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ENVIRONMENTAL CHARACTERESTICS OF MANIYAR RESERVOIR, KERALA

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Abstract: Reservoirs offer ample scope for fish yield optimization through adoption of suitable management norms. Kerala reservoirs are situated in unique geo-climatic conditions and there is need to study the environmental characteristics of these ecosystems for the development of fisheries in the state. Water quality characteristics such as temperature, pH, alkalinity, hardness, dissolved oxygen, carbon dioxide, phosphate, nitrite, nitrate, and chlorophyll of Maniyar reservoir (9°57' N latitude and 76°53'E longitude), part of Pampa irrigation project were studied for one year. All the stations investigated have more or less optimal and suitable environmental conditions for fish growth. Management measures can improve the nutrient status and plankton production in the reservoir.

Key words: Water quality, Dissolved gases, Nutrient status, Productivity.

INTRODUCTION

Reservoirs constitute the largest inland fishery resource of the country both in terms of size and production potential. Though created basically for irrigation or power, the Indian reservoirs offer ample scope for fisheries development through adoption of suitable management norms.

The state of Kerala has more than 30 reservoirs, spread over an area of 29635 ha. Most of these are logistically suitable for aquaculture due to their manageable size, but few are commercially exploited. A deep insight into the ecodynamics is lacking in majority and there is a need to study the environment and the dynamics of biotic communities for drawing up management plans.

River Pampa and its main tributaries are extensively dammed for irrigation and power mainly in Pathanamthitta district. Maniyar reservoir (9°57'N latitude and 76°53'E longitude) constructed by the Water Resource Department, Government of Kerala as part of Pampa irrigation project on Kakkadu river, a tributary of Pampa. The Maniyar masonary barrage is 16.67 m in height, providing a catchment area of 280 km; water spread area 5.7 km^2 and storage capacity 34.62 m^3. Besides meeting the irrigation needs of Pathanamthitta district, the Maniyar reservoir contribute to a hydroelectric project of 12 MV. Present is the pioneer study on the environmental characteristics of Maniyar reservoir and the management strategy needed for the development of fisheries in the reservoir.

MATERIALS AND METHODS

Regular monthly samples of surface water were collected for one year (Nov. 2007- Oct. 2008) from three stations in the reservoir. Station I was close to the barrage at Maniyar, station II (Padayanippara) 5 km upstream and station III (Muthalavaram), 2 km upstream of station II. Water samples were taken using a clean plastic bucket from the surface. Standard procedures (Strickland and Parsons,1972; Grasshoff *et al*., 1983; Trivedi and Goel, 1984; APHA, 1988) were followed for the analysis of various parameters and all parameters were statistically treated with 2 way ANOVA.

RESULTS AND DISCUSSION

A number of geochemical, meteorological, morphometric and hydrographic factors contribute to the productivity of reservoirs. Area, mean depth and regularity of shoreline are the important morphometric characteristics having

significant bearing on the productivity of impoundments (Jhingran, 1991; Sugunan, 1995). The impact of climatic cycle and edaphic factors are critical in determining the productivity and production of the target population.

Rainfall, Water depth, Transparency

Maniyar reservoir is experienced with heavy precipitation throughout the year, maximum during the southwest monsoon. The annual rainfall obtained in the catchment area of the reservoir was 2425 mm. Depth influences the physical and chemical properties of water. 1–1.5 m depth is essential for the survival of fish. Depth of the water column in the Maniyar reservoir was found to be more than 1.5 m up to 7 km upstream of the barrage. The entire water column was found to be transparent at stations II and III while at station I light penetration varied from 0.6 (July) to 3. 0 m (March). Floodwater drainage necessitates the opening of the outlet shutters during the periods of heavy rainfall.

Air and Water temperatures

Monthly variations in air temperature (Fig. 1) at the dam site was between 27 and 36°C while the fluctuation in water temperature (Fig. 2) was between 22.5 and 30°C. Significant seasonal variations in air temperature ($P<0.05$) was observed in the reservoir while the variation in annual mean was between 31.2 (Stn III) and 32°C (Stn I). However, water temperature remained statistically same at all stations and seasons. Annual mean of water temperature varied between 25.2 (Stn III) and 26.7°C (Stn I).

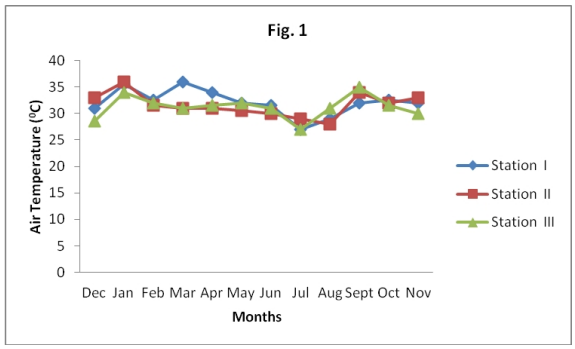

Fig. 1. Monthly variations in air temperature at the Maniyar reservoir

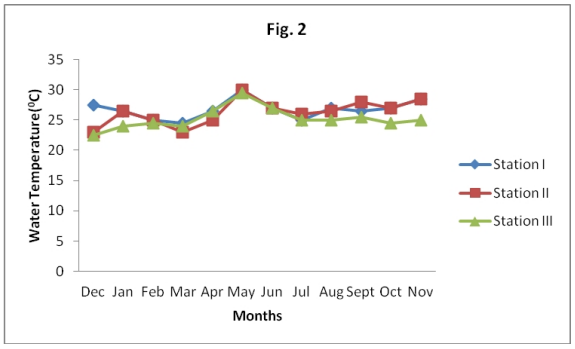

Fig. 2. Monthly variations in water temperature at the Maniyar reservoir

pH

There were no significant variations in surface water pH between stations or seasons while the general distribution of pH in the reservoir water indicated slightly acidic (Fig. 3). Streams and rivers carrying large quantities of humic materials are in general slightly acidic. Spatial distribution of pH developed a zonal trend with decreasing pH values towards the upstream. Every water body shows seasonal as well as diurnal variations in pH and the relationship between CO_2, alkalinity and pH is well known in limnology (Wetzel, 1983; Boyd, 1990). However, larger fish crops are usually produced in water, which is just on the alkaline side of neutrality.

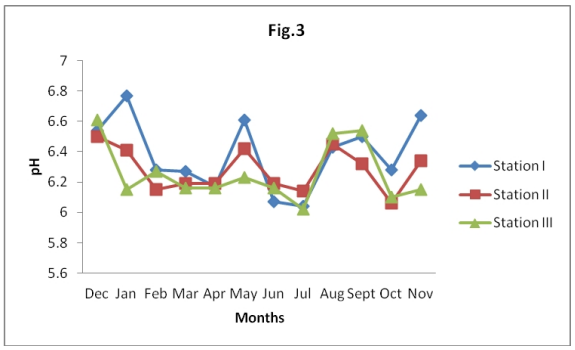

Fig. 3. Monthly variations in pH at the Maniyar reservoir

Total alkalinity

In natural freshwater, alkalinity caused by carbonates of calcium and magnesium along with CO_2 form an equilibrium system and is important in its biological productivity. Water with low alkalinity is biologically less productive (Sakhare, 2006), below 30 mg/l $CaCO_3$ limits

organic production (Boyd, 1990) and value above 40 mg/ l as $CaCO_3$ is needed for a medium production (Jhingran, 1991). Total alkalinity values were invariably low in the Maniyar reservoir water (Fig. 4), but with significant seasonal variations (P< .05).

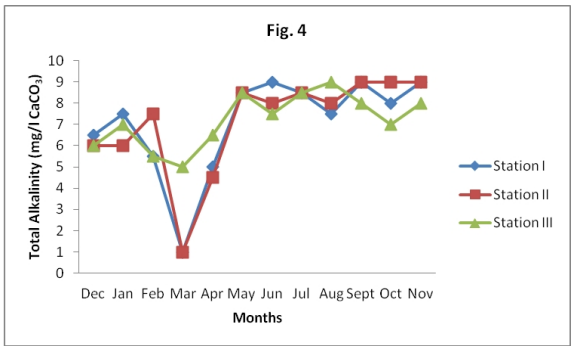

Fig. 4. Monthly variations in total alkalinity at the Maniyar reservoir

Total hardness

Water hardness less than 5 ppm gives slow growth, distress and leads to fish mortality. Optimum hardness for fish culture is around 75 to 150 ppm (Das, 1996) while values above 15 ppm permits aquaculture activities (Swingle, 1967). Water hardness was considerably higher at all stations in the reservoir (Fig. 5). Pronounced seasonal variations in total hardness was observed (P<0.05) and the overall variation was between 27 (stn III) during March and 162 mg /l $CaCO_3$ (Stn I) during November.

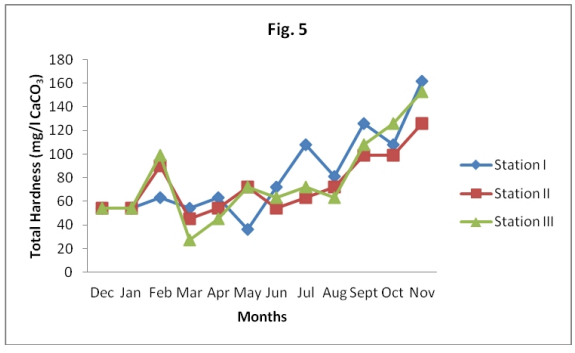

Fig. 5. Monthly variations in total hardness at the Maniyar reservoir

Dissolved oxygen

Well-oxygenated conditions were prevailed during the whole year at all stations. The quantity of dissolved oxygen in water is dependent on water temperature, partial pressure of oxygen in the air, concentration of dissolved salts, pH, amount of chlorophyll etc (Wetzel, 1983) and also on other gases like CO_2, methane and hydrogen sulphide in water (Saxena, 1999). Dissolved oxygen in warm water fish habitats should not be less than 5 mg/ l for 8 hrs in a day, a level less than 3 mg/ l suffocates the animals (Boyd, 1982). Dissolved oxygen in the Maniyar reservoir varied between 5.18 and 9.02 mg/ l (Fig. 6) with significant seasonal variation.

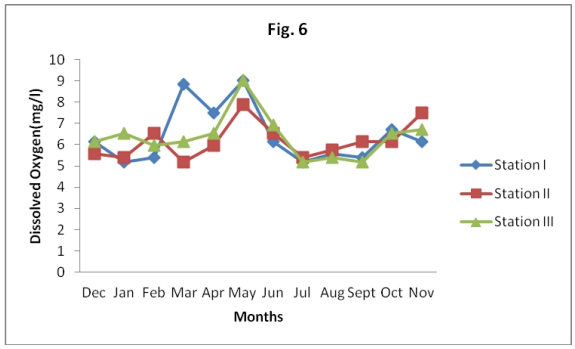

Fig. 6. Monthly variations in dissolved oxygen at the Maniyar reservoir

Carbon dioxide

Samples were collected in the early morning hours and measurable amount of carbon dioxide were observed in all sampling stations (Fig. 7). The CO_2 content of water depends on temperature, depth, rate of respiration, decomposition of organic matter, chemical nature of the bottom and the geographical features of terrain surrounding the water body (Sakhare, 2007). Statistically significant spatial (P<0.05) as well as seasonal (P<0.01) variations were observed in the distribution of carbon dioxide. Free CO_2 in excess of 20 ppm is regarded as harmful to fishes.

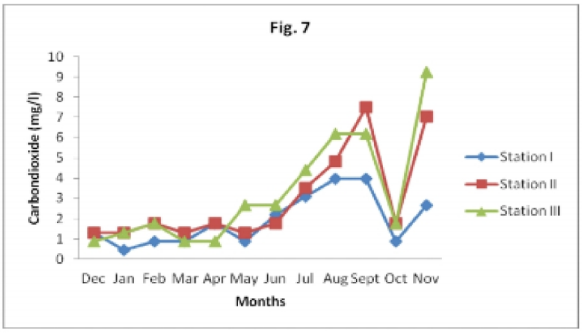

Fig. 7. Monthly variations in CO_2 at the Maniyar reservoir

Nutrients

Biological productivity is directly linked with nutrient status of water. Presence of dissolved nutrients in optimum level is essential for sustained primary production. The concentration of nutrients depends primarily on the bio-geochemical cycles of the habitat. Phosphate is the most common limiting nutrient and its deficiency often leads to low productivity. Phosphate concentration in the Maniyar reservoir water varied from .0.01 to 3.678 µg at.l (Fig. 8). Rainfall during the monsoon and post monsoon resulted in massive transportation of sediment to the reservoir leading to the peak concentration of nutrients. Most of the Indian reservoirs are characterized by low level of phosphate and the level seldom exceeds 0.1 ppm (Sugunan, 1997). Reservoirs of Kerala portray low status of phosphate with low productivity (Khatri, 1985; Harikrishnan and Azis, 1989; Sahib and Azis, 1989; Sabu Thomas and Azis, 1996).

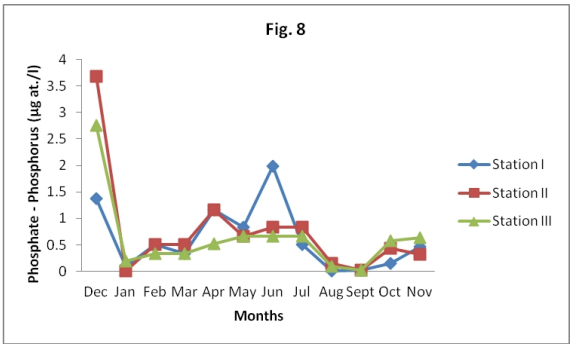

Fig. 8. Monthly variations in phosphate-phosphorus at the Maniyar reservoir

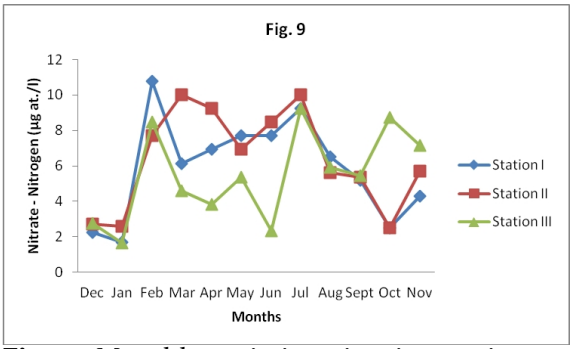

Fig. 9. Monthly variations in nitrate-nitrogen at the Maniyar reservoir

Nitrate- nitrogen in the waters of Indian reservoirs is mostly in traces, rarely exceeds 0.5 ppm. However, lack of this nutrient is an indication of low productivity. Nitrate is low in the Maniyar reservoir water, recorded an overall variation between 1.643 to 10.786 µg at./l (Fig. 9). An irregular pattern was observed in the distribution of nitrite while the cumulative impact of rainfall and surface runoff is evident. Variations in the concentration of nitrite were between 0.143 to 3.429 µg at./l (Fig. 10).

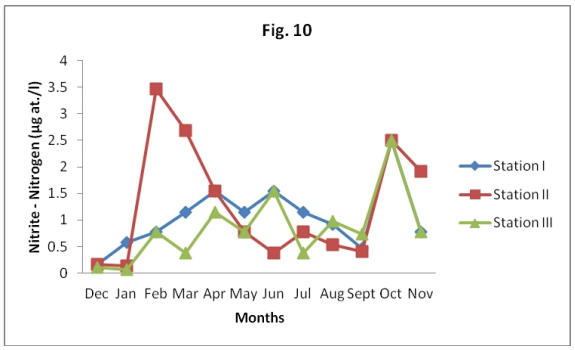

Fig. 10. Monthly variations in nitrite-nitrogen at the Maniyar reservoir

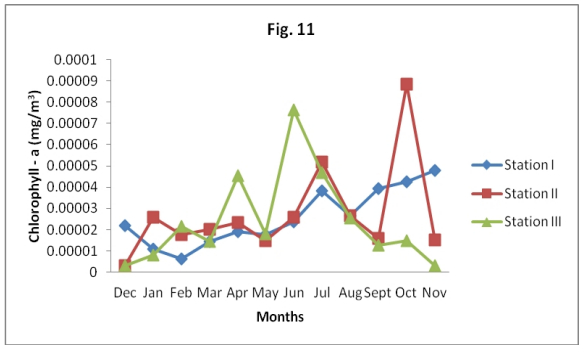

Fig. 11. Monthly variations in chlorophyll *a* at the Maniyar reservoir

Primary production

Productivity of reservoirs depends on the effects of geographical, meteorological, morphometric and hydrographic variables and the existing biotic communities. The rate of energy fixation is low in the Maniyar reservoir throughout the year. The gross and net productivity values were within the range 0.07 to 1.8 gC / m^3 /hr and 0 to 0. 79 gC/m^3/hr respectively. Generally low production is observed in oligotrophic lakes with low pH and

low concentration of nutrients in water. Concentration of chlorophyll *a* was also low (Fig. 11). A temporal variation in the concentration of the pigment is more prominent than the spatial variation.

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