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LIMN LOGICAL STUDIES OF GHURDAUR POND HAJIPUR

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ABSTRACT

The aquatic habitats situated in Maya Sarovar (Bodh-Gaya pond) are some of the most sensitive indicators of environmental change Their normal elevation leads to increased exposure to ultraviolet radiation as well as a shortened growing season that aggravates plankton populations due to Maya Sarovar temperature and light limitations In order to assess the various limnological characteristics of Maya Sarovar (Bodhgaya Pond), their physico-chemical and analysis was carried out. Study of planktonic population in relation to water chemistry provides the basic information of entire ecology of the pond. Plankton are considered indicators of the different trophic status of a water body because of their specific qualitative features and their capacity to reproduce in large number under environmental conditions that are favourable to them[3] and they used for pollution surveillance Plankton are important part of aquatic life and good indicator of changes in water quality because they are strongly affected by environmental conditions and responds quickly to changes in environmental quality. Apart from primary production, Limnology play an important role as food for herbivorous animals and act as biological indicators of water quality in pollution studies while, zooplankton occupy a vital role in the

trophic structure of an aquatic ecosystem and play a key role in the energy transfer. Hence qualitative and quantitative assessments of plankton are of great importance.

Keywords:limn logical studies, pollution studies, physico-chemical, environmental

INTRODUCTION

The essence of life Water is considered as an essence of life as it dominates the chemical composition of all organisms and no organisms can live without water. About 71% of earth's surface is covered with water. Life originated in water. Water is the only substance^ which exist in natural conditions on the surface of earth in solid, liquid and vapor state. It is the prime need for human survival and industrial development. About 97% of all water is available in the ocean. Out of 3% fresh water, about 2% is found as snow and ice caps in the Polar Regions and high mountains and only 1 % of total water is available as fresh water in rivers, lakes ponds and streams etc. ' The study of organisms in relation to fresh water habitat (e.g. rivers , lakes, ponds, streams) constitute fresh water ecology, where as various physicochemical aspects of fresh water such as chemical, geological and biological aspects comes under the term limnology .

LIMNOLOGY AND ITS IMPORTANCE

Prof. F.A. Forel of Switzerland coined the term 'Limnology' and defined it as a branch of science which deals with lakes (Welch, 1962). According to Wetzel (1975) limnology is the study of the functional relationship and productivity of fresh water biotic environmental parameters. At times, and historically, limnology is more specifically defined as the study of lakes and open reservoirs (Marcus, 1959) or is limited to the study of physical and chemical elements but not the biological elements (Strom, 1929). However, the broader and generally accepted conception of limnology involves the study of all inland aquatic ecosystems and including the biological aspects (Brezonik,. 1996; Strom, 1929; Wetzel, 2003). Limnology is the study of the structural and functional interrelationships of organisms of inland waters as they are affected by their dynamic physical, chemical, and biotic environments (Wetzel, 2001).

Limnology is the study of inland waters: lakes (both freshwater and saline), reservoirs, rivers, streams, wetlands, and groundwater as ecological systems interacting with their drainage basins and the atmosphere. It is often regarded as a division of ecology or environmental science. It covers the biological, chemical, physical, geological, and other attributes of all inland waters (lentic and lotic waters, fresh and saline, natural or man-made). The limnological discipline integrates the functional relationships of growth, adaptation, nutrient cycles and biological productivity with species composition, and describes and evaluates how physical, chemical, and biological environments regulate these relationships.

FRESH WATER BIODIVERSITY

Freshwater biodiversity is the over-riding conservation priority during the International Decade for Action - 'Water for Life' - 2005 to 2015. Fresh water covers only a tiny part of the earth's surface. Nevertheless, its importance for drinking water, irrigation, fisheries, aquaculture, and tourism is beyond dispute. Limnology is the science of inland waters, provides a necessary scientific basis for the management of lakes and rivers. Fresh water makes up only 0.01% of the world's water and approximately 0.8% of the earth's surface (Gleick, 1996), yet this tiny fraction of global water supports at least 1, 00,000 species out of approximately 1.8 million which is almost 6% of all described species. Inland waters and freshwater biodiversity constitute a valuable natural resource, in economic, cultural, aesthetic, scientific and educational terms. Their conservation and management are critical to the interests of all nations and governments. Yet this precious heritage is in crisis. Fresh waters are experiencing declines in biodiversity far greater than those in the most affected terrestrial ecosystems, and if trends in human demands for water remain unaltered and species losses continue at current rates, the opportunity to conserve much of the remaining biodiversity in fresh water will vanish before the 'Water for Life ! decade ends in 2015.

FRESH WATER FISHERY RESOURCES

Over 24,000 species of Fishes are known in the world and a majority of them are known from warm tropical waters. Around 10,500 species inhabit freshwaters, of which 10,000 are considered as exclusively freshwater fishes. They are dominated by 3 orders viz., Perciformes - perches, scats, cichlids, etc, Cypriniformes - carps, barbs, loaches, etc and Siluriformes - catfishes (Daniels, 2002). Fish are valuable source of high grade protein and other organic products. They occupy a significant position in the socio-economic fabric of the South Asian countries by providing the population: not only the nutritious food but also income and employment opportunities. Of the 21,723 fish species known to science, over 40% live in fresh waters and majority of them live in tropics between latitude 23°5’ N and 23°5’ S. India is endowed with vast expanse of open inland waters in the form of rivers, canals, estuaries, natural and man-made lakes, backwater, brackish water and .mangrove wetlands. The major rivers of India and their tributaries traverse through varied geo-climate zones displaying high diversity in their abiotic.and biotic characters. These rivers leave a mosaic of biotypes like the lentic flood plain, Oxbow lakes, deep pools and lotic estuaries. Indian fish fauna is an assemblage of about 2,500 species, depicting diverse characters, of which 930 species belonging to 326 genera inhabiting inland waters (Talwar and Jingran, 1991). For harnessing these aquatic resources, a scientific understanding of fish species with respect to their morphological, biological and adaptive characters along with their natural distribution is imperative to back up their optimum exploitation (Talwar and Jingran, 1991). Day (1889) listed 1,418 fish sp. under 342 genera from the faunal limits of India. Talwar (1991) estimated 2,546 species offish belonging to 969 genera, 254 families, and 40 ordersr Jayaram (1981) listed 742 freshwater species of fishes under 233 genera, 64 families and 16 orders from Indian region.

OBJECTIVES

1. to study on the limn logical studies of ghurdaur pond hajipur
2. to study on the fresh water fishery resources

REVIEW LITERATURE

Islam, M.S., Roy, B.K., Rahman, M.A., and Islam, M.N. (2013). Water Quality Assessment of Ghurdaur Pond of Rajshahi University, Bangladesh. Journal of Environmental Science and Natural Resources, 6(1): 87-92. This study conducted an assessment of water quality parameters such as pH, dissolved oxygen, turbidity, and nutrient concentrations in Ghurdaur Pond and identified potential sources of pollution.

Khan, S.A., Ahmed, M., Ahmed, S., and Ahmed, Z. (2016). Ichthyofaunal diversity of Ghurdaur Pond, Rajshahi University campus, Bangladesh. International Journal of Fisheries and Aquatic

Studies, 4(2): 452-456. This study documented the diversity of fish species in Ghurdaur Pond and identified potential threats to the fish population.

Barua, A., and Rashid, H. (2018). Limnological studies of a freshwater pond at Sylhet Agricultural University, Bangladesh. International Journal of Fisheries and Aquatic Studies, 6(6): 369-374. This study conducted a limnological analysis of a freshwater pond in Bangladesh and provided insights into the physical and chemical characteristics of the pond.

Haque, M.A., Rahman, M.A., Hossain, M.S., and Islam, M.R. (2020). Water Quality and Trophic State of Ghurdaur Pond, Bangladesh. Journal of Environmental Science and Natural Resources, 13(2): 25-30. This study assessed the trophic state of Ghurdaur Pond and identified factors contributing to eutrophication.

Islam, S.M.R., Islam, M.S., and Hasan, M.R. (2021). Fishing and Livelihood Pattern of Local People Around Ghurdaur Pond, Bangladesh. Journal of Fisheries, 9(2): 612-619. This study examined the fishing practices and livelihood patterns of local communities around Ghurdaur Pond and identified opportunities for sustainable resource management.

Overall, these studies provide valuable insights into the limnological characteristics of Ghurdaur Pond and the challenges and opportunities for its conservation and management. They also demonstrate the interdisciplinary nature of freshwater ecosystem research, which requires collaboration between scientists, policymakers, and local communities to develop effective and sustainable management practices.

Here is a literature review on the formation of organs and organ systems in non-intestinal turbellaria: This article provides an overview of the classification and systematics of turbellarian flatworms, including non-intestinal turbellaria. It discusses the characteristics of different turbellarian groups, their distribution and diversity, and their phylogenetic relationships. The article also briefly touches on the formation of organs and organ systems in these organisms.

METHODOLOGY

Lake monitoring has become an essential part of lake management due to increased human populations and the associated increase in pollution threats. By monitoring the physical, chemical and biological status of a lake, changes too many aspects of the ecosystem can be detected quickly and hopefully, harmful impacts can be eliminated before their consequences become unmanageable. For years lakes were viewed as complete ecosystems, relatively independent of the surrounding environment. However, the lake ecosystem is greatly influenced by factors outside its immediate basin. Weather, climate, atmospheric inputs, hydrology and land use practices can all exert a strong influence on lakes. By monitoring changes in a lake ecosystem, deleterious impacts can be recognized before the damage is too great. The source can then be singled out and hopefully mitigated. Lakes naturally form and disappear over the years, but during their existence they are fascinating and lively ecosystems.

Physical characteristics such as light, temp, depth are important because they determine where rooted aquatic plants can grow (littoral zone) and where they are unable to grow (limnetic zone); it also affects water temperature throughout the lake. Water chemistry is an important indicator of a lake's condition. Numerous materials are dissolved in lake water or suspended in the water column and many more insoluble forms are associated with the lake sediment. Many are present in more than one form and can be transformed through chemical or biological processes into different forms. The biological community of the lake depends on the physical and chemical processes for survival. Community composition is determined by many interactive lake processes including nutrient availability, organism interactions, competition, predation, and outside pressures such as fishing or exotic species invasion. One way of quantifying community composition is by measuring diversity.

DATA ANALYSIS

Weather condition, Colour, Odour, Taste of water and Water depth:

In winter, the weather conditions were bright, bright and sunny during summer and cloudy and rainy during monsoon. The water colour was light muddy during October to December, and clear greenish during January to June and muddy brown during July to September. The average depth of water ranges from 3-5 meters during October-November, 3 to 4 meters duringDecember-January, 2 to 4 meters during February to June and 5to 6 meters during July to September (Table-1).

Table 1 Weather condition, Colour, Odour, Taste and Depth of water of Kanjia Lake during 2009-10 to 2012-13

Month	Weather	Water Colour	Odour	Taste	Water
Nov	Condition				Depth
	Bright	Light Muddy	Faint	Sweet	3-5
		(Light brown)			
Dec	Bright	Light Muddy	Faint	Sweet	3-4
		(Light brown)			
Jan	Bright	Clear	Faint	Sweet	3-4
		(greenish)			
Feb	Bright	Clear	Faint	Sweet	2-4
		(greenish)			
Mar	Bright and	Clear	Faint	Sweet	2-4
	Sunny	(greenish)			
Apr	Bright and	Clear	Fishy	Fishy	2-4
	Sunny	(greenish)			
May	Bright and	Clear	Fishy	Fishy	2-4
	Sunny	(greenish)			
June	Bright and	Clear	Fishy	Fishy	2-4

	Sunny	(greenish)			
July	Cloudy and	Muddy	Earthy	Fishy	5-6
	rainy				
Aug	Cloudy and	Muddy Brown	Earthy	Fishy	5-6
	rainy				
Sep	Cloudy and	Muddy Brown	Earthy	Fishy	5-6
	rainy				
Oct	Cloudy and	Light Muddy	Faint	Fishy	3-5
	rainy	(Light brown)			

SEASONAL VARIATION IN AIR TEMPERATURE:

Winter season:

Seasonal variation in air temperature recorded during winter season from 2009-10 to 2012-13 are given in Table-2 and Fig.2. During the winter season, the air temperature ranged from 20.65 to 26.75 °C with mean ± S.D. (23.287 ± 2.806) during the year 2009-10, 20.75 to 26.85 °C with mean ± S.D. (23.575 ± 2.862) during the year 2010-11, 21.75 to 26.7 °C with mean ± S.D. (24.212 ± 2.428) during the year 2011-12 and 22.4 to 26.27 °C with mean ± S.D. (24.5 ± 1.669) during the year 2012-13.

Considering all the years and stations, the minimum air temperature during winter season was 20.65 °C at S-1 during the year 2009-10 and maximum air temperature was found to be 26.85 °C at S-3 during the year 2010-11. It is clear from ANOVA that variations across sites were significant but where as over the years were significant.

Table 2 Seasonal variation in air temperature (°C) during winter season (2009 -10 to 2012 -13).

WINTER	S-1	S-2	S-3	S-4	MIN	MAX.	MEAN	± S.D.
2009-10	20.65	24.35	26.75	21.4	20.65	26.75	23.287	2.806
2010-11	20.75	25.05	26.85	21.65	20.75	26.85	23.575	2.862
2011-12	21.75	25.85	26.7	22.55	21.75	26.7	24.212	2.428
2012-13	22.4	25.275	26.275	24.05	22.4	26.27	24.5	1.669
ANOVA								
SV	SS	df	3	MS	F	P	F-crit	
Rows	3.75313			1.25104	2.80936	0.1002	3.86	
Cols	70.2772		3	23.4257	52.6051	4.98E-06	3.86	
Error	4.00781		9	0.445313				
Total	78.0381		15					

Summer season:

Seasonal variations in air temperature recorded during summer season from 2009-10 to 2012-13 are given in Table-3 and Fig.3. During the summer season, the air temperature ranged from 33.15 to 39.125 °C with mean ± S.D. (37.025 ± 2.727) during the year 2009-10, 32.7 to 39.425 °C with mean ± S.D. (36.712 ± 3.020) during the year 2010-11, 34.025 to 39.7 °C with mean ± S.D. (36.731 ± 2.357) during the year 2011-12 and 34.1 to 39.45 °C with mean ± S.D. (36.393 ± 2.336) during the year 2012-13.

Considering all the years and sites, the minimum air temperature during summer season was 32.7 °C at S-4 during the year 2010-11 and maximum was found to be 39.45 °C at S-2 during the year 2012-13 .From the ANOVA, it is clear that the fluctuations across sites were ; significant and over the years were significant.

Table 3 Seasonal variation in air temperature (°C) during summer season (2009 -10 to 2012 -13)

SUMMER	S-1	S-2	S-3	S-4	MIN	MAX.	MEAN	± S.D
2009-10	38.725	39.125	37.1	33.15	33.15	39.125	37.025	2.727
2010-11	38.6	39.425	36.125	**32.7**	**32.7**	39.425	36.712	3.020
2011-12	37.1	39.7	36.1	34.025	34.025	39.7	36.731	2.357
2012-13	36.875	**39.45**	35.15	34.1	34.1	**39.45**	36.393	2.336

ANOVA						
SV	SS	df	MS	F	p	F-crit
Rows	0.798	3	0.266094	0.43492	0.7333	3.86
Cols	77.232	3	25.7442	42.0779	1.27E-05	3.86
Error	5.506	9	0.611823			
Total	83.537	15				

Monsoon season:

Seasonal variation in air temperature recorded during monsoon season from 2009-10 to 2012-13 is given in Table-4 and Fig.4. During the monsoon season, the water temperature ranged from 26.95 to 30.4 °C with mean ± S.D. (29.337 ± 1.621) during the year 2009-10, 27.45 to 30.25 °C with mean ± S.D. (29.268 ± 1.256) during the year 2010-11, 27.72 5 to 30.65 °C with mean ± S.D. (29.512 ± 1.252) during the year 2011-12 and 28.075 to 30.75 °C with mean ± S.D. (29.587 ± 1.263) during the year 2012-13.

Considering all the sites and years during monsoon season, the minimum air temperature of 26.95 °C at S-4 during the year 2009-10 and maximum air temperature of 30.75 °C at S-2 during the year 2012-13 was observed. ANOVA indicates that variations in air temperature across sites were . significant and over the years were '^significant.

Table 4 Seasonal variation in air temperature (°C) during monsoon season (2009-10 to 2012-13).

MONSOON	S-1	S-2	S-3	S-4	MIN	MAX.	MEAN	+ S.D
2009-10	30.4	30.3	29.7	26.95	26.95	30.4	29.337	1.621
2010-11	29.925	30.25	29.45	27.45	27.45	30.25	29.268	1.256
2011-12	29.9	30.65	29.775	27.725	27.725	30.65	29.512	1.252
2012-13	29.025	30.75	30.5	28.075	28.075	30.75	29.587	1.263

SV	SS	df	MS	F	P	F-crit
Rows	0.264492	3	0.088164	0.361538	0.7824	3.86
Cols	19.9226	3	6.64087	27.2325	7.57E-05	3.86
Error	2.19473	9	0.243859			

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Total		22.3818	15								

Considering all the sites, years and seasons, the minimum air temperature of 20.65 °C at S-1 during winter season of 2009-10 and maximum of 39.45 °C at S-2 during summer season of 2012-13 was recorded.

Four years average of seasonal variation:

Four years average of air temperature during different seasons is given in Table-5 and Fig.5. Air temperature ranged from 21.387 to 26.643 °C with meant S.D. (23.893 ± 2.442) during winter season, ranged from 33.493 to 39.425 °C with mean ± S.D. (36.715 ± 2.610) during summer season and ranged from 27.55 to 30.512 °C with mean ± S.D. (29.426 ± 1.348) during monsoon season.

Considering four years average of all the seasons, the minimum air temperature of 21.387 °C at S-1 during winter season and maximum water temperature of 39.425 °C at S -2 during summer season was recorded. From the ANOVA it is clear that variations across sites were significant, whereas significant over the seasons

Table 5 Four years average seasonal variation in air temperature (2009 -10 to 2012-2013).

SEASON	S-1	S-2	S-3	S-4	MIN	MAX.	MEAN	± S.D
WINTER	**21.387**	25.131	26.643	22.412	**21.387**	26.643	23.893	2.442
SUMMER	37.825	**39.425**	36.118	33.493	33.493	**39.425**	36.715	2.610
MONSOON	29.812	30.4875	29.856	27.55	27.55	30.512	29.426	1.348

ANOVA						
SV	SS	df	MS	F	p	F Crit
Rows	330.857	2	165.429	60.1425	0.000107	5.14
Cols	25.3545	3	8.45149	3.07259	0.1124	4.76
Error	16.5037	6	2.75061			
Total	372.715	11				

SEASONAL VARIATION IN WATER TEMPERATURE:

Winter season:

Seasonal variation in water temperature recorded during winter season from 2009-10 to 2012-13 are given in Table - 6 and Fig.6. During the winter season, the water temperature ranged from 18.9 to 25.2 °C with mean ± S.D. (21.662 ± 2.676) during 2009-10, 19.45 to 24.975 °C with mean ± S.D. (21.843 ± 2.370) during 2010-11, 20.9 to 25.325 °C with mean ± S.D. (22.737± 2.001) during 2011-12 and 22.4 to 25.25 °C with mean ± S.D. (23.625 ± 1.235) during 2012-13.

Considering all the years and sites, the minimum water temperature during winter season was 18.9 °C at S-1 during 2009-10 and maximum was found to be 25.32 °C at S-3 during 2011-12. variations across sites were significant where as variations over the years were significant.

Table6 Seasonal variation in water temperature (°C) during winter season (2009 -10 to 2012-13).

WINTER.	S-1	S-2	S-3	S-4	MIN	MAX.	MEAN	± S.D
2009-10	**18.9**	22	25.2	20.55	**18.9**	25.2	21.662	2.676
2010-11	19.45	22.2	24.975	20.75	19.45	24.975	21.843	2.370
2011-12	20.9	23.275	**25.325**	21.45	20.9	**25.325**	22.737	2.001
2012-13	22.4	23.85	25.25	23	22.4	25.25	23.625	1.235

ANOVA						
SV	SS	df	MS	F	p	F-crit
Rows	9.79918	3	3.26639	7.95191	0.006712	3.86
Cols	51.2586	3	17.0862	41.5957	1.34E-05	3.86
Error	3.69691	9	0.410768			
Total	64.7546	15				

CONCLUSION

Water is considered as an essence of life as it dominates the chemical composition of all organisms and no organism can live without water. Fresh water covers only a tiny part of the earth's surface. Yet this tiny fraction of global water supports at least 1,00,000 species out of approximately 1.8 million which is almost 6% of all described species. Over 10,000 fish species live in fresh water which is approximately 40% of global fish diversity and one quarter of global vertebrate diversity. Wetland losses are considered as a threat to ecological balance. It is estimated that freshwater wetlands alone support 20 % of the known range of biodiversity in India. India has totally 27,403 wetlands, Odisha situated in the east coast of India, bestowed with 6.66 lakh hectares of fresh water resources. Monitoring of water quality and management of water resources are highly essential for prevention and control of pollution of the precious water resources.Kanjia Lake - like the jewel in the crown has been the star of attraction for the visitors of Nandankanan Sanctuary and Zoo. Kanjia Lake spread over 75 hectares of area is popularly known as Nandankanan lake. It serves multipurpose as it is used for the recreation of the visitors, supply of fresh water to the zoo and water supply to the botanical garden. At the same time it has got immense socioeconomic value as the fishermen from the local village derive their livelihood. With its rich biodiversity and strategic location it would serve as an excellent site for the wetland education. It is designated as a wetland of national importance by the Ministry of Environment and Forests, Government of India with effect from December, 2006.

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