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Limnology a brief review with special reference to benthic zone.

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ABSTRACT

Limnology is the Greek word, limens means lake and logos means knowledge also called freshwater science, is the study of inland water. It is often recorded as a division of ecology or environmental science. It covers the biological, chemical, physical, geological and other attributes of all inland waters (running and standing waters, fresh and saline, natural or man-made). This includes the study of lakes and ponds, rivers, springs, streams and wetlands. A more recent sub discipline of limnology, termed landscape limnology, studies, manages and conserves these aquatic ecosystems using a landscape perspective. Benthos are the organisms that live on or inside the deposits at the bottom of water body (Idowo and Ugwumba, 2005). These organisms play a vital role in the circulation and recirculation of nutrients in aquatic ecosystem. Most benthic organisms feed on the debris and settle on the bottom of the water and in turn form a major food link in the food chain as fishes, birds and mammals depends directly orindirectly on this benthos as their food.

Keywords: Limnology, lakes and ponds, benthic zones, benthic macro-invertebrate.

INTRODUCTION

Limnology is the Greek word, limens means lake and logos means knowledge also called freshwater science, is the study of inland water. It is often recorded as a division of ecology or environmental science. It covers the biological, chemical, physical, geological and other attributes of all inland waters (running and standing waters, fresh and saline, natural or man-made). This includes the study of lakes and ponds, rivers, springs, streams and wetlands. A more recent sub discipline of limnology, termed landscape limnology, studies, manages and conserves these aquatic ecosystems using a landscape perspective. Limnology is closely related to aquatic ecology and hydrobiology which study aquatic organisms in particular regards to their hydrological environment (Cole, 1994).

Fresh water biology is the scientific biological study of freshwater ecosystem and is a branch of limnology. It seeks to understand the relationships between living organisms in freshwater and their physical and chemical environment.

The discipline is also widely used in a number of industrial processes such as sewage treatment and water purification which utilize biological processes to effect purification. Fresh water is naturally occurring water on earth surface in ice-sheets, ice-caps, glaciers, ice-bergs, bogs, ponds, lakes, rivers and streams and underground as groundwater in aquifers and underground streams. Fresh water is generally characterized by having low concentration of dissolved salts and other total dissolved solids. The term specifically excludes seawater and brackish water although it does include mineral rich water such as chalybeate springs.

A lake is a body of relatively still water of considerable size, localized in a basin that is surrounded by land apart from a river, stream or other form of moving water that serve to feed or drain the lakes. Lakes are inland and not a part of ocean and therefore are distinct from lagoons and are larger and deeper than ponds. (Likens and Gene, 2009). Lakes can be contrasted with rivers or streams which are usually flowing however most lakes are fed and drained by rivers and streams.

Natural lakes are generally found in mountain areas, rifts zones and areas with ongoing glaciations. Other lakes are found in indoor endorheic basins or along the course of mature rivers. In some parts of the world there are many lakes because of chaotic drainage patterns left over from the last ice age. All lakes are temporary over geologic time scales, as they will slowly fill with sediments or spill out the basin containing them. Many lakes are artificial and are constructed for industrial or agricultural use, for hydro-electric power generation, domestic water supply, for aesthetic and recreational purposes.

In German Language Lake i.e. lake or lache means water pooled in riverbed or pool, puddle and Icelandic lakes meant slow flowing streams. Lakes have numerous features in addition to lake type, such as drainage basin (also known as catchment areas), in flow and out flow, nutrient content, dissolved oxygen, pollutants, pH and sedimentation. Changes in the level of lakes are controlled by the difference between the input and output compared to the total volume of the lake. Significant input sources are precipitation to the lakes, run off carried by streams and channels from the lakes catchment areas, groundwater channels, aquifers and artificial sources from outside the catchment area. Output sources are evaporation from the lake surface and groundwater flows and any extraction of lake water by humans. As climate conditions and human water requirement vary, these will create fluctuations in the lake level.

Lake can also be categorized on the basis of their richness in nutrients, which typically affects plant growth. Nutrient poor lakes are said to be oligotrophic and are generally clear, having a low concentration of plant life. Mesotrophic lakes have good clarity and an average level of nutrient. Eutrophic lakes are enriched with nutrient, resulting in good plant growth and possible algal blooms. Hypertrophic lakes are bodies of water that have been extensively enriched nutrients. These lakes typically reach this condition due to human activities, such as heavy use of fertilizers in the lake catchment area. Such lake is of little use to human and have a poor ecosystem due to decreased dissolved oxygen (Du Mont,2010).

Safe drinking water is essential to human and other life forms even though it provides no calories or organic nutrients. Access to safe drinking water has improved over the last decades in almost every part of the world, but approximately one billion people still lack access to safe water and over 2.5 billion lack accesses to adequate sanitation. (MDG Report, retrieved, 2008). However, some observers have estimated that by 2025 more than half of the world population will be facing water based vulnerability (Kulshreshtha1998).

A recent report suggests that by 2030 in some developing countries of the world the water demand will exceed supply by 50%. Water plays an important role in the world economy, as it functions as a solvent for a wide variety of chemical substance and facilitates industrial cooling and transportation. Approximately 70% of the fresh water used by humans goes to the agriculture. (Baroni et al, 2007)

Lakes and ponds are made up of zones, each with its own challenges. The littoral zone is the area closest to the shore where light reaches all the way to the bottom. Plants rooted to the bottom and algae live here. Animals may include tiny crustaceans, flatworms, insect larvae, snails, frogs, fish and turtles. The limnetic zone is the layer of open water where photosynthesis can occur. The light decreases the deeper you go until a depth is reached where the rate

of photosynthesis becomes equal to the rate of respiration. Aquatic life is dominated by planktonic algae, zooplankton, swimming insects and fish. Very deep lakes have an area known as the profundal zone where light does not reach. This zone is inhabited by organisms that are either attached to or crawl along the sediments at the bottom of the lake. The sediments support a large population of bacteria and fungi. The decomposers break down the organic matter and release inorganic nutrients, (Eggleton,1931). Aquatic communities contain a variety of species that represent different trophic levels, taxonomic levels, functional characteristics and tolerance changes. Careful selection of target taxanomic groups can provide a balance assessment sufficiently broad to describe the structural and functional condition of an aquatic ecosystem.

Benthos are the organisms that live on or inside the deposits at the bottom of water body (Idowo and Ugwumba, 2005). These organisms play a vital role in the circulation and recirculation of nutrients in aquatic ecosystem. Most benthic organisms feed on the debris and settle on the bottom of the water and in turn form a major food link in the food chain as fishes, birds and mammals depends directly orindirectly on this benthos as their food. Without benthic organisms these large animals would not be able to survive (Barnes and Hughes,1988).

Benthic macro invertebrates have a great potential as biological indicators because they are ubiquitous, integrate the effect of a multiple stressors on the aquatic system and are relatively easy to sample and identify. The term benthos includes bottom dwelling organisms. This group represents a great assemblage of plants and animals. Among these animals are representative of most of the phyla. As might be expected, the benthos varies widely with different condition of bottom, both at the same level and so diverse and so marked that it is difficult to discuss them as a whole.

Fresh-water benthic macro invertebrates or more simply “benthos” are animals without backbones that are larger than 0.5 millimeter. These animals live on rocks, logs, sediments, debris and aquatic plants during some periods in their life. The benthos includes crustaceans such as crayfish, molluscs such as clams and snails, aquatic worms and the immature forms of aquatic insects such as stonefly and mayfly nymphs.

These animals are widespread in their distribution and can live on all bottom types, even on manmade objects. They can be found in hot springs, small ponds and large lakes. Some are found in the soil beneath puddles. Many species of benthos are able to move around and expand their distribution by drifting with currents to a new location during aquatic phase of their life or by flying to a new stream during their terrestrial phase. Species are found thought the year, but the largest numbers occurs in spring just before the reproductive period.

Benthos is an important part of the food chain. Many invertebrates feed on algae and bacteria, which are on the lower end of the food chain. Some shred and eat leaves and other organic matter that enters the water. Because of their abundance and position as “middleman” in the aquatic food chain, benthos plays a critical role in circulation and recirculation of nutrients. As benthic invertebrates die, they decay leaving behind nutrients that are reused by aquatic plants and other animals in the food chain. Unlike fish, benthos cannot move around much so they are less able to escape the effects of sediments and other pollutants that diminish water quality. Therefore, benthos can give us reliable information on stream and water quality. Their long life cycles allow studies conducted by aquatic ecologists to determine any decline in environmental quality.

Benthic communities can be used to monitor stream quality conditions over a broad area or they can be used to determine the effects of point source discharges from sources such as sewage treatment plant and factories. Ecologists who evaluate environmental quality using the benthos often consider the following characteristics of a benthic sample.

1. Taxa richness: A measure of the number of different types of animals; greater taxa richness generally indicates better water quality.
2. Pollution tolerance: Many types of benthos are sensitive to pollutants such as metals and organic wastes. Mayflies, stoneflies and caddis flies are generally intolerant of pollution. If a large number of these insect types are collected in a sample, water quality in a stream is likely to be good. If only pollution tolerant organisms such as non-biting midges and worms are found, the water is likely to be polluted.
3. Functional groups: The presence or absence of certain feeding groups (such as scrapers and filterers)

may indicate a disturbance in the food supply of the benthic animals in the stream and the possible effects of toxic chemicals.

The term benthic is derived as for "depths of the sea" (CAML 2008), but the term is also used in freshwater biology to refer to the zone and organisms at bottom of fresh water bodies such as lakes, rivers and streams (NABS 2008). The benthic zone is one of the important ecological region of the water body. It comprises the bottom such as the ocean floor or the bottom of a lake- the sediment surface and some sub surface layer. Organisms living in this zone or in the bottom of the water body are called benthos. The adjective benthic refers to something connected with or occurring on the bottom of a body of water (CSC 2008).

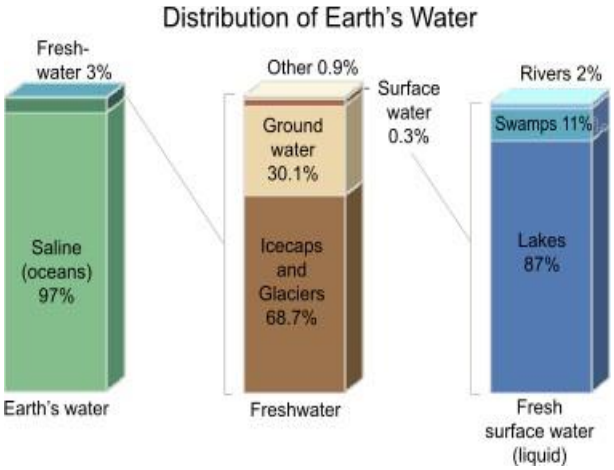
The benthic zone provides many valuable products and ecological services. Benthic organisms play an important role in food chains, such as food for humans and some play a critical role in the breakdown of organic matter. Some benthic zones such as areas of coral reefs, kelp forests and eelgrass beds help to buffer wave action along coastlines, providing storm protection. The benthic zone provides an area for spawning, foraging and refuge for various fish species and benthic habitats function in nutrient cycling and removal of contaminants from the water, such as with the removal by filters feeders (scallops, mussels and so on) of pollutants, organic matter and sediments (CSC 2008).

Benthic habitats are very diverse, depending upon their depth and location and have distinct biological, physical and geochemical characteristics. The superficial layer of the soil lining is an integral part of benthic zone, as it greatly influences the biological activity that takes place. The benthos can be categorized in various ways. One division classifies the primary producers (algae, aquatic plants) living on the bottom as "phytobenthos" and all consumers (protozoa and benthic animals) living on or near the bottom as "zoobenthos" (NABS 2008). The term epibenthos is used for those organisms living on top of the sediment and hyperbenthos for those living just above the sediment.

Benthos also can be categorized according to size:

- Macrobenthos, size greater than one mm
- Meiobenthos, size less than one mm but greater than 32 μm (μm is thousandths of a millimeter)
- Microbenthos, size less than 32 μm

Large invertebrate benthic organisms, which may be known macrobenthos, or macro invertebrates (NABS 2008), include such marine examples as sea stars, oysters, clams, sea cucumbers, brittle stars, and sea anemones and freshwater examples as snails, crayfish, and the larva of many aquatic insects (dragonflies, mayflies, caddis flies). The faunal composition and diversity increases with depth until the mid or lower benthic region, then decreases towards the abyssal plain. Bottom organisms tend to have four feeding strategies; filtering suspended material from the water (ex. coelenterates), collecting material that has settled on the sediment surface (ex. Sea cucumber) deposit feeding (ex. polychaetes) and predatory (ex. brittle stars).



As light does not penetrate very deep ocean water, the energy source for the benthic ecosystem is often organic matter from higher up in the water column that drifts down to the depths. This dead and decaying matter sustains the benthic food chain; most organisms in the deep water benthic zones are scavengers or detritivores. Diversity, density and biomass of benthic communities are influenced by degree of organic pollution and toxicity of industrial waste, thus the diversity and density has a great bio-indicator value.

Limnology plays an important role in decision making processes for problems like dam constructions, pollution control, fish and aquaculture practices. Changing water quality is reflected in the biotic community structure as shown by the diversity and abundance pattern of species. Study of limnological parameters assume greater importance for its practical applications as it provides the most precise results and make possible an insight into the interaction among various physicochemical factors.

Conflict of interest

The author declares that there is no conflict of interest.

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