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Distribution of plankton population in shrimp *ghers* of Bagherhat, Bangladesh

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Abstract
Analysis of plankton sample recorded a total of 5 classes phytoplankton *viz* Bacillariophyceae, Chlorophyceae, Cyanophyceae, Dinophyceae, and Polyhymenophorea. Total 50 phytoplankton species were identified. Among the phytoplankton 18 species belonged to Bacillariophyceae, 12 to Chlorophyceae, 8 to Cyanophyceae, 7 to Dinophyceae, and 5 to Polyhymenophorea. Bacillariophyceae was the dominant group of phytoplankton throughout the study period. Toxin producing dinoflagelates were recorded from the shrimp ghers. A total of 11 kinds of different zooplankton genera were recorded, 4 of which were belonged to Copepoda, 3 to cladocera, 3 to Rotifera and 1 to Decapoda. Copepoda was the dominant group among the zooplankton which was followed by Rotifera and Decapoda. Temperature varied from 27°C to 32°C, transparency 24.5-29.6 cm and pH 6.7 to 9. Salinity fluctuated from 12 to 32.5‰ in both ghers. PO_4-P and NO_3-N ranged from 0.9 to 4.2 ppm.

Key word: Phytoplankton, Zooplankton, Water quality, Shrimp gher

Introduction

Coastal shrimp culture in Bangladesh has been expanded rapidly as elsewhere in this region over the last two decades. About 75% of these shrimp ponds are located in greater Khulna region such as Khulna, Bagherhat and Satkhira districts. Shrimp ponds in Bagherhat are primarily extensive The extensive ponds here rely on tidal flushing for water exchange and post larval recruitment, so farmer have little control over the water quality in their ponds. A successful aquaculture largely depends on overall aquatic environment. Scientific management of a water body is closely related to the acquisition of knowledge of the environmental factors specially physico-chemical and biological factors that largely affect the aquatic productivity. Good water quality in shrimp pond is essential for survival and adequate growth (Boyd 1990, Burford 1997).Water quality determines the species optimal for culture under different environments (Jhingran 1991, Dhawan and Karu 2002). Moreover, suitable water quality enhance primary production, which in turn enhances secondary and tertiary production. The phytoplankton production represents a vital link in the food chain. The zooplankton forms the principal source of food for most of the fish.

Both the qualitative and quantitative abundance of plankton in water are of great importance in managing the successful aquaculture operation as they vary from location to location.

There is no information on plankton studies and water quality from the ghers of Bagerhat region. The present study aims to address the lack of basic information on water quality and plankton population in extensive shrimp gher in Bagherhat. By examining the samples of coastal water body, we will be also able to detect the beneficial and harmful plankton and thus will also be able to protect the coastal area from inimical affect of harmful planktons.

Materials and methods

Study area

The study was carried out in two large shrimp in Gher Bagerhat district, over a period of six months from April 2006 to September 2006. Gher I is situated in the village of Boroipara, and Gher II is situated in the village of Airpara in Fakirhat thana.

Analysis of water quality parameters

Water quality parameters (temperature, transparency, pH, PO_4-P, NO_3-N, and plankton analysis were determined fortnightly. Water samples were collected from Gher I and Gher II randomly from surface to a depth of 20 cm. between 9-12 A.M. Surface water temperature, transparency and pH were determined using a celsius thermometer, secchi disc and an electronic pH meter (Jenway 3020, Germany). Salinity was measured with a hand Refractometer. Nitrate-nitrogen (NO_3-N) and phosphate-phosphorus (PO_4-P) of collected water samples were measured in the using a data logging spectrophotometer (Odyssey 2500, HACH, USA) with high range chemicals (NitraVer 5 Nitrate Reagent Powder Pillows for NO_3-N, and PhosVer 3 Phosphate Reagent Power Pillows for PO_4-P analysis).

Plankton studies

For qualitative and quantitative analysis of plankton, water samples were collected a known volume (20 litres) of sub surface water from different location in each gher. Sample was passed through a plankton net (mesh aperture 25 μm). Each concentrated plankton was collected from the bucket (50 ml) and transferred to a plastic bottle and preserved in 5% buffered formalin with distilled water. The quantitative estimation of phytoplankton and zooplankton were done by Sedge-wick-Rafter counting chamber (S-R cell) method in Limnology Laboratory, Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh using a microscope. A 1 ml of concentrated sample was put into the S-R cell and left for 10 min to allow the plankton settle. The plankton in 10 randomly selected fields in the cell was identified up to genus level and counted. This procedure was repeated three times for each sample and the mean number of plankton was recorded and expressed numerically per litre of water for each station. Plankton density was calculated according to Stirling (1985) using the formula:

$$N=\frac{A\times 1000\times C}{V\times F\times L}$$

Where,
N= Number of plankton cells or units per litre of original water.
A= Total number of plankton counted
C= Volume of final concentration of the sample in ml
V=Volume of a field (mm^3)
F= Number of the field counted
L=Volume of original water in litre

Identification of plankton were according to Prescott (1962), Bellinger (1992), Needham and Needham (1962). Identification was made down to species level where possible.

Results

Water quality parameters

The monthly variation of surface water temperature at the collecting stations followed a clear maximum in April and a minimum in July for both Ghers. The highest recorded temperature (32°C in Gher I and 31.8°C in Gher II) was in April and May respectively and the lowest (27°C in Gher I and in Gher II) was in July, . During the study period salinity showed an irregular pattern for both sites, fluctuating from 12 to 28‰ in Gher I 12.6 to 32.5‰ in Gher II. In most of the sampling months pH of the water were above the neutral point. pH fluctuated from 6.9 to 9 in Gher I and 6.7 to 8.5 in Gher II respectively. Transparency ranged, 24.5 to 29.6 cm. Nitrate-nitrogen ranged from 0.9 to 2.1 ppm, the highest value was in September, and the lowest value in April. While in Gher II nitrate-nitrogen ranged from 1 to 1.8 ppm, the highest value was September and August and the lowest value in April and June. Phosphate-phosphorus ranged from 2.5 to 4.2 ppm in Gher I, the highest value was in September and the lowest value in June. In Gher II, phosphate-phosphorus ranged from 1.9 to 4.1 ppm, the highest value was in September and the lowest value in June 2006 (Table 1).

Phytoplankton

The phytoplankton population was identified up to genus level and re grouped in to the various classes or groups. The phytoplankton population was comprised of 50 genera belonging to Bacillariophyceae, Chlorophyceae, Cyanophyceae, Dinophyceae, and Polyhymenophorea groups. Among the different phytoplankton species recorded, 18 belong to Bacillariophyceae, 12 to Chlorophyceae, 8 to Cyanophyceae, 07 to Dinophyceae and 5 to Polyhymenophorea (Table 2). Bacillariophyceae appeared to be most abundant in Gher I (54.7×10^3 cells/L) and in Gher II (70.7×10^3 cells/L) in April, and least abundant in Gher I (9.7×10^3 cells/L) and Gher II (12.7×10^3 cells/L) in September respectively. Bacillariophytes showed another peak of abundance in June. Among the Bacillariophytes, the most abundant species were *Amphora ovalis, Nitzschia*

Table 1. Fortnightly variations of water quality parameters in the Bagerhat region (Fakirhat) of Bangladesh at both Ghers during the study period

Sampling date / Water quality parameters	Gher	1-Apr	15-Apr	1-May	15-May	1-June	15-June	1-July	15-July	1-Aug	15-Aug	1-Sep	15-Sep
Temperature (°C)	I	32	30.8	31	30.6	30.5	29.9	29	27	30	29	29.7	30
	II	31.5	30	31.8	31	30	29.7	29.5	27	30.1	30	29.2	29.7
Salinity	I	28	27.5	26	25.9	24	23.5	17	18	18	17.6	12	12.8
	II	32.5	31.9	27	26.1	23.4	22	16.8	17	15.9	16.1	12.7	12.6
pH	I	9	8.5	7.7	8	8.1	8	8	7.6	6.9	7.2	7.7	7.8
	II	8.5	8.4	7.2	7.6	7.7	8	7.9	7.5	6.7	7.1	7.9	7.5
Nitrate nitrogen (mg/L)	I	0.9	1	1.3	1.2	1.1	1.5	1.8	1.7	1.7	1.2	2.1	1.9
	II	1.1	1	1.4	1.2	1	1.2	1.7	1.4	1.8	1.1	2	1.8
Phosphate phosphorus	I	2.9	2.7	4.1	3.7	2.7	2.5	3.2	2.8	4.1	3.9	4.2	4.1
	II	2.7	2.8	3.7	3.5	1.9	2.2	2.9	2.7	3.7	3.7	4.1	3.9

acicularia, Coscinodicus lineatus and *Rhizosolenia alata*. Among the Chlorophytes, *Ulothrix aequalies, Cosmarium bioculatum* were most abundant species. Except in August and September, Bacillariophyceae was the dominant group of phytoplankton throughout the study period in both the sampling stations. Chlorophyceae, was the second most dominant group. The most dominant species of Cyanophyceae were *Trichodesmium erythraeum. Nostoc pruniforme,* and *Aphanizomenon flos-aquae*. Polyhomenophorea were most abundant in Gher I (2.7×10^3 cells/L) and in Gher II (1.9×10^3 cells/L) in April and found in least abundant during August and September in both ghers. During the study the period a number of toxin producing harmful algal species, namely, *Dinophysis caudata* were found. Bloom of *D. caudata* resulting fish kill were also observed for the first time in the area.

Table 2 List of phytoplankton genus observed

Bacillariophyceae	Chlorophyceae	Cyanophyceae	Dinophyceae	Polyhymeno-phorea
Amphora	*Ankrisorodesmus*	*Anabaena*	*Balechina*	*Codonaria*
Asterionella	*Chlamydomonas*	*Aphanizomenon*	*Ceratium*	*Codoncella*
Bacteriostrum	*Clostridium*	*Aphanothece*	*Ceratocorys*	*Epiplocydoides*
Biddulphia	*Cosmarium*	*Microsystis*	*Dinophysis*	*Favella*
Coscinodiscus	*Golenkinia*	*Nostoc*	*Gonyaulax*	*Rhabdonella*
Cycloteua	*Gonatozygon*	*Oscillatoria*	*Noctiluca*	
Diatoms	*Pleurococcus*	*Spirulina*	*Pyrocystis*	
Fragillaria	*Scenedesmus*	*Trichodesmium*		
Gyrosigma	*Spirogyra*			
Hemiaulus	*Tetraedon*			
Navicola	*Ulothrix*			
Nitzschia	*Volvox*			
Rhizosolenia				
Surirella				
Synedra				
Tabellaria				
Thalassionema				
Triceratium				

Zooplankton

The zooplankton population were composed of different species of Rotifera, Decapoda, Copepoda and Cladocera. Out of 11 identified taxa, 3 belonged to Rotifera, 1 to Decapoda, 4 to Copepoda and 3 to Cladecora (Table 3). Some of them occurred during each sampling month and some did not. The zooplankton were most abundant in Gher I (107.5×10^3 cells/L) and in Gher II (132.5×10^3 cells/L). September and least abundant (36.75×10^3 cells/L) in Gher I and (35.5×10^3 cells/L) in Gher II in July. Copepods were the most dominant group among the zooplankton, 31-32% in Gher I and

Gher II of the total population. Each species of Copepoda showed noticeable fluctuations during the period of study. Four species of Copepoda such as *Cyclops,* Nauplius, *Diaptomus, Tigriopus.* Nauplius was observed during the study. They were abundant in April. Rotifera was the next dominant group represented by 3 genera, *Brachionus, Keratella,* and *Trichocerca* showed noticeable fluctuations in their abundance during the study period. Rotifers showed their maximum abundance in September in Gher I (32.5×10^3 cells/L) and in Gher II (39.5×10^3 cells/L) respectively. and Minimum abundance was observed in June.. Decapods were abundant in September in both the gher.

Table 3 List of zooplankton Genus observed

Rotifera	Decapoda	Copepoda	Cladocera
Brachionus *Keratella* *Trichocerca*	*Processa* sp.	*Cyclops* *Diaptomus* Nauplius *Tigriopus*	*Daphnia* *Diaphanosoma* *Moina*

Discussion

Temperature is the most important environmental factor with multisided effects on plants and animals. Temperature regulates the growth, reproduction, and metabolism as well as feeding intensity of fish. In the present study, water temperature was found to vary from 27-32°C and 27-31.8°C in Gher I and Gher II respectively. The highest temperature was found on April in Gher I and May in Gher II and the lowest was found in both Ghers in July . Santhanam and Srinivasan (1996) recorded temperature ranging from 28 to 30.5°C with the maximum in May 1994 in the Tuticorin Bay of India. During the study period the observed temperature are with in the optimal range.

The highest salinity 28‰ was found in April and the 32.5‰ was found April at Gher I and Gher II respectively. The lowest salinity of 12‰ and 12.6‰ was found in September in September at Gher I and Gher II respectively. Salinity showed variations during the study period due to circulation in the Bay, rivers discharge and dilution due to rainfall. Mahmood (1986) recorded the highest salinity 34‰ in the estuary of Matamuhuri river at Chakaria, Chittatong in the cost of Bay of Bengal in March.

The level of pH ranged from 6.9 to 9 at Gher I and Gher II. The highest pH was found in April. Islam and Hossain (1991) recorded pH values of 7.8, 7.7, 7.9 and 7.7 and 7.2 at six different sampling stations of the Bahgerhat water bodies of Bangladesh. Therefore the gher water was suitable for shrimp culture.

During the study period various types of phytoplankton and zooplankton were identified upto genera levels. The results seasonal variation environmental parameters and plankton suggest that the favourable period occurs from April to July when temperature rises and nutrients accumulate from fresh water run-off due to monsoon rainfall and more coastal upwelling and eddy diffusion due to strong wind action during April to July. Maximum phytoplankton cell densities in the coastal water of during this study were (163.65$\times10^3$ cells/L at Gher I and 154.3$\times10^3$ cells/L at Gher II in June and April respectively. The phytoplankton community at the two sampling Ghers differed slightly from one to other. Although salinity, temperature, pH, nitrate-nitrogen and phosphate-phosphorus differences was observed between the stations were rather limited, these differences in environmental factors measured can explain the observed differences in species distribution and abundance. Indeed, phytoplankton species distribution was related to above factors. These differences in environmental condition can be explained by the position of the Ghers. Gher I positioned about 2 km upstream from Chitra river that are also connected more influenced by the discharge of the river waters, which explains the lower salinity. The rain cycle thus seem to be main factor controlling the seasonality of phytoplankton assemblages in the observed estuarine waters. There was no significant differences in phytoplankton species composition and abundance between the two Ghers.

The variations in monthy densities of total phytoplankton may be attributed to wide range of parameters including temperature, DO etc. The dominance in plankton population species during the various months of the study period was probably attributed to variations in the optimal conditions for particular species. In the present study different dinoflagellate species occurred almost round the year and among them *Dinophysis caudata* formed bloom during April and June when heavy freshwater flood was being discharge into the Bay through that rivers as run-off. Harmful algal blooms due to nutrient enrichment and the impacts of these algal blooms on the water quality and fishery resources have also been reported in different coastal locations of India (Santhanam *et al* 1996). The highest cell densities of phytoplankton were 163.65$\times10^3$ cells/L at Gher I and 154.3$\times10^3$ cells/L at Gher II were found during are June and April respectively. The zooplankton collected by the plankton net were mainly composed of herbivorous species. Normally phytophagous zooplankton grow more when phytoplankton are abundant. In the present study, zooplankton population was poor during the *Dinophysis caudata* bloom in April, 2006 and June. *Dinophysis caudata* is known to secrete toxins which possibly happened during the present reported bloom too. Possibly some zooplankton were killed by *Dinophysis* toxins as because fish mortality was also reported during the bloom period. High concentrations of phosphate phosphorus were recorded during the bloom months that might have a relationship with the bloom. Santhanam and Srinivasan (1996) reported that phosphate phosphorus accumulation through runoff waters in the coastal water of the Tuticorin Bay of India that triggered *D. caudata* bloom. Santhanam and Srinivaasan (1996) recorded the highest phytoplankton cell number (1.1$\times10^6$ cell/L) during monsoon months in the Tuticorin Bay of India which was supposed to be caused by continuous discharge of sewage water during the rainy periods. They also observed a considerable variations in species composition during the study period and found diatom as a dominant group round the year. The dynamic characteristics of plankton distribution in the coastal habitats are also strongly influenced by tidal currents and salinity gradients, and thus timing of sampling together with spatial location in relation to salinity and coastal environment mosaics will determine plankton type and concentration. Interrelationship among physico-chemical parameters such as light, temperature, pH and nutrients are important regulatory factor in the physiology and behavior of phytoplankton. Thus differential adaptation of phytoplankton to the physico-chemical parameters in their natural habitats can explain why in some genera become dominant in particular season or not. In this study, seasonal distributions of the large phytoplanktonic organisms inhabiting the gher water were determined together with their successions and environmental parameters.

References

Bellinger, E.G., 1992. A key to common algae: freshwater, estuarine and some coastal species. The Institution of Water and Environmental Management. London, U.K., 138 p.

Boyd, C.E., 1982. Water quality Management of pond fish culture. Elsevier Sci. Pub.Co. Amsterdam-Oxford, New York, 318 p.

Burford, M., 1997. Phytoplankton dynamics in shrimp ponds. *Aquaculture Research* 28: 351-360.

Dhawan, A. and S. Karu, 2002. Pig dung as pond manure: Effects on water quality, pond productivity and growth of carp in polyculture system. NAGA: The ICLARM Q., 25: 11-14.

Islam, K.R. and M.M. Hossain, 1991. Effects of shrimp scrapping activities on the soil sea environment in the coastal area of Chittagong, Bangladesh, *Marine Pollution Bulletin*. 17: 462-463.

Jhingran, V.G., 1991 Fishes and Fisheries of India. 3rd Edn. Hindustan Publishing Corporation, India, 727 p.

Mahmood, N., 1986. Effect of shrimp farming and other impacts on mangroves of Bangladesh. Paper presented at the 3rd session of the PIFC working party of experts on Inland Fisheries, Bangkok, Thailand, June 19-27, 1986. FAO Fish Report. No. 370. pp. 46-66.

Needham, J.G. and P.R. Needham, 1962. A guide to the study of Fresh Water Biology. 5th ed. Holden day Increased. San Franscisco, 108 p.

Prescott, G.W., 1962. Algae of the Western Great Lakes Area. Wm. C. Brown co. Increased. Dubuque, Iowa, pp. 946.

Santhanam, R. and A. Srinivasan, 1996. Impact of Dinoflagellates *Dinophysis caudate* Bloom on the Hydrography and Fishery Potentials of Tuticorim Bay, South India. Harmful and Toxic Algal Blooms, Yasumoto, T., Oshima, Y and Fukuyo, Y. (eds.), *International Oceanography Commission* of UNESCO.

Stirling, H.P., 1985. Chemical and biological methods of water analysis for aqua culturists. Institute of Aquaculture, University of Stirling, Scotland, 119 p.

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