AQUATIC FLORA AND FAUNA (2 UNITS)

FIS 311

LECTURE GUIDE

BY:

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Fresh-water ecosystems are often categorized by two basic criteria: water movement and size. In lotic or flowing-water ecosystems the water moves steadily in a uniform direction, while in lentic or standing-water systems the water tends to remain in the same general area for a longer period of time. Size varies dramatically in each category. Lotic systems range from a tiny rivulet dripping off a rock to large rivers. Lentic systems range from the water borne within a cup formed by small plants or tree holes to very large water bodies such as the Laurentian Great Lakes. Fresh-water studies also consider the interactions of the geological, physical, and chemical features along with the biota, the organisms that occur in an area.

Physical environment

The quantity and spectral quality of light have major influences on the distribution of the biota and also play a central role in the thermal structure of lakes. The light that reaches the surface of a lake or stream is controlled by latitude, season, time of day, weather, and the conditions that surround a water body. Light penetration is controlled by the nature of water itself and by dissolved and particulate material in a water column.

Water exhibits a number of unusual thermal properties, including its existence in liquid state at normal earth surface temperatures, a remarkable ability to absorb heat, and a maximum density at 39.09°F (3.94°C), which leads to a complex annual cycle in the temperature structure of fresh-water ecosystems.

As water is warmed at the surface of a lake, a stable condition is reached in which a physically distinct upper layer of water, the epilimnion, is maintained over a deeper, cooler stratum, the hypolimnion. The region of sharp temperature changes between these two layers is called the metalimnion. The characteristic establishment of two layers is of major importance in the chemical cycling within lakes and consequently for the biota.

As the surface waters of a lake cool, the density of epilimnetic waters increases, which decreases their resistance to mixing with the hypolimnion. If cooling continues, the entire water column will mix, an event known as turnover. At temperatures below 39.09°F (3.94°C), water again becomes less dense; ice and very cold water float above slightly warmer water, maintaining liquid water below ice cover even in lakes in the Antarctic. Many lakes in the temperate zones undergo two distinct periods of mixing annually, one in the spring and the other in the fall, that separate periods of stratification in the summer and winter.

Water movement is more extensive in lotic than in standing-water ecosystems, but water motion has important effects in both types. Turbulence occurs ubiquitously and affects the distribution of organisms, particles, dissolved substances, and heat. Turbulence increases with the velocity of flowing water, and the amount of material transported by water increases with turbulence. Flowing-water ecosystems are characterized by large fluctuations in the velocity and amount of water. Aside from surface waves on large lakes, most water movement in lentic systems is not conspicuous.

Chemical environment

For an element, three basic parameters are of importance: the forms in which it occurs, its source, and its concentration in water relative to its biological demand or effect. Most elements are derived from dissolved gases in the atmosphere or from minerals in geological materials surrounding a lake. In some cases the presence of elements is strongly mediated by biological activities. *See also* Biogeochemistry.

Oxygen occurs as dissolved O_2 and in combination with other elements resulting from chemical or biological reactions. It enters water primarily from the atmosphere through a combination of diffusion and turbulent mixing. When biological demands for oxygen exceed supply rates, it can be depleted from fresh-water ecosystems. Anoxic conditions occur in hypolimnia during summer and under ice cover in winter when lake strata are isolated from the atmosphere. Oxygen depletion may also occur in rivers that receive heavy organic loading. Aside from specialized bacteria, few organisms can occur under anoxic conditions.

Carbon dioxide is derived primarily from the atmosphere, with additional sources from plant and animal respiration and carbonate minerals. Its chemical species exert a major control on the hydrogen ion concentration of water (the acidity or pH). *See also* pH.

Phosphorus occurs primarily as a phosphate ion or in a number of complex organic forms. It is the element which is most commonly in the shortest supply relative to biological demand. Phosphorus is thus a limiting nutrient, and its addition to fresh-water ecosystems through human activities can lead to major problems due to increased growth of aquatic plants.

Nitrogen occurs in water as N_2, NO_2, NO_3, NH_4, and in diverse organic forms. It may be derived from precipitation and soils, but its availability is usually regulated by bacterial processes. Nitrogen occurs in relatively short supply relative to biological demand. It may also limit growth in some fresh-water systems, particularly when phosphorus levels have been increased because of human activity. *See also* Nitrogen fixation.

A variety of other elements also help determine the occurrence of fresh-water organisms either directly or by the elements' effects on water chemistry.

Biota

In addition to taxonomy, fresh-water organisms are classified by the areas in which they occur, the manner in which they move, and the roles that they occupy in trophic webs. Major distinctions are made between organisms that occur in bottom areas and those within the water column, the limnetic zone. Production is the most difficult variable to measure, but it provides the greatest information on the role of organisms in an ecosystem. *See also* Biological productivity; Biomass.

Plankton organisms occur in open water and move primarily with general water motion. Planktonic communities occur in all lentic ecosystems. In lotic systems they are important only in slow-moving areas.

Phytoplankton (plant plankton) comprise at least eight major taxonomic groups of algae, most of which are microscopic. They exhibit a diversity of forms ranging from one-celled organisms to complex colonies. *See also* Algae; Bacillariophyceae; Phytoplankton.

Zooplankton (animal plankton) comprise protozoans and three major groups of eukaryotic organisms: rotifers, cladocerans, and copepods. Most are microscopic but some are clearly visible to the naked eye. *See also* Copepoda; Population ecology; Rotifera; Zooplankton.

Animals, such as fishes and swimming insects, that occur in the water column and can control their position independently of water movement are termed nekton. In addition to their importance as a human food source, fishes may affect zooplankton, benthic invertebrates, vegetation, and lake sediments.

Benthic organisms are a diverse group associated with the bottoms of lakes and streams. The phytobenthos ranges from microscopic algae to higher plants. Benthic animals range from microscopic protozoans and crustaceans to large aquatic insects and fishes. *See also* Food web.

Bacteria occur throughout fresh-water ecosystems in planktonic and benthic areas and play a major role in biogeochemical cycling. Most bacteria are heterotrophic, using reduced carbon as an energy source; others are photosynthetic or derive energy from reduced compounds other than carbon. *See also* Bacterial physiology and metabolism.

Interactions

Ultimately the conditions in a fresh-water ecosystem are controlled by numerous interactions among biotic and abiotic components. Primary production in a fresh-water ecosystem is controlled by light and nutrient availability. As light diminishes with depth in a column or water, a point is reached where energy for photosynthesis balances respiratory energy demands. In benthic areas, the region where light is sufficient for plant growth is termed the littoral zone; deeper areas are labeled profundal.

Nutrient availability generally controls the total amount of primary production that occurs in fresh-water ecosystems. One classification scheme for lakes ranks them according to total production, ranging from oligotrophic lakes, where water is clear and production is low, to eutrophic systems, characterized by high nutrient concentrations, high standing algal biomass, high production, low water clarity, and low concentrations of oxygen in the hypolimnion. Eutrophic conditions are more likely to occur as a lake ages. This aging process, termed eutrophication, occurs naturally but can be greatly accelerated by anthropogenic additions of nutrients. A third major lake category, termed dystrophy, occurs when large amounts of organic materials that are resistant to decomposition wash into a lake basin. These organic materials stain the lake water and have a major influence on water chemistry which results in low production. *See also* Bog; Eutrophication.

Lecture 1: Introduction

- Identification and classification of aquatic habitat
    a) Lentic habitat
    b) Lotic habitat
    c) wetlands
- Typical Characteristic of freshwater habitat
    a) Physical characteristics
    b) Chemical characteristics
    c) Biological characteristics

Lecture 2: Study and identification of characteristic tropical freshwater flora I

- Phytoplankton
    a) Blue-Green algae
    b) Green algae
    c) Diatoms
    d) Red algae
    e) Other types of algae

Practical 1:

Objectives: To help students identify different phytoplankton present in water bodies

- Collection of water samples from different sources for screening and identification
- Drawing and Classification of phytoplankton

Lecture 3: Study and identification of characteristic tropical freshwater fauna

- Zooplankton (microscopic invertebrates)
- Macroscopic invertebrates
- Vertebrates

Practical 2:

Objectives: To help students identify different zooplankton present in water bodies

- Collection of water samples from different sources for screening and identification
- Drawing and Classification of zooplankton
- Collection of aquatic animals
- Drawing and classification of collected animals

Lecture 4: Study and identification of characteristic tropical aquatic flora II

- Aquatic Macrophytes
  a) Floating weeds
  b) Submergent weeds
  c) Emergent weeds

Practical 3:

Objectives: To help students identify different aquatic macrophytes present in/around water bodies

- Collection of macrophytes samples from lotic and lentic water bodies for screening and identification
- Drawing and Classification of aquatic plants

Lecture 5: Study and identification of characteristic tropical coastal fauna

Practical 4:

Objectives: To help students identify different shellfishes present in/around Nigeria coastal water bodies

- Collection of shellfishes from coastal water bodies for identification
- Drawing and Classification of different shellfishes collected

Lecture6: The ecology, utilization and management of aquatic flora

Practical 5:

Objectives: To help students understand interactions/interrelationships in an aquatic ecosystem

- Demonstrate the relationships between flora and fauna in an aquatic ecosystem
- Demonstrate utilization of aquatic plant for man use
- Management of aquatic plants for ecosystem/habitat conservation

Lecture7: The ecology, utilization and management of aquatic fauna

Practical 6:

Objectives: To help students understand interactions/interrelationships in an aquatic ecosystem

- Demonstrate the relationships between flora and fauna in an aquatic ecosystem
- Demonstrate economic utilization of aquatic fauna for man use
- Management of aquatic animals for sustainable ecosystem/habitat conservation

Lecture 8: Control of aquatic weeds in ponds:-

i) Chemical method:

- Identification of different commonly used chemicals for the control of aquatic weed
- Method of application of herbicides in the control of aquatic weeds
- Disadvantages of the use of chemical in the control of aquatic weeds

ii) Mechanical method:

- Various methods of control of aquatic weeds using mechanical means
- Advantages associated with the use of mechanical method for the control of aquatic weeds

iii) Biological method

- Identification of biological agents used for controlling aquatic weeds
- Advantages and disadvantages associated with biological aquatic weed control method