helpful to conservation efforts for plants and animals, but also provides data that can affect humans as well.

In the study of freshwater ecology, scientists attempt to get accurate ideas of how a body of fresh water goes about its daily existence. Every detail, from the microbial creatures busily creating algae, to the large reptilian or avian predators present, affects the life of the ecosystem. New factors can disrupt and reorganize the ecosystem dramatically, and can range from an introduced exotic species, chemical runoff from a new industrial plant, or even increased usage if the lake becomes a tourist spot. By understanding how this body of water behaves under normal circumstances, freshwater ecologists can make an educated guess as to how new factors will sometimes affect the local environment.

For conservation efforts, freshwater ecology can give roughly accurate ideas of how populations of plants or animals are surviving in their environment. This can help determine whether a fading species is given protective status by governing bodies, or whether an already endangered species is recovering due to conservation efforts. Although most of the work is based on probabilities and population graphs rather than literal census taking, freshwater ecologists can give a fairly clear picture of which way a species is going, and identify key factors that determine its situation.

Humans benefit from the studies of freshwater ecology as well. As the largest component of the ecosystem, the water is constantly tested and analysed for important data such as chemical composition and possible hazards. The work of freshwater ecologists can be used to determine the viability of a new drinking water source, or test a current water source for possible contamination. By protecting drinking water sources, freshwater ecologists are contributing not only to the good of the environment, but the good of their own species as well.

The Scope of Fresh Water Ecology

From the discussion so far, it is obvious that the subject of fresh water ecology is concerned with the study of organisms in fresh waters, as well as their interactions with themselves and their environment. The study of ecology in freshwater is usually divided into 2 categories, lentic (still) and lotic (running) water. These two bodies of water also have a bearing on which organisms are likely to occupy the area. Specifically, the following, among others, can be identified as constituting the major areas of concern of this course.

1. Identification of the various species of organisms that inhabit fresh waters. This therefore includes all the plant and animal species that are found in fresh water communities. It also includes all the algae, the micro invertebrates, fungi, and tiny organisms that occur, and form part of the fresh water ecosystems. Also of interest here is an understanding of the structure, and characteristics of the fresh water ecosystem.
2. The various forms of interactions that occur within these ecosystems are also of interest in this course. Interactions between the different plant and animal species in terms of feeding relationships or energy transfer, as well as material cycling are considered here.
3. Another area of concern here is the influence of human activities in altering, or bringing about changes in fresh water ecosystems. Human activities often result in changes in species composition, and sometimes the water quality of the ecosystem. Such often result in pollution of the water, which if not ameliorated negatively affect the health of the organisms of the fresh water. Human activities have sometimes resulted in eutrophication and alteration of salinity levels of affected fresh waters.

4. Also within the scope of fresh water ecology is the aspect of fresh water aquaculture systems and affluent control. This is examined as an attempt to manage fresh water ecosystems, by properly utilising such waters not only in terms of pollution control, but also with respect to provision of food for human population. This is also aimed at ensuring a health environment for the fresh water organisms, as well as human beings which exploit the environment for their livelihood.
5. Wetlands and catchment management are also significant in the study of fresh water ecology. The nature and significance of wetlands is of concern here. The management of catchment areas also constitutes a major area of concern for fresh water ecologists.

STUDY EXERCISES

1. Explain the subject of fresh water ecology
2. Identify the scope of fresh water ecology.

LESSON TWO

THE STRUCTURE AND CHARACTERISTICS OF FRESH WATER ECOLOGY

The structure of the fresh water ecology refers to the nature and arrangement of the species and components of a typical fresh water ecosystem. Four main constituents of the living environment that form the fresh water ecosystem can be summarised as follows.

- Elements and Compounds: These are some essential elements (such as carbon, oxygen, nitrogen, calcium and lead) and their compounds, which are absorbed by organisms in the ecosystem, and are required as a food source or for respiration. Many of these elements and their compounds are required by plants and are passed along the food chain.

- The Primary Producers: These refers to plants which are autotrophic by nature In other words these plants are capable of synthesizing food by harnessing energy from inorganic compounds through the process of photosynthesis(plants do so by absorbing energy from the sun and using it the process of Primary Productivity). These plants (and some bacteria) are therefore the primary producers, as they produce (and introduce) new energy into the ecosystem.

- Consumers: These are the organisms that feed on other organisms as a source of food. These organisms depend on the primary producers for food supply, and may be primary consumers who feed from the plant material or secondary consumers who feed on the primary consumers. Consumers who feed directly on the producers are mainly omnivores, while those who feed indirectly by feeding on the omnivores are known as the carnivores.

- Decomposers: These are mainly micro-organisms which depend on the remains of the producers and consumers for survival. They therefore contribute to the energy transfer by breaking down dead organic material (detritus), and during this reaction, release critical elements and compounds which in turn are required by plants. Plants, along with other organisms will inevitably die out, and the organic material produced by these dead plants decomposes into the soil, allowing new energy to be stored in the nutrient soil for plants to re-absorb.

This simple classification of life in the ecosystem indicates a simplified relationship where each passes on energy in the food chain allowing one another to survive.

The non-living component of the fresh water environment consists of the water and substance which provides an anchor to the living organisms. There are always interactions of the living component not only within the organisms, but also with the non-living component.

Food Chains and Ecological Pyramids

An ecological pyramid indicates energy passing along from autotrophic organisms to carnivores at the top of the chain. Those at the bottom of the food chain are usually the smallest in size but not always, and are almost inevitably the largest in number. Those who feed off these primary producers are less in number, usually because they are larger and require more than one portion of prey per meal as a means of fulfilling nutritional requirements for a larger organism. This situation continues to the top of the chain, where few secondary consumers are eaten by an even smaller amount of tertiary consumers.

This is typical of a food chain in a freshwater community. Sometimes the pyramid diagram of a food chain can be inversed, usually in the case of parasites and hyper-parasites, where many smaller organisms rely on much larger organisms as a means of food and survival. Just like in the case of other ecosystems where the simply food chain is merely illustrative, the same is the case of fresh water ecosystems. The nature of energy transfer or feeding relationship is often very complex, and can best be described as a food web, where more than one organism are dependent on organisms of the lower trophic level for food supply.

When energy is passed on, there is always a net loss in the energy that is available in the ecosystem. This is because some energy is always lost somewhere along the line due to inefficiencies and waste produced by each of the organisms that contains some of the biological energy that was created inside them. Detrivores (decomposers) will feed on this waste matter, and once again the energy will be re-siphoned back into the food chain.

Trophic Levels

Food chains that allow a diversity of species to survive are divided into trophic levels, with plants providing the first trophic level as they are the primary producers of most food chains. In almost all freshwater ecosystems, animals will be present, and form part of the many grazing food chains in the area. Other organisms leach the energy from dead organic matter forming detritus food chains. Such relationships allow the free flow of organic energy to be passed along from species to species, and provide an environment where food is available for them to survive.

The most important fact to be taken from this is that no matter what species occupies an area; chances are they will require another species to be in abundance in the area for feeding. The population of a particular species will depend on density dependant and density independent factors, therefore the abundance of food in the ecosystem (a density independent factor), comes into play. The prey of a particular species will also require the existence of a food source for them to survive, and so forth.

Therefore we can see how the complex interrelationships between organisms allow an ecosystem to support such a wide variety of organisms. Plants are the essential constituent for a healthy freshwater ecosystem, being the primary producers and harnessing energy from sunlight, they provide the building blocks and energy to allow the arrival of herbivores, and subsequently omnivores and carnivores into the ecosystem.

STUDY EXERCISES

1. Briefly explain the structure of fresh water ecosystems
2. Explain the existence of ecological pyramids in fresh water ecology.

LESSON THREE

AQUATIC ORGANISMS

Aquatic organisms can be classified into four major groups, each varying in their biological characteristics, habitat, and adaptations, but linked within a complex network of ecological roles and relationships. All these organisms are found in fresh water ecosystems, and an overview of each group may be understood by examining the following sub divisions:

- Microorganisms
- Plants
- Invertebrates
- Vertebrates

Aquatic Organisms: Microorganisms

Microorganisms include members of the plant kingdom, protozoa, bacteria, and fungi. These organisms differ radically, and share only their small size; most are not visible without a microscope, though colonies of some can be seen with the naked eye. They are present in large quantities everywhere and can survive extreme physical and chemical conditions. Many microorganisms play foundational roles in aquatic ecosystems, capturing the sun’s energy through photosynthesis and, through their role in decomposition, releasing nutrients stored in organic tissue. A further look at these organisms may be done by highlighting the different types.

1. Bacteria

Some of the smallest and most ancient organisms on earth, bacteria are present in virtually every environment and are abundant in all aquatic systems. In rivers and streams, many of the bacteria wash in from the surrounding land, and their abundance can increase dramatically after a rainfall. The abundance of bacteria is typically in the millions per millilitre (mL), and in the hundreds of millions per millilitre in especially productive or polluted waters.

If conditions are right, bacteria reproduce extremely rapidly by simple division to produce very large numbers in a short period of time. Bacteria can be found suspended in the water, associated with decaying material (such as dead wood or leaves), or coating the surface of rocks, stones and sand grains as part of the biofilm (the slippery coating on hard surfaces in rivers). They can make up a large fraction of the living material in aquatic ecosystems.

Bacteria display the greatest range in the metabolic ability of any group of organisms. There are both autotrophic and heterotrophic bacteria. Heterotrophic bacteria are a crucial link in the decomposition of organic matter and the cycling of nutrients in aquatic systems.

Autotrophic bacteria are primary producers in aquatic systems as are true algae. For this reason, autotrophic bacteria (predominantly cyanobacteria) are often categorized as 'algae', though the organisms are by no means closely related. Cyanobacteria used to be mistakenly called 'blue-green algae'. Ecologically, much of what applies to algae is relevant to autotrophic bacteria.

2. Fungi

These occur as single cells, and in filaments called hyphae. Most aquatic fungi are microscopic; those known as hyphomycetes are the most abundant and important. Fungi are heterotrophic, and, like heterotrophic bacteria, obtain their nutrition by secreting exoenzymes into their immediate environment, which break compounds down into simpler substances such that the fungi can easily absorb. Fungi are critical to the decomposition of plant matter in aquatic ecosystems, because they are among the few organisms that can break down certain plant structural compounds such as cellulose and lignin.

3. Protozoa

These are microscopic, single-celled organisms that sometimes group together into colonies. There are both autotrophic and heterotrophic types of protozoa. Unlike bacteria and fungi, which absorb dissolved organic compounds from their environment, heterotrophic protozoa (such as the amoebas and Paramecium) consume other organisms such as algae, bacteria, or other protists. Together with other microorganisms, protozoa make up the biofilm coating sediments and hard surfaces on riverbeds, though some protozoa are free-swimming. Certain protozoa are parasites and cause diseases such as giardia (beaver fever).

4. Algae and Phytoplankton

Several groups of largely autotrophic protists are referred to as algae. Like the term 'microorganisms' it is an informal term, used for convenience to describe microorganisms that carry out photosynthesis; the cyanobacteria are often included as algae. Algae vary in size from microscopic to large colonies that can be macrophytes. Several types of algae—including phytoplankton—play an important role in supplying the energy at the base of many aquatic food webs.

Phytoplankton are small, microscopic plants that live suspended in the open water. They are generally more abundant in lakes than rivers, and are absent from fast-flowing streams, or where the rate at which the plants are washed downstream is greater than the rate at which they reproduce. Damming a river leads to still-water conditions more suitable for phytoplankton, and nuisance algal blooms may develop in reservoirs. Inputs of nutrients, including nitrogen and phosphorus, can also lead to algal blooms.

Phytoplankton can exist as single cells or in chains or colonies. They are direct food sources for many zooplankton and some fish, and constitute the base of the food web in deep waters. Phytoplankton vary in their requirements for nutrients, light, and other conditions. Fresh water ecosystems support a complex mixture of phytoplankton that can change markedly with environmental conditions. In rivers containing significant amounts of phytoplankton, the concentration of algal cells (number per unit volume) is generally highest when flows are lowest, while elevated suspended sediment loads during high flows can lead to reduced light and photosynthesis. Some phytoplankton can cause taste and odour problems in water, and anoxic conditions that can kill fish. Some cyanobacteria produce toxins lethal to various fish, wildlife, and domestic species.

5. Periphyton and Biofilm

Algae, bacteria, fungi, protozoa, and the breakdown products of dying cells form layers on submerged surfaces, including bottom sediment, rocks, submerged leaves and branches, and macrophytes. The term periphyton refers to a layer consisting mainly of algae, but the entire assemblage of layers is often known as biofilm. Periphyton is an important food source in shallow, stony rivers with adequate light penetration. Heterotrophic organisms, including larger invertebrates such as snails and insects, scrape the biofilm from surfaces, while some larger animals, such as fish, also feed on biofilm. Biofilm can be important in absorbing or breaking down chemical contaminants as well. Seasonal changes in the abundance of periphyton reflect fluctuations in river discharge, as layers of algal cells build up in times of low or decreasing flow, and wash away during flood periods.

Aquatic Organisms: Plants

1. Macrophytes

Macrophytes (literally 'large plants') are individual aquatic plants that can be seen by the naked eye, and can be categorized based on where and how they grow. Based on this categorization, the following types can be identified.

- Rooted macrophytes: These are always rooted in the riverbed or lake substrate, and are thus restricted to areas where flow is low enough to permit fine sediments to accumulate. Rooted macrophytes may have leaves entirely submerged (under the water), floating on the surface, or emergent above the surface. In turbid water, little light penetrates and photosynthesis is restricted, hence only plants with floating or emergent leaves can thrive. Rooted macrophytes may extract nutrients from the substrate as well as absorbing them from the water as algae do.

- Floating aquatic macrophytes are rootless plants that persist only in backwater areas where the flow slackens—otherwise they are carried downstream. Because their photosynthetic surfaces are above the water surface, these plants can grow in deep, turbid water and places where rooting sites are sparse.

Macrophyte abundance can fluctuate seasonally as a result of scouring of the bottom sediments and washout of plants during heavy rains. For this reason, the number of macrophytes in river channels generally peaks during periods of low flow.

Aquatic macrophytes are important in many aquatic ecosystems, especially wetlands, slower moving water in streams and rivers, and in shallower areas of lakes. Aquatic macrophytes add three-dimensional complexity to aquatic habitat, and can provide habitat, refuge, and spawning areas for animals such as aquatic insects and fish, as well as a surface for periphyton growth. As they are primary producers, aquatic macrophytes produce organic matter which can be eaten by some fish; however, most of this plant material is unpalatable to herbivores while it is alive. Energy is transferred to animals primarily when the dead plant tissue and associated decomposers are eaten.

Large populations of aquatic macrophytes can have negative effects on aquatic ecosystems and the people that rely on them. In some cases, floating plants are so numerous that they form dense mats covering the water surface. Their buoyant leaf crowns merge above the surface while the root masses dangle below into the water. The interlocking vegetation mat blocks light penetration down the water column and prevents the growth of other plants. In extreme cases, the underlying water becomes deoxygenated, and floating plants become a nuisance by inhibiting the passage of boats and interfering with fishing.

Invasive species of macrophytes can be particularly disruptive to natural aquatic ecosystems.

2. Riparian Vegetation

Riparian vegetation is plant growth that lines the banks of rivers and other inland water bodies. These plants protect river banks from wave action and erosion, and offer shelter, feeding, and breeding areas for fish, birds and other organisms. Leaves, twigs, and other organic matter from riparian vegetation can provide significant quantities of organic matter to streams and rivers. The riparian zone can contain a variety of plants—from grasses to trees—often in a gradual transition with distance from the bank, reflecting different species' tolerances for soil saturation.

STUDY EXERCISES

1. Mention the various microorganisms that constitute part of the fresh water organisms
2. Briefly describe the plants in a typical fresh water ecosystem

LESSON FOUR

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This lesson continues from the previous one, and it takes a look at the invertebrates and vertebrates that occur in aquatic ecosystems.

Invertebrates

Invertebrates include all animals without a backbone. They are far more diverse and abundant than vertebrates, and many groups of invertebrates are found in fresh water ecosystems. Invertebrates living on or in aquatic sediments are termed benthic invertebrates. Benthic invertebrate communities—including measurements of population abundance and diversity—are often used as indicators of aquatic ecosystem health. Some of the more common benthic invertebrates are described below.

- Worms: These are an informal collection of three major groups, including flatworms (Platyhelminthes), roundworms (nematodes), and segmented worms (annelids). Flatworms include a major group that is free-living and often predatory (Turbellaria), and two major groups, Trematoda (flukes) and Cestoda (tapeworms), that have adult stages that are entirely parasitic, although their intermediate stages may be aquatic. Some flukes and tapeworms are important parasites of human beings, often causing serious illnesses.

- Molluscs: These include the familiar groups of snails (gastropods) and bivalves (clams and mussels). A hard shell encloses, wholly or in part, the bodies of most molluscs. Snails feed by scraping biofilm from surfaces, collecting organic matter deposited in the sediment, consuming macrophytes, or feeding on decaying animals. Bivalves have gills, which they use both for breathing and for collecting small particles from the water.

- Insects: These are the most diverse group of animals on earth. Most insects are terrestrial, while some have life stages that are aquatic (e.g., dragonflies and mosquitoes). A few insects are entirely aquatic (e.g., aquatic beetles). While most aquatic insects live on or near the bottom of waterbodies, though some (such as the larvae of the phantom midge Chaoborus) can swim into the water column. Most aquatic insects have gills and need water with dissolved oxygen while others, such as mosquito larvae, breathe through the surface film of still waters. Insects may be herbivores, carnivores, or detritivores. Stream and river insects are crucial in the processing of organic matter. Some scrape biofilm, others shred larger leaves into smaller particles, while still others filter or collect these smaller particles. This chain of processing reduces large organic matter to successively smaller and smaller particles.
- Zooplankton are aquatic animals that cannot swim against water currents, typically because they are too small to do so. However, many zooplankton can swim significant distances in fairly still waters. Because they cannot swim against currents, they are more important in lakes than in running water, as running water usually carries them downstream faster than they can reproduce. However, they can be abundant in large slow flowing rivers. Zooplankton are heterotrophic and are significant sources of energy and nutrients to carnivorous invertebrates and some vertebrates.

Aquatic Organisms: Vertebrates

All animals that have a backbone are called vertebrates. They are generally the most familiar of animals, and include fish, amphibians, reptiles, mammals, and birds.

1. Fish

Fish display every major feeding type: herbivorous fish feed onperiphyton or macrophytes, or may even filter phytoplankton from the water; carnivorous fish feed on molluscs, worms, insects, zooplankton, and other fish; omnivorous fish may feed on specific types of prey, or feed indiscriminately on nearly anything they can consume. Due to this diversity in modes of feeding, different fish can occupy very different places in a food web.

As with feeding behaviour, some fish occupy very specific habitats while others can be found in a wide variety of lakes and rivers. The distribution of fish can be influenced by a large number of factors, including oxygen concentration, temperature, the presence of macrophytes, the availability of suitable substrate for spawning, and current speed (in streams and rivers). Changes in fish habitat (such as reduction of flooding due to damming) can favour some types of fish, and disadvantage others.

2. Amphibians

These are cold-blooded vertebrates that generally live out their juvenile stages in aquatic environments and then move onto land as adults; however, some amphibians remain aquatic for their entire life. The most familiar amphibians are frogs, toads, and salamanders.

When amphibians transform from juvenile to adult, they often undergo a significant change in diet. Tadpoles, for example, are usually herbivorous, consuming periphyton or macrophytes, but adult frogs are carnivorous, feeding on animals such as insects, worms, snails, or nearly any other animal that they are capable of swallowing whole. Frog tadpoles are an important food source for some fish. In addition, aquatic birds and some reptiles (such as aquatic snakes) prey upon the adults. Due to the dependence of amphibians on water and warmer temperatures, they are most active in the summer and often hibernate on land in the winter.

3. Reptiles

Unlike amphibians, reptiles are largely a terrestrial group of animals. In the oil sands region, they include turtles and snakes. As they are also cold blooded, reptiles depend on environmental conditions to regulate their body temperature. Reptiles lay eggs on land and it must be warm enough for eggs to hatch and grow. Reptiles are more active in the summer months when temperatures permit and they often hibernate during the winter. Reptiles have a thick skin that allows them to tolerate dry conditions and are not as dependent on water as amphibians are. However, some reptiles spend large amounts of time in water and feed there. Most reptiles, including those that feed in fresh water, are predatory and capture a variety of prey.

STUDY EXERCISES

1. Identify the plants and invertebrates that are found in aquatic ecosystems.
2. Highlight the relationship between the vertebrate species of a fresh water ecosystem.

LESSON FIVE

FACTORS AFFECTING FRESH WATER ECOSYSTEMS

The factors that affect the development and operations of fresh water ecosystems are mainly biotic and abiotic factors. Abiotic factors are essentially non-living components that affect the living organisms of the freshwater community. The abiotic factors can be further divided into two; those which relate to temperature and those which relate to water conditions. The biotic factors on the other hand are those factors that relate to living organisms within the ecosystem.

When a variety of species are present in such an ecosystem, the consequent actions of these species can affect the lives of other species in the area. These factors, which determine the sort of life that will suit adaptation to the conditions of the ecosystem, are referred to as biotic factors.

Abiotic Factors: Temperature

As described in above, the light from the sun is a major constituent of a fresh water ecosystem, providing light for the primary producers, plants. There are many factors which can affect the intensity and length of time that the ecosystem is exposed to sunlight. Some of these factors are as follows;

- Aspect - The angle of incidence at which light strikes the surface of the water. During the day when the sun is high in the sky, more light can be absorbed into the water due to the directness of the light. At sunset, light strikes the water surface more acutely, and less water is absorbed. The aspect of the sun during times of the day will vary depending on the time of the year.

- Cloud Cover - The cloud cover of an area will inevitably affect intensity and length of time that light strikes the water of a freshwater ecosystem. Species of plants rely on a critical period of time where they receive light for photosynthesis.

- Season - The seasons in an ecosystem are very different, and this is because less light and heat is available from the sun in winter and vice versa for summer, therefore these varying conditions will affect which organisms are suited to them. This factor applies more in temperate environments than the tropics, where little differences may be experienced at different seasons.

- Location - The extreme latitudes receive six months of sunlight and six months of darkness, while the equator receives roughly 12 hours of sunlight and darkness each day. This sort of variance greatly affects what type of organisms would occupy freshwater ecosystems due to these differences.

- Altitude - For every one thousand metres above sea level, average temperature drops by one degree Celsius. Altitude will also affect the aspect of which sunlight hits the freshwater ecosystem, therefore playing a part on which organisms will occupy it.
- Temperature- As you can see, many abiotic factors can play a part in determining the end product, which organisms live and succeed in the freshwater ecosystem. The sun provides light for photosynthesis, but also provides heat giving a suitable temperature for organisms to thrive in. The temperature of a freshwater environment can directly affect the environment as a whole and the organisms that occupy it.

  Furthermore, enzymes operate best at an optimum temperature, and any deviation from this temperature 'norm' will result in below optimum respiration in the organism. All aquatic organisms are ectotherms, meaning their body temperature varies directly with its environment. Temperature also affects the density of substances, and changes in the density of water means more or less resistance for animals who are travelling in the freshwater environment.

  The above examples of abiotic factors involve physical characteristics of the freshwater environment, which are continued, with subsequent information studying how the chemical composition of the freshwater ecosystem also affects which organisms survive in the environment and how they cope in these conditions.

Abiotic Factors - Water Conditions

Evidently, the light and heat from the sun play an important role in providing suitable conditions. However, the water conditions also inevitably have an effect on life in the ecosystem.

A still body of water will inevitably be disturbed by various factors, which will affect the distribution of organisms in the water. Wind is considered to be the prime factor responsible for disturbing water, though changes in temperature can create convection currents where temperature is evened out across the body of water via this movement.

Naturally, a river will have water movement as water succumbs to gravity and moves downstream. These are relatively constant factors that affect water movement though, for example, human intervention can also cause water movement. The surface tension of the water will also affect the organisms that occupy the area, depending on the cohesion of water at the surface; it can affect the amount of oxygen that reaches organisms living below the water surface.

These factors all affect the way of life for organisms occupying such a freshwater ecosystem. On a more molecular level, the chemical compositions of the water, soil and surrounding air also play a part in determining the face of the ecosystem.

The oxygen concentration of the water and the surrounding air will have great bearing on which organisms can survive in a particular environment. Oxygen is required for aerobic respiration in animals, and the concentration of oxygen in an area is determined by many factors, including temperature and abundance of organisms for example.

Many chemical reactions and cellular processes rely on the availability of oxygen; therefore the concentration of oxygen in the ecosystem will inevitably alter the ecosystem itself. The same applies to carbon dioxide concentration, which is required for photosynthesis, and can also affect the pH of the water for example.

It is thus evident that many factors will affect the overall existence of organisms in an ecosystem. The chemical and physical characteristics to begin with will determine which organisms are most likely to survive in the freshwater ecosystem. In turn, these pioneers entering the environment will actively manipulate these factors and change the schematics of the ecosystem as a whole, meaning that they also play a part in determining which organisms will succeed in a particular environment.

TUDY EXERCISES

1. Explain the Temperature related factors affecting the functioning of any fresh water ecosystem
2. Discuss how water conditions of fresh water ecosystem may affect its operation.

LESSON SIX

LIFE IN AQUATIC ECOSYSTEMS

Organisms living in aquatic ecosystems are dependent on the resources of their environment. Biological communities—including the types of animals present and their relative abundance—are also shaped through the interactions with other organisms. This section explores in greater detail the relationships between living organisms and the relationship of living creatures with their environment, which include the following;

- The Building Blocks of Life
- Energy and Food
- Food Chains and Food Webs
- Biomass and Production

The Building Blocks of Life

All living organisms need water, energy, carbon, nutrients and oxygen to stay alive, grow and reproduce. Living organisms differ in their specific requirements (e.g., by life stage or activity) and in the processes they use to secure these essentials.

- Water

Living organisms are primarily composed of water and cannot function without it, although the resting stages for some organisms can survive with very little of this substance. In aquatic habitats, water is a source of oxygen (i.e., dissolved oxygen) and food (e.g., suspended particles of organic matter).

- Energy

Almost all energy used by organisms is derived, directly or indirectly, from the sun; the exception includes some bacteria that derive energy from chemical sources (e.g., by oxidizing inorganic compounds such as sulphide). Plants use energy from sunlight to manufacture a range of sugars by the chemical process of photosynthesis. When animals eat plants, they make use of the energy 'fixed' by the plant. Organisms who cannot manufacture their own food using the sun's energy must consume other organisms to obtain carbon, energy and nutrients.

- Carbon

Carbon is a building block in the sugars, proteins, and fats that make up the tissues of all organisms. In plants, carbon dioxide and water, together with energy derived from sunlight, are incorporated into sugar molecules during photosynthesis. The sugars are stored in the plant body in the form of starch, but can be combined with other chemicals to form different types of molecules (such as protein). A schematic diagram of the carbon cycle is shown on the right.

- Nutrients

Nitrogen and phosphorus are the most important nutrients for the growth of algae and aquatic plants, as they are often in short supply relative to the needs of these organisms. Other nutrients, such as potassium, iron, sulphur, and selenium, are also required, though these are usually abundant relative to the amount that algae and plants require.

Within aquatic environments, nutrients are derived from the erosion of minerals and soils within the basin, organic matter, or from human inputs. The addition of nutrients to aquatic systems—for example, from industrial outputs, sewage or agricultural runoff—can have major impacts on aquatic systems, sometimes leading to eutrophication (excess nutrients leading to excessive plant growth).

- Oxygen

Oxygen is a basic requirement for most organisms, although there are some microorganisms that can grow in (or even require) environments without oxygen, while others can tolerate very low levels. Organisms that spend their entire life in water ‘breathe’ oxygen dissolved in the water.

Energy and Food

Every organism must acquire energy to live, grow and reproduce. In aquatic ecology, biologists often classify organisms according to how they obtain energy. Because sunlight is the ultimate source of energy used by organisms on the earth's surface, a basic distinction lies between those who use its energy directly—autotrophs—and those who receive it indirectly by consuming other organisms—heterotrophs.

Autotrophs

Autotrophs, or producers, are organisms that can manufacture their own organic material from inorganic sources. Most autotrophs carry out this process using photosynthesis, the process by which plants and algae use solar energy to combine carbon dioxide with water to produce starch, sugars and oxygen. Photosynthesis is the most important biological process on the planet, and its products drive the biological activity of nearly all ecosystems, including aquatic environments. The oxygen produced is available to be used by other organisms, making photosynthesis an important controller of carbon dioxide and oxygen in the environment.

Photosynthesis in aquatic systems is carried out by a wide variety of autotrophs, which range in size from microscopic single-celled organisms to large aquatic plants called macrophytes. Autotrophs are primary producers, because they produce the first level of organic carbon from inorganic compounds. Ultimately, all other types of organisms (heterotrophs) are dependent on the organic carbon produced by autotrophs

Because photosynthesis depends on sunlight, the distribution of autotrophs is reliant in part on the amount of light available in an aquatic ecosystem. In shallow, stony rivers, periphyton (or biofilm) – especially diatoms and cyanobacteria – are the main source of primary production, but shade from riparian vegetation can limit photosynthesis; nutrients may also be in short supply in these habitats. In wider rivers, reduced shading from riparian vegetation allows the river surface to receive more light. However, in deep or turbid sections, light penetration may be insufficient to sustain growth of autotrophs.

Heterotrophs

Heterotrophs, or consumers, are organisms that must obtain energy by consuming other organisms (autotrophs or other heterotrophs) as food.

From the perspective of energy flow in ecological systems, heterotrophs can be classified according to what they eat:

- Herbivores are called primary consumers because they eat only plants.

- Carnivores are called secondary consumers because they feed on other animals.

- Omnivores feed both on autotrophs and on other heterotrophs; that is, they eat both plants and animals. Many aquatic organisms, including fish, are omnivorous.

- Detritivores consume dead organic matter (detritus). Detritivores include many bacteria and fungi, invertebrates such as worms and insects, and some scavenging vertebrates. Aquatic insects, for instance, shred dead leaves, but also consume bacteria and fungi growing on the leaves.

Heterotrophs can also be classified according to how they obtain food energy (i.e., functional feeding groups), and by their specific roles in the aquatic ecosystem (Cummins and Klug 1979):

- The grazer-scraper category includes herbivores that feed on periphyton and biofilm. Shredders are detritivores feeding on coarse organic particles, especially leaf litter derived from the riparian zone.

- Collectors eat fine organic particles and can be subdivided according to whether the food particles they collect are suspended in the water (e.g., filtering-collectors or filter-feeders), or have been deposited on the substratum (collector-gatherers).

- Deposit-feeders ingest fine bottom sediments and the organic material that they contain.

- Predators are species that eat other animals.

STUDY EXERCISES

1. Briefly explain the essential elements of an aquatic ecosystem
2. Explain the basic functions of autotrophs in an aquatic ecosystem
3. Attempt a simple classification of heterotrophs

LESSON SEVEN

FRESH WATER COMMUNITIES 1

The study of ecology in freshwater is usually divided into two main categories, lentic (still) and lotic (running) water. These two bodies of water also have a bearing on which organisms are likely to occupy the area. An attempt is made here to discuss the nature of these two categories of fresh water, and also, investigate how they affect the life which lives in them. This lesson examines the still water communities while the next lesson will be devoted for the running water communities. A third category of fresh water ecology, known as wetlands, is also identified. It relates to areas where the soil is saturated or inundated for at least a substantial part of the year. Freshwater ecosystems cover 0.80% of the Earth's surface and inhabit 0.009% of its total water. They generate nearly 3% of its net primary production, and contain 41% of the world's known fish species.

Freshwater Communities and Lentic Waters:

Lentic (still water) communities can vary greatly in appearance and size, from a small temporary puddle to a large lake, and is capable of supporting life to some extent. The type of life which is supported will depend greatly on the biotic and abiotic components of the freshwater ecosystem explained earlier.

The creation of many of today's long standing freshwater lentic environments are a result of geological changes over a long period of time, notably human activities such as mining and road construction, glacial movement, erosion, and volcanic activity. The consequence of these actions results in troughs in the landscape where water can accumulate and be sustained over time. The size and depth of a still body of water are major factors in determining the characteristics of that ecosystem, and will continually be altered by some of the causes mentioned above over a long period of time.

One of the important elements of a still water environment is the overall effect that temperature has on it. The heat from the sun takes longer to heat up a body of water as opposed to heating up dry land. This means that temperature changes in the water are more gradual, particularly so in more extensive areas of water. When this freshwater ecosystem is habitable, many factors will come into play, and eventually determine the overall characteristics of the environment which organisms will have to adapt to.

As with osmosis, temperature will even out across a particular substance over time, and this applies to a still body of water. Sunlight striking the water will heat up the surface, and over time will create a temperature difference between the surface and basin in the body of water. This temperature difference will vary depending on the overall surface area of the water and its depth.

With time, two distinctly different layers of water become established, separated by a large temperature difference and providing unique ecological niches for organisms. This process is called stratification, where the difference in temperature between surface and water bed are so clear that they can easily be distinguished apart. The surface area is referred to as the epilimnion, which is warmed water as a result of direct contact with sunlight. The lower layer on the other hand is known as the hypolimnion, is found below the water surface and due to increased depth, receives less heat from the sun and therefore results in the colder water underneath.

Previous sections have elaborated on the importance of light to the freshwater community. Some factors can affect the amount of light received by autotrophic organisms (organisms that perform photosynthesis) can affect their level of photosynthesis and respiration, hence affect their abundance and therefore, subsequent species that rely on them.

Man has continuously polluted water sources, especially since the industrial revolution. Litter for example, and especially non-biodegradable litter, will block out light for light dependant organisms. An oil spillage will also have the same effect, perhaps more extreme as the oil will situate itself on the surface of the water and block out light.

Organic material and sediment can enter the still water environment via dead organisms in the area, and water flowing into the area from hills and streams. Buoyant material will also block out light required by the primary producers of the ecosystem.

The friction caused by moving water against the water bed and its banks will result in disturbing loose sediment. Depending on the weight of this sediment, heavier particles will slowly sink back to the bottom of the body of water while lighter materials will remain suspended in the water. The lightest material will rise to the surface, resulting in less light available to organisms underneath the surface.

Naturally, the consequences of the above will result in less light for organisms that rely on photosynthesis as a means of food, and subsequently, organisms that feed on these autotrophic organisms will soon find that their food source is less freely available.

Another major factor affecting still water communities is the oxygen concentration of the surrounding area. Oxygen concentration is primarily affected by three factors

- The surface area which the body of water is exposed to the open air environment
- The circulation of water, mainly due to temperature variations in different areas of the water body (convection currents)
- Oxygen created as a result of respiration, consumption, and the oxygen consumed by animals and bacteria.

As mentioned earlier, temperature can also affect the concentration of oxygen available, which in turn, means that the depth of the water will therefore also have an effect. In turn, carbon dioxide levels, which are closely related to the oxygen levels available, will be required by organisms undergoing photosynthesis. The availability of these will affect the organisms in the ecosystem. Their relationships with temperature will also affect their availability.

Evidently, some of these factors vary through different conditions, and changes in one of the factors usually results in changes in the others. This is also the case of pH, for example, as an increase in carbon dioxide results in a drop in the value of pH.

With this information, we can now understand how organisms survive in these habitats in relation to these conditions described.

Still Water Animals:

Through millions of years of evolution, animals living in an aquatic environment have diversified to occupy the ecological niches available in the ecosystem. In studying the habitats of these particular organisms, three main areas of the freshwater environment can be distinctly classified.

- The Profundal Region – This refers to an area of still water that receives no sunlight, and therefore lacks autotrophic creatures. The animals in this zone rely on organic material as a means of food, which is sourced from the more energy rich areas that are above this region.

- The Pelagic Region - The pelagic region can be found below the surface water, and is defined by the light that is available to it. The pelagic region does not include areas near the shore or sea bed.

- The Benthic Region - The benthic region incorporates the entire freshwater environment in contact with land, barring the shallow shore areas. The benthic region is capable of hosting a large volume of organisms, as nutrient and mineral rich sediments are available as a food source while part of the benthic region can occupy the euphotic zone, the area of water where light is available. This will allow an ecological niche for autotrophic organisms which in turn can be a food source for herbivores.

Another distinctive niche for the animal community is that above (epineuston) and below (hyponeuston) the water surface. Epineustic animals receive food from the surrounding hydrosere vegetation, where small animals fall into the water from vegetation and are preyed upon by these epineustic animals.

Below these surface dwelling animals are a collection of animals called the nekton, which live in the pelagic and profundal regions, though rise to the pelagic regions to feed upon these epineustic animals. Fish are included in this nekton community, which play a vital cog in these freshwater communities. Some of these fish are only temporary members of the community, as they move between fresh and salt water. Anadromous fish spawn in freshwater, but live much of their lives in salt water. Catadromous fish are the opposite of this, and spend much of their lives in the freshwater community. Each way, the fish present in the environment at any time form the link between the upper and lower layers of the freshwater community.

Previous sections have described how plants are the primary producers of the freshwater community, harnessing new energy from the sun into the environment. The next page looks at some of the animals that rely on these plants in the community, and animals that survive in the depths of the water and along the water shore and bed.

Freshwater Lentic Communities and Animals:

Plants that live partially or completely submerged in water are deemed hydrophytes. A form of symbiosis occurs with these hydrophyte plants, which provide means for algae and other organisms to survive in the surrounding environment. This is because the hydrophytes provide the conditions for the likes of algae and bacteria to survive in the environment. In return, herbivorous animals tend to feed on this rich blanket of algae as opposed to the plants themselves, thereby protecting them from being consumed.

Animals in this environment feed on these algae, and also upon the detritus matter (the rich organic material found on the water bed). It is an area of abundant organic material because the plants that survive in this area provide a source of food, and also a source of shelter which can provide protection from predators or a location to hatch offspring in a closed protected area.

This energy rich environment and suitable conditions allows a wide range of aquatic animals to successfully breed and survive in the area .Particularly, herbivores thrive in these niches of the community, as there is a rich sources of food (plants) growing from the nutrient rich soil.

Still Freshwater and Plants

Plants in the freshwater community provide a means of food for herbivores, and harness new energy into the community as a whole via photosynthesis from available sunlight. Plants are usually the pioneers of a new ecosystem, and therefore a bustling freshwater environment will have an abundance of plants.

The ecological niche alongside the still water banks is occupied by plants called hydroseres, which are partially or totally submerged by water along the banks. Some of these hydroseres are rooted in the water, though some of their leaves penetrate the water surface, while others float on the surface, one side in contact with the water, the other side in contact with the open air environment. In essence, hydroseres possess evolutionary adaptations and dithering respiration rates from land plants that have allowed them to adapt in live in such an environment. Such evolutionary adaptations in plants have resulted in changes in their physical structure to suit the environment, and therefore making freshwater plants distinctly unique in appearance.

An example of these adaptations is the lack of rigid structures in freshwater plants. This is due to the density of the water (much higher than that of an open air environment), which 'pushes' against the plant in its daily life. This allows such plants to be more flexible against oncoming water tides, and prevents damage to the plant.

As plants require a minimum concentration of gases in their diet such as carbon dioxide, they also require a degree of buoyancy so that contact can be made with the open air environment. Adaptations may include;

- Air Spaces - Air spaces in the plant will decrease density and increase buoyancy.

- Broad Leaves - Broader leaves will spread their weight more evenly across the water surface allowing them to float.

- Waxy Cuticle - On the upper half to allow water to run off the surface to prevent the weight of the water dragging the leaves under the surface.

As these plants are either partially or totally submerged in water, their transpiration rate is very different from that of land plants. Such adaptations allow the freshwater community plants to cope with these conditions and thrive. However, alterations to the transpiration rate of these plants have proved essential, as without these adaptations they would not be able to maintain their water balance.

STILL WATER COMMUNITY PLANTS

Freshwater Plants and Water

As mentioned about still water plants, the method of transpiration as a whole is altered in freshwater plants, due to the abundance of water in their external environment, or in the case of some, uptake of water from a wet environment, but loss of water via their leaves in the open air environment.

An example of transpiration problems for such plants is as follows;

- The plant lives in a marshy environment, where roots uptake water from soaked ground, allowing plenty of water to be up taken and transported up and across the plant.
- The difference in water concentration between the plants' leaves and the open air environment is so great that much of the water absorbed is lost to the external environment, meaning the plant loses water rapidly.
- Such a problem is solved by evolutionary adaptations as described in the plant water regulation page. These adaptations essentially address the issue of re-balancing the critical deviations between the water that is absorbed and lost in a plant.

Freshwater Plants and Nutrients

In addition to the need for plants to maintain a suitable water concentration in plant cells, they also require various nutrients which are found in the nutrient rich soil and the surrounding waters. In addition to the carbon, hydrogen and oxygen required for photosynthesis, plants require a range of macro-elements, notably magnesium (Mg), nitrogen (N), phosphorous (P) and potassium (K). Some of these elements, notably the gases, are readily available in the atmosphere, while carbon dioxide is produced from decomposing organic matter. Other elements are readily available in the soil, with nutrients becoming available from decomposing matter adding to the fertility of the surrounding soil. Oxygen becomes available from the photosynthetic activities of plants, which provide the link between oxygen and carbon dioxide concentrations in the area.

Availability of such elements will affect the productivity of the plants in the freshwater ecosystem, and the combined productivity of the ecosystem as a whole. Evidently, the environmental factors of the freshwater ecosystem has great bearing on how plants survive in the community

STUDY EXERCISES

1. Highlight the major factors that affect the concentration of oxygen in lentic fresh water communities.
2. Identify the various zones of fresh water communities
3. Explain the ecological niches occupied by animals in still fresh water communities
4. Explain the significance of plants in still fresh water ecosystem
5. Highlight the various ways of adaptation by plants in fresh water ecosystems.

LESSON EIGHT

FRESH WATER COMMUNITIES 11

This lesson is a continuation of the previous one which examined the fresh water communities in still waters. The lesson therefore takes a look at the running water ecosystems.

RUNNING WATER

Water Sources

Running water freshwater communities are also known as lotic communities. Lotic communities are formed by water being introduced to the freshwater body from a variety of sources, such as;

- Rainfall - A percentage of water in the running water community will be present as a result of rainfall directly entering it.
- Surface Water - Deriving from previous rainfall, water will flow and eventually join the running water community.
- Underground Water - Water absorbed into the soil, which can also resurface and enter the surface water body.
- Water Table - Deep underground, there is a reservoir of water, known as the 'water table', which can also provide water for the running water community.

There are also many other, less significant ways through which water can enter the stream; for example, due to human interference such as an outlet pipe, or water transpired by plants in the nearby area. The accumulation of this water from the areas mentioned above also introduces essential minerals and nutrients that are ideal for plant growth, the primary producers of a community. With that in hand, alongside an abundance of water, pioneers can occupy the running water environment.

Affecting Factors

One of the main differences between lotic and a lentic community is the fact that the water is moving at a particular velocity in lotic communities. This can have great bearing on what organisms occupy the ecosystem and what particular ecological niche they can exist in. Running water can bring many factors into play affecting the lives of the organisms in this particular environment. Such factors may include the following;

- Movement of minerals and stones caused by the velocity and volume of the water, thereby constantly changing the stream characteristics. The faster and higher volume of water present will result in a direct increase in amount and size of particles shifted downstream.

- Standing waves are used by salmon at the bottom of waterfalls to spurn them upstream. At the same time, they cause small air pockets caused by oxygen replacing the splashing water, which results in a small micro-habitat becoming available suited to particular organisms

- Erosion is caused by the running water breaking down the river bank and beds, causing the geography of the river to change over a long period of time. This means that hydroseres previously occupying the river bank may find themselves distanced from the running water for example, and over time this would mean the overall ecosystem characteristics would change.

Such factors play a vital role in determining the overall chemical, physical and biological face of the running water ecosystem. We shall now look at these physical and chemical differences that make up a running water ecosystem which will inevitable affect the biological make-up of the freshwater ecosystem.

Running Water Freshwater Communities

This section continues from the previous one introducing lotic (running water) communities. The following are some of the physical and chemical factors that provide the framework of a running water community in which organisms in their favoured ecological niches occupy.

- Temperature - The difference between running water and still water temperature is that running water communities' temperature varies more rapidly but over a smaller range. In Summer, water from the source of the river is usually colder than the water found at the delta because it has not been exposed to the warm air heated by the sun. The reverse occurs in Winter where water is warmer until exposed to the colder air.

- Light - On the whole, less light penetrates a running water body due to ripples in the water, debris blocking out sunlight to lower layers as well as overhanging shrubs that perhaps are taking advantage of a tributary water source. These are all examples of how the intensity of light reaching the lotic community can be affected, and in turn, directly affects the rate of photosynthesis done by plants in the community.

- Chemical Composition - Many factors can alter the chemical composition of the freshwater environment, including precipitation, the percolation of water via vegetation and sea spray to name a few. All in all, various elements and compounds are required by organisms in their daily activities and fluctuations or even an absence of such elements and compounds results in a direct effect on the lives of such organisms.

- Organic Matter - Organic matter (previously external to the running water environment) can also play a part in altering the ecosystem. This mostly occurs due to overhanging vegetation, although organic matter can be drawn into the ecosystem by the various sources mentioned above.

Such factors all play a part in the lives of animals and plants occupying the lotic environment

Lotic Communities and Algae

Generally the diversity of plant species in a lotic community is small compared to that of a still water (lentic) community, although small parts of the lotic community host similar conditions to that of a lentic community. Most plants have gone through evolutionary adaptations to cope with the force and different conditions that running water brings. Such adaptations have allowed a number of species to successfully take advantage of the lotic community as their ecological niche.

As these conditions are harsher for a typical species of plant, more notably larger plants, smaller species have found the conditions of the lotic community more favourable. This is due to the fact that they are more flexible in regards to the physical conditions of the water. Algae can grow in all sorts of different places and surfaces, and therefore are a successful constituent of the running water ecosystem. Most of these algae have developed evolutionary adaptations over time that prevents the water current sweeping them away.

There are many species of algae, all of which are capable of growing and reproducing at a quick rate. This consequence results in competition for niches in the freshwater environment, and in light of this, colonies of algae can heavily occupy one area at one moment in time and weeks later they can be succeeded by other species which can succeed in more favourably conditions.

Algae are also the primary producers of this community, since they harness new energy into the ecosystem from the sun which provides the primary consumers with a valuable food source. Algae communities are always found in the lotic community, and are variable on a short-term basis.

STUDY EXERCISES

1. Briefly discuss the various sources of water that constitute lotic water communities
2. Explain the factors affecting organisms in lotic water ecosystems
3. Examine the factors that provide framework for running water communities.
4. Discuss the significance of algae in lotic waters.

LESSON NINE

LOTIC WATER COMMUNITIES ANIMALS

As mentioned in the previous lessons, the running water environment offers numerous microhabitats that simulate favourable conditions for many types of animals to successfully succeed the freshwater lotic community. As with plants, animals in this ecosystem have also undergone evolutionary adaptations to better suit this running water environment. As with plants and their rooting structure, animals have also adapted to cope with the current of the stream.

Some of these animals are sessile, meaning they are immobile and fixed to the one place. These animals are usually small, and include the protozoans and some freshwater sponges. These animals either remain attached to the mass of a plant or the water bank surface or rock. They usually obtain their food via tentacles which branch out into the flowing water and form a catchment area that can trap microscopic organisms (such as plankton) that is floating downstream.

As much as these sessile animals have developed adaptations to prevent being washed downstream, they are not thought to be one of the important pillars of the freshwater community. Over time when biotic and abiotic factors affect the landscape of the ecosystem over time, the location of these animals may not be as favourable as it once was, and they are unable to correct this due to their immobile nature. With this in light some animals have developed adaptations that allow them to travel through the water without being inhibited in same spot.

These animals have developed some of the following adaptations over time that helps them cope with prevailing conditions:

- Suckers - These suckers attach themselves to a surface that leeches them into position and can also assist movement in any given direction.

- Hooks / Claws – The animals have developed very sharp claw – like objects that can dig into any given object and allow the animal to cling to a position or claw their way around the surface.

- Body flattening - This adaptation can allow the animal in the water bear less of the brunt of the force of water moving downstream, therefore reducing it as an inhibitor of their movement. This also allows these animals to enter confined areas (such as under stones) that may present a useful environment for them to live in.

- Streamlining - Just like man-made transport, animals that have underwent streamlining adaptations on their external appearance means that less resistance is presented by the running water when the animal attempts to move.

- Flight - Some animals have adaptations allowing them to fly, removing themselves from the force of the current at ground level and enabling them to move upstream more easily if need be.

Freshwater Communities and Plankton

Plankton are microscopic organisms that live suspended in the water environment, and form a very important part of the freshwater community. Their movement is aided by convection or wind induced currents. In almost every habitat of a freshwater ecosystem, thousands of these organisms can be found, and due to their small size and simplicity, they are capable of occupying large expanses of water and multiplying at an exponential rate.

Plankton can be subdivided into two categories.

- Phytoplankton - Phytoplankton are microscopic plants which obtain their energy through the process of photosynthesis. However, some species of bacteria are also capable of photosynthesis and also fall under this taxonomic category. They are important to the ecosystem because they are part of the primary producing community and assist in recycling elements such as carbon and sulphur which are required elsewhere in the community.

- Zooplankton - Zooplankton consist mainly of crustaceans and rotifers, and on the whole are relatively larger than their phytoplankton counterparts.

Plankton are relatively unspecialised as their environment does not resist the large populations that can exist within the ecosystem. Physiologically, there are many evolutionary adaptations that can be found that assist in the buoyancy of plankton which prevent their deaths by allowing them to be suspended in the water away from harm.

They can be found in large amounts in small areas, and as they are consumed in large numbers by herbivores and carnivores, they reproduce asexually to maintain their population. This is opposed to sexual reproduction with other organisms, which would take longer although it would increase genetic variation within the species.

Factors Affecting Plankton Distribution

Many factors can affect the distribution of plankton in an ecosystem, which has a detrimental effect on the rest of the ecosystem, because as mentioned, they form an essential part of the ecosystem. Phytoplankton harness new energy from sunlight and provide many other organisms as a means of food due to this while zooplankton are also an important source of food for many species. In light of this, a knock on effect of starvation would occur if there is a lack of plankton in a particular environment.

Phytoplankton are more abundant in areas with a high intensity of light, as they can convert this light energy into chemical energy while higher temperatures increase growth and multiplication of both phytoplankton and zooplankton. Elementary, the amount of available nutrients in the environment plays a significant role in the distribution and density of phytoplankton.

STUDY EXERCISES

1. Explain the various methods of animal adaptation in lotic water communities
2. Briefly discuss plankton as it occurs in lotic water communities.
3. Discuss the factors that may determine the distribution of plankton distribution in lotic water communities.

LESSON TEN

HUMAN INFLUENCE ON FRESHWATER ECOSYSTEMS

As with all ecosystems, the existence and operations of human society inevitably have an effect on the way of life in a freshwater community. Particularly in the Western society, where a huge amount of resources are harnessed from the land to fund lifestyle, there is a resulting effect on the ecosystems of the planet.

For each action that man takes in this lifestyle, there is a resultant effect on the ecosystem, and the following looks at some scenarios where human action results in a response from the ecosystem, either physically or chemically, which in the long run affects the lives of organisms that live in these communities;

- Hot water is used in many industries to cool machinery. This water is often removed via a discharge pipe into the river. This increase in temperature can affect the level of oxygen freely available to organisms, which, in turn affects respiration and essentially their way of life. Due to this temperature change, life in the fresh water ecosystem is affected.

- Removal of foliage next to a freshwater ecosystem allows more running water to enter its capacity. In light of this, periods of heavy rainfall can result in the water levels fluctuating greatly, which in turn can also affect the temperature of the water quite considerably not to mention all the new chemical agents that would enter the stream from this extra water.

- Recreational use of water bodies such as canoeing also has an impact on fresh water ecosystems. Litter introduced through this activity can remain on the surface of water and block out sunlight required by the primary producers for photosynthesis. If these primary producers' way of life is affected in such a way that their population level decreases, there is a knock on effect to all those organisms that rely on these primary producers for survival.

- At a molecular level, chemicals discharged into the water, notably from industries or pesticides from farmland can affect the freshwater environment considerably. Higher concentrations of particular chemicals (perhaps toxic) mean a lower concentration of essential chemicals required by the organisms of the ecosystem. If this scenario prevails, the fresh water organisms would not perform respiration and function at an optimum level, thus reducing overall biomass in the ecosystem.

- Fishing activities have been recognised to have great effect on fresh water ecosystems. These activities, apart from directly having a toll on the existing species within the ecosystem, have often been accompanied with the introduction of some materials into the water. These materials have often been discovered to impact negatively on the entire ecosystem functioning and stability. In places where trawlers are used for fishing activities, the trawl nets are dragged along the seabed sweeping up all the fish in their path, while at the same time smashing ancient corals, ripping up sponges and destroying the other marine life which makes up these fragile deep sea communities that have taken thousands of years to develop.
- Other human activities such as construction, building, cultivation and deforestation also have far reaching implications on adjacent fresh water ecosystems. These activities increase the debris and other eroded materials in the fresh water, which also affects the available oxygen for organisms in the water bodies. This also affects the overall composition and quality of the water, and thus the general livelihood of the organisms.

As is already known, there are many environmental factors that arise due to the usage of water in one way or another by our species. The most important fact to take from this is that when we use water in the above examples, we are upsetting the fine balance of the ecosystem as a whole, thus enabling far reaching disruptions in the lifestyles of other organisms living in that particular ecosystem.

In conclusion therefore, we can summarise that human effects on aquatic ecosystems can result from pollution, changes to the landscape or hydrological systems, and larger-scale impacts such as global climate change. The complexity of aquatic ecosystems and the linkages within them can make the effect of disturbances on them difficult to predict. These linkages mean that damage to one component of the ecosystem can lead to impacts on other ecosystem components. Increasing our understanding of aquatic ecosystems can lead to better practices that minimize impacts on aquatic environments. In light of this, and with more consideration towards our environment, conservation measures should be used to ensure little or no detrimental damage is caused to these environments, while at the same time man can continue to harness the water as a valuable resource.

MANAGEMENT OF FRESH WATER ECOSYSTEMS

This involves the activities of man that are aimed at ensuring the protection and conservation of fresh water ecosystems and communities in general. Such activities are always the deliberate efforts of man which not only improve the condition of the fresh waters, but are also geared towards conserving the entire communities. These activities of man include the following;

- Aquatic Weed Management

This refers to the deliberate activities embarked upon by man, which are aimed at controlling weeds and other aquatic plants. This is often done in all types of aquatic ecosystems.

- Farm Ponds

This relates to all attempts that are meant to enhance the effective and sustainable existence and operations of aquatic communities. This activity involves the construction, fertilization, recirculation, and general management of ponds and other water reservoirs.

- Fish Production

Aquaculture is a human activity that involves the management of fish farms. This activity which aims at improving the production of different categories of fish also ensures the general management of the entire ecosystems in which the fish and other aquatic organisms survive. The production of fish has gained population in many countries including

Nigeria, also involves the conservation of the ponds or water bodies in which the fish is reared.

- Pond and Lakefront Revegetation

In many areas, deliberate attempts are made to enhance the landscape management, revegetation of adjacent aquaculture farms. This activity also improves on the conditions the adjacent terrestrial ecosystem, and ultimately restricts the possibility of contamination of the aquatic community.

- Recreation

Fresh water management has been extended to the creation of artificial lakes or ponds for the purpose of recreation. Since such Ponds are deliberately conserved and protected, the aquatic communities are by implication being protected from wanton human influences.

- Controlled fishing

In realisation of the increased intensity of fishing activities in many parts of the world, attempts have been made to put in place some policies, and sometimes legislations, to guard against destruction of fish and their habitats. This is especially prominent in Nigeria and other developing countries where the use of chemicals and other toxic materials for fishing is rampant.

STUDY EXERCISES

1. Discuss the various ways through which man may interfere with fresh water communities
2. Explain the possible strategies for the management of fresh water ecosystems

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