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"Correlation Analysis of Physicochemical Parameters and Zooplankton Found in Dholi Dhaja Dam, Surendranagar, Gujarat"

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Abstract

A two-year (July 2021 - June 2023) study was done the physico-chemical parameters and zooplankton diversity of the Dholi Dhaja Dam in Surendranagar, Gujarat, India. To assess waterbody efficiency, various parameters were monitored, including pH, solids (total dissolved, total, and suspended), and oxygen levels (dissolved and biological oxygen demand). Water samples were collected from specific points, 21 distinct zooplankton species belonging to five taxonomic groups: Protozoa, Rotifera, Copepoda, Cladocera, and Ostracoda were identified from the selected study site. Significant positive correlations were observed between zooplankton diversity and both pH ($r = .710^{**}$, $p < .01$) and BOD ($r = .598^{**}$, $p < .01$). This suggests that increased alkalinity and nutrient richness in the water promote greater zooplankton diversity. These findings contribute to our understanding of Dholi Dhaja Dam's ecological status and the relationship between zooplankton and physico-chemical parameters of this study site.

Keywords: Zooplankton diversity, physico-chemical parameters, Dholi Dhaja Dam, Surendranagar, Gujarat, correlation, pH, BOD.

INTRODUCTION:

The Earth is often known as the "blue planet" due to the substantial coverage of water on its surface, amounting to around 75%. The majority of this water, about 97%, exists in the form of oceans, while the remainder is distributed among polar ice caps and groundwater. Despite this abundance, humans only utilize a minor fraction, specifically 0.33%, of the total water available. India stands out as a country rich in water resources, contributing 4% to the global water supply. (India-WRIS wiki 2015) [22].

The significance of freshwater ecosystems in alleviating the consequences of climate change cannot be overstated. These ecosystems play a vital role by offering essential services like flood control and water

purification. They facilitate the movement of salts and nutrients from elevated regions to lower-lying lakes, ponds, and wetlands, ensuring a continual exchange of nutrients. Nevertheless, human activities such as eutrophication, acidification, the introduction of non-native species, and pollution pose substantial challenges to the well-being of river and small lake ecosystems (Moss et al., 2010) [16]. These anthropogenic factors exacerbate the impact on freshwater faunal biodiversity, which is already vulnerable to natural seasonal fluctuations (Dudgeon et al., 2006) [8].

Life depends on water, which serves as a crucial medium for numerous biochemical processes. It is indispensable for sustaining life on Earth and forms the basis of the intricate web of life. Water plays a fundamental role in shaping the growth and operations of the natural world, constituting phytoplankton and zooplankton as essential components that underpin the aquatic ecosystem (Mishra 2014) [15]. Zooplankton plays a vital role in freshwater ecosystems by connecting various levels of the aquatic food chain. It includes all minute aquatic organisms that move passively through water, spanning a size range from micrometers to several centimeters. (CSIRO 2000) [7].

quality evaluation involves analyzing various physical, chemical, and biological parameters of water, with emphasis on those that may affect human health and the health of the aquatic ecosystem (Chapman, 1996) [5]. The rapid economic growth associated with industrial waste, chemicals, and sewage discharge is leading to water contamination and degradation of water quality and aquatic life. Without proper monitoring and preventative measures, these water resources are at risk of depletion in the near future, emphasizing the need for sustainable utilization practices (Pathak & Mankodi 2013) [17].

Surendranagar district, situated in the western region of India, is renowned for its rich aquatic ecosystems, encompassing numerous lakes, dams, and important rivers one such fresh water reservoir is Dholi Dhaja Dam. This dam plays a critical role in sustaining the local ecosystem and economy, making it imperative to assess and understand their health and sustainability. The present study aims to investigate the coorelation between diversity of zooplankton and the physico-chemical parameters of this dam, with the goal of gaining insights into the role of zooplankton in the food chain and evaluating water quality. The findings of this study will be crucial in informing and guiding effective management and conservation practices to ensure the long-term well-being of dholi dhaja dam, Surendranagar, Gujarat.

MATERIALS AND METHODS

Surendranagar, situated in the Saurashtra region of Gujarat, India, is a district characterized by various freshwater features, including lakes, dams, and significant rivers. The focus of this research centers on the Dholi Dhaja Dam (22°43'16.28"N, 71°35'06.87"E). This dam is chosen due to its proximity to Surendranagar city and its role in providing water for human consumption and other needs. The study involves the collection of samples to assess both the biodiversity of zooplankton and the physico-chemical parameters of the water. Samples are gathered from the surface of each dam, further these reading were analysied to study correlation between zooplankton diversity and physico-chemical parameters and GPS locations are meticulously recorded to ensure the precision of the sample collection process.

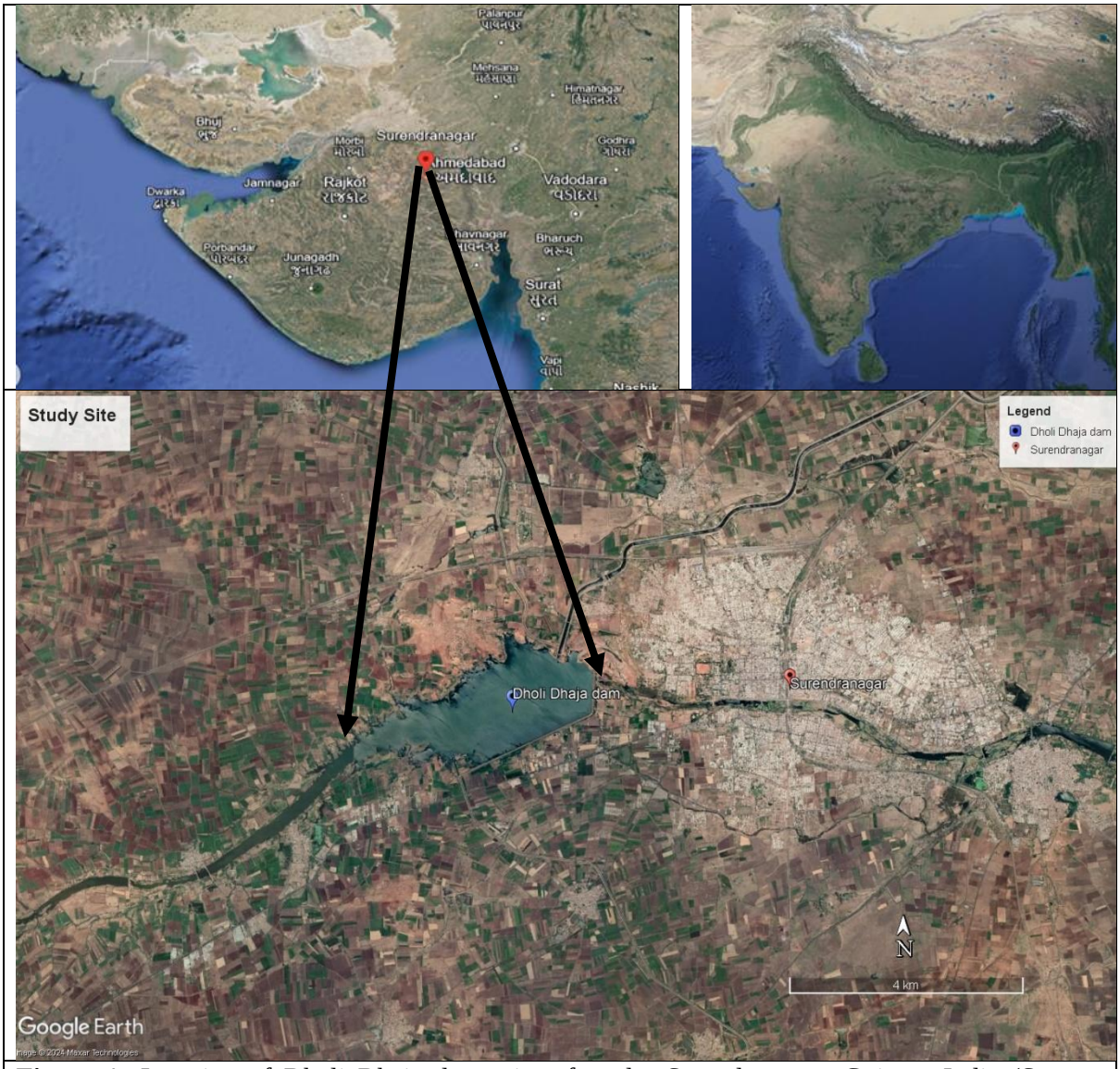

Figure 1: Location of Dholi Dhaja dam- site of study: Surendranagar, Gujarat, India (Source: https://earth.google.com/web/)

SAMPLE COLLECTION

Physico-chemical parameters:

The study involved collection of water samples for evaluating the physico-chemical characteristics. On-site measurements of dissolved oxygen were taken at the time of sampling, while other parameters were analyzed in the laboratory using analytical procedures outlined in APHA (2012) [1]. Over the course of the study, seven key water quality parameters were analyzed including pH, Total Solids (TS), Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Dissolved Oxygen (DO), and Biological Oxygen Demand (BOD). Zooplankton samples were collected from the surface water using a 60µ mesh Nylon plankton net with a conical shape.
Study of seasonal abundance of zooplankton in the water:

The identification of zooplankton was conducted using several zooplankton identification manuals, including (Sharma 1998, Thorp and Covich 2009, Phan et al., 2015, Conway et al., 2003, Kasturirangan 1963, Michael and Sharma 1988, Bick 1972, Shiel 1995, and Khan 2000) [2, 6, 11, 13, 14, 18, 19, 21, 22]. Qualitative analysis of the zooplankton samples was carried out using a compound microscope and a light microscope, examining various zooplankton species (Goswami & Mankodi 2012) [9]. Hardy species were immediately preserved in formalin. The qualitative and quantitative examination of zooplankton was performed using Lackey's drop method. Some other groups, such as Rotifers, undergo significant morphological changes during preservation, making it necessary to observe them in their living conditions (Mishra 2014) [15].

RESULTS AND DISCUSSIONS:

The study identified a total of 28 zooplankton species belonging to four major groups: Protozoa (11 species), Rotifera (11 species), Copepoda (3 species), and Cladocera (4 species) (Table 1). Interestingly, zooplankton diversity peaked during winter and dipped to its lowest point in the monsoon season.
Dholi Dhaja Dam stood out with the highest abundance of protozoans and rotifers compared to other zooplankton groups. This dominance could be linked to the high sewage influx from surrounding settlements, creating a favorable environment for these organisms. These findings highlight the potential influence of human activities, particularly sewage discharge and industrial pollution, on shaping the diversity and composition of zooplankton communities. This underscores the critical need to identify and manage pollution sources to safeguard the ecological balance and health of this aquatic ecosystems.

Table 1: Zooplankton diversity of Dholi Dhaja Dam	
	Zooplankton species
Protozoa	
1	*Coleps hirtus*
2	*Dileptus sp.*
3	*Epistylis sp.*
3	*Euglena virdis*
4	*Euplotes patella*
5	*Tetrahymena pyriformes*
6	*Loxophyllum sp*
7	*Paramoecium Aurelia*
8	*Paramoecium caudatum*
9	*Phacus sp.*
10	*Stentor sp.* (Free swimming)
Rotifera	
11	*Asplanchna sp.*
12	*Brachionus angularis angularis*
13	*Brachionus caylciflorus*
14	*Brachionus rubens*
15	*Brachionus urceolaris*
16	*Filinia longiseta*
17	*Keratella quadrata*
18	*Keratella tropica*
19	*Lecane bulla*
20	*Polyarthra vulgaris*
21	*Trichocerca rattus*
Copepoda	
22	*Nauplii sp.*
23	*Cyclops sp.*
24	*Heliodiaptomus viddus*
Cladocera	
25	*Ceriodaphnia sp.*
26	*Ceriodaphnia pulchella*
27	*Daphnia obtuse*
28	*Daphnia carinata*

A 2022 study by Sharma et al. investigated the zooplankton diversity of the Anas River in Jhabua, Madhya Pradesh, spanning two years. Their findings revealed a total of 31 zooplankton species, categorized into eight distinct orders: Protozoa, Rotifera, Copepoda, Cladocera, and Ostracoda. Notably, Rotifers emerged as the most dominant group, followed by Cladocerans, Copepods, Protozoans, and Ostracods (Sharma et al., 2022).
In 2022, Jani et al. conducted a study on zooplankton biodiversity and physicochemical parameters in Junagadh city. They investigated seven different sites over an eight-month period from August 2021 to March 2022. The

study recorded zooplankton communities belonging to eight different groups and identified a total of 70 zooplankton species in the selected sites of Junagadh district (Jani et al., 2022) [10].

CORRELATION ANALYSIS BETWEEN AVIAN DIVERSITY, ZOOPLANKTON AND PHYSICO-CHEMICAL PARAMETERS:

Table 2: Pearson's correlation coefficients between different variables of Dholi Dhaja dam.

	Zooplanktons	pH	BOD	DO	TS	TDS	TSS
Zooplanktons	1						
pH	.710**	1					
BOD	.598**	.864**	1				
DO	.055	.466*	.482*	1			
TS	-.104	-.438*	-.388	-.918**	1		
TDS	-.076	-.421*	-.373	-.926**	.999**	1	
TSS	-.162	.249	.220	.923**	-.914**	-.931**	1

(= Correlation is significant at the 0.01 level, * = Correlation is significant at the 0.05 level)**

Table 2: Indicate significant positive correlation was observed between zooplankton and Physico-chemical parameters.

Zooplankton and pH: A strong positive correlation ($r = 0.710$, $p < 0.01$) suggests that higher pH levels are associated with increased zooplankton abundance. This may be due to the prevalence of specific zooplankton species that thrive in alkaline conditions.

Zooplankton and BOD: A moderate positive correlation ($r = 0.598$, $p < 0.01$) indicates that higher BOD levels tend to coincide with greater zooplankton numbers. This could be attributed to certain zooplankton species flourishing in nutrient-rich environments.

pH and BOD: A very strong positive correlation ($r = 0.864$, $p < 0.01$) suggests that increases in pH typically correspond to higher BOD levels. This may be explained by the enhanced activity of certain microorganisms responsible for organic matter breakdown under alkaline conditions.

pH and DO: A moderate positive correlation ($r = 0.466$, $p < 0.05$) indicates that higher pH levels tend to coincide with increased dissolved oxygen (DO) content. This could be due to the inhibition of certain chemical reactions that consume oxygen in alkaline environments.

BOD and DO: A moderate positive correlation ($r = 0.482$, $p < 0.05$) suggests that higher BOD levels generally correspond to slightly lower DO concentrations. This is likely due to the oxygen consumption by microorganisms during organic matter breakdown.

DO and TSS: A very strong positive correlation ($r = 0.923$, $p < 0.01$) reveals a close relationship between DO and total suspended solids (TSS). This suggests that higher DO levels are associated with lower TSS concentrations, potentially due to oxygen-dependent processes like particle aggregation and sedimentation.

TS and TDS: A near-perfect positive correlation ($r = 0.999$, $p < 0.01$) indicates that total solids (TS) and total dissolved solids (TDS) are virtually identical. This is expected as TS should be the sum of both TDS and total suspended solids.

In 2014, Bird and Day conducted a study focusing on the effects of habitat transformation on the physico-chemical characteristics such as pH, DO, BOD, TDS, TSS and TS of temporary wetlands in the south-western Cape region of South Africa. The research aimed to investigate how changes in habitat due to human activities have influenced the various physical and chemical properties of these wetland ecosystems (Bird and Day, 2014) [3].

The study by Khaire in 2020 also found that the abundance of different species of zooplankton varied with changes in physico-chemical parameters. The author also observed that physico-chemical parameters of water

play a crucial role in determining the population of zooplankton and their abundance in aquatic ecosystems (Khaire, 2020) [12].
In 2021, Brraich et al. conducted a comprehensive study on the water quality parameters of Harike Wetland in Punjab, spanning from June 2018 to August 2019. The research involved the measurement of various water quality parameters, including water temperature, pH, alkalinity, dissolved oxygen, total dissolved solids, nitrates, and phosphates. To assess the relationships between different physico-chemical parameters, Pearson Correlation analysis was employed to determine the correlation coefficients. The study revealed the significant influence of pollution load from multiple sources on the seasonal variations and water quality parameters of the wetland, particularly pH, nitrates, and phosphates specifically, pH exhibited a negative correlation with all other parameters except phosphates. Water temperature (excluding dissolved oxygen), alkalinity, total dissolved solids, and nitrates displayed a significant positive correlation with other physico-chemical parameters (Brraich et al., 2021) [4].

CONCLUSION:

This study aimed to evaluate the zooplankton diversity and physico-chemical parameters of Dholi Dhaja Dam, Surendranagar, Gujarat, India. Further analysis delved into the physicochemical parameters of Dholi Dhaja Dam and their potential influence on zooplankton diversity. Notably, statistically significant positive correlations were observed between zooplankton abundance and both pH and BOD levels. These findings suggest a potential role for these parameters in shaping and supporting diverse zooplankton communities within the reservoir ecosystem.
Specifically, pH exerts a significant influence on overall water quality and can directly impact the survival and reproductive success of aquatic organisms, including zooplankton. Similarly, BOD levels serve as an indicator of organic pollution load and can indirectly affect zooplankton abundance by influencing dissolved oxygen availability. Therefore, the observed correlations highlight the potential importance of maintaining optimal pH and managing organic pollution inputs to promote and sustain diverse zooplankton assemblages within the Dholi Dhaja Dam ecosystem.

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