Original Article

"To Study The Seasonal Variations In Ichthyofauna On Account Of Planktons Of Kolar Water Reservoir Bhopal"

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Abstract

At Kolar Reservoir in Bhopal, Madhya Pradesh, India, research on phytoplankton, zooplankton, and ichthyol fauna was conducted. Cyanophycea, Bacillariophyceae, Chlorophyceae, and Euglenophyceae were the four groups that made up the phytoplankton community during the study period. Cyanophyceae was the dominant group among the four. During monsoon season, there was a noticeable quantity of phytoplankton. Five groups—Rotifera, Cladocera, Copepoda, Protozoa, and Ostracoda—represented the zooplankton. Twelve genera belonging to the appropriate orders represented the diversity of fish in the Kolar Reserve. Major carps, exotic carps, and other species were among them. The maximum fish diversity was discovered in the post-monsoon months of November and December. Based on the quantity of fish species, seasonal diversity indicators such as Palou's evenness, Marg alef's species richness, and Shannon-Wiener species diversity were derived to assess the health of Kolar reservoir's ecosystem. These investigations will support the preservation and management of the Kolar Reservoir's Ichthyofauna and other aquatic ecosystems.

Keywords: Ichthyofaunal diversity, seasonal variation, Phytoplankton, Zooplankton, diversity indices.

INTRODUCTION :

Studying how size affects the relative weight of elements that determine variety in reservoirs is an excellent idea. On a large scale, reservoirs are new, and their communities include both introduced species and species from the ancient riverine fish fauna (Fernando & Holck 1991; Oliveira & Goulart 2000; Oliveira et al. 2004). On a regional level, reservoirs exhibit transversal gradients (upstream downstream of tributaries) and longitudinal gradients (river-dam). Few species have been lost from the freshwater ecosystem of India due to irrational fishing methods, environmental aberrations like decreased water volume, increased sedimentation, water abstraction, and pollution over the years. Some of these species fall under the categories of endemic, endangered, and threatened species. India's freshwater resources have only ever been considered from the standpoint of economic productivity.

In addition to receiving sewage and industrial waste, they are to be sources of irrigation, urban-industrial water supply, or hydropower. They may also yield edible fish (Bhakta & Bandyopadhyay 2008). Reservoirs have a wide range of economic effects that can be felt locally, nationally, internationally, and even on a global scale. These are referred to as direct impacts and are typically measured in terms of increased output of agricultural commodities, hydropower, navigation, fishing, tourism, recreation, drought prevention, and reduced flood damages.

The Indian Government has implemented a number of initiatives such as stocking dams with different fish species, rehabilitation of fishes going extinct due to the construction of dams, ranching programs, environmental modeling, fish ways, etc. for the protection of aquatic biota as a result of the ongoing evaluation of the effects of dams on aquatic life and use of Environmental Impact Assessment (EIA). Dams are frequently stocked with fish, which has a number of advantages, including the development of new fisheries and the improvement of already existing ones. Along with all these conservation initiatives, we also need to concentrate on researching the fish biodiversity in reservoirs. For the goal of conservation, research on the fish production from dams needs to be prioritised. The current paper highlights the reservoirs' potential in India with regard to fish community and biodiversity perspectives for conservation as well as stock enhancement and management challenges, and it promotes the development of creative strategies for preserving river and reservoir fish biodiversity.

In India, there are more than 400 different species present in the water reservoirs. These moist regions are crucial because they provide the human race with a variety of nice and helpful resources. Some are used for irrigation, while others are used for washing, relaxation, and the supply of potable water or raw water. All of these water bodies have experienced a variety of environmental issues due to increasing urbanisation and ongoing demographic changes, particularly in the second half of the 20th century. Through (i) input sewage, (ii) solid waste disposal, (iii) and other anthropogenic activities, it leads to the degradation of water quality. These have an impact on the biodiversity of the lakes and the animals of water bodies. Seasonal rains and a large water discharge during the monsoon cause most reservoirs to flush out quickly, which discourages the colonisation of macrophytic populations. Lack of adequate supply of an appropriate substrate affects periphyton growth. Due to its propensity for drifting and quick turnover, plankton is a key component of the trophic chain and events in the reservoir ecosystem. The quantity of plankton in a reservoir affects the generation of fish either directly or indirectly. The type and amount of plankton depended on the physico-chemical characteristics of the water. The creatures that make up the plankton ecosystem range in size from microscopic plants to tiny animals. Bentho and nekton are the other two types of life that can be found in an ecosystem. Aquatic earthworms, insect larvae, and some fish are examples of benthic life. Larger swimming creatures like fish are included in Neton. For many fish, plankton is their primary source of diet. The phytoplankton and zooplankton are two more divisions of the plankton.

An example of phytoplankton is algae and diatoms. They are at the bottom of the food chain and provide the food resources needed by other organisms to survive in the ecosystem. The wind and sea currents control how the phytoplankton moves. The four main classes of algae are the Chlorophyceae, Cyanophyceae, Euglenophyceae and Bacillariophyceae. Algae in natural water are typically 102–106 cells/ml in size and abundant. The presence of phytoplankton appears to be an excellent indicator of freshwater pollution. The bulk of artificial reservoirs' phytoplankton communities are dominated by blue-green algae. As a thermocline forms in the late summer and phytoplankton depletes the surface's nutrients, the number of planktons decreases. It is known as the summer minimum.
Zooplanktons are widely distributed in a body of water's shallow sections. In contrast to phytoplankton, zooplankton is dispersed notably horizontally and vertically throughout an ecosystem. The zooplankton makes up an important group because it sits in the middle of the food chain. Many of them consume bacteria and algae, and fish then consume them. They also reveal a water body's trophic state. In the eutrophic waters, they multiplied.

Additionally, they are vulnerable to pollution, and several species are known to be signs of contamination. Some of the creatures can occasionally be found in significant numbers, generating swarms, in freshwater reservoirs. These swarms mimic the cloud appearance by forming bands, streaks, or thick and thin concentrations, and they can also change the colour of the water in a noticeable way. Protozoans, crustaceans such cladocerans, copepods, ostracods, and rotifers are the most prevalent zooplankton species.

Studying how size affects the relative weight of elements that determine variety in reservoirs is an excellent idea. On a large scale, reservoirs are new, and their communities include both introduced species and species from the ancient riverine fish fauna (Fernando & Hock 1991; Oliveira & Goulart 2000; Oliveira et al. 2004). On a regional level, reservoirs exhibit transversal gradients (upstream downstream of tributaries) and longitudinal gradients (river-dam). Few species have been lost from the freshwater ecosystem of India due to irrational fishing methods, environmental aberrations like decreased water volume, increased sedimentation, water abstraction, and pollution over the years. Some of these species fall under the categories of endemic, endangered, and threatened species. India's freshwater resources have only ever been considered from the standpoint of economic productivity.

Fish live in almost all conceivable aquatic habitats. The total number of fish species recorded so far is about 21,723 out of 39,900 species of vertebrate out of these, there are 8,411 freshwater and 11650 marine species. In India there are 2,500 species of fishes of which, 930 are freshwater and 1,570 are marine species (Kar et al., 2003). India occupies 9th position in terms of freshwater biodiversity. Fish and fishery products represent a very valuable source of protein and essential micronutrients for balanced nutrition and good health. In 2009, fish accounted for 16.6 percent of the world population’s intake of animal protein and 6.5 percent of all protein consumed. Globally, fish provides about 3.0 billion people with almost 20 percent of their intake of animal protein, and 4.3 billion people with about 15 percent of such protein. Differences among developed and developing countries are apparent in the contribution of fish to animal protein intake. However, in both developing and developed countries, this share has declined slightly in recent years as consumption of other animal proteins has grown more rapidly. The fish not only provide food and a livelihood for millions of the world’s poorest people, but also contribute to the overall economic wellbeing by means of export commodity trade, tourism and recreation (World fish Center, 2002). It is estimated that freshwater fishes contributes more than 6% of the world’s annual animal protein supplies for humans (FAO, 2007). The fisheries sector has been recognized a powerful income and employment generator as it stimulates growth of a number of subsidiary industries and is a source of low cost animal protein to the people particularly to the economically weaker sections of the society and thereby it is an advantageous position to ensure national food security. Currently, one-third of the world’s 6 billion people rely on fish and other aquatic products for at least one-fifth of their annual protein intake, and catches by subsistence and artisanal fisheries make up more than half of the essential proteins and minerals intake for over 400 million people in the poorest countries in Africa and south Asia. Fisheries and aquaculture directly employ over 36 million people worldwide, 98 per cent of whom are in developing countries. The share of developing countries in freshwater fisheries is about 94 % (FAO, 2007). Fisheries and aquaculture also support global trade worth over 78 billion dollars in 2008 (FAO, 2008 and World Bank, 2009). The world demand exceeds production and per capita consumption is also steadily increasing. During 2010, the annual yield from both capture and culture, was 149 million tones (FAO, 2012). In Bangladesh, Indonesia and the Philippines freshwater fishes comprise 50% of animal protein intake, while in Thailand and Vietnam its share is 40%. It is the major and often the only source of animal protein for low income families (Briones et al., 2004). There are serious threats to this valuable resource with most wild fisheries near maximum sustainable exploitation levels (Delgado et al., 2003). Fishing provides a lasting vestige of utilizing the resources of a global commons, which are often part of maintaining traditional and cultural customs (Clausen and York, 2008). Inland fisheries are providing 60 million full and part time jobs in fishing and other activities such as processing with over half these jobs done by women. Worldwide annual fish catch from rivers and lakes is about 13 million tones with the true figure perhaps as much as 30 million tones due to under reporting of catches. Almost 70 per cent of the total inland catch is in Asia with 25 per cent in Africa and around 4 per cent in Latin America. Much is consumed domestically underlining the critical importance to the people and economies of the developing world. The new report, compiled by the UN Environment Program (UNEP) and the World Fish Centre, also highlights the wide ranging importance of inland fisheries in diet, and especially among children, above and beyond the supply of protein. "Inland fisheries is playing more important role in supplying micronutrients, especially vitamin A, calcium, iron and zinc, other than protein supply" said in the report Blue Harvest: Inland Fisheries as an Ecosystem Service. A fish not only provides nutritional benefits, but it also plays an important role in the functioning of aquatic ecosystems. As they consume the planktons, plants, insects, and other fish is critical to the sustainability and flexibility of river and lake habitats.

The Chondrichthyes (cartilage fishes) and Osteichthyes subclasses make up the majority of the fish population in India. (bony fishes). Of all the bony fish groups in the Indian subcontinent, the endemic fish families make up 2.21%. India is home to 223 endemic fish species, or 8.75 percent of all fish species known to exist in the Indian subcontinent. Water quality characteristics have a significant impact on fish assemblages in lakes and reservoirs. (Carol et al., 2006). Water bodies that have been contaminated may shift in trophic status, making them unsuitable for aquaculture. Fish growth and reproduction may be negatively impacted by a number of physico-chemical or biological variables that function as stress. (Iwama et al., 2000).

Any aquatic ecosystem's trophic status is determined by its plankton populations. Fish production, which is the end result of the aquatic environment, is the result of the translation of energy from one tropic level to the next highest. Planktonic organisms in aquatic systems are fundamentally linked in the food chain and play an important role in this process. Therefore, it is crucial to regularly evaluate physico-chemical and biological water quality indicators to assess the status of water bodies with regard to fish culture. Lakes and rivers each have different types of environmental conditions, while reservoirs fall somewhere in the between. These variations can be seen in the morphology, hydrological, physico-chemical, and biological traits. (Li, 2001).

MATERIALS AND METHODS:

The current inquiry was conducted to examine the physico-chemical properties, seasonal distribution, and variety of fish and plankton (zooplankton and phytoplankton) in the Kolar reservoir, For a period of two years, from September 2020 to July 2022. Seasonally, between the hours of 9 and 11 am, samples for the analysis of plankton and water quality parameters were taken, and they were always taken at the same time each sampling day. With the use of an inspection boat, water samples for the examination of physico-chemical parameters, phytoplankton, and zooplankton were obtained from 5 locations in the reservoir.

Phytoplankton Sampling and Analysis:

Surface water samples of 20 liters (0.5 m) were collected from each site seasonally for two years, from September 2020 to July 2022, to analyse the seasonal change of phytoplankton. Water was filtered through a plankton net made of bolting silk (No. 25, Mesh size 40 m) to gather phytoplanktons. The filtered sample had a final volume of 50 ml, which was transferred to a plastic bottle and labeled with the time, date, and location of the sampling. To stop cell activity, promote sedimentation, and improve staining, the samples were kept outdoors using Lugol's iodine solution at 1 ml/100 ml of sample. The preserved sample was then diluted to 10 ml and the sample bottles were taken to the lab for plankton examination. After shaking the 10 ml, 1 ml was pipetted out, and under an optical microscope (100x magnifications), phytoplankton was estimated qualitatively and quantitatively using a "Sedgwick Rafter" counting cell (Trivedi and Goel, 1984). Using the standard keys of Desikachary (1959), Edmondson (1959), Whitford and Schumacher (1973), Prescott (1973), Palmer (1980), and Anand, the phytoplankton was systematically identified up to the species level (1998). The number of organisms per liter was used to express the density of phytoplankton using an average of 10 replicates for each sample.

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Indian scenario:

In India potential of fish culture is yet to be fully exploited. Fishes being rich source of proteins and have high nutritive value. Indian fisheries has diverse resources both in terms of aquatic habitats ranging from glaciers lakes to deep seas and a rich biodiversity of fish and shellfish of more than 10% of global biodiversity. India is endowed with 8.129 km of coastline and 2.02 million Sq.km of perennially, clear and mercury free water, within the exclusively economic zone. In the inland sector, the country has 4,5000 km of rivers, 1,26,334 km network of canals, reservoirs and lakes, covering 3.3 million hectares and freshwater ponds and tanks, which are nearly 2.4 million hectares.

Indian fisheries and aquaculture is an important sector of food production, providing nutritional security to the food basket, contributing to the agricultural exports and engaging about fourteen million people in different activities with diverse resources ranging from deep seas to lakes in the mountains and more than 10 % of the global. biodiversity in terms of fish and shellfish species, the country has shown continuous and sustained increments in fish production since independence. Constituting about 4.4 % of the global fish production, the sector contributes to 1.1 % of the GDP and 4.7 % of the agriculture GDP. The fish production of the country has increased from 0.75 million tones in 1950 to over 68.69 lakh tones at present. Therefore, an overall eight times increase with production of over 30.24 lakh tones from the inland fisheries and 38.45 lakh tones from the marine sector. The country has occupied the 2nd position in the world in terms of inland fish production and third position in overall fish production (Annual report, 20017- 18). Indian fisheries and aquaculture is an important sector of food production, providing nutritional security to the food basket, contributing to the agricultural exports and engaging about fourteen million people in different activities with diverse resources ranging from deep seas to lakes in the mountains and more than 10 % of the global biodiversity in terms of fish and shellfish species, the country has shown continuous and sustained increments in fish production since independence. Constituting about 4.4 % of the global fish production, the sector contributes to 1.1 % of the GDP and 4.7 % of the agriculture GDP.

Fish Sampling :

Fish were sampled seasonally at 5 stations using gillnets by fishermen as part of the research of ichthyo-fauna diversity in the reservoir. Gillnets with mesh sizes of 14 mm and 26 mm (2 m high, 100 m long) were placed close to the coast (depth 3 m), while 40 mm mesh nets (3.5 m high, 100 m long) were placed in the reservoir's deeper section. In order to maintain a consistent fishing effort, nets were put in the late afternoon (17:00–19:00 hours) and recovered the next morning (9:00–11:00 hours). The obtained specimens were stored in 10% formalin for further identification and measured for total length (cm) and total weight (mg). Using established sources like Day (1967), Jhingran (1983), Datta Munshi and Shrivastava (1988), Talwar and Jhingran (1991), and Jayaram, the collected fish were identified in the laboratory (1999).

RESULTS AND DISCUSSION :

Phytoplankton composition during three seasons

According to a study that lasted an average of two years, premonsoon season (747.30/l), postmonsoon season (662.56/l), and monsoon season (217.51/l) were the times when phytoplankton was most prevalent in the reservoir (Table 4.2). The total phytoplankton gathered from several seasons and sites varied significantly, according to an ANOVA (P 0.05). (Appendix II, Table 1). Cyanophyceae, Chlorophyceae, Bacillariophyceae, and Euglenophyceae were all present throughout the premonsoon season as phytoplankton in the reservoir. Chlorophyceae made up 36.82% of all phytoplankton during this season and was the group that predominated in the reservoir (275.30/l).

The following prominent group, the Bacillariophyceae (224.47/l), was responsible for 30.02% of the total phytoplankton. Bacillariophyceae came in second, followed by Cyanophyceae (18.42%) and Euglenophyceae (4.52%), in that order (Fig. 4.3 and Fig.4.4). This season saw a total of 30 phytoplankton species documented, with Synechocystis (18.57%) emerging as the dominating species and Spirogyra sp. (0.14%) emerging as the least dominant (Table 4.3).

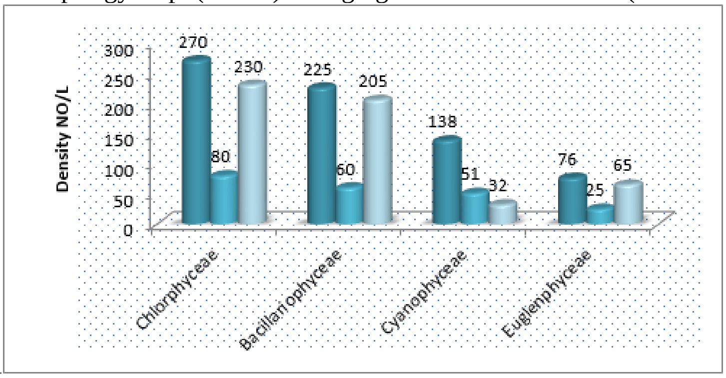

Fig.4.1 Sesonal distribution (mean) of phytoplankton groups in Kolar reservoir

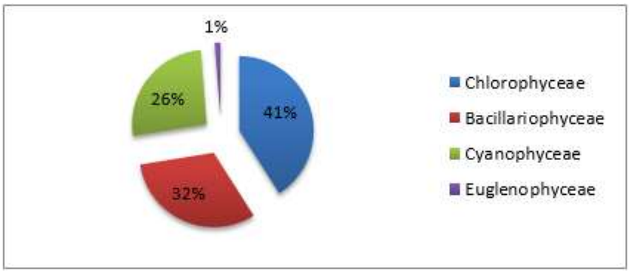

Fig.4.2 Percentage distribution (mean) of phytoplankton groups during premonsoon in Kolar reservoir

Members of the Euglenophyceae were not observed in the reservoir during the monsoon season. Chlorophyceae, Bacillariophyceae, and Cyanophyceae had respective densities of 80.08/l, 61.15/l, and 24.58/l during this season (Table 4.2). There were just 8 species recorded during this season, with Synechocystis accounting for 26.22% of the total population. Navicula cuspidata was the species with the lowest dominance (7.42%). (Table 4.3).

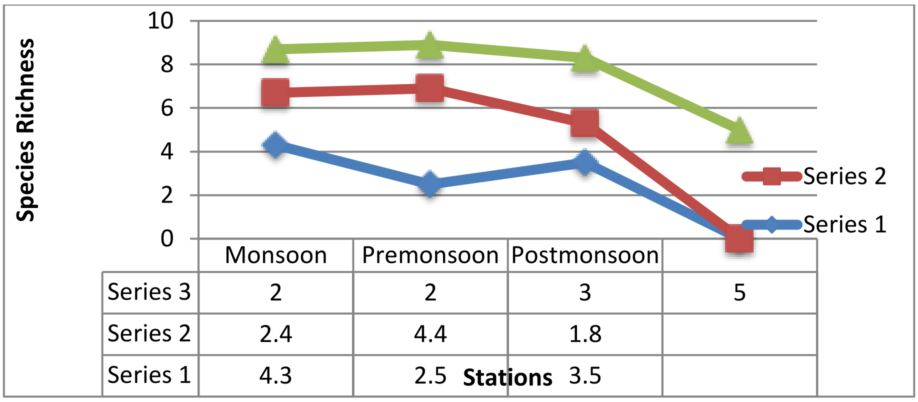

Fig.4.3 Seasonal variations in species richness (mean) of phytoplankton at various stations in Kolar reservoir

The richness of Margalef likewise revealed high richness values in the postmonsoon season and low richness levels in the monsoon season. Premonsoon season saw a moderate increase in Margalef's wealth (Fig. 4.8). Premonsoon richness levels varied from 2.371 at station 5 to 3.467 at station 3 at that time. It fluctuated throughout the monsoon from 0.987 at station 2 to 1.302 at station 5. In the postmonsoon season, Margalef's richness value ranged from 3.275 (station 1) to 4.242 (station 5).

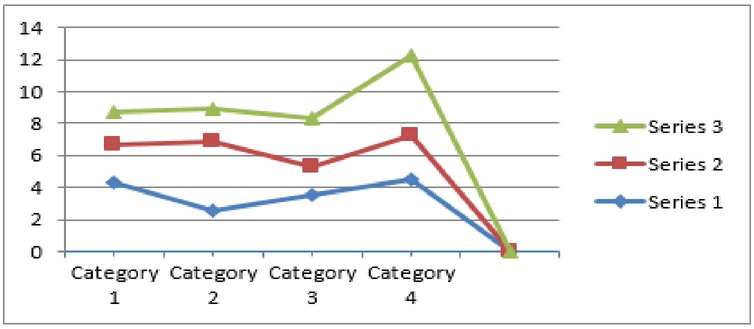

Fig.4.4 Seasonal variations in Margalef's richness (mean) of phytoplankton at various stations in Kolar reservoir

According to the Shannon-Wiener diversity indices (Fig. 4.9), phytoplankton diversity was found to be highest in the postmonsoon season and lowest in the monsoon season. The Shannon-Wiener diversity indices of the phytoplankton were medium during the premonsoon season, with low values at station 5 (2.549) and high values at station 2. (2.945). It ranged during monsoon season from 1.710 at station 3 to 1.996 at station 5. Postmonsoon revealed index values ranging from 2.896 (station 2) to 3.221. (station 5).

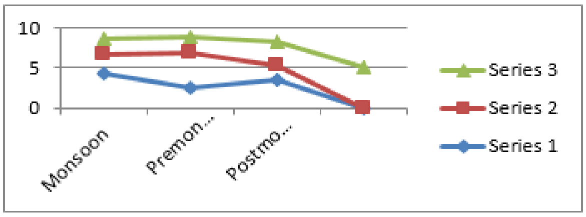

Fig.4.5 Seasonal variations in Shannon -Weiner diversity indices (mean) of phytoplankton at various stations in Kolar reservoir

In the reservoir, during the monsoon season, the Pielou's evenness levels were high. In the premonsoon and postmonsoon seasons, respectively, evenness values were low and moderate (Fig. 4.10). In the premonsoon season, station 5 had the highest evenness values (0.954), while station 2 had the lowest evenness values (0.038). (0.891). It was highest at stations 1 and 4 (0.975) and lowest at station 3 (0.886) during the monsoon season, while the evenness values were highest at stations 4 (0.973) and lowest at station 3 during the postmonsoon season (0.910).

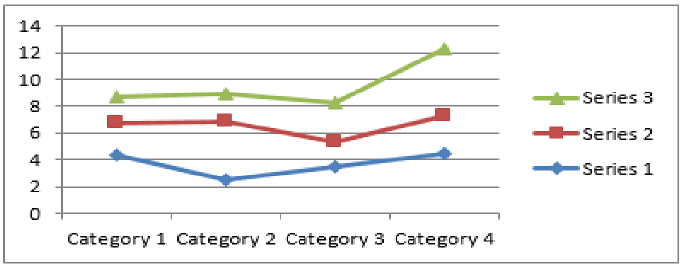

Fig.4.6 Seasonal variations in Pielou's evenness (mean) of phytoplankton at various stations in Kolar reservoir

Zooplankton group/ species and composition in the reservoir

Protozoa, Rotifera, Copepoda, Cladocera, and Ostracoda were only a few of the five groups that made up the zooplankton community in Kolar reservoir for this study. Zooplankton species from 31 different genera, including 20 different species, were identified. Of them, 10 species (9 genera) belong to Protoza, 6 species (4 genera) to Rotifera, 8 species (5 genera) to Cladocera, 3 species (1 genera) to Ostracoda, and 4 species (2 genera) to Copepoda.

The reservoir had a total zooplankton count of 319.68/l, with the Prtozoa making up the largest group in terms of organisms/litre (114.45/l), giving the population of total zooplankton an average percentage composition of 35.80%. Cladocera (111.89/l), Rotifera (83.86/l), and Ostracoda (9.48/l) came after it (Table 5.1 and Fig.5.1). Groups like Copepoda, Rotifera, Cladocera, and Ostracoda made up 35.80%, 35%, 26.23%, and 2.97% of the total zooplankton, respectively (Fig.5.2). The most prevalent zooplankton was Nauplius larvae (51.5/l), which made up 16.11% of the reservoir's total zooplankton. Following it in order of average numbers were Mesocyclops leuckarti (Copepoda), Keratella tropica (Rotifera), Daphnia pulex (Cladocera), and 39.67/l, respectively. Of the entire zooplankton population, Mesocyclops leuckarti, Daphnia pulex, and Keratella tropica made up 12.41%, 9.46%, and 9.46%, respectively. The least frequent species in the reservoir during the study period, Heliodiaptomus viduus, had an average population of 2.73/l and contributed just 0.85% of all zooplankton (Table 5.1).

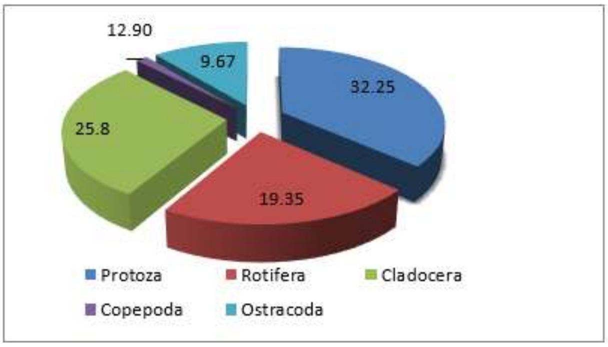

Fig. 5.1 Percentage distribution (mean) of zooplankton groups in Kolar reservoir

Ichthyofaunal diversity:

The reservoir contained fish from thirteen different genera. The majority of genera are members of the order Cypriniformes. In Kolar Reserve, four species of large carps (Cypriniformes), one Mahseer, two species of minor carps (Cypriniformes), two species of murrels (Ophiocephaliiformes),two species of large/medium catfishes and one species each of Clupciformes and exotic were discovered.

order	group	fishes
Cypriniformes	Major carps(6)	*Labeo rohita* (Rohu) *Catla catla* (Catla) *Cirrhinus mrigala* (Mrigal) *Labeo calbusa* (Kalot) *Hypophthalmichtys nobilis* (Silver bighead) *Tor tor* (Mahseer)
Cypriniformes	Minor carps (3)	*Cirrhinus reba* (Rewah) *Puntius serana* (Kharpata) *Notopterus notopterus*(patola)
Cypriniformes	murrels	*Channa punctatus*(Samhal)

		Channa striatus
Siluriformes	catfishes	*Wallago attu* (Padien) *Mystis seenghala*

The KOLAR reservoir's fish fauna was studied by collecting samples seasonally from five predetermined points throughout three seasons (premonsoon, monsoon, and postmonsoon). During the two years of research, 5800 fish weighing 1266.76 kg were taken. The fish were recognized, and the abundance, biomass, and diversity indices were determined for each station and season. The composition of the reservoir's species In the current study, 13 fish species from 5 genera, 4 families, and 3 orders were reported in the reservoir. The family Cyprinidae was shown to be the most diversified, with ten species, whereas the remaining families each had a single species. *Catla catla*, *Labeo rohita* (Rohu), and *Cirrhinus mrigala* were the fish caught in the kolar reservoir.

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