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Natural productivity of fish ponds in relation to physico-chemical parameters at Chilya hatchery Thatta, Sindh, Pakistan

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Abstract

The analysis of physico-chemical and biological parameters of two fish ponds; brooder rearing pond (Pond-I) and fry stocking pond (Pond-II), at Chilya fish hatchery were carried out during January - December 2006. Ranges of temperature of water 14-35.2°C, 14.5-34.7°C; dissolved oxygen 7.69-12.71 mg/l, 7.82-12.3 mg/l; pH 7.2-7.9, 7.87-8.4; total alkalinity 75-142 mg/l, 106-181 mg/l; total hardness 83-120, 102-189 mg/l; total dissolved solids (TDS), 270-348, 226-3920 mg/l; total nitrogen 0.15-0.47, 0.528-1.47 mg/l and orthophosphate 0.12-0.372, 0.74-1.21 mg/l respectively were recorded at the ponds.

Algal flora in Pond-I consisted of 7 species of Cyanophyta, 11 species of Chlorophyta while in Pond-II 12 species of Cyanophyta, 13 species of Chlorophyta and 2 species of Bacillariophyta were found,7 species of aquatic plants, *Hydrilla verticillata*, *Najaz minor*, *Potamogeton pectinatus*, *Nymphia sp*. *Typha domingensis* and *Phragmites vallatorn* were also recorded from pond -II.

Among zooplankton the brooder pond had the population of rotifers (5 species) and micro crustaceans (3 species). In fry pond, 4 species of rotifers and 7 species of micro crustaceans were present.

The results revealed that the water quality variables of Chilya fish hatchery were suitable for fish culture. No known source of pollution enters the ponds. On the northern side there is an outlet channel of Keenjhar lake which supplies water to fish ponds. Rich algal flora and zooplanktons were observed in Pond-II (fry pond). This may be due to the artificial feeding and availability of macrophytes which maintain the water temperature, light penetration, nitrates, phosphates and total dissolved solids (TDS).

Keywords: Limnology of ponds, Chilya fish hatchery, Plankton, Algae.

1. Introduction

Artificial breeding places such as hatcheries incorporate biotic interrelations with socio-economic benefits for human society. The developing countries are facing shortage of protein in diet; therefore much attention is given to aquaculture which provides a cheap source of protein in the shape of fish.

The first fish hatchery in Sindh was established near village Chilya, in district Thatta to cater the requirements of fish seed in lower Sindh. The hatchery is situated on National Highway, 10km from Thatta towards Hyderabad. It spreads over an area of 0.74/s km^2 consisting of 12 circular holding tanks, 45 nurseries, 9 brooder ponds and 20 fry stocking ponds.

This hatchery is a technical unit aimed at production of high quality fish seed and carrying out research activities to boost fish production. Many varieties of fish including indigenous as well as exotic species breed in this hatchery during various periods of the year. The breeding of major carps including *Catla catla*, *Labeo*

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rohita, *Cirrhinus mrigala*, *Ctenopharyngodon idella* and *Hypothalmichthyes molitrix* starts from May and ends in mid August whereas *Cyprinous carpio* breeds during February to March.

The primary productivity of the aquatic habitats depends on the physico-chemical conditions in relation to other environmental factors. Hence, considering the importance of the studies on the limnological aspects, the present study of the two fish ponds was undertaken.

2. Materials and Methods

Samples of water, planktons and macrophytes were collected four times, in January, April, August and December, 2006 from the two ponds, i.e. brooder rearing (pond-I) and fry stocking (pond-II). The area of these earthen ponds was 0. 25 km^2 each and depth of 1.5meter.

Water samples from both the ponds were collected in sterilized plastic bottles for analysis of chemical parameters. The temperature, TDS, pH and dissolved oxygen of water were in site recorded with WTW 320 conductivity meter, Ecoscan pH digital meter, and Oxy. 315i/SET meter respectively. Alkalinity and hardness were determined by titration with standard HCl 0.01N with methyl orange and phenolphthalein as indicators. Total nitrogen Kjeldhal was determined using mercuric oxide red as catalyst. Orthophosphate was evaluated by reducing phosphomolybdic acid (formed with ascorbic acid to molybdenum blue on Hitachi 880 model A. spectrophotometer). All parameters were determined according to the recommended methods of APHA (1992).

Zooplankton samples were collected with the help of plankton net (mesh size 55μ). For quantitative analysis, 50 liter of water sample was filtered in same plankton net from both the ponds and the specimens were preserved in 3-5% formalin solution in. The enumerations of the plankton were done in counting tray under the binocular microscope at x100.

Phytoplankton samples were collected with plankton net (mesh size 30μ) and preserved in 2-4 % formalin solution. For the analysis of seasonal variation of phytoplankton, the samples were centrifuged at 1000rpm for 10-15 minutes. Residues of phytoplankton were counted in Sedgwick Rafter counting chamber by drop method. Macrophytes were collected with hand net and plant-gripner. Identification was confirmed according to Shameel (2001) and Kazmi (2002). In the brooder pond the fish feed exclusively on natural food while in the fry pond artificial feed is provided to the young fish.

3. Results and Discussion

Temperature of the ponds water was found vary to seasonally, minimum (14- 14.5 °C) in the winter month (January) and maximum (34.7-35.2°C) in the summer (August) (Fig.1). The role of temperature in controlling chemical and metabolic reactions is well known as pulses of productivity occur with rise and fall of temperature (Das and Singh, 1992). A slight seasonal variation in temperature was observed in the ponds, but no thermal stratification was observed between surface and bottom.

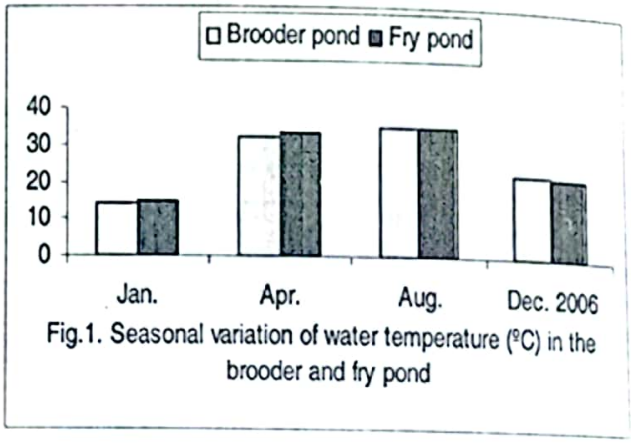

Fig.1. Seasonal variation of water temperature (°C) in the brooder and fry pond

Dissolved oxygen is one of the most important ecological parameters to assess the productivity of an aquatic habitat. Its fluctuation depends upon the temperature and algal population. It was low (7.69-7.82 mg/l) in summer and high (12.3-12.71mg/l) in winter during the abundant both phyto and zooplankton population **(Fig.2).** The dissolved oxygen contents were even higher than 5mg/l in both ponds due to the high photosynthetic activity and air currents.

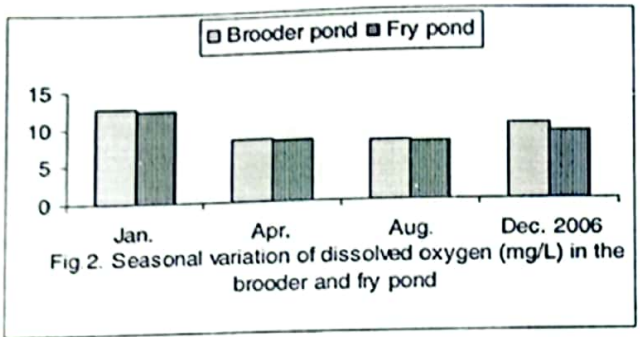

Fig 2. Seasonal variation of dissolved oxygen (mg/L) in the brooder and fry pond

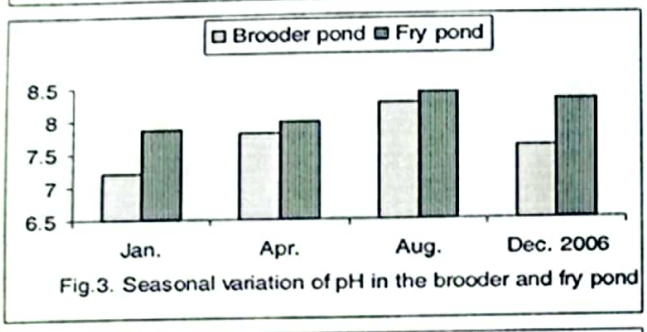

Fig.3. Seasonal variation of pH in the brooder and fry pond

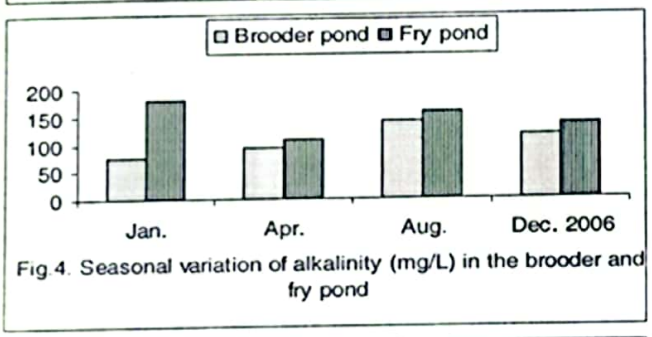

Fig.4. Seasonal variation of alkalinity (mg/L) in the brooder and fry pond

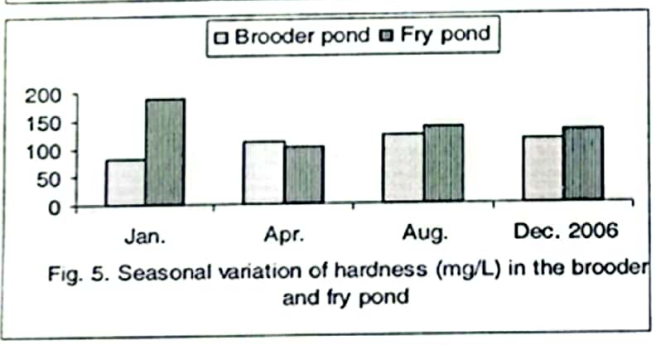

Fig. 5. Seasonal variation of hardness (mg/L) in the brooder and fry pond

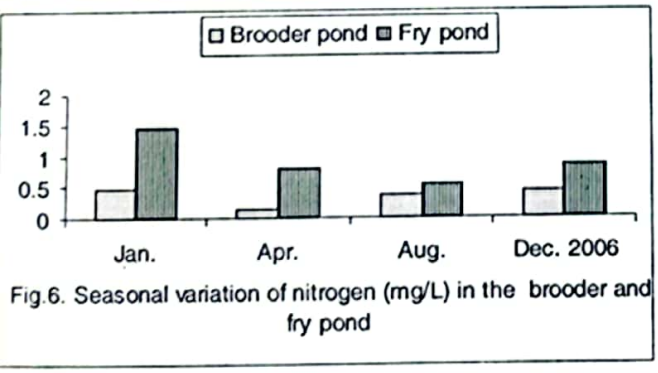

Fig.6. Seasonal variation of nitrogen (mg/L) in the brooder and fry pond

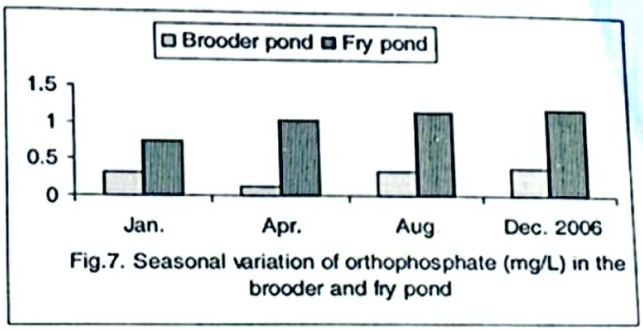

Fig.7. Seasonal variation of orthophosphate (mg/L) in the brooder and fry pond

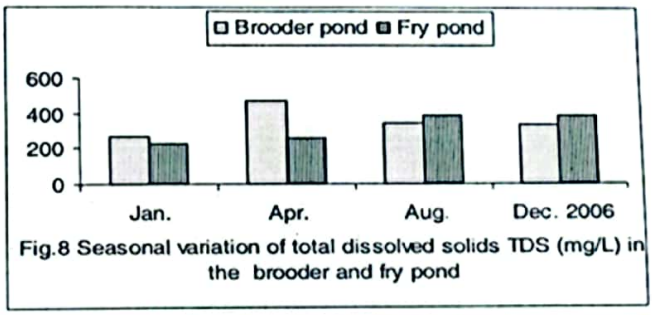

Fig.8 Seasonal variation of total dissolved solids TDS (mg/L) in the brooder and fry pond

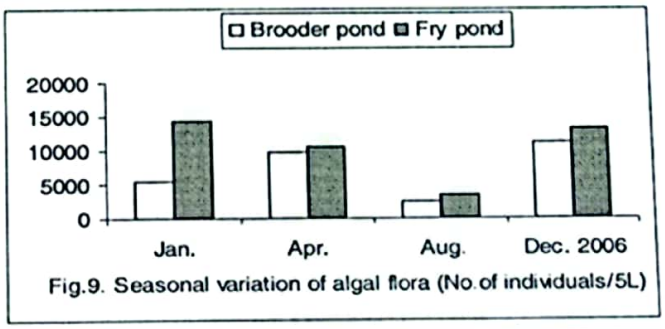

Fig.9. Seasonal variation of algal flora (No.of individuals/5L)

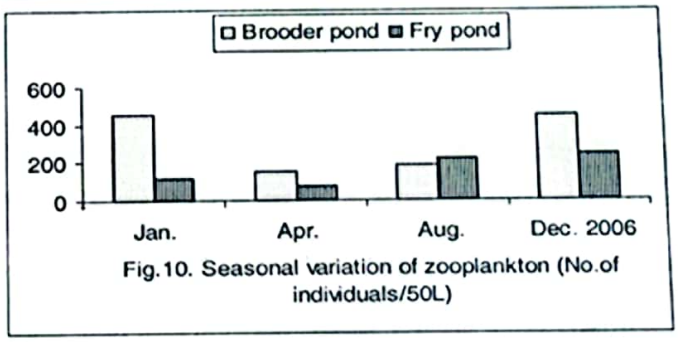

Fig.10. Seasonal variation of zooplankton (No.of individuals/50L)

The high pH ranges (7.87 to 7.9) in ponds were observed in August due to high rate of photosynthetic activities by aquatic macrophytes and rich algal and phytoplankton population, on other hand the low pH values in January and April may be attributed to low photosynthetic activity. Total alkalinity (106-181 mg/l) and total hardness (102-189 mg/l) in pond-II were higher due to the photosynthesize process. Clarke (1954) stated that more carbonate is formed when free CO_2 is drawn up from the water by photosynthesis.

High values of total dissolved solids (TDS) were 473 mg/l in April pond-I conceivably due to the application of supplementary feeding to fish.

A positive co-relationship between phytoplankton population and nutrients (total nitrogen 0.15-0.47 & 0.528-1.47 mg/l, and orthophosphate 0.12-0.372 & 0.74-1.21 mg/l) was observed in the ponds.

Seasonal density fluctuation of 18 algal species including 7 species of Cyanophyta, 7 Chlorophyta, 3 of Euglenophyta and 1 belonging to Charophyta in brooder pond is given in **Table-1**. Cyclic variation in phytoplankton population was strongly effected by seasonal and ecological influences. In tropical regions dry and rainy climate showed distinct variations (Harris, 1986).*Aphanocapsa gravillei* dominated from April to December, *Chroococcus limneticus*, *C. minor*, *C. tenax* were present in January and December and early August. *Coelosphaerium kuetzingianum* was recorded in April and December, while *Merismopedia glauca* and *Oscillatoria* species were frequent throughout the year. Palmer (1969) concluded that *Oscillatoria* species were more likely present than other species when organic pollution exists. *Cosmarium granatum, C. formosulum, C. leave and Phacus acuminatus* were widespread from August to December. Temperature plays an important role in the periodicity of bluegreen algae as emphasized by earlier workers (Hutchinson, 1967; Rao, 1972 and Nazneen, 1980).

Table 1. Seasonal abundance of algal flora in the brooder pond (Pond-I)

Taxa		January	April	August	December
Cyanophyta					
1	*Aphanocapsa gravillei*	00	3142	104	2700
2	*Chroococcus limneticus*	120	00	00	445
3	*C. minor*	528	00	00	347
4	*C. tenax*	1262	3068	00	1487
5	*Coelosphaerium kuetzingianum*	00	1196	00	938
6	*Merismopedia glauca*	1292	00	226	748
7	*Oscillatoria jasorvensis*	918	1038	860	628
Chlorophyta					
8	*Cosmarium granatum*	9	00	598	620
9	*C. formosulum*	00	00	78	220
10	*C. leave*	00	00	109	00
11	*Phacus acuminatus*	82	0	227	0
12	*Scenedesmus bijugatus*	75	38	0	102
13	*S. dimorphus*	20	00	90	284
14	*Stigeoclonium tenue*	00	1172	00	1324
15	*Coelastrum microporum*	00	28	87	00
16	*Euglena proxima*	24	00	00	28
17	*Enteromorpha salina*	1210	00	00	1442
18	*Paranema trichophorum*	0	00	108	00
19	*Chara zeylanica*	6	0	0	83
	Total	**5546**	**9682**	**2487**	**11396**

Table 2. Seasonal abundance of algal flora in the fry pond (Pond-II) at Chilya hatchry

	Taxa	January	April	August	December
	Cyanophyta				
1	*Anabaena limnetica*	00	00	220	2921
2	*A. planktonica*	00	00	00	67
3	*Chroococcus limneticus*	1207	00	00	805
4	*C. tenax*	109	2027	00	1925
5	*Coelosphaerium kuetzingianum*	00	00	637	468
6	*Merismopedia glauca*	929	00	230	560
7	*M. elegans*	105	00	00	372
8	*Oscillatoria jasorvensis*	467	00	520	82
9	*O. limosa*	220	70	0	00
10	*O. formosa*	00	00	204	00
11	*Nostoc spongiforme*	00	00	320	337
12	*Spirulina major*	468	00	20	597
	Chlorophyta				
13	*Cosmarium undulatum*	97	00	209	65
14	*C. formosulum*	123	185	00	00
15	*C. leave*	00	102	00	00
16	*Mougeotia sphaerocarpa*	00	00	758	1853
17	*Phacus acuminatus*	00	00	64	38
18	*Rhizoclonium sp.*	5362	6728	00	2922
19	*Scenedesmus dimorphus*	00	00	78	43
20	*Spirogyra subsalse*	2930	486	00	00
21	*Stigeoclonium tenue*	203	89	00	00
22	*Coelastrum microporum*	4	480	30	00
23	*Euglena proxima*	66	00	00	40
24	*Enteromorpha salina*	940	204	00	00
25	*Chara zeylanica*	30	40	00	2
	Bacillariophyta				
26	*Cyclotella kuetzingana*	520	00	35	00
27	*Cocconeis pediculus*	536	00	00	90
	Total	**14316**	**10411**	**3325**	**13187**

Table 3. Higher aquatic plants (Macrophytes) in the fry pond (Pond-II)

	Taxa	January	August	December
1	*Najas minor*	+	+	+
2	*Hydrilla verticillata*	+	+	+
3	*Potamogeton pectinatus*	-	+	+
4	*Scirpus nodulus*	+	+	+
5	*Typha domingensis*	+	+	+
6	*Phragmites vallatorn*	+	+	+
7	*Nymphia sp.*	-	+	-
8	*Nylimbo sp.*	-	+	-

In the fry pond, **27** species of algae were recorded **Table - 4.** The species of genus *Anabaena, Coelosphaerium, Mougeotia, Nostoc, Phacus, and Scenedesmus* were dominant in August and December while *Chroococcus, Cocconies* and *Spirulina* were common in January and December. The genera of *Merismopedia, Oscillatoria, Cosmarium, Rhizoclonium* was rarely recorded in January, August and December. Seenayya and Raju (1972) observed that phosphates were high just prior to the development of bloom of *Anabaena raciborski*. Nazneen (1980) also reported the occurrence of *Anabaena* only during spring and early summer in Keenjhar lake. The variations in algal community may probably be due to the change of temperature and other chemical parameters. Hutchinson (1967) emphasized that the distribution of phytoplankton in lakes is regulated mainly by temperature, light, nutrients, toxicants, parasitism, grazing and inter-specific competition.

Table 4. Zooplankton density (Individuals/50L) in the brooder pond (Pond-I) at Chilya hatchery

Taxa		January	April	August	December
Rotifera					
1	*Brachionus quadridentatus*	130	0	0	85
2	*B. falcatus*	46	0	0	77
3	*Keratella tropica*	112	0	0	39
4	*Lecane luna*	54	7	2	14
Cladocera					
5	*Alona rectangula*	8	2	65	12
6	*Bosmina longirostrus*	36	21	40	122
7	*Ceriodaphnia reticulata*	0	16	0	0
8	*Daphnia lumholtzi*	2	0	4	0
Copepoda					
9	*Cyclops affinus*	0	28	38	6
10	*Microcyclops varicans*	8	3	20	0
11	*Thermocyclops hylinus*	6	1	0	0
Miscellaneous		52	76	18	89
Total		**454**	**154**	**187**	**444**

Table 5. Zooplankton density (Individuals/50L) in the fry pond (Pond-II)

Taxa		January	April	August	December
Rotifera					
1	*Brachionus quadridentatus*	24	17	0	0
2	*B. calyciflorus*	15	0	0	47
3	*Keratella tropica*	0	26	13	0
4	*K. quadrata*	0	0	18	0
5	*Monostyla pygmae*	8	0	0	132
Cladocera					
6	*Alona rectangula*	23	0	0	24
7	*Bosmina longirostris*	18	0	0	27
8	*Chydorus poppei*	2	0	0	0
Copepoda					
9	*Cyclops affinus*	12	0	8	0
Miscellaneous		16	34	178	19
Total		118	77	217	249

Seasonal variation in densities of three groups of zooplankton (Rotifera, Cladocera and Copepoda) in the brooder pond and in the fry pond are given in **Table 6 and 7**. *Brachionus*, *Keratella*, and *Monostyla* species were dominant in January and December. *Alona rectangular* and *Bosmina longirostrus* were dominant and commonly occurred throughout the year in Brooder pond, while both species were absent in the fry pond in April and August. The present findings conform to the observations of Choubey (1992) that a restricted occurrence of *Alona rectungula* and *Bosmina longirostris* in the month of September, November and December. Bosmina longirostris has been considered a good indicator of trophic conditions (Swar and Fernando, 1980). *Ceriodaphnia reticulate*, *Chydorus poppei* and *Daphnia lumholtzi* were rare in both the ponds. Seasonal succession of cladoceran in Lake Ikeda (Japan) showed different rate of succession in different months, and no two species were found to be alike in their succession behavior (Baloch, 1995). *Cyclops affinus* and *Microcylops varicans* were common during summer season (April and August). *Microcyclops varicans* was absent in December. Dad (1981) reported the highest population of cyclopoids in the month of June from clear water area of Chambal river. The results showed the higher populations of cyclopoids in the brooder pond due to clear water as macrophytes were absent. *Thermocyclops hylinus* was found in January and April. In Fry pond the presence of *Cyclops affinus* was observed during January and August. The analysis of zooplankton samples from the brooder pond showed the abundance of rotifers in winter (January and December). *Brachionus quadridentatus* was found abundant in February and April in Gandhi Sager reservoir (Nayar, 1970). Green (1972), Chengalth *et al.*, (1974), Pejler (1977), Fernando (1980) and Sharma (1983) mentioned the importance of genus *Brachionus* in tropical rotifer communities. It was also commonly recorded from Manchar lake (Mahar *et al.*, 2000). *Brachionus* and *Monostyla* are regarded as indicators of eutrophication (Gannon and Stemberger 1978, Maemets 1983 and Mahar *et al.*, 2004). The present findings agree with the above observation. Artificial feed is the major cause of organic pollution and eutrophication. *Lecane* was recorded throughout the year in the brooder pond with slight variation. Dussart *et al.*, (1984) reported the presence of many species of. *Lecane* in the tropical water bodies of Asia and Australia. *Keratella* was abundant in the brooder pond during January and December while in the fry pond these species were commonly recorded in April and August. Pejler (1983) mentioned that along a trophical scale, the number of planktonic rotifer species successively increases up to mesoeutrophic condition after which the number declines till hyper-eutrophic stage. The differences in biological parameters of two ponds reflect the ecological conditions affected by seasonal changes.

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