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Comparative Ecology of Some Fish Culture Ponds of district Vaishali, Bihar

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ABSTRACT

Comparative ecology of some fish culture ponds of rural areas of district Vaishali, Bihar was studied during the year 2019 from January to December. For the study Dhobghatti Pond, Panapur Pond, Pahetiya Pond and Baghi Ponds were selected named as Pond I, II, Pond III and Pond IV for analysis purpose. During the study, the physico-chemical parameters included were temperature (Temp.), transparency (t), pH, total alkalinity (TA), dissolved oxygen (DO), Iron (F), Calcium (Ca), Magnesium (Mg), Sulphur (S), Phosphate (P), total organic Nitrogen (TON) and gross and net productivity were analysed and compared with ideal values of various physico-chemical parameters for aquaculture in freshwater (CIFE, Mumbai) and noted that these ponds demand resurrection for profitable aquaculture.

Keywords: *physico-chemical, aquaculture, net productivity.*

INTRODUCTION

Aquatic ecosystems usually contain a wide variety of life forms including bacteria, fungi, and protozoan; buttom-dwelling organisms such as insect larvae, sanils and worms, free-floating microscopic plants and animals known as plankton; large plants such as grasses and reeds; and also fish, amphibians, reptiles, and birds. Viruses are also a significant part of the microbial ecology in natural waters and have recently been shown to play an important role in the nutrient and energy cycles. Plants, animals and microbes interact with each other and their environment bringing about changes in the water quality with the performance of ecological services, such as decomposition and nutrient cycling. The assemblages of these organisms vary from one ecosystem to another because the habitat conditions unique to each type o ecosystem tend to affect species distribution. Freshwater ecosystems like rivers are relatively oxygen- rich and fast flowing compared to lakes. The species adapted to these particular river conditions are present or absent in the still waters of lake and ponds. Organisms capable of adhering to exposed surfaces are found in the upper reaches of streams. Such adhering organisms are termed periphyton includes attached clumped and filamentous green and blue green algae and various sessile nymphs and planarians. Farther downstream floating and emergent vegetation may be found along with sessile invertebrates and those that burrow in the softer substrate, such as clams and burrowing mayfly nymphs. Chemically, the upper reaches of lone environments are rich in oxygen; as the water moves downstream and becomes sluggish, the oxygen level tends to drop. Due to the continual addition of nutrients and detritus en route, nutrient levels tend to be higher downstream.

MATERIALS AND METHODS

The physico-chemical parameters included were temperature (Temp.), transparency (t), pH, total alkalinity (TA), dissolved oxygen (DO), Iron (F), Calcium (Ca), Magnesium (Mg), Sulphur (S), Phosphate (P), total organic Nitrogen (TON) and gross and net productivity (GP and NP respectively). Parameters like Temp, T, TA, Do and pH were analyzed using portable water analyzer (systronics) and Griph meter (Hana, Japan). F, Ca, Mg, S and P were analysed through water testing kit recommended by World Health Organisation (WHO). Geneva, supplied by CPR Environmental Education centre, and animals are also a part of the watershed community and all depend on the watershed and they in turn influence what happens there. Accordingly, what happens in a small watershed also affects the larger watershed. Soil, water and vegetation are the most vital natural resources for the survival of man and animals. To obtain the maximum and optimum production from all the resources, the three resources need to be managed efficiently. They need to be managed effectively, collectively and simultaneously, and all these can be conveniently and efficiently managed in a watershed.

RESULTS AND DISCUSSION

As mentioned earlier, three of these ponds- Pond I-Dhobghatti Pond, Pond II-Panapur Pond, and Pond III-Pahetia Pond, are known to be in practice in fish productivity. Selection of Pond IV-Baghi Pond which annually registers a good yield was made for comparison. The present area of study witnesses almost extreme hot and cold temperature. Flood inundating all the ponds is a recurrent phenomenon. The study period represent summer (May- June). June is the hottest month during which mercury soars up to 42-43°C and monsoon breaks almost in the middle of this month. Pre-monsoon rains are often severe causing first spell of food and its tributaries, the river known for first appearance of fish spawn in the country (Pandey *et al*., 2000). With the onset of monsoon mercury comes down a little (3-8°C) added with interrupted strong wind and relative humidity at its peak (93- 96°C) in later part the night often becomes cold under influence of wind providing wide diurnal variation in climatic factors like temperature.

The physico- chemical properties of water (Table 1) and soil (Table 3) have been presented. The table indicates a poor physico-chemical profile of pond I, II and III in comparison to pond IV. The three ponds are also highly turbid. The poor biochemical profile of the ponds is reflected in total gross and net productivity of these ponds which ranges between 22.4- 30.6 mg/ C/ m3/ hr and 10.6 to 15.2 mg/C/ m3/ hr respectively in comparison to pond IV which reflect improved gross and net productivity. The physico- chemical features of standard productive pond laid out by Central Institute of Fisheries Education (CIFE) Mumbai has also been supplemented (Table 1) for comparison. Among the chemical parameters, iron, sulphate, calcium, magnesium appear to lie within ideal prescribed values but the total phosphate and nitrogen exhibit elevated profile. The granulometric texture of the soil revealed high sand content (Table 3) followed by clay and silt, a feature characterizing sandy loam, which is usually not very conductive for absorption and release of energy.

The biotic status (Table 4) of the ponds indicate phytoplankton enrichment but identification of some of the species (Table 5) reveals gross appearance of an obnoxious algal form that are known to have toxic potentials and do not hold any value in the food chain of aquatic fauna. Fish in particular is a plankton feeder and their survival requires a plankton enriched ecosystem. The per cent abundance of zooplanktons is quite low. The table further indicates a low carp population but high percentage of catfishes and miscellaneous fish fauna.

Table 1
Ideal values of various physico-chemical parameters for aquaculture in freshwater (CIFE, Mumbai)

	Parameters	Freshwater
1.	Colour (Colour units)	Clear water with greenish hue<100
2.	Transparency (cm)	20.35
3.	Clay turbidity (mg/l)	<30
4.	Solids (mgI^{-1}) a) Total b) Suspended	 <50 30 – 200
5.	Temperature (^0C) Tropical climate Temperate climate	 25 – 32 10 – 12
6.	pH	6.7 – 9.5
7.	Hardness (mgl^{-1})	30 – 180
8.	Alkalinity (mgl^{-1})	50 – 300
9.	Chlorides (mgl^{-1})	31 – 50
10.	Salinity (ppt)	<0.5
11.	Dissolved O_2 (mgl^{-1})	5-10
12.	Dissolved free CO_2 (mgl^{-1})	<3
13.	Ammonia nitrogen (mgl^{-1}) a) Unionised (NH_2) b) Ionized (NH_4)	 0.01 0.10
14.	Nitrite nitrogen (mgl^{-1}) (NO_2^{-N})	0.05
15.	Nitrate nitrogen (mgl^{-1}) (NO_2-N)	0.1-3.0
16.	Total Nitrogen (mgl^{-1})	0.05 – 4.5
17.	Total Phosphorus (mgl^{-1})	0.05 – 0.4
18.	Calcium (mgl^{-1})	74-150
19	Magnesium (mgl^{-1})	20 – 200
20.	Sulphate (mgl^{-1})	20 – 200
21.	Silica (mgl^{-1})	4-16
22.	Iron (mgl^{-1})	0.01 – 0.3
23.	Biochemical oxygen Demand (BOD) (mgl^{-1})	<50
24.	Chemical oxygen demand (COD) (mgl^{-1})	<50
25.	Hydrogen sulfide (mgl^{-1})	<0.002
26.	Residual Chloride (mgl^{-1})	<0.003
27.	Primary productivity (mgc/m^2/day)	1000 – 3000

Table 2
Physico-Chemical Profile of the Studied Ponds (Ponds I – IV)

Parameter	Unit	Pond* I	Pond* II	Pond* III	Pond* IV
Temperature	^0C	33.6	34.3	32.9	34.6
pH		9.3	8.9	9.2	7.9
Transparency	cm	98	92	99	62
Total alkalinity	mgl^{-1}	316	203	265	143
Dissolved oxygen	mgl^{-1}	5.6	6.9	5.8	9.5
Redox potential	minhos, cm	475	462	555	336
Iron	mgl^{-1}	0.33	0.33	0.28	0.25
Sulphate	mgl^{-1}	196	165	190	114
Calcium	mgl^{-1}	56	46	63	64
Magnesium	mgl^{-1}	116	112	112	86
Total phosphate	mgl^{-1}	0.49	0.45	0.53	0.22
Total nitrogen	mgl^{-1}	4.25	5.26	5.96	3.20
Gross production	$mgc/m^3/hr$	30.7	28.8	22.5	83.6
Net production	$mgc/m^3/hr$	15.3	14.6	10.5	43.5

* Pond I: Dhobghatti Pond
* Pond II: Panapur Pond
* Pond III: Pahetiya Pond
* Pond IV: Baghi Pond

Table 3
Physico-Chemical profile of bottom soil

Parameter	Unit	Pond* I	Pond* II	Pond* III	Pond* IV
Sand	%	4	74	59	44
Silt	%	8	9	5	4
Clay	%	25	32	22	12
pH	%	8.5	8.6	8.7	7.8
Organic carbon	%	0.40	0.45	0.38	0.36
$CaCO_3$	%	2.27	3.0	3.0	2.05
Phosphate	%	0.6	0.66	0.5	0.3
Redox potential	$Mmhos^{-1}$	465	566	458	362

Pond I, II, III & IV in Table-2

Table 4
Biotic Status of studied ponds (Pond I – IV)

Parameter	Unit	Pond* I	Pond* II	Pond* III	Pond* IV
Phytoplankton	M/I	1122	1210	1153	1710
Zooplankton	M/I	95	115	85	370
Major carps	% abundance	2.5	1.5	1.8	10.0
Minor carps	% abundance	1.6			4.0
Catfishes	% abundance	11.3	8.5	7.0	2.0
Shrimp	% abundance				
Mollusc	% abundance	1.5	1.6	2.0	0.6
Crab	% abundance	0.2	0.3	0.2	0.4
Miscellaneous	% abundance	14	12	16.3	18.0

Table 5
Details of Biotic status of the ponds (Ponds I – IV) (Identification of Species)

Algae	Euglenophyceae	*Euglena spirogyra* *Duglena polymorpha*
	Myxophyceae	*Microcystis acruginosa* *Synechoccus aeruginosa* *Gleotrichia sp.* *Anabaena variabilis* *Aphanizomenon sp.* *Nostoc sp.* *Rivularia sp*
	Chlorophyceae	*Volvox* *Closteriditm sp.* *Caldophora* *Spirogyra* *Zygnema*
	Bacillariophyceae	*Rhizosolena sp*
	Dinophycea	
	Xanthophycea	
	Rhodohyceae	
	Crysophyceae	
Weeds	Submerged	*Ceraphyllum* *Hydrilla verticiulla* *Naja sp.* *Vallisnaria sp.* *Oltelia sp.*
	Emergent	*Nymphea* *Nelumbo nucifera*
	Marginae	*Ipomea* *Polygomum* *Marsilea*
	Floating	*Jussiaea sp.* *Lemna sp.* *Eichomia sp.* *Wolffia* *Salvinia molesta* *Azolla pinnate*
	Marginal weeds (algae)	*Char asp.* *Nitella sp.*
Zooplanktons	Protozoa	*Asplanchna* *Brachionus* *Monostyla*
	Copepoda	*Cyclops* *Diphinosoma*
	Crustacean	*Ceridophina* *Daphnia* *Moina*
	Arthropoda	*Plalycentropus* *Chironomus* *Carika sp.*
	Mollusca	*Pila glabusa* *Prbicular* *Lymnea* *Gyranlus* *Gobula*

	Fish	*Chela inbuca (Chelwa)* *Cotla catla (Katari)* *Cirrhinus mrigala (Naini)* *Puntius ticto (Pothia)* *Chama staitus (Saura)* *Channa punctatus (Garai)* *Heteropneustes fossilis (Singhi)* *Xenentedon cancilla (Kana)* *Glosogobius giuris (Bulla)*
	Amphibia	*Rena timocharii* *Rana tigrina*
	Aves	*Egretta alba modesta (Bagula)* *Ardea punctali monilesis (Khalva)*

The range of the physico-chemical values characterizing the present ponds indicate that the parameters like pH, TA and DO are reasonably dependable tools that may be followed to determine productive status of a particular pond (Yadav and Shashi, 2011; Shweta and Shashi, 2014; Alam and Shashi, 2014 and Khare, 2002) finds agreement with the physico-chemical profile of three poorly productive (I, II, III) and productive (IV) ponds. It has been opined that pH and TA increase with deterioration in water quality while DO inversely deceases (Yadav and Shashi, 2011). Jha (1997) holds that low DO indicates a condition of stress. pH ranging between 7.1 – 8.2 characterises a productive pond while increase in the same value reflects gradual deterioration in water quality (Table 2) from productivity point of view. TA and T also increase with deteriorating water quality. Similar findings have been put forth by Thorat and Musarrat, 2000 in order to characterize productive and unproductive water bodies of Auranagabad. For aquaculture practices, iron, concentration in the range of 0.01 to 0.3 mg/l has been found to be congenial (Table 2) in present ponds concentration of iron ranges between 0.24 – 0.32 mg/l indicating a moderate status. In contrast calcium exhibits rather low and almost a consistent range in all the three ponds. Among inorganic constituent sulphate that is converted into sulphide due to bacterial reduction reflect a moderate range of concentration increasing with deterioration in water quality. Its concentration in present ponds varied between 160-195 mg/l in comparison to productive pond having a concentration of 113 mg/l. Hydrogen sulphide escaping into the air form high sulphide containing water causes odour nuisance in eutrophic ponds. The threshold concentration of H_2S in clean water in between 0.025 and 0.25 $\mu g/l$. Hydrogen sulphide have toxic effects. Average concentration of magnesium in productive ponds has been recorded by Khare, 2002; Shashi, 2015, 2016 and Alam *et al.*, 2006 to be 85 mg/*l* in pond of Darbhanga while the same goes up to 163.5 mg/*l* in eutrophic ponds.

Phosphorus is essential in the growth of organisms and can be the nutrient that limits the primary productivity of a water body, thus is a major nutrient factors stimulating eutrophication of ponds (Ramchandra *et al.*, 2005; Thorat and Musarrat *et al.*, 2000) in natural water the phosphorous occurs solely as phosphates. In instances where phosphate is a growth limiting nutrient, its elevation in water may accelerate the growth of photosynthetic aquatic organism in nuisance quantities. The present ponds contained 48, 46 and 52 mg/*l* in comparison to control having .22 mg/*l* phosphate concentration. If compared with the ideal values (Table 1) the concentration appears to be at upper threshold level. The suggests that levels, though can sustain aquaculture practices but economically viable output requires phosphate in the range of 0.14 – 0.26 mg/*l* as also recorded in present productive pond (0.22

mg/*l*). Elevation in the phosphate concentration beyond 0.30 mg/*l* approximately triggers the process of water deterioration with gradual increase in micro-phostosynthetic community that ultimately becomes a nuisance for economic exploitation of the small water bodies.

Routine household practices like laundering or other cleanings employing surfactants detergents are major source of phosphate over enrichment of the water bodies because different forms of phosphate (orthophosphates, condensed phosphates, polyphosphates and organically bound phosphates) are the chief constituent of many commercial cleaning preparation. Besides orthophosphates applied to agricultural practices as fertilizers are also carried into the surface water with runoff (Walter, 2002; Bharti and Ramanibai, 2002). Nitrogen frequently is considered a growth limiting nutrient (Kaur *et al*., 1996). The present concentration of nitrogen, like phosphate, exhibit an elevated trend approaching upper threshold level 4.5 mg/*l* and often beyond with a corresponding phosphate concentration variable between 0.46 – 0.52 mg/*l*. This creates a major shift in normal N:P ratio. It has been indicated that the nutritional enrichment of water bodies, especially phosphorous components causes significant shift in phytoplankton community leading towards cyanobacteria, in particular the toxic genera. The present documentation of abundance of myxophycease (cyanophyleae) thus finds justification due to elevated P and disturbed N:P ratio. Verma (1998) has already reported three consecutive cases of cyanobacterial blooms in ponds of Darbhanga. The findings indicate onset of the factors leading to eutrophication of these bodies. Toxic algae characteristically form dense algal blooms under favourable circumstances and have been responsible for death of fish, livestock and waterfowl (Pandey *et al.*, 2000). Though, in freshwater certain species of this group fix atmospheric nitrogen to supplement their N requirements *viz*., Anabaena, Nostoc and this hold potential value as biofertilizer (Kapoor and Arora, 2000). But some of this group has gained recognition as a water contaminant having capability to elaborate potential lethal toxins. The group cyanophyceae consisting of 50 genera and 250 species of freshwater blue green algae only six *viz.*, Microcystic, Anabaena, Aphanizomenon, Oscillatoria, Nostoc and Gleotrihia have been considered toxic (Verma, 1998; Yadav and Sashi, 2011; and Alam and Shashi, 2014).

The nutrient sources of the present water bodies include both allocthonus supply of organic matter through catchment runoff and autochthonus sources of macrophytic decomposition besides the diet and decay of aquatic organism. These two sources are highly variable causing fluctuation in nutritional profile of the water ecosystem. In addition, the nutrient cycle is a complex phenomenon involving storage, release and utilization of the nutrients available in water soil and their interphase either in organic or inorganic forms. In deep water bodies as well as those having less macrophytes or accumulation of organic nutrients, an optimum balance in nitrogen and phosphate concentration is maintained creating an ideal environment for utilization of N and P for primary productivity.

CONCLUSION

Thus, the findings clearly suggest that the three ponds which have been investigated on account of their productivity have a physico-chemical profile that is not conducive for intensive aquaculture practices. The soil phase also reflects a heavy nutrient load that does not supported fish culture operation. These ponds demand resurrection for profitable aquaculture. Unfortunately, resurrection through chemical process is a complex phenomenon demanding proper scientific background and rejuvenation of small fresh water bodies through dredging has yet to gain roots among the people concerned.

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