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Correlation of Limnological Features with Ichthyofauna in Hatnur Reservoir in Jalgaon, Maharashtra, India

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ABSTRACT

Background: Limnologycovers the study of all inland waters including running and standing waters, fresh and saline, natural or man-made reservoirs. Unplanned urbanization, rapid industrialization and indiscriminate use of artificial chemicals lead to heavy and varied pollution in aquatic environments causing to deterioration of Limnological features and depletion of aquatic fauna including fish. Scarcity of research related to limnological features and ichthyofauna diversity in Hatnur reservoir stimulated to undertake the present work.

Methods: River Tapi (or Tapti) is arising in Madhya Pradesh and flows westward between two spurs of the Satpuda Range across Maharashtra state, and through Gujarat state to the Gulf of Khambhat. Hatnur reservoir (750 90'E, 210 12'N) formed due to an earth-fill dam on Tapi river near Hatnur village in Jalgaon district of Maharashtra state. Water quality parameters were assessed using standard methods described by APHA and fish diversity was evaluated in the Hatnur reservoir.

Results: Seasonal fluctuations in water quality parameters and their relationship with ichthyofauna inhabiting the Hatnur reservoir were assessed. The results obtained in the present study indicated that physicochemical properties of water samples collected from the Hatnur reservoir were within recommended limits of the Bureau of Indian Standards (BIS).

Conclusion: It is concluded that water in Dam was less polluted, suitable for agricultural and domestic use and suitable to inhabit the fish diversity. Future studies should focus on under-explored and unexplored areas of the Tapi riverine system in North Maharashtra to comprehensively document the fish diversity.

Key-words: Hatnur dam, Fish species, limnology, Physico-chemical factors, River Tapi

INTRODUCTION

India's known animal diversity includes about 8,61,696 insects, 21,723 fish, 240 amphibians, 460 reptiles, 1,232 birds and 397 mammals. Ichthyofauna diversity has extraordinary significance in ecosystems, and their unique biological traits and ecological roles make them valuable organisms for assessing, monitoring, and managing biodiversity in natural ecosystems.

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Site-specific biotic and abiotic characteristics determine fish diversity to be specific to a particular site. The accomplishment of various species and the pattern of abundance, diversity and distribution are completely correlated and influenced by the canopy cover [1,2]. Freshwater ecosystems and other wetlands are colonized by a diverse array of aquatic organisms including fish [3]. Wetlands are one of the Earth's richest ecosystems, offering ''sanctuary'' to a wide diversity of plants and animals including fish. In addition, they play other key roles, for example, provisioning and maintaining water quality for countless living organisms. Wetland is considered a transitional area between land and water that harbor special types of flora and fauna. Such habitats are well known for high diversity in class, composition and four broad categories of functions viz.

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physical/hydrological, chemical, biological and socioeconomic [4]. Although the value of wetlands for fish and wildlife protection has been known for several decades, some of the other benefits like conservation of biodiversity, maintenance of water quality, recharge and discharge of water regime, etc. have been identified only in recent years. Fishes form one of the most important groups of vertebrates for man, influencing his life in various ways. Millions of human beings suffer due to hunger and malnutrition, and fishes form a rich source of food and provide a means to tide over the nutritional difficulties of man. In addition to serving as an important item of food, fishes provide several byproducts to us and thus fish have considerable economic importance to man [5].

River Tapi is one of the major rivers of peninsular India with a length of around 724 km; it runs from east to west. Tapi River rises near Multai in the Betul district of Madhya Pradesh and flows through Maharashtra and Gujarat for about 724 km before outfalling into the Arabian Sea near Surat. Tapi River Basin is situated in the northern part of the Deccan Plateau and extends over an area of 65145 sq km which is nearly 2% of the total geographical area of the country [6]. Nearly 80% of the basin lies in the State of Maharashtra and the Hatnur dam is the first stage of the Upper Tapi Project. It consists of 717 m long Ogee shaped gated overflow weir in the centre with 1863 m long earthen embankment on either side constructed across the river Tapi near Hatnur village in Jalgaon district of Maharashtra State. It is having a live storage capacity of 255 MCM to irrigate 3,78,384 hectares of land in Raver, Yawal, Chopda and Amalnertalukas of Jalgaon district by a right bank canal of 95 km length. Considering the importance of River Tapi as a major wetland in the North Maharashtra region so far its fish species inhabiting capacity is concerned, it is worth assessing the seasonal variations of the Physico-chemical properties of water from Hatnur reservoir and its co-relation with fish diversity [6].

MATERIALS AND METHODS

Study Area- Hatnur dam(75^0 90'E, 21^0 12'N) is an earth-fill dam constructed on river in Tapi River Basin near village Hatnur, Taluka Bhusawal, District Jalgaon, Maharashtra, India (Fig. 1). It is one of the biggest dams in North Maharashtra region. The dam is meant for irrigation, power generation, water supply and flood control. Hatnur reservoir has gross storage capacity of 388.00 Mm^3 and has a catchment area of 29430 sq. km. Study area visited during in each season during 2019-2020 and water samples were analyzed and taxonomic identification of fish was carried out in Post Graduate Research Center of Department of Zoology of Mahatma Gandhi Shikshan Mandal's Arts, Science and Commerce College, Chopda affiliated to Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon, Maharashtra State, India.

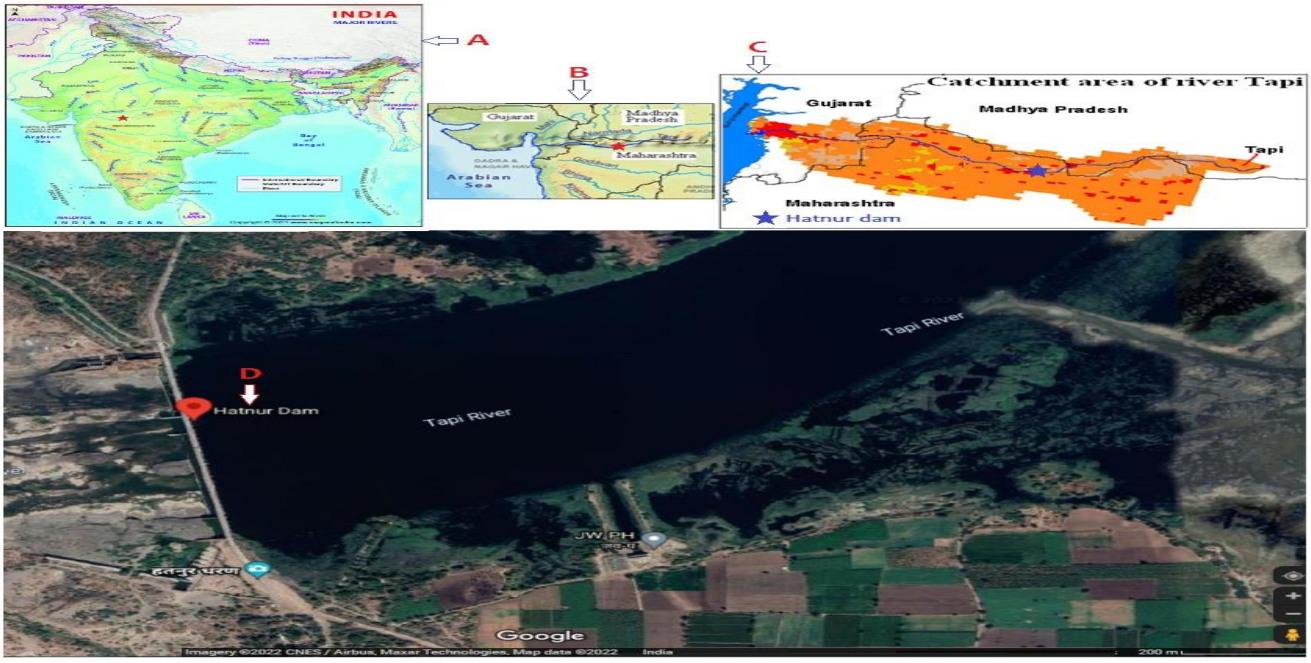

Fig. 1: A: India map showing major rivers,
B, C: Catchment area of Tapi basin, **D:** Satellite image of Hatnur Dam

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Water quality parameters- Water samples have been collected twice. Polyethylene bottles were used for the collection of the sample. Seasonal variations in atmospheric temperature were recorded during each season. Samples collected from Hatnur dam were analyzed for various physicochemical parameters including Water Temperature, pH, Turbidity, Transparency and Dissolved Oxygen (DO) in the laboratory. Analysis of physicochemical parameters was done according to standard methods [7].

Fish catch and Identification- Fish specimens were collected using cast net taking help of local fishermen present at Hatnur dam as well as from the local fish market and preserved in 3% formalin after carefully noting down the color and other external features and brought to the PG Research Centre of Department of Zoology. Labels indicating serial number, exact locality, date and time of collection were tagged to each specimen. Standard books and keys were used for the identification of species [8-11]. Similarly, personal talks with fishermen communities' also revealed valuable information about the taxonomic status of fish. Western Region Office of Zoological Survey of India, Pune cooperated and provided useful information about every fish specimen collected from Hatnur dam.

Statistical Analysis- Carl Pearson Correlation analysis is done by using Analysis Tool Pack of MS Excel 2019. Two variables are subjected, namely, ecological parameters of water and fish abundance; for two-way ANOVA analysis. The level of significance was tested at p= 0.01 and 0.05.

RESULTS

Seasonal variation of physico-chemical parameters of water samples collected from Hatnur reservoir is depicted in Fig. 1. The mean ambient temperature was highest in summer (41.42±1.15°C) and lowest (23.72±1.87°C) in winter. The mean water temperature was also following the same trend. The mean value of Dissolved Oxygen (DO) in water samples collected from Hatnur reservoir was found maximum (7.9±0.73 mgL^{-1}) in the winter season and minimum (5.8±0.38 mgL^{-1}) in summer (Fig. 2). During summer season, the DO of water in Hatnur reservoir was found depleted while during winter, the oxygen holding capacity of water was increased, thus showing the inverse relationship (Fig. 3).

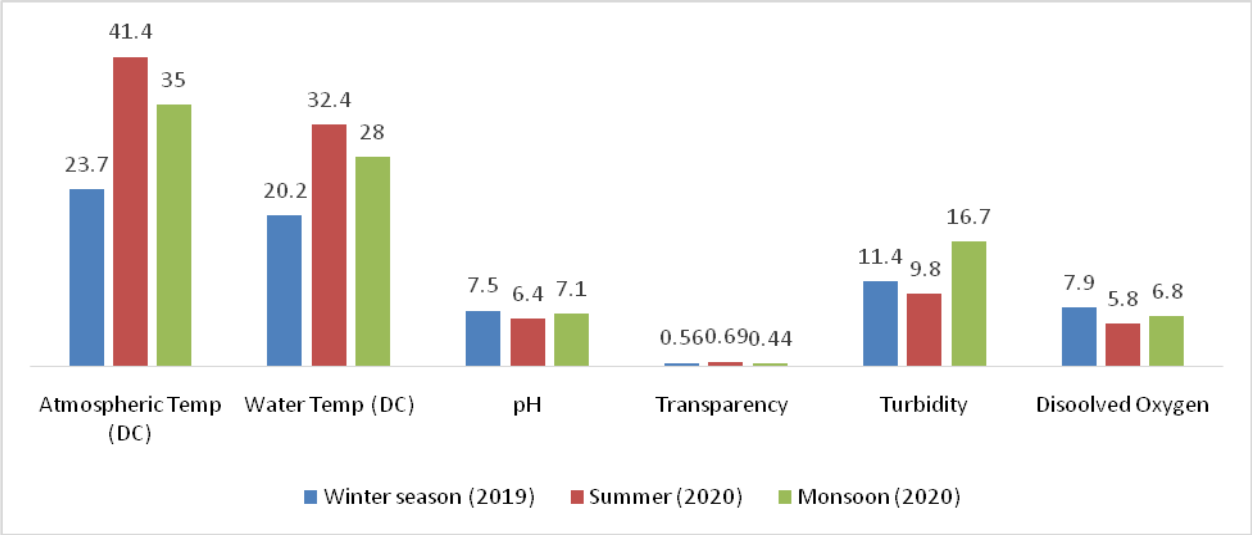

Fig. 2: Seasonal variation in limnological features of Hatnur reservoir

The pH of water samples collected from Hatnur reservoir was slightly alkaline during winter (7.5±0.13) and monsoon (7.1±0.08), which was turned to slightly acidic (6.4±0.09) during summer. Nephelometric Turbidity Unit (NTU) is the measure of turbidity of a fluid or the presence of suspended particles in water. The observational data related to turbidity and transparency of water from Hatnur reservoir indicated that the highest turbidity (16.7±2.35 NTU) was noted during monsoon and lowest during summer (9.8±1.03 NTU). There was an inverse relationship found between turbidity and transparency of water in Hatnur reservoir during the study period (Fig. 4).

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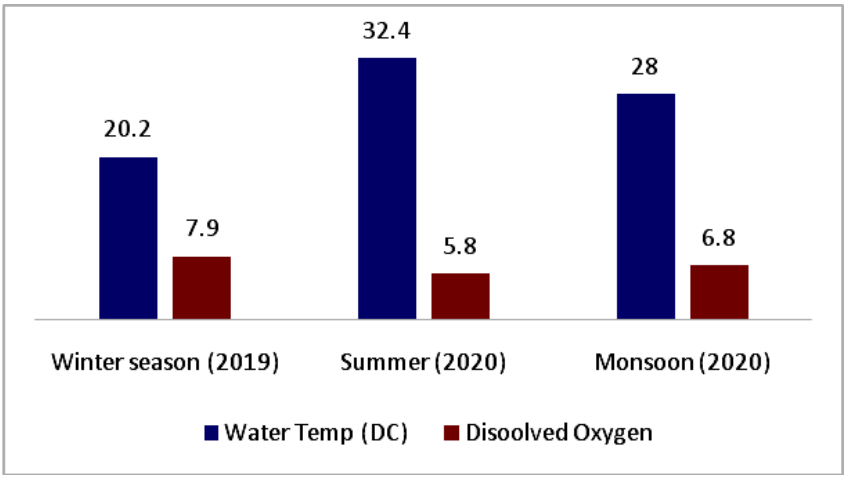

Fig. 3: Inverse relation between water temperature and dissolved oxygen

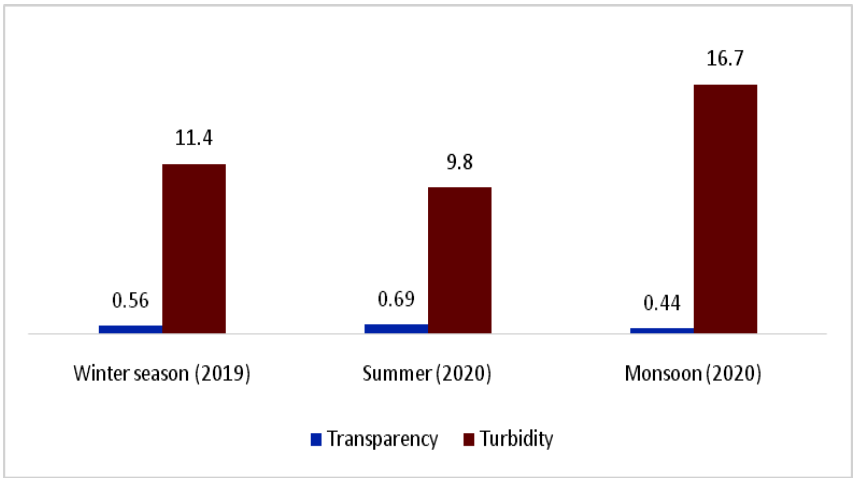

Fig. 4: Inverse relation between transparency and turbidity of water at Hatnur reservoir

Ichthyofauna recorded in Hatnur reservoir- The fish catches made at Hatnur reservoir during the study period showed the presence of carps, catfishes and other fishes. It was observed that numerically the carps dominated over other groups of fish in each fish catch during winter season of 2019 as well as during the summer and monsoon seasons of 2020. About the diversity of ichthyofauna, Table 1 summarizes the fish catches that were dominated by major carps and catfish belonging to the subclass: Teleostomi and 5 Families viz., Cyprinidae, Silirudae, Claridae, Channidae, and Mestacembelidae. In 12 months of period, total of 20 fish species as given below were located in Hatnur dam.

Table 1: Fish species found in Hatnur reservoir during the study period (2019-20)

Common Name/ Variety	Order	Scientific Name
Major carps (4 species)	Cypriniformis	*Labeo rohita* (Ham.)
		Catla catla (Ham.)
		Cyprinus carpeo (Linn.)
		Cirrhinus mrigala (Ham.)
Minorcarps (5 species)	Cypriniformis	*Labeo calbasu* (Ham.)
		Labeo bata (Ham.)
		Labeo fimbriatus (Bloch.)
		Labeolunatus (Bloch.)
		Labeo dussumieri (Ham.)

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Cat Fishes (6 species)	Siluriformis	*Clarius batrachus* (Linn.)
		Ompak bimaculatus (Bloch.)
		Wallago attu (Schn.)
Murrels (2 species)	Channiformis	*Channa punctatus* (Bloch.)
		Channa striatus (Bloch.)
Trash Fishes (3 species)	Cypriniformis	*Amblypharyngodon mola* (Ham.)
		Puntius sophore (Ham.)
	Mastacembeleformes	*Mestacembelus armatus* (Lacepede.)

Correlation analysis between water quality parameters with fish abundance- Correlation analysis depicted that each water quality parameter influences other parameters of water as well as indicating direct relationship with fish fauna inhabiting in Hatnur reservoir. Correlation analysis showed that fish abundance had a significant positive correlation with pH, dissolved oxygen and transparency but negatively correlated with water temperature and turbidity (Table 2). The correlation matrixes indicated significant negative correlation (r=-0.95) between pH and temperature.

Table 2: Correlation analysis between water quality parameters with fish abundance

	A	B	C	D	E	F
A	1					
B	-0.95**	1				
C	-0.99**	0.98**	1			
D	0.377*	-0.646	-0.49*	1		
E	-0.063	0.37	0.194	-0.948**	1	
F	-0.79*	0.78*	0.98**	0.98**	-0.99**	1

A = Water Temperature ^{0}C, B= pH, C=Dissolve oxygen (mhL^{-1}), D=Transparency (m), E=Turbidity (NTU), F= Fish abundance
**** Correlation is significant at the 0.01 level (2-tailed), * Correlation is significant at the 0.05 level (2-tailed)**

DISCUSSION

Aquatic life is influenced by temperature since it is one of the most important physical factors of the water. Air temperature is determined by the air masses over the particular landmass, climatic condition, time of sample collection, solar radiation and topography [12]. Air, as well as water temperature, plays an indispensable role in the physicochemical and physiological behaviour of biotic components of aquatic ecosystems [13]. In the study area, the air temperature was recorded higher than the water temperature during all seasons due to the climatic and geographical conditions of the Jalgaon district.

Dissolved oxygen (DO) is the most important parameter, which can be used as an index of water quality, primary production and pollution [14]. DO content is the most significant factor regulating metabolic processes of the organism and also the community as a whole. Water bodies receive oxygen from the atmosphere and aquatic plants. Running water, such as that of a swift-moving stream and rivers as observed during monsoon, dissolves more oxygen than the still water of a pond, lake or stagnant water in a reservoir [15]. DO in general affect the solubility and activity of various nutrients and therefore, the productivity of an aquatic ecosystem. A marked variation of dissolved oxygen content in water bodies of India was observed by various investigators and it varies greatly from one water body to the other in the same area [16].

Temperature also plays a significant role to maintain dissolved oxygen levels because temperature establishes a maximum oxygen-holding capacity of water. High water temperatures (86°F or higher) reduces oxygen-holding capacity. It was an important note that a similar trend was observed in the present investigation.

The pH of natural waters is due to available hydrogen ion concentration, the pH of the raw water sources is mostly lying within the range of 6.5 to 8.5. The tolerance of individual species varies, pH values between 6.5 and 8.5 usually indicate good water quality and this range is typical of most major drainage basins of the world [17,18].

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The pH of an aquatic ecosystem is important because it is closely linked to biological productivity as it affects the population, composition and distribution of aquatic organisms in an aquatic ecosystem. The pH of water is attributed to climatic conditions, photosynthetic activities by primary producers and various anthropogenic activities. Similar findings related to higher values of pH during summer were recorded by Kumar *et al.* [19], which may be due to increased photosynthetic activity by phytoplankton and macrophytes. Whereas, Bade *et al.* [20] reported contradictory observations between pH and temperature of water from Sai reservoir from Maharashtra.

Turbidity and transparency (measured using Secchi Depth) are measures of how clear a water sample is. When solids are suspended in the water, they can become murky. The murkier the water appears from these solids, the higher the measured turbidity and the lower the transparency. A greater Secchi Depth equals greater transparency or clearer water. Transparency is often measured in the field instead of turbidity. Environment Protection Agency states that transparency is an integrated measure of light scattering and absorption [21]. It is important to note that turbidity does not quantify the amount of total suspended solids (TSS). The analytical results of the physicochemical parameters of water samples collected from the Hatnur reservoir during the study resembled the findings of several investigators [4,13-15,18,22,23].

CONCLUSIONS

The results obtained in the present study indicated that the physicochemical properties of water samples collected from the Hatnur reservoir were within recommended limits of the Bureau of Indian Standards (BIS). It can be concluded that the water at Hatnur Dam was less polluted and thus suitable for agricultural and domestic use. Thus study also demonstrated that quality of water is suitable to inhabit the fish diversity.

It is suggested that future studies should focus on under-explored and unexplored areas of the Tapi riverine system in North Maharashtra to comprehensively document the fish diversity of the region. The diversity and distribution pattern of icthyofauna could be used for identifying prioritizing sites for freshwater biodiversity conservation in the region.

CONTRIBUTION OF AUTHORS

Research concept- Namrata D. Chaudhari
Research design- Prof Prakash S. Lohar
Supervision- Prof Prakash S. Lohar, Dr Anil G.Patil
Materials- Namrata D. Chaudhari
Data collection- Namrata D. Chaudhari
Data analysis and Interpretation- Namrata D. Chaudhari, Prof Prakash S. Lohar
Literature search- Namrata D. Chaudhari
Writing article- Namrata D. Chaudhari
Critical review- Prof Prakash S. Lohar
Article editing- Prof Prakash S. Lohar
Final approval- Prof Prakash S. Lohar

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