Physico-Chemical Characteristics, Species Diversity and Density of Zooplankton

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Abstract - Zooplankton is tiny, free-floating creatures that are essential to aquatic environments' food webs. The zooplankton community responds strongly to changes in temperature, pH, dissolved oxygen, and nutrition levels in their environment. There are about 8,000 species of zooplankton that have been described so far. This includes everything from copepods and rotifers to cladocerans and krill. Temperature, nutrition levels, and predation are only a few of the elements that might affect the species diversity of zooplankton. The density of zooplankton fluctuates greatly with both latitude and season, with populations peaking in the warmer months of spring and summer when food and temperature conditions are optimal. As zooplankton play a crucial part in the food chain and are an important food supply for many fish and other aquatic creatures, it is crucial to understand their physico-chemical properties, species diversity, and density to effectively monitor and manage aquatic ecosystems.

Keywords - Physico-chemical, Species Diversity, Density of Zooplankton

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1. INTRODUCTION

Due to their role in sewage clearing and as natural water cleaners, zooplankton is a globally significant ecological criterion in water quality evaluation. Diverse heterotrophic creatures known collectively as zooplankton feed on phytoplankton, recycle nutrients via their metabolism and provide energy to higher trophic levels. Zooplankton is a crucial component of the aquatic food chain and a major driver of secondary production in freshwater ecosystems because they facilitate the movement of energy from lower to higher trophic levels. Important functions include nutrient recycling and energy cycling within their respective ecosystems. They make up the foundation of aquatic ecosystems everywhere, since they are the primary natural food sources for fish and hence crucial to their continued existence and development. Since zooplankton is so sensitive to its surroundings, it serves as a reliable indication of water quality changes. That's why physico-chemical criteria are so important for determining how healthy a body of water is. A broad range of perturbations, such as nutrient loading, acidity, sediment intake, etc., elicit responses from zooplankton populations. The seasonal changes and physicochemical characteristics of water are the primary determinants of the abundance and distribution of zooplankton in aquatic habitats. It is an effective method for assessing the level of water contamination.[1]

The physicochemical properties and the stability of an aquatic habitat greatly influence the kind of organisms that may thrive there. The physical and chemical properties of an aquatic system are intimately linked to the organisms that may thrive there. The health of any body of water may be evaluated best via the use of physicochemical parameters. The ecosystem's biodiversity is sensitive to even small changes in the physicochemical elements that make up an ecosystem. The spread of plankton has been studied about many physicochemical factors. Several researchers have examined the connections between physicochemical variables and plankton. Yet, since plankton species respond rapidly to changes in their environment, they provide a useful indication of water quality.[2]

Zooplanktons, a kind of plankton, are significant members of the aquatic food web due to their ability to disperse far, their high population density, the variety of species they harbor, and their stress resistance. It's crucial to the aquatic food chain because it facilitates secondary energy transfer between autotrophs and heterotrophs. They play an essential role in the aquatic food chain and boost freshwater ecosystems' biological output.

Climate change, physical and chemical characteristics, and the presence or absence of vegetation all have a role in determining where zooplankton populations are found. Zooplankton populations are heavily reliant on phytoplankton, as well as aquatic microphytes and macrophytes. Limnological features of water have a major role in determining the abundance and distribution of zooplankton in aquatic ecosystems. Fish make up the upper trophic level in wetland ecosystems because they feed mostly on aquatic arthropods and zooplankton.[3]

2. PHYSICO-CHEMICAL PARAMETERS

Chemical effluents from factories, sewage from homes with chemicals, dyes, detergents, and other organic materials all contribute to water pollution.

To understand the concentration of different solutes at a certain location and time, we may look at the water quality. Parameters allow us to assess how well water meets its intended purposes and where adjustments may be made. [4]

Every natural system has inherent self-cleaning mechanisms. The biota in a body of water is mostly accountable for its self-cleaning properties. In the context of water resource management, understanding how well a system can filter out impurities is crucial. The conservation of fresh water is a pressing issue, and understanding biota is the key.

The average person needs between 1,400 and 2,400 liters of clean water per year for personal consumption, household chores, agriculture, and industry. Unless water management is very sophisticated, this quantity is the bare minimum for families, industry, and agriculture in a middle-income nation.[5]

Yet, although it is home to around 20% of the world's population, India is only home to 4% of the world's fresh water. From a high of 2384 cubic meters in 2000, the country's per capita water availability is predicted to shrink to 1500 cubic meters by 2005, putting it in the "water panic" category. All illnesses in India are caused by contaminated water, and as a result, roughly 73 million workdays are lost every year.

Many human activities, including washing, swimming, bathing, and the dumping of household, industrial, and agricultural waste, take place in India's fresh water bodies. As a result, pollutants such as silt, pesticides, industrial effluents, and sewage are introduced.[6]

2.1 Physical characteristics of water

i. Temperature

The degree to which water is hot or cold is a quality known as its temperature. A substance's average thermal energy, is described by this unit. It has a role in both biological (metabolic) and physical processes, making it a crucial ecological factor. There is no other single component that has such a wide range of direct and indirect impacts on water. It changes the water's properties and is thus essential to the health of aquatic ecosystems. The thermal properties of water are best seen in freshwater situations. Compared to marine environments, these ecosystems experience more seasonal and diurnal temperature variations. The temperature difference between the day and night is more pronounced in shallow seas. Thermal stratification is more widespread in tropical lakes.[7] Sunlight reflecting off the top of tropical lakes causes a temperature difference between the water's upper and lower layers. Epilimnion refers to the higher, warmer layer, and hypolimnion to the lower, cooler layer. A layer known as the thermocline may be found between the two zones we established.

ii. Colour and Turbidity

Sometimes, the first thing that catches the eye about freshwater is its color, which may be either clear or murky. Unfortunately, these factors alone do not provide accurate information about the water's whole chemical makeup. Yet, both reduce the amount of sunlight that reaches the water's surface, which may have a major effect on plant life like as algae and macrophytes. Water clarity and low turbidity are prerequisites for some algae. Clay, silt, finely split organic and inorganic debris, plankton, and other tiny creatures all contribute to the turbidity of water as suspended and colloidal particles. Dissolved dyes and other light-absorbing compounds may muddy the water. The growth of phytoplankton, algae, and macrophytes is stunted by increased turbidity because less light can reach their tissues. Turbidity caused by organic particles decreases the quantity of oxygen that may dissolve in water.

iii Transparency

Light energy from the sun is essential to aquatic food webs. It determines how much sunlight reaches the body of water. The range of light depends on both its wavelength and the angle of the incident. Water transparency is a unique characteristic that can't be explained by a simple addition of turbidity and color. How much light can pass through a column of still water depends on how transparent the water is. The turbidity of water has a direct correlation to its degree of see-throughness. Hence, the energy dynamics of an aquatic system are heavily impacted by the water's transparency and turbidity.[8]

iv Density

Water density is crucial to the majority of the water's most vital functions. Water's density is measured in terms of its mass per liter. It is a quantitative indicator of the density of stuff. The density of water changes with its internal temperature and pressure as well as the number of dissolved chemicals. There is a linear relationship between total dissolved solids and density. Except for mineral waters (springs), inland saltwater bodies, and water bodies vulnerable to marine influence, dissolved solids in inland waters are typically below 1 g / l.

2.2 Chemical Characteristics of Water

The soils and rocks that water has percolated through the influence it's chemical composition. Urban and agricultural runoff, as well as municipal and industrial treated effluent, all affect water quality. The chemical composition of water is modified both by microorganisms and by chemical reactions.

Water's chemical properties may be broken down into the following groups:[9]

- Acidity
- Alkalinity
- Hardness
- Turbidity

i. Acidity of Water

The acidity or alkalinity of water is quantified by its pH value. It is the inverse logarithm of the concentration of hydrogen ions. Logarithmic in nature, the pH scale runs from zero (very acidic) to fourteen (very basic) (very alkaline). With a tenfold fall in hydrogen ion concentration and a corresponding decrease in acidity, the water becomes less acidic as the hydrogen ion concentration increases from 1 to 2. The pH scale indicates the degree of acidity or alkalinity. The amount of hydrogen ions present in water is quantified using the PH scale. The process through which water gets ionized

HOH H+ + OH-

In neutral solutions [OH] = [H] hence pH = 7

When [H] rises and pH falls below 7, acidity has risen (because H is a log of [H]). Several procedures used to cleanse water and wastewater, as well as prevent corrosion, rely on the pH value of the water they use.[10]

ii. Alkalinity of Water

Generally speaking, bicarbonates are generated via reactions in the soils through which the water percolates account for the alkalinity of natural water. It's a proxy for the water's ability to act as a buffer by neutralizing acidic substances. Carbonates and hydroxides might have a role. As a buffer against sudden shifts in pH, alkalinity is crucial for fish and aquatic life. Alkalinity is indicated by a pH value greater than 7. Water's alkaline species may counteract acidic ones. Alkalinity (or causticity) is mostly composed of OH-, CO32-, and bicarbonate HCO3 ions. Bicarbonate ions are the typical culprits of water's alkalinity.

iii. Hardness of water:

Definition of hard water

Water hardness is caused only by calcium and magnesium salts. The carbonate and bicarbonate forms of calcium and magnesium are responsible for short-term hardness, whereas the chloride and sulfate forms are responsible for long-term hardness.[11]

If your water is hard, you'll need extra soap to get a good lather or froth going. Whilst water hardness poses no health risks to humans, it may damage boilers, hot pipes, and other such systems due to the precipitation of the material and the resulting reduction in storage and transport capacity. Nevertheless, absolute soft water is not suitable for human consumption since it might lead to health problems, particularly for those with heart conditions. CaCO3 (Calcium Carbonate) concentration is a standard method for describing water hardness.

Table 1 - Degree of Hardness

Concentration of CaCO3	Degree of hardness
0 – 75 mg / L	Soft
75 – 150 mg / L	Moderately hard
150 – 300 mg / L	Hard
300 up mg / L	Very Hard

Boiling alone is sufficient for removing low hardness, but the addition of lime is necessary for removing excessive hardness. The removal of iron and manganese concentrations and the decrease of suspended particles, such as microorganisms, are additional benefits of this approach.[12]

iv. Turbidity of Water:

The turbidity of water is a measure of the amount of suspended and colloidal particles in the water, both of which reduce the amount of light that can pass through the water. Because of its positive effects on health and appearance, this is crucial. Human interference, decomposing plant material, algae blooms, suspended sediments, and plant nutrients all reduce the transparency of natural water basins. The concentration of total suspended solids (TSS) may be roughly estimated by measuring turbidity for very little money. Yet, it helps determine drinking-water quality in the context of water treatment, where it has little value unless in very clear waters.

v. pH value

The acidity or alkalinity of water is quantified by its pH value. Hydrogen ions (H+) and hydroxide ions (OH–) are the only ions found in pure water (OH–). Neutral water has an equal quantity of hydrogen ions and hydroxide ions. Water with a pH value below 7 is considered acidic because the concentration of hydrogen ions is higher than that of hydroxide ions. In contrast, water with a pH value over 7 is considered alkaline because the concentration of hydroxide ions has exceeded that of hydrogen ions. As the pH scale is logarithmic, a shift of only one unit indicates a tenfold shift in the concentration of hydrogen or hydroxide ions.

Raw water may become acidic because carbon dioxide dissolves into a mild carbonic acid. Organic acids formed during plant breakdown may also be present in groundwater and surface water. A pH of 4 is possible in the surface water that flows off of a peaty moorland watershed. Typically, limestone aquifers are the source of alkaline waters due to the dissolution of bicarbonate, carbonate, and hydroxide salts of calcium, magnesium, sodium, and potassium. Pipes corrode and metals like copper, zinc, and lead dissolve in soft acidic waters. The scale may develop in hard, alkaline fluids, and some of these liquids may even be plumbosolvents.[13]

vi. Colour

Humic and fulvic compounds leached from peat or other decaying plants, as well as naturally occurring salts of iron or manganese, may all cause discoloration of water. Peaty moorland catchments may produce highly pigmented surface water. The brownish hue typical of this kind of water varies and typically reveals a striking seasonal influence, with peak concentrations occurring in the late fall and winter. There is a comparable seasonal rise in coloration in water sourced from lowland rivers after leaf fall.

Substances in suspension may give water a tinge of color, but the real hue won't show up until it's filtered. The platinum-cobalt (Pt-Co) scale, which is used to quantify color, provides readings in milligrams per liter, which are directly comparable to the degrees Hazen scale. Water coloring removal is essential not just for aesthetics but also because chlorination of highly colored waters may lead to high amounts of trihalomethanes. In addition to clogging reverse osmosis membranes, high levels of coloration decrease the effectiveness of disinfection using ultraviolet (UV) irradiation, chlorination, and ozonation.

Without a definite numerical standard, but with the mandate "Acceptable to consumers and no abnormal variation," the color of drinking water is an indicator parameter in the Drinking Water Directive. A maximum concentration of 20mg/l Pt-Co is outlined in the UK's water quality laws. While filtration methods may be used to remove the color from tiny quantities, their effectiveness is typically low.

3. CULTURE OF ZOOPLANKTONS AS LIVE FOOD FOR FISH LARVAE

The intensification of aquaculture has a major impact on the structure and dynamics of aquatic ecosystems. Although establishing and maintaining a healthy zooplankton population is crucial for every pond fish grower.

zooplankton are essential to the diets of most aquatic creatures, notably fish fry and other larval stages of these species. Certain zooplankton is employed to feed the young of fish species that are notoriously picky eaters. This is because, once the yolk sac has been broken down, it provides most fish with their primary source of sustenance. Marine fish larvae have long known that zooplankton plays an important role as a major feeding source.

There is a consensus among scientists that more zooplankton in the water means more fish. A region's potential for fisheries has been connected to differences in zooplankton production across estuarine, coastal, and oceanic habitats. If you want to know how productive an aquatic environment can be, you need to know that zooplankton is the backbone of the secondary energy web.

Calculating the zooplankton standing crop is a proxy for measuring the level of fertility in the ocean. To a greater or lesser extent, plankton availability affects the success or failure of fisheries, especially those that target pelagic species. Places with a lot of plankton biomass are called "enrichment zones," and they tend to have a lot of fish. It is believed that the ecological efficiency of moving from one trophic level to the next is roughly 10%.[14]

Naturalistic survival rates of fish juveniles and larvae are significantly influenced by plankton, with consequential effects on the adult fish population. These microscopic creatures play a key role in shaping the destiny of the fish population. Mortality rates among larvae decline as they become older because they can survive without plankton.

3.1 Effect of zooplankton as feed for fishes

While common carp are capable of eating a wide variety of foods, animals make up more than 75% of their diet. Initially, fish graze on smaller species like rotifers and cladoceran nauplii, but after a few days, they switch to bigger prey like cladocerans and copepods. Zooplankton consumption rises as fish become bigger. Adult carps' diets consist of a broad range of different foods, although zooplankton makes up anything from practically zero to more than ninety percent of that diet. Fish populations, sizes, and growth rates have all improved thanks to the introduction of live zooplankton. As plankton are a staple in the diets of fish that specialize in eating them, they have both immediate and long-term effects on fish populations.

Two years of research were conducted to demonstrate the value of the body of water, the richness of the zooplankton community it supports, and the range of its physicochemical characteristics. All physicochemical characteristics measured at Pawana dam are within the World Health Organization's safe range. The water from the Pavana dam has been tested, and it has been proven to be safe for human consumption. Based on the results of this research, the Pawana River is a better place to find a wide variety of zooplankton than the Pawana dam. Food abundance, secure environments, and a favorable climate might all be contributing factors. Among the samples, we see members of all four categories. There were the most Rotifera (19 species) and the fewest Cladocera (9 species). While the number of copepod species seen was low, the number of these organisms overall was high in the samples. As expected of a benthic group, ostracods had the smallest showing.

Fish Cyprinus Carpio's development was studied by cultivating zooplankton in the lab (namely Cyclops, Brachionus, and Daphnia) and then observing the results. The zooplankton was grown using a combination of chicken manure, baker's yeast, crushed oil cake, and mixed culture. After 15 days, the mean population size was significantly larger in all diets compared to the control. Fingerlings fed a Brachionus diet grew longer than those fed a control diet. The culture of people who ate a wide variety of foods was the most diverse. As compared to the control group, fingerlings given a diet consisting of both Brachionus and a mixed diet gained the most weight.[15]

4. CONCLUSION

In conclusion, the physico-chemical characteristics, species diversity, and density of zooplankton are essential aspects of aquatic ecosystems that influence their health and balance. Zooplankton plays a vital role in the food chain, serving as a food source for many fish and other aquatic organisms. Understanding the physico-chemical characteristics that influence zooplankton, their species diversity, and their density can help monitor and manage aquatic ecosystems. Changes in these factors can signal changes in the health of the ecosystem and affect other organisms in the food web. Therefore, ongoing monitoring of zooplankton populations is necessary to maintain healthy and balanced aquatic ecosystems.

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