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# Effect of water temperature on density of phytoplankton community in Khadakwasla reservoir with reference to conservation of endangered fish Mahseer

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**Key words:** Phytoplankton, Water temperature, Relationship, Mahseer conservation

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**Abstract**

Phytoplankton plays an important role in determining ecological health of any aquatic ecosystem. Though evident that various physical parameters have relations with the phytoplankton communities, the relationships seem to be highly context-specific. The present study aims to find the relation between one of the important physical parameters, water temperature and the density of phytoplankton community in the Khadakwasla reservoir with respect to the conservation of threatened fish Mahseer. An essential precondition for successful aquaculture production is to understand the available food resources in the reservoir and any factors impacting the along with the feeding habit and nutrition of fish species to be stalked. In the present study a linear relationship was observed between water temperature and the density of phytoplankton community in the Khadakwasla reservoir in the study period. Observed values for both water temperature and phytoplankton density indicate that Khadakwasla reservoir is a favourable site for endangered fish Mahseer.

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## Introduction

Biological indicators are used for assessing the water quality because they react either positively or negatively to the changing parameter of water. In the present study we have tried to analyze relationship between water temperature and phytoplankton density for Khadakwasla with a view for conservation of threatened fish Mahseer.

Temperature is considered as one of the most important abiotic filters, or drivers (Sunagawa *et al.*, 2015) and it also drives the species succession (Anderson and Rynearson, 2020) and nutrients (Redfield, 1958). It is reported that temperature can regulate growth and cellular metabolism in life of phytoplankton (Eppley, 1972). Phytoplankton is readily exposed to a variety of thermal conditions which is generally, through both passive transport along ocean currents, and seasonal cycles (Doblin and van Sebille, 2016).

Though several studies have been conducted on water bodies in North India like on the Yamuna River (Chopra *et al.*, 2012), Ganga River and its tributaries (Negi *et al.*, 2012), Chandrabhaga River (Sharma *et al.*, 2007), Sutlej River (Sharma *et al.*, 2013) and Jhelum River (Hafiz *et al.*, 2014). Water quality of Khadakwasla was also discussed by Hansda *et al.* (2018); there is still data scarcity on effect of temperature on phytoplankton composition of Khadakwasla reservoir.

As in its adult stage, Mahseer is known to be an omnivore fish. Due to the mouth opening and massive size of the fish in earlier days Mahseer was considered as a carnivore fish (Malhotra, 1982). But it is evident from gut analysis of several samples of Mahseer collected from rivers of Pokhara Valley, where gut contained not only small insects and plants but also rice grains. It is found that Mahseer also feeds on algal coatings on rocks, green filamentous algae, insect larvae, and small molluscs (Shrestha, 1997; Negi, 1994; Dubey, 1985). In natural habitat it is reported that mahseer fingerlings food constituted of insect matter (81.4 percent), plant matter (15.9 percent) and other items including fish (1.6 percent) (Nautiyal and Lal, 1984).

Therefore, the present study aims to determine the influence of temperature phytoplankton composition of the reservoir. Apart from India such studies related to the effect of physico-chemical parameters and phytoplankton have been previously conducted in several rivers like on the Greater Zab River, Imo River, Nigeria (Ogbuagu and Ayoade, 2012), River Thames, UK (Waylett *et al.*, 2013), and Kenti River, Republic of Karelia (Chekryzheva, 2014), Iraq (Ali, 2010), River Haraz, Iran (Jafari *et al.*, 2011).

## Materials and methods

The current study involves examining both the physical and biological aspects of the Khadakwasla reservoir with a view of the mahseer fish species conservation. These various parameters work in tandem, and when considered collectively, they offer a comprehensive overview of the reservoir's potential to support the threatened fish mahseer population. For the current study we are keeping our focus on Water temperature and its impact on the population density of phytoplankton community. The methodology employed for conducting this study is outlined below.

### *Study area*

Khadakwasla, which is located around 20 kilometres from Pune, is primarily known for its dam, which serves as a crucial water source for the city. Adjacent to this dam, there are notable institutions like the National Defence Academy and the Central Water & Power Research Station (CWPRS). In the near vicinity lies Sinhagad Fort, accompanied by the twin dams of Panshet and Varasgaon. These two dams primarily cater to irrigation water needs.

### *Sampling stations*

A noticeable consistency and uniformity in the visual characteristics of the water are evident throughout the expanse of the reservoir. The presence of aquatic macro vegetation is notably limited. Four specific sampling stations were designated within this reservoir.

### *Sampling method*

Sampling constitutes the foundational and pivotal phase of any limnological exploration. Its significance

is so profound that the outcome, accomplishments, and even setbacks of the endeavour are heavily contingent upon the well-crafted strategy and blueprint governing sample collection. The approach to sampling is meticulously determined, factoring in an array of variables including the investigation's objective, method appropriateness, time constraints, and workforce capability, efficiency, and size, available resources encompassing finances and facilities, and notably, the inherent characteristics of the system under scrutiny. As a result, a comprehensive guidebook cannot feasibly offer exhaustive directives concerning the selection of sampling stations, timing and frequency of sampling, as well as the quantity and dimensions of the samples.

From May 2015 to April 2017, water samples were collected on a monthly basis from the four sampling stations located within the Khadakwasla reservoir. To ensure accurate results, the water temperature, a dynamic physical parameter, was analyzed on-site due to its tendency to fluctuate rapidly. Temperature value was gathered from the surface, middle, and lower depths of the water column and average of the value is used for analysis. Conversely, the estimation of plankton levels was conducted in a laboratory setting. The analysis of these parameters adhered to the guidelines outlined in the Standard Methods by Golterman *et al.* (1978), Boyd (1979), NEERI (1986), and APHA (2012).

*Water temperature*

Using a basic mercury thermometer graded from 0 to 50°C, and subdivided into 10 intervals per degree, measurements were taken for water temperatures.

*Phytoplankton*

To assess phytoplankton density, a 1-liter water sample was gathered and placed in a container. To preserve the phytoplankton within, Lugol's solution was introduced. The preserved sample was transported to the laboratory to undergo quantitative examination. Subsequently, the sample underwent centrifugation to allow complete settling of sediment. The liquid supernatant was carefully extracted using a pipette, and the sample was then condensed to a volume of 10 millilitres, following the methodology outlined by Wetzel and Likens (1979). For the quantitative estimation of phytoplankton drop count method was used.

*Pearson's correlation coefficient*

In statistics, the Pearson correlation coefficient (PCC) is a correlation coefficient that measures linear correlation between two sets of data. The value of this coefficient always lies between -1 and 1 and it is often used to reflect if there is linear correlation of variables. In our present study we have used it to understand relationship between water temperatures and densify of phytoplankton in Khadakwasla reservoir.

**Results and Discussion**

It is evident that the water quality of an aquatic ecosystem is influenced by geological, hydrological, climatic and anthropogenic factors (Boon *et al.*, 1992; Bartram and Balance, 1996). Water temperature is one of the key parameters that are responsible for controlling aquatic life in a headwater stream (Wetzel, 1983). Growth of phytoplankton composition is governed by the temperature (Rajkumar *et al.*, 2009; Singh, 1960).

*Water temperature*

As discussed earlier, temperature as a key factor for the autotrophs to flourish well. It also stands as a paramount determinant influencing the physiological functions across various aquatic diverse heterotrophs. A direct correlation between the metabolic rate of fishes and the ambient temperature is well established. Water temperatures have fluctuated between 21.7°C and 28.6°C in the Khadakwasla reservoir, where these variations fall within the range advised by Jhingaran (1983). The Mahseer fish, categorized as a carp species, thrives in ecological niches akin to those inhabited by other commercially important carp. Consequently, it can be inferred that the prevailing temperatures in Khadakwasla reservoir create a favourable environment for the prosperous growth of the Mahseer fish (Nigam, 2019).

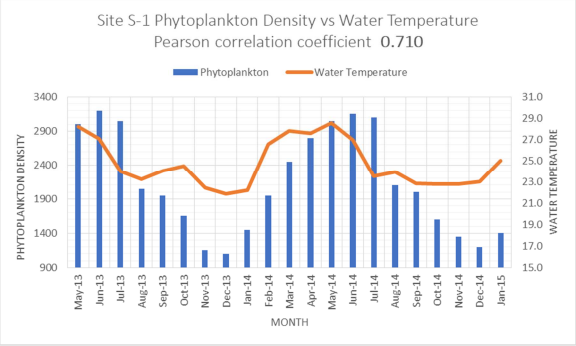


**Fig. 1.** Site S-1 phytoplankton density vs. water temperature

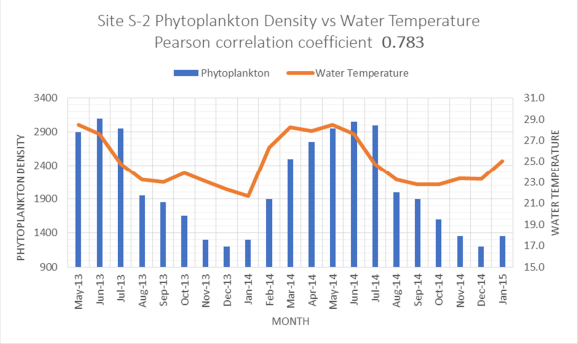


**Fig. 2**. Site S-2 phytoplankton density vs. water temperature

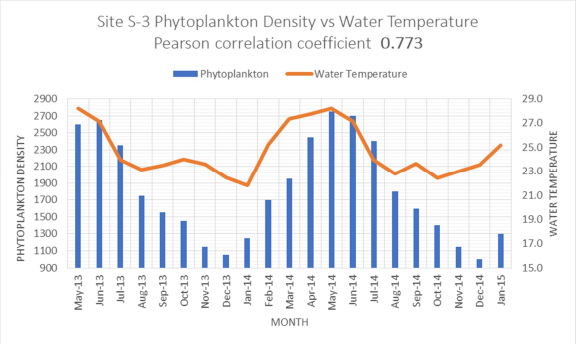


**Fig. 3.** Site S-3 phytoplankton density vs. water temperature

During the study period, at site S-1 maximum temperature was recorded as 28.6°C in May-14 and minimum temperature was 21.9°C in Dec-13 (Fig.1). For site S-2, maximum and minimum values were recorded 28.5°C in May-13 and 21.7°C in Jan-14 (Fig. 2). Maximum temperature recorded at Site S-3 was 28.2°C in May-13 and May-14 whereas minimum temperature was 21.80C in Jan-14 (Fig. 3). Finally, site S-4 maximum value was recorded as 27.9°C in May-13 and May-14 and minimum temperature was 22.1°C in Jan-14 (Fig. 4). Looking at the collected data it is clear that water temperature follows the same trend as atmospheric temperature and weather.

The interaction between environmental factors determining the ecological variations and production potentialities in an ecosystem has been known since long. Several evidences of loss of fish due to ignorance of correlation between environmental factors and fish production are in existence (FAO, 2018).

*Phytoplankton quantitative analysis*

Phytoplankton, the microscopic, free floating or freely swimming plant organisms are one of the primary producers of the organic matter in an aquatic ecosystem and are known to have a typically short life span. Phytoplankton play a vital role in fixing inorganic carbon and building up organic matter through primary productivity thus making them a subject of prime importance due to possession of this unique ability. In the present study on Khadakwasla reservoir, the total number of phytoplankton ranged from 1000 to 3200 org/lit across all 4 sites during the study period. Though, Welch (1952) classified the lakes with high plankton abundance as eutrophic and higher values were observed in the summer season during the present study. According to Jhingran (1983) blooms often cause heavy mortality of fish, the mortality being variously attributed to oxygen depletion by algae, to their probable decomposition, to the physical choking of the gills and to the toxins liberated by the metabolism of algae. However, no such incidence was recorded in Khadakwasla reservoir and hence there is no significant stress on fish.

During the study period, at site S-1 phytoplankton density was recorded with a maximum value of 3200 organisms/ltr in June-13 and minimum value of 1100 organisms/ltr in Dec-13 (Fig. 1). Maximum density of phytoplankton recorded at Site S-2 was 3100 organisms/ltr in Jun-13 whereas minimum density was 1200 organisms/ltr in Dec-13 and Dec-14 (Fig. 2). For site S-3, maximum and minimum values of phytoplankton density were recorded 2750 organisms/ltr in May-14 and 1000 organisms/ltr in

Dec-14 respectively (Fig. 3). And finally for site S-4 maximum value was recorded as 2850 organisms/ltr in Jun-13, May-14 and Jun-14 and minimum temperature was 1000 organisms/ltr in Dec-14 (Fig. 4). A descending trend was observed in the density of phytoplankton in the rainy season as compared with the summer season growth.

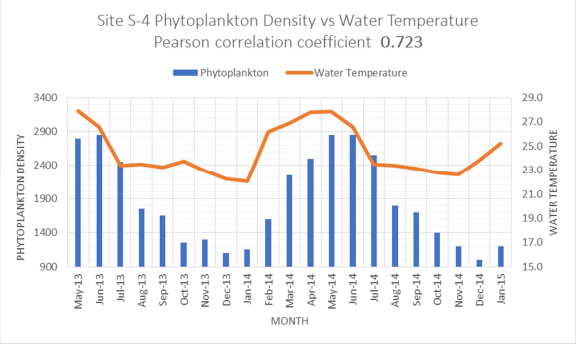


**Fig. 4.** Site S-4 phytoplankton density vs. water temperature

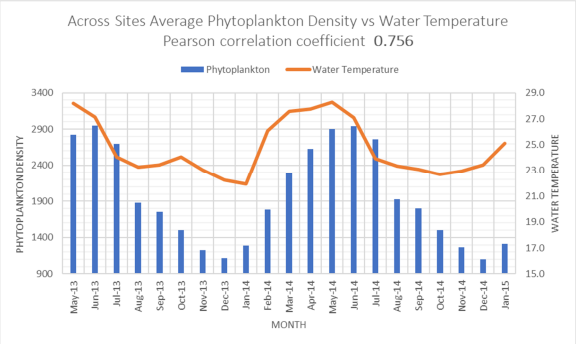


**Fig. 5.** Across sites average phytoplankton density vs. water temperature

*Relationship between water temperature and density of phytoplankton*

As we know that water temperature governs the availability of oxygen (Kowalkowski *et al.*, 2006). In the given study we used Pearson correlation coefficient to identify relationship between water temperature and density of phytoplankton using the values recorded at 4 sampling sites every month during the study period. In the given study it was observed that the water temperature has positive correlation with the phytoplankton density. The Pearson correlation coefficient value was calculated to be 0.710 for site S-1 (Fig. 1), 0.783 for site S-2 (Fig. 2), 0.773 for site S-3 (Fig. 3) and 0.723 for site S-4 (Fig. 4). Average value of the coefficient was found to be 0.756 across all sites (Fig. 5). These values clearly indicate a linear relationship between water temperature and density of phytoplankton community in Khadakwasla reservoir. Similar findings were reported from Tyne River, South Africa (Sibanda *et al.*, 2013). Major factor responsible for the growth of phytoplankton composition is the temperature (Rajkumar *et al.*, 2009; Singh, 1960). Factors like light, water temperature, water current, substrate and water chemistry are known to control phytoplanktonic growth (Hynes, 1970; Whitton, 1975; Biggs, 1996). Apart from water temperature available nutrients and light play a vital role in the abundance and composition of phytoplankton communities. (Reynolds, 2006; Altman and Paerl, 2012; Basu and Pick, 1997). Similarly in Tungabhadra River (Suresh *et al.*, 2013) same relationship was also reported.

**Conclusion**

This study summarizes the monthly and seasonal variations of physico-chemical parameter Water Temperature and its influences on phytoplankton community of Khadakwasla reservoir across 4 sampling stations on the reservoir. Water temperature is observed to vary as per variation in atmospheric and weather. Density of phytoplankton community also varied mostly with variation in Water Temperature. During rainy season a dip in phytoplankton density is recorded across all sites. This indicates that there may be other factors like turbidity, insufficient availability of sunlight etc. maybe affecting the phytoplankton density. Pearson correlation coefficient is used in the current study to understand the relationship between water temperature and density of phytoplankton community on the values recorded across all the 4 sites. The values of coefficient clearly indicate a positive linear relationship between these two variables.

Based on all the above observations it can be concluded that ambient temperature and abundance of phytoplankton community in Khadakwasla reservoir makes it an ideal site for conservation of threatened fish Mahseer.

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