Physico – chemical and Planktonic Investigational Review on Limnology of Fresh water Holder Malsisar Dam Jhunjhunun District of Rajasthan (India)

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ABSTRACT:

This review presents an integrated analysis of the physico-chemical parameters and planktonic diversity of Malsisar Dam, focusing on correlations that shape freshwater ecosystem function and sustainability. Sampling from June 2023 to November 2024 identified strong seasonal variations in water parameters and planktonic populations. The study provides baseline metrics essential for ongoing ecological monitoring and sustainable water management in Rajasthan's semi-arid landscape. Nestled within Rajasthan's semi-arid landscape, Malsisar Dam emerges not only as a vital freshwater resource for Jhunjhunun district but as a living laboratory where the geneses of aquatic health and sustainability unfold. This inventive review interlaces the physico-chemical tapestry—temperature, pH, dissolved oxygen, nutrient profiles and the dynamic ballet of planktonic communities to decode the ecological pulse of the reservoir. Through a systematic, season-wise and month wise sampling. the study reveals a striking interplay: alkaline waters, moderate nutrient enrichment, and variable thermal regimes sculpt microscale habitats, fostering a diverse planktonic assemblage led by rotifers and arthropods. The limnological lens employed not only quantifies water quality, electrical conductivity, TDS, ions and biotic indices, but also illuminates how climatic cycles, monsoon pulses, and anthropogenic inputs modulate biodiversity and underlying biogeochemical fluxes. Plankton density peaks align with post-monsoon nutrient surges, mapping subtle ecological recovery and resilience patterns. Comparative analyses with other desert-region reservoirs underscore Malsisar's intrinsic uniqueness and adaptive potential.

Ultimately, this review elevates Malsisar Dam as a sentinel site: where physico-chemical narratives and planktonic signals intertwine to forecast ecosystem stability and water resource futures. The findings build a foundation for regionally tailored conservation strategies, positioning limnology as an indispensable guide for sustaining life and livelihoods in semi-arid India.

Keywords: Planktonic Diversity, Malsisar Dam, Physico-chemical tapestry, Ecosystem.

INTRODUCTION - The most sensitive component of the ecosystem is comprised of aquatic species, particularly plankton, which indicates that there has been a disturbance in the environment. A necessity for the proper management of an aquatic environment is the possession of information about the quantity, composition, and seasonal succession of the same. Not only does phytoplankton play a vital role in primary production, but it also serves as a source of nutrition for herbivorous animals and serves as a biological indicator of water quality in studies that investigate pollution. As an additional indication of water contamination, the communities of phytoplankton, particularly the many species of diatoms, are used. The biological continuity of the lentic fresh water bodies is multimodal, and phytoplankton is used for the purpose

of biomonitoring the ecological disturbance that is brought about by a variety of physicochemical causes, pollutants from sewage, and other anthropogenic factors. The plankton community, which includes phytoplankton and zooplankton, is an essential and versatile structural component of aquatic biocenoses. It is responsible for the primary and secondary links in the trophic chains of the ecosystem, and it plays a specific role in the processes of transporting and accumulating substances and energy in the biogeochemical processes. Alterations in a wide variety of aquatic ecosystems are primarily brought about by climate shifts on a global and regional scale, as well as other human influences. Any changes to the environment have an impact on the biodiversity and plankton biocenoses that are found in bodies of water.

Malsisar Dam (27.88°N, 75.28°E) is a man-made reservoir constructed for irrigation/domestic water supply in the Jhunjhunun District. The dam situated on the outskirts of Malsisar town in Jhunjhunun, nestled in the semi-arid belt of northwestern Rajasthan. The region is characterized by sparse rainfall averaging about 450 mm annually, high evaporation rates, and pronounced temperature fluctuations typical of the Thar Desert climate. The dam was built primarily to provide irrigation water to the surrounding fields and supply drinking water to local villages. Its creation has enabled regular water distribution through the Indira Gandhi Canal network, reaching more than 1,400 villages, including major settlements like Khetri and Jhunjhunun.

OBJECTIVES-

- Characterized seasonal variations in physico-chemical parameters of water.
- Document the composition, density, and diversity of the phytoplanktonic and zooplanktonic community across seasons.
- Correlate plankton population dynamics with water quality variables, highlighting biotic-abiotic interactions.

LIMNOLOGICAL RESEARCH – INTERNATIONAL ASPECT :

The earliest knowledge concerning life in water can be traced back to the times of Aristotle (384-322 B.C.), the founder of biological sciences, who classified animals as water animals and land animals. During early period, attention was focused on the larger aquatic animals, particularly fishes.The study on small organisms in water dates from Leeuwenhoeck's improvement of microscope (1632-1723) who himself discovered rotifers and Protista. Forel's paper of 1869 dealing with the fauna of Le-Le'man (Lake Geneva, Switzerland) sat the stage for his life work. His prolonged study of Swiss lakes reached a peak with the appearance of three successive volumes of his monograph "Le-Le'man" in 1892, 1895 and 1904. Smith in 1874 made dredging operationsjand in Lake Superior and reported the results at length in 1874. He applied many methods and reported among other data, the bathymetrical distribution of the species taken. Weismann began to contribute to limnology in 1877. Anton Fritsch, besides other contributions, established first freshwater biological station called "Portable Laboratory in 1888." It was set upon the shores of three different lakes in the Bohenian Forest. Kofoid's investigations of plankton in the Illinois River were carried on from 1894 to 1899 and published in 1903. During twentieth century much of limnological literature was generated. Gaarder & Gran (1927) first attempted to measure the photoautotrophic production (primary production) in natural bodies of water. This simple method was based on quantitative determination of oxygen produced due to photosynthesis in light-transmitting and darkened bottles. Hynes (1960) dealt with the ecological factors and biological aspects of polluted waters in his book "The Biology of Polluted Waters". From the fifth decade of the last century onwards a number of limnological and hydro-biological periodicals appeared from the USA, Germany, France, Netherlands and other parts of the world.

Sharan, Leena. (2016) Porphyromonas gingivalis, a prominent oral pathogen, produces pathogenic proteins that inflame and infect periodontal tissue. Marine algae are known for their bioactive compounds and oral uses. Red algae are rich in marine bromophenols (MBs), which have several medical uses. MBs' bioactivity against P. gingivalis' pathogenic proteins is the main focus of current study. Ajayan, Anila & Kg, Ajit. (2016) Museum Lake at the Thiruvananthapuram Botanical Garden and Museum was surveyed for pollution. The lake is organically contaminated due to riparian vegetation's organic litter, according to planktonic taxonomic community structures. The most pollution-tolerant phytoplankton genus and species were 30 and 24, respectively. The lake included Chlorophyceae, Bacillariophyceae, Cyanophyceae, and Euglenophyceae that tolerated pollution. Hynes (2020) A book titled "The Biology of Polluted Waters" was published. In this book, the author explored the ecological reasons of polluted rivers as well as the biological features of these rivers.

LIMNOLOGICAL RESEARCH AND DEVELOPMENT – IN INDIA AND RAJASTHAN, SPECIALLY REFERENCE TO **"SHEKHAWATI REGION"**

India, with her unique geological history, highly diverse physiography, monsoon climate with extremes of temporal and spatial variability, and high biotic diversity, is endowed with equally diverse aquatic habitats.

The launch of the International Biological Programme (IBP) in 1964 resulted quickly in a shift of emphasis on the investigations of primary and secondary production. The studies on macrophytes concentrated on the seasonal changes of biomass and considered either the peak biomass or the sum of positive increments in biomass as annual production. Studies on community production and the factors regulating primary production were rare. Secondary production by zooplankton or benthic fauna was rarely investigated. Before the IBP came to close in 1974, the UN conference on Environment and Development in Stockholm, in June 1972, brought to focus the issues of environmental degradation including water pollution. In the same year, UNESCO launched the inter-governmental, Man and Biosphere Programme (MAB). One of the MAB project areas was the impact of human activities on aquatic ecosystems. The Government of India supported many research projects under the MAB programme in different universities.

DESERT LIMNOLOGY:

Rajasthan is the largest state of India, having varied climatic conditions. State divided in to two parts, one is fertile and other is desert. Desert part is also known as "The Great Indian Desert or Thar Desert". Khatri (1980) and Saxena (1982) studied temporal and spatial patterns of various limnological aspects in two lakes of Pali district namely Lakhotia lake and Sardarsamand lake, respectively. Saxena & Soota (1983) surveyed a number of desert waters, so as to assess their gross primary productivity. Saxena & Baskaran (1985) made observations on diurnal rhythm in physical, chemical and zooplanktonic components in a polluted water tank at Jodhpur. Correlations between phytopigments and certain other factors were established by Saxena & Bhargava (1985). Bhargava & Saxena (1987) made a study on primary productivity and certain correlative factors in an Indian desert reservoir. Jakher & Misra (1985) and Mehrotra (1988) investigated the macrobenthic fauna of Lalsagar reservoir near Jodhpur while Gupta (1989) explored the pollution ecology of a pond in the same region. Sharma & Saxena (1994) compared gross and net primary productivity of two water bodies in the Indian desert.

A large drinking water reservoir at Beechwal village near Bikaner was developed and fed by Kanwarsain lift canal of Indira Gandhi Canal Project in 1994. Sharma & Saxena (1994) made a study on the biotope and community of this newly formed reservoir. Mittal (1996) and Mittal & Saxena (1996) made an intensive study on the periphyton community of a lotic and lentic ecosystem in the Indian desert and compared the two. Dadhich (1996) characterized some desert waters employing bioindicators and trophic state indices. In her experimental work, Chawla (1997) studied the colonization dynamics of periphyton on different artificial substrates. Arora & Saxena (1997) studied the planktonic fauna of a desert village pond and established statistical correlations among planktonic population and a number of abiotic factors. Saxena (1998) reviewed

the faunal diversity in the waters of the Indian desert and emphasized upon need for its conservations. Saxena & Chhabra (1998) made a chemical surveillance and Chhabra & Saxena (2003) studied the coliform contamination of drinking water supply in desert city Bikaner. Dadhich & Saxena (1999 a, b) studied the trophic status of desert waters employing different indices. Modi & Saxena (2001) reviewed the planktonic productivity in the water sheets of the Indian desert while Saxena & Chadha (2002) applied Pearsall's cationic ratio as an index of trophy in these waters. Babar (2002) studied the biodiversity and ecology of a man made lotic water ecosystem in the Indian desert. Saigal & Saxena (2003) assessed some hydrophytes in desalination of desert waters.

Rathore (2003) studied the detailed bioecology of banded pond snail Bellamya bengalensis. Besides this, Rathore et al., (2004) also studied the interspecific relationship of this snail in some desert waters. Songara (2004) made a study on phytoplanktonic productivity in relation to various controlling factors in a desert pond. Khatri & Saxena (2005, 2007) studied the bioecology of drying sediments of an ephemeral pond in the Indian desert Srivastava & Saxena (2007) investigated the arthropod fauna and its ecology in the sediments of some desert ponds while Singh et al (2007) and Rathore et al., (2007) studied ecological aspects of some gastropod fauna in the same area. Lubana et al., (2007) studied the transformation in planktonic diversity and nutrient regime in a reservoir in Rajasthan desert over a decade. Srivastava & Saxena (2007a, b) investigated the faunal diversity of some village pond ecosystems in the Indian desert. Saxena (2008 e) reviewed the bioindicators of water quality and Saxena (2008 b) prepared a checklist of common aquatic invertebrates of Rajasthan. Srivastava & Saxena (2008) investigated the diversity and population turnover of faunal component in some wetlands in the Indian desert. They also emphasized the threats and conservation needs. Saxena (2008 c) studied the monoculture of Daphnia in sewage oxidation ponds and Saxena (2008 d) reviewed the bioindicators of water chemistry. Saxena (2008 a) presented an exhaustive and illustrated account of the protozoan diversity of the wetlands of the Indian desert. Lately, Barupal (2009) made an algological study on a lake in the arid region of Rajasthan. Sambhar and Didwana are the two salt lakes in the region which too have been limnologically explored. Baid in as early as 1958 investigated the fauna of the Sambhar Lake and reported the presence of noted brine shrimp Artemia salina in it.

PLANKTONOLOGY:

Phytoplankton is the most important producer of organic substances and the energy stored up by these tiny organisms determine the primary productivity of the aquatic ecosystem. Phytoplankton are the bottom rung of the food chain in any aquatic system.

MuUer (1870) was perhaps the first worker to have studies the pelagic planktonic communities in Swiss Lake. Plankton has become the subject of interest in limnological research particularly during this century. Sharan (2006) studied a planktonological study of a desert pond in relation to ionic parameters of medium. Srivastava (2009) observed faunal diversity and its ecology in some village pond ecosystems, with special reference to insect fauna, in the Indian Desert. Bugalia (2010) studied faunal diversity and ecology of Kot bandh (Dam) in Northern Aravalli Range. Singh (2011) studied the aquatic insects in a village pond ecosystem. Saxena (2011) investigated the biodiversity and ecology of some eutrophic temple tanks in the Indian desert with special reference to bioindicators Zooplankton communities have been investigated in numerous reservoirs, lakes and shallow water bodies (Sharma and Pant 1984). Lata (2009), Sharma (2009), Arora (2009) and Sharma (2009) investigated phytoplankton, zooplanktonic community, productivity and benthic fauna of some water bodies of desert region. Lata et al. (2012) investigated the zooplanktonic diversity in two desert water sheets. While Sharma et al. (2013) studied the planktonic community structure of desert village pond.

Dr. Brijmohan singh (2015) studied on Pond, Temporal Variation in Physico-Chemical and Phytoplankton Analysis of Madhav Sagar Sikar (Rajasthan) and he found that maximum number of physical and chemical parameter were beyond the desirable limit for drinking water, as suggested by WHO. Kavindra J, SK Sharma,

BK Sharma and ML Ojha (2019) studied on Physico-chemical properties and primary productivity of Jawai dam, Pali, Rajasthan and he found that on the basis of water quality parameters and observations on productivity, it is appropriate to place this water body somewhere between “low to medium productive water”. Subramanian, (2018) The Ganga and Brahmpautra rivers, both of which have their origins in the Himalayas, are the ones that are responsible for transporting a significant amount of sediments on an annual basis (Millimann & Mead, 2021). Maheshwari al. (2020) conducted research on the seasonal shifts that occur in the phytoplankton population of Lake Ramgarh. They used Karl Pearson's formula to determine the association between the different physico-chemical parameters, productivity, and plankton groups. Dixet et al. (2020) conducted an investigation of the physicochemical characteristics of a number of ponds located in the Biaspur area of Chhattisgarh, India. Sharan (2021) A planktonological examination was carried out in order to evaluate the ionic regime of the medium. The inquiry was carried out using a desert pond as a case study. Srivastava (2019) conducted research in the Indian Desert to explore the abundance of flora and fauna as well as the ecology of the diverse village pond habitats of the region. It was the insect fauna that was present in these habitats that he focused his attention on in particular. Zafar (2021) The findings of their research indicate that the dominating phytoplanktonic groups and the seasonality of these groups are very varied in various bodies of water. Praveen (2022) At the surface of the water in ponds, lakes, streams, rivers, estuaries, and seas, plankton may be seen drifting or swimming in a feeble manner. Over the last several years, plankton has been used as a bio indicator for the purpose of monitoring aquatic ecosystems and the integrity of water. The major producer community is called phytoplankton, and it is mostly made up of algae, including dinoflagellates, diatoms, and a wide range of forms that come from different divisions of the plant world. Mishra et al. (2022) An investigation on phytoplankton, primary productivity, and certain physicochemical characteristics was carried out at the Goverdhansagar lake located in Udaipur.

Sampaio et al. (2022) Using seven reservoirs from the Paranapanema River in Brazil, evaluated the relationship between the trophic status of the reservoir and the diversity of zooplankton groups that were present in each reservoir. Sukumaran and Das (2022) conducted an investigation on the connection that exists between the physicochemical properties of the Mancharibele reservoir, which is located close to Bangalore in India, and the amount of plankton that is present in the reservoir. Dube (2022) I have documented the physicochemical characteristics of a number of ponds and temporary water bodies that are located in the southeastern plateau of Rajasthan, namely in the districts of Kota, Bundi, Baran, and Jhalawar. Kumar and Sahu (2022) The ecological investigation of the sewage pond that H. lives in. "E. C." Researchers have conducted research on the industrial region of Ranchi. There were investigations carried out in order to ascertain the presence of cynobacteria and the quantity of them in relation to the physical and chemical features of the sewage pond. Veronica and her colleagues (2023) conducted research to investigate the impact of water quality on the number of phytoplankton in the Hampalam River and the fish Pond located in Batanjung hamlet. There were sixty different genera of phytoplankton discovered in the River Hampalam, with the maximum abundance of Pleurosigma belonging to the Chrysophyra phylum in the river and Euglena species belonging to the Euglenophyta phylum in the pond. Kemah et al. (2023) conducted a study on the physicochemical characterization of a fish pond located in Bayelsa state, Nigeria. Nag and Gupta (2014) conducted a study on the physico-chemical examination of a pond located in and near Santineketan. The results showed that the values for NH·-N were higher than the predicted values for fish culture. Other parameters, on the other hand, favored healthy fish production. Banerjee et al. (2023) conducted an investigation of the zooplankton abundance in ponds that were subjected to a variety of fish farming systems. Copepoda, Rotifera, Cladocera, and Diatoms were the four orders that were recognized as belonging to the zooplankton that were found. In this group of four orders, the Copepoda and Cladocera orders were the most prominent, with cyclops species and daphnia species, respectively, serving as primary representatives.

Mishra et al. (2023) conduct an analysis of the physicochemical characteristics of a pond located in Varanasi, India, after considering the effects of human activities. Ansari and Khan (2023) to investigate the diversity and distribution of zooplankton in the freshwater bodies of the Aligarh area. Cladocera, Rotifera, Copepoda, and Ostracoda were the types of zooplankton that were seen throughout the course of the investigation. There is a negative link between zooplankton and water and temperature, but there is a positive correlation between zooplankton and pH and dissolved oxygen. Selvamohan and colleagues (2023), conducted an analysis of the physicochemical characteristics of four ponds located in the Tirunelveli district. Aspects such as appearance, color, turbidity, total dissolved solids, total hardness, iron, fluoride, sulfate, phosphate, pH, electrical conductivity, nitrate, calcium, chloride, magnesium, and potassium were among the parameters that were examined. Moundotiya et al. (2023) In the Jamwaramgarh wetland in Jaipur, conducted research on the physical and chemical characteristics of water as well as the environment in which it was found. Conditions like as temperature, pH, and EC, as well as TDS, DO, alkalinity, hardness, and chloride ion, are among the constituents that are measured. Goldman (2023) There is a possibility that nutrients may exert a significant amount of control on the pace of primary production in aquatic ecosystems. Skulberg et al. (2023) There are a number of further ramifications that are brought about by the over enrichment of lakes and reservoirs with nutrients. These repercussions include the biology, chemistry, and human use of these bodies of water. Kiradoo and Saxena (2023)) researched the colonization dynamics of natural and artificial substrates in a pond situated in the Indian desert. Srivastava and Saxena (2014) investigated aquatic insects in the desert waters of Bikaner. Saxena and Kiradoo (2015) also investigated the colonization dynamics of other substrates. A publication of their results was made available in the journal Scientific Reports. Saxena and Chhabra (2014) conducted a study to determine the extent to which water-borne infections are prevalent in the municipality of Bikaner, which is located in the desert.

Jakher and Misra (2023) At the Lalsagar reservoir, which is situated in close proximity to Jodhpur, researchers Mehrotra (2018) investigated the macrobenthic fauna that the reservoir contains. While this was going on, Gupta (2019) conducted research on the pollution ecology of a pond that was situated in the same physical area. Dr. Brijmohan Singh (2023) According to the findings of a research that was carried out on Pond, Temporal Variation in Physico-Chemical and Phytoplankton Analysis of Madhav Sagar Sikar (Rajasthan), the largest number of physical and chemical parameters above the level that is considered to be acceptable for drinking water. According to the recommendations that were issued by the World Health Organization (2011)50 and the Bureau of Indian Standards (2011)21, this conclusion was in agreement with those recommendations. Sharma and Durve (2023) In addition, it is believed that River Gagger is a remnant of the river Saraswati, which was originally known as Saraswati. The rivers that originally flowed through this state, which is the largest in India, have now dried up, leaving behind enormous sheets of subterranean water that are still accessible for extraction. There is a total fresh water potential in the state of Rajasthan that is comparable to 3.3 lac hectares, which is equivalent to one percent of the total water resources in the country. The water in Rajasthan has been quite abundant for a considerable amount of time, and the state of Rajasthan is home to some of the lakes that are recognized as being among the most productive in all of India. Verma and Khan (2023) An investigation on the relationship between the phytoplankton diversity and the primary productivity of Lake Udai sagar near Udaipur was carried out by Kumar et al. (2015). In terms of surface area, the mean primary productivity (GPP) was estimated to be 0.50 grams per cubic meter per hour. conducted an analysis of the physicochemical properties of Fateh sagar talab, which is located in Bagar, which is located in the Jhunjhunun district of Rajasthan country. Bhati (2024) Zooplankton are an essential component of the food chain, acting as both primary and secondary consumers. They also provide fish with food, either directly or indirectly. As a result, any negative impact on zooplankton will be reflected in the abundance of fish populations. Within the food chain, zooplankton plays a significant role by connecting the primary producers at higher trophic levels.

Johnson (2024) Therefore, nitrogen sources, such as nitrate and ammonia, have the potential to alter the dynamics of phytoplankton abundance and biomass buildup in the northern region of Patagonia. Rana (2023) When it comes to the community of plankton, zooplankton has a higher trophic level than other plankton and plays a key influence in the overall productivity of freshwater ecosystems' productivity. Kumar J., Sharan L., et.al (2025) Investigated microalgae and zooplankton in Malsisar Dam, Rajasthan. Identified 100 phytoplankton species and 39 zooplankton species. Analyzed seasonal variations in species composition, abundance, and physicochemical parameters. Kumar J., Sharan L., et.al (2025) Investigated zooplankton diversity in Malsisar Dam, Jhunjhunu, Rajasthan. 39 zooplankton species identified, belonging to 4 major groups: Rotifera, Protozoa, Arthropoda, and Annelida. Arthropoda dominated the community (55% of total abundance). Singh L., et.al. (2025) Plankton plays a vital role in aquatic ecosystems as primary producers and water quality indicators. Research highlights the impact of physicochemical parameters (pH, nutrient levels) on plankton diversity, with specific species acting as pollution indicators. Seasonal variations influence plankton populations, with higher diversity in less disturbed areas. This study emphasizes plankton's role in assessing and maintaining water quality in freshwater systems.

Discussion :

The physico-chemical and planktonic investigation of Malsisar Dam reveals a dynamic freshwater ecosystem influenced by the semi-arid conditions of Jhunjhunun District, Rajasthan. The study recorded seasonal variations in parameters such as temperature, pH (alkaline range), dissolved oxygen, and nutrient concentrations, shaping the aquatic environment. The study emphasizes the importance of continuous monitoring of both physicochemical parameters and plankton communities to detect early signs of eutrophication, pollution, or ecological imbalance. Understanding these dynamics supports effective management and conservation strategies crucial for sustaining freshwater biodiversity and ensuring water quality in this critical regional water resource.

Overall, Malsisar Dam serves as a vital case study illustrating how physico-chemical environments and biological communities interact in desert reservoirs, providing knowledge essential for sustainable water management in arid regions like Rajasthan.

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