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# Food and Feeding Habits of *Puntius gonionotus* (Thai Sarpunti) in Rice Field

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**Abstract:** In the present experiment the fingerlings of *Puntius gonionotus* (Thai Sarpunti) were stocked in the experimental rice field plot of Agronomy Field Laboratory, Bangladesh Agricultural University, to study their food and feeding habits in rice field. The fingerlings of this fish were stocked after 20 days of transplanting rice seedlings and the samplings of fishes were done once in every month from June to August. The gut contents of fishes were analysed by the numerical method and percentage of frequency of occurrence method. The water quality parameters such as temperature, Dissolved Oxygen (DO), pH, total alkalinity, chlorophyll-a, nitrate-nitrogen and phosphate-phosphorus showed monthly variations and they were within productive range. A total of 37 genera of phytoplankton belonging to Chlorophyceae, Euglenophyceae, Cyanophyceae and Bacillariophyceae were recorded in the water of the experimental plot of rice fields and in zooplankton population a total of 13 genera belonging to Rotifera, Cladocera and Copepoda were recorded. Among the 4 groups of phytoplankton Chlorophyceae was the most dominant group and Euglenophyceae was the least dominant group and in zooplankton Rotifera was recorded as the most dominant group and Cladocera as the least dominant group. However among the plankton population, phytoplankton was recorded highly dominant over zooplankton in the water of rice field. Among the genera of phytoplankton *Fragilaria, Navicula, Surirella, Chlorella, Chrysococcus, Scenedesmus, Ulothrix, Euglena, Cyclotella* and *Oscillatoria* and among the genera of zooplankton *Brachionus, Cyclops, Asplanchna and Nauplius* were dominant in water of the plot. The total number of genera of phytoplankton recorded in the gut contents of *P. gonionotus* were 36 and that of the genera of zooplankton recororded were 6. Among the 4 groups of phytoplankton Bacillariaophyceae was the most dominant and preferred group. With respect to zooplankton. *P. gonionotus* showed very less preferance on them. Among the genera of phytoplankton the relatively more preferred genera were *Navicula, Closterium, Fragilaria, Chrysococcus, Oscillatoria, Tabellaria, Scenedesmus, Ulthrix and Aphanizomenon. P. gonionotus* showed very less preference on the genera of zooplankton. *P. gonionotus* may be regarded as planktivores feeding mostly on phytoplankton.

**Key words** : Food habit, feeding habit, *Puntius gonionotus*, rice field

## INTRODUCTION

Fish culture as an integrated and concurrent activity with rice culture in the same field is important for rational utilization of limited land resources, as well as a sustainable source of protein, additional income and employment generation reported by Pullin[1], Taylor *et al.*[2] Das *et al.*[3], Ghosh[4] and Sarkar[5].

Small fishes can be profitably grown in various shallow water bodies specially in rice field where water remain 3-4 months in a year. Now a days, some of the small fishes are being cultured in rice fields among with rice. Bangladesh has more hatn 28.3 lakh ha of seasonal paddy fields, where water stands for 4 to 6 months. DoF[6], providing greater scope for rice fish culture. In case of rice-fish integration rice and fish are directly benefited each other. Activity of fishes in the rice fields enhance the fertility and environment of rice fields and as a result rice yield increased 10-15% with few exception observed by Hora and Pillay[7], Khoo and Tan[8], Nie *et al.*[9], dela Cruz[10], Kamp and Geragory[11]. The fish production from those water bodies could be increased to a great extent by introducing improved rice fish culture technologies and it requires very little extra labour in addition to rice cultivation and can be earned additional income at the same time. Fish on the otherhand, can play an important role as pesticide by eating rice pest.

In order to culture and manage the fish on scientific basis, knowledge about the various ecological factors, which are responsible directly or indirectly for optimum fish production from a water body must be improved. Among the factor food and feeding habits of fishes are

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the prerequisites to understand the interspecific relationships for efficient management of certain fishes. But our knowledge regarding the food consumption of fish under natural condition is still insufficient. The food and feeding habits of fish vary with time of day, season, species and size of the fish and with ecological factors and with different food substances present in the water body. As stated by Hynes[12] the composition of food in aquatic habitats varies throughout the year and each important food item tends to have a maximum importance at a certain reason.

The knowledge of food and feeding habits helps to select such species of fishes for culture as would produce optimum yield by utilizing all the available potential food of the water bodies properly without any competition. The food study helps us to identify good or bad environments and indicates the future course of action for proper fisheries management. It also helps to know interspecific relationship and the productivity of the water bodies. By studying the food and feeding habits, one can understand what programme should be taken for the development of the water bodies to produce more fish.

Moreover, the objectives of the dietary studies should include how fish live and grow, what fish may influence their abundance and distribution and the relative quality of feeding condition. It has both theoretical and practical importance, so as to determine directly the exact type that a fish consume in its natural habits.

Very little work has been done on the food and feeding habits of *Puntius gonionotus* (Thai sarpunti) in the rice field; and the published information of food and feeding habits of the fish in rice fields is not available. So the present work was undertaken to fillup the gap in the available information on the above aspects of the fish in rice field. The present study was conducted to determine the food and feeding habits of *P. gonionotus* in rice field, situated in the Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensingh.

The objectives of the present study were to determine the quality and quantity of food eaten by *P. gonionotus*; to determine the variation of food items eaten by the mentioned fish and to determine the relative abundance of different food items in the gut contents of fishes in relation to their availability in the rice field.

## MATERIALS AND METHODS

The experiment was conducted in the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh from April to August, 1999 to study the food and feeding habits of *P. gonionotus* (Thai sarpunti) in rice field.

**Experimental site:** The experiment was conducted in the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh. The site was selected in a relatively low land area within the deep-tubewell irrigation facilities of the field laboratory. The site consists of one experimental plot with 0.02 ha in area. Small water channels (0.70 m width and 0.30 m depth) were made to supply water from deep-tubewell.

A 0.70 m high and 0.50 m wide embankment surrounding the experimental plot was made to keep the plot free from flood during heavy rainfall. A common inlet and outlet was provided on the dykes to regulate water depth. Within it plastic nets strengthen by bamboo poles were placed at the outlet and inlet to prevent entrance of wild fish and escapement of stocked fish.

**Land preparation:** Wetland preparation was followed in the present experiment, which is practiced in most tropical countries stated by Singh *et al.*[13] . The land was ploughed properly with power tiller and country plough and then leveled properly by laddering to keep even water depth throughout the plot. Then weeds were removed from the plots before the transplantation of rice seedlings. To provide refuge during high water temperature and low water depth a small ditch and a trench connecting the ditch were constructed in the plot. The area of each ditch and a trench connecting the ditch were constructed in the plot. The area of each ditch was $4m^2$ and the depth was about 70 cm. The width and depth of the trenches were 40 and 30 cm, respectively which were almost similar to the practiced of Indonesian farmers reported by dela Cruz and in Bangladesh Mazid *et al.*[14].

**Fertilization:** The rice plot was fertilized with Urea, Triple Super Phosphate (TSP), Muriate of Potash (MP) and gypsum at the rate of 200, 150, 75 and 166 kg $ha^{-1}$, respectively. All inorganic fertilizers except Urea were applied evenly 2-3 days before transplanting the rice seedlings and during final ploughing and leveling. Urea was applied after 15, 55 and 70 days of transplanting rice seedlings with one third of total dose during each application.

**Rice varieties and transplantation:** The high yielding variety of rice BR-2 having resistant power to insects and diseases was selected for this experiment. The seedlings of rice was raised in a separate seedbed near the experimental field. Forty days old seedlings were uprooted carefully for transplanting in the experimental plot. Then

the rice seedlings were transplanted on 18 May, 1999 in alternate row spacing of 35+15cm as recommended by Hossain *et al.*[15]. The plant to plant distance was given 20 cm. The alternative row spacing would provide enough space for movement of fishes.

**Stocking of fish fingerlings:** To determine the food and feeding habits the fingerlings of *P. gonionotus* (Thai Sarpunti) were stocked in the rice field 20 days after transplantation of rice seedlings. The fingerlings of *P. gonionotus* were stocked at the rate of 24/dec (6000 $ha^{-1}$). The mean initial length and weight of the species was recorded at the time of stocking in the rice field.

**Management of fishes:** For maintaining the suitable water depth for fish in the rice field water was supplied regularly form the deep-tubewell. During heavy rainfall the excess water was removed through the outlet. During the culture period no supplementary feed was used.

**Study of water quality parameters:** During the study period water temperature was recorded with a Celsius thermometer. Dissolved oxygen and pH were measured directly by using a digital electronic oxygen meter (YSI, Model 58) and pH meter (Jenway, Model 3020), respectively. Total alkalinity was determined using methyl orange indicator and standard EDTA solution by titrimetric method (APHA, 1992). These parameters were recorded weekly and then averaged for each month.

The concentration of nitrate-nitrogen (mg $L^{-1}$) and phosphate-phosphorus (mg $L^{-1}$) of water samples were determined in laboratory after filtering the water samples taken from rice field plot by using a spectrophotometer (Hack DR 2000) and reagent pillow nitrover and phosver-3, chlorophyll-a (μg $L^{-1}$) was measured from the filter paper (What man GF/C) used for filtering the water samples. The filter paper was dissolved in 10 mL acetone and made ready for the analysis of chlorophyll-a. Later chlorophyll-a was determined by using a spectrophotometer (Milton and Roy Spectronic, Model 1001) and 664 and 750 nm wavelengths. These parameters were recorded fortnightly and then averaged monthly.

**Plankton study in the water of rice fields**

**Collection, preservation and enumeration:** Plankton samples were collected monthly from the experimental plot. Ten litres of water sample were collected from different areas and depths of the water of rice field and passed through a fine meshed (25 μ) plankton net. Filtered samples were taken in a measuring cylinder and carefully made up to a standard volume of 50 mL. Then the collected plankton samples were preserved in 5% buffered formalin solution in small plastic vials for subsequent studies. From each 50 mL preserved sample, 1 mL sub-sample was examined using a Sedge-wick-Rafter cell (S-R cell) and a binocular microscope (Olympus, Model B–2, with phase contrast facilities).

**Counting of plankton:** The S-R cell is a special type of slide having a counting chamber which is 50 mm long, 20 mm wide and 1 mm deep, the volume of the chamber is 1 mL. the counting chamber is equally divided into 1000 fields each having a volume of 0.001 mL. Ten square fields of the cell chosen randomly and all planktonic organisms of these fields were counted. Then expressed numerically in per liter of water. Calculation of plankton samples was done by using the following formula:

$$N = \frac{AX100XC}{VXFXL}$$

Where:

N = Number of plankton cells or units per liter of original water.
A = Total number of plankton counted.
C = Volume of final concentrate of the samples in ml.
V = Volume of field in cubic mm
F = Number of fields counted.
L = Volume of original water in litre.

**Study of gut content of fishes**

**Sampling of fishes:** To determine the food and feeding habits of *P. gonionotus*, in the rice field the fishes were sampled from the rice fields monthly for three months from June to August. The samplings were done from 9 am to 11 am and 15 fishes were caught at each sampling day from the plot. Accordingly a total of 45 fishes were collected during the culture period (3 months). Immediately after collection the fishes were preserved in 10% formalin solution.

**Examination of the stomach contents:** At first the length of the individual fishes were recorded in cm. Then the stomach of each fish was dissected out and the contents of in were removed very carefully on a petridish to determine the different food items eaten by the fish. Only the anterior portion of the digestive tract lying between the oesophagus and the first major curve of the small intestine was taken instead of entire gut. McComish[16], McKehnie and Penner[17] and Dewan[18], were also adopted similar method in their study.

The gut contents were analysed by the following methods:

- Occurrence method (Hynes) where the number of fish in which each food item occurred was listed as percentage of the total number of fish examined.
- Numerical method (Hynes) where the number of individual of each food item were recorded and expressed as percentage of the total number of organisms found in all the fish examined.

Of these methods, the numerical method of Hynes and percentage of frequency of occurrence as out lined by Dewan *et al.*[19]. were used in the present study because these were the best and most simple and easiest methods and gave better results. Many researchers Van Someren[20], Pillay[21], Dewan *et al.*[22] and Ali and Islam[23] used numerical and percentage of frequency of occurrence method in their study.

Food contents of the gut were taken out and diluted in 5 mL distilled water. Similar method has also been adopted by Dewan *et al.*[24], Miah *et al.*[25] and Miah *et al.*[26]. One mililiter sub-sample from 5 mL sample were transferred by a pipette to a S-R-cell. Ten fields out of 1000 fields of the counting cell were counted and multiplied by 500 to get the total number of plankton in the gut. By using a binocular microscope all organisms were counted and indentified upto genus level. Then the occurrence of each and every food item in the individual gut was recorded.

## RESULTS

**Water quality parameters in rice fields:** The water temperature of the plot is more or less similar. The value of it was found to vary from 26.96 to 28.30°C. The mean value of the same recorded was 27.76±0.13 (Table 1).

The value of dissolved oxygen contents recorded in the rice field was 3.93 to 4.43 mg $L^{-1}$. The mean value of dissolved oxygen recorded was 4.11±0.09 mg $L^{-1}$.

The pH value was 6.14 to 7.01. The mean value of pH recorded was 6.64±0.10 (Table 1).

Total alkalinity value recorded during the study period was found to vary from 36 to 82 mg $L^{-1}$ and the mean values was 54.22±8.30 (Table 1).

The ranges of chlorophyll-1 recorded was 13.02 to 19.20 μg $L^{-1}$. The mean value of chlorophyll-a was 16.04±1.62 (Table 1).

The nitrate-nitrogen values in the water of rice field recorded was 1.63 to 2.63 mg $L^{-1}$. The mean value was 2.34±0.11 mg $L^{-1}$ (Table 1).

The phosphate-phosphorus contents in the plot recorded was 0.15 to 0.82. The mean value of phosphate-phosphorus in the water of rice field was 0.60±o.05 mg $L^{-1}$ (Table 1) .

**Plankton population in the water of rice field**

**Phytoplankton population:** The total phytoplankton population recorded were divided into 4 broad groups viz., chlorophyceae, Euglenophyceae, Cyanophyceae and Bacillariophyceae during the study period. A total of 37 genera of phytoplankton were recorded in experimental plot. Out of 37 genera 20 genera were belonged to Chlorophyceae, 2 to Euglenophyceae, 7 to Cyanophyceae and 8 to Bacillariophyceae (Table 2).

**Zooplankton population:** The zooplankton population recorded during the study period were grouped into Rotifera, Cladocera and Copepoda. A total of 13 genera of zooplankton were recorded out of 13 genera 7 were belonged to Rotifera, 3 to Cladocera and 3 to Copepoda (Table 2).

Among the phytoplankton populations Chlorophyceae was found to be the most dominant group ($6.1X10^3$ $L^{-1}$ in number and 39.94 by percentage in number). The Bacillariophyceae was the next domiant group ($3.6X10^3$ $L^{-1}$ in number and 23.38 by percentage in number). Euglenophyceae was the least dominant group.

Among the zooplankton Retifera was found to be the most dominant food group $1.8X10^3$ $L^{-1}$ in number and 11.87 by percentage in number. Cladocera was the least domiant group.

However, by average number the total phytoplankton population and zoopankton population varied from $10.1X10^3$ to $16.1X10^3$ $L^{-1}$ and $2.3X10^3$ to $6.2X10^3$ $L^{-1}$ (Table- 1).

In the water of the plot the dominant genera of phytoplankton were *Chlorella* (3.60%) *Scenedesmus* (2.88%) and *Ankistrodesmus* (2.88%) *in* Cholorophyceae. *Euglena* (2.16%) *in* Euglenophyceae, *Anabaena* (2.16%), *Gomphosphaeria* (2.16%), *Microcystis* (2.16%) *and oscillatoria* (2.16%) *in* Cyanophyceae *and Fragilaria* (5.7%), *Navicula* (5.76%), *Cyclotella* (3.60%) in Cholorophyceae, *Phacus* (1.07%) in Euglenophyceae, *aphanizomenon* (0.72%) in Cyanophyceae and *Tabellaria* (0.71%) and *Nitzschia* in Bacillariophyceae. The least dominant genera of phytoplankton were *coelastrum* (1.01%), in *Cyclotella* (3.60%) in Bacillariophyceae. On the other hand the dominant genera of zooplankton in this plot were *Asplanchna* (2.88%) in Rotifera, *Moina* (2.16%) in Cladocera and *Cyclops* (2.88%) in Copepoda. But the least domiant zooplankton were *Filinia* (0.72%) in Rotifera, *Daphnia* (1.44%) in Cladocera and *Diaptomus* (0.72%) in Copepoda (Table 3).

In the plots among the genera of phytoplankton the most dominant genera were *Fragilaria* and *Frustullaria*, which were closely followed by *Surirella Chlorella, Chrysococus, Cyclotella and Scenedesmus.* Among the

Table 1: Mean monthly values of water temperature, Dissolved Oxygen (DO), pH, total alkalinity, nitrate-nitrogen ($NO_3$-N) and phosphate-phosphorus ($PH_4$-P) obtained in the water of rice field

| | Monthly average values | | | |
|---|---|---|---|---|
| Parameters | 15.06.99 | 15.07.99 | 15.08.99 | Mean±SD with range |
| Water temperature (°C) | 27.75±0.09 | 27.63±0.10 | 27.90±0.19 | 27.76±0.13 (26.96-28.30) |
| Dissolved oxygen (mg $L^{-1}$) | 3.98±0.07 | 4.06±0.06 | 4.28±0.13 | 4.11±0.09 (3.93-4.43) |
| pH | 6.88±0.07 | 6.85±0.04 | 6.19±0.20 | 6.64±0.10 (6.14-7.01) |
| Total alkalinity (mg $L^{-1}$) | 41.50±2.30 | 39.17±4.68 | 82.0±17.92 | 54.22±8.30 (36-82) |
| Chlorophyll-a (µg $L^{-1}$) | 14.76±1.14 | 18.17±1.83 | 15.18±1.88 | 16.04±1.62 (13.02-19.20) |
| Nitrate-nitrogen ($NO_3$-N mg $L^{-1}$) | 1.80±0.06 | 1.87±0.07 | 2.12±0.20 | 1.95±0.11 (1.63-2.63) |
| Phosphate-Phosphorus ($PO_4$-P mg $L^{-1}$) | 0.81±0.08 | 0.50±0.04 | 0.48±0.04 | 0.60±0.05 (0.15-0.82) |

Table 2: List of genera of Phytoplaknton and Zooplankton recorded in the water of the experimental plot in rice field

| Food items | Name of genera | Total No. of genera |
|---|---|---|
| Clorophyceae | *Actinastrum, Ankistrodesmus, Ceratium, Chlorella, Chrysococcus, Clostmerium, Coelastrum, Cosmerium, Gloeocystis, Gonatogygon, Scendesmus, Micrasterium, Oocystis, Pediastrum, Staurastrum, Tetraedron, Volvox, Zygnema, Oedogonium, Ulothrix.* | 20 |
| Euglenophyceae | *Euglena, Phacus* | 02 |
| Cyanophyceae | *Anabaena, Aphanocapsa, Gloeotrichia, Gomphosphaeria, Microcystis, Oscillatoria, Aphanizomenon.* | 07 |
| Bacillariophyceae | *Cyclotella, Fragilaria, Frustularia, Navicula, Surirella, Tabellaria, Nitzschia, Nostoc.* | 08 |
| Total Phytoplankton | | 37 |
| Rotifera | *Asplanchna, Brachionus, Filinia, Keratella, Polyarthra, Trichocerca, Notholca.* | 07 |
| Cladocera | *Daphnia, Diaphanosoma, Moina.* | 03 |
| Copepoda | *Cyclops, Diaptomus, Nauplius* | 03 |
| Total Zooplankton | | 13 |

genera of zooplankton the most dominant genera were *Asplanchna Brachionus* and *Cyclops* which were closely followed by *Nauplius and Diaphanosoma*.

**Plankton population in the gut contents of fishes:** The gut contents of 45 fishes of *P. gonionotus* were analysed by two methods namely, frequency of occurrence method and numerical method. The total length ranges of the fishes studied were 14.50 to 19.20 cm for *P. gonionotus*.

**Phytolankton population in the gut contents of fishes:** The phytoplankton population recorded in the gut contents of fishes were broadly divided into 4 groups viz., chlorophyceae, Euglenophyceae, Cyanophyceae and Bacillariophyceae.

The total number genera of phytoplankton recorded in the gut contents of *P. gonionotus* were 36. Out of 36 genera 18 were Chlorophyceae; 2 Euglenophyceae, 8 Cyanophyceae and 8 Bacillariophyceae. In *P. gonionotus* Bacillariophyceae was the most dominant food group by percentage in number (36.70) and by percentage of occurrence (100), which was closely followed by Chlorophyceae (31.94% ) in number and 100% in occrrence (Table 4).

**Zooplankton population in the gut contents of fishes:** The zoo plankton population recorded in the gut contents of fishes were divided into 3 groups viz., Rotifera, Cladocera and Copepoda. A total number of 6 genera of Zooplankton were recorded in the gut contents of *P. gonionotus*. Out of 6 genera 2 genera were recorded in Rotifera 2 in Cladocera and 2 in Copepoda (Table 4).

Phytoplankton was found to be the most dominant food group in the gut contents of *P. gonionotus* which constituted more that 92% in number in the gut contents. Zooplankton food groups consitituted 7.43% in the gut contents of *P. gonionotus*. The above findings indicate that *P. gonionotus* is planktivores (Table 5).

**Generic contribution of phytoplankton in the gut contents of fishes:** Among all the genera of phytoplankton *Navicula* was found to be the most dominant genus in the speies of fish under present study, which contributed 88% by occurrence and 18.11% in number in the gut contents of *P. gonionotus* (Table 6).

In *P. gonionotus* the most dominant genus of zooplankton recorded was *Notholca*, which contributes 26 by percentage of frequency of occurrence and 5.33 by percentage in number. The next dominant genus recorded in the gut contents of this fish was *Cyclops*. The genera of phytoplankton were highly dominant in the gut contents of *P. gonionotus* which indicates that fish prefer to feed mostly on phytoplankton with little preference for zooplankton.

**Abundance of food items in the gut contents of fishes in relation to their availability in the water of rice fields:** The genera of phytoplankton such as *Navicula, Oscillatoria, Fragilaria, Aphanizomenon, Scenedesmus, Chrysococcus, Closterium, Tabellaria and Ulothrix* which contributed significantly in the gut contents of the

Table 3: Composition of different food items in the water of rice fields by average number and by percentage in number

| Food items (Phytoplankton) | Name of genera | Average No. | % in No. |
|---|---|---|---|
| Chlorophyceae | *Actinastrum* | 333.33 | 2.16 |
| | *Ankistrodesmus* | 444.44 | 2.88 |
| | *Creatium* | 388.88 | 2.52 |
| | *Chlorella* | 555.55 | 3.60 |
| | *Chrysococcus* | 388.88 | 2.52 |
| | *Closterium* | 222.22 | 1.44 |
| | *Coelastrum* | 166.66 | 1.01 |
| | *Cosmerium* | 222.22 | 1.44 |
| | *Gloeocystis* | 222.22 | 1.44 |
| | *Gonatogygon* | 388.88 | 2.52 |
| | *Scenedesmus* | 444.44 | 2.88 |
| | *Micrasterium* | 222.22 | 1.44 |
| | *Oocystis* | 222.22 | 1.44 |
| | *Pediastrum* | 222.22 | 1.44 |
| | *Staurastrum* | 222.22 | 1.44 |
| | *Tetraedron* | 388.88 | 2.52 |
| | *Volvox* | 222.22 | 1.44 |
| | *Zygnema* | 333.33 | 2.16 |
| | *Oedogonium* | 333.33 | 2.16 |
| | *Ulothrix* | 222.22 | 1.44 |
| Total Chlorophyceae | | 6166.58 | 39.94 |
| Euglenophyceae | *Euglena* | 333.33 | 2.16 |
| | *Phacus* | 166.16 | 1.07 |
| Total Euglenophyceae | | 500.00 | 3.23 |
| Cyanophyceae | *Anabaena* | 333.33 | 2.16 |
| | *Aphanocapsa* | 222.22 | 1.43 |
| | *Gloeotrichia* | 111.11 | 0.72 |
| | *Gomphosphaeria* | 333.33 | 2.16 |
| | *Microcystis* | 222.22 | 1.43 |
| | *Oscillatoria* | 333.33 | 2.16 |
| | *Aphanizomenon* | 111.11 | 0.72 |
| Total Cyanophyceae | | 1666.66 | 10.79 |
| Bacillariophyceae | *Cyclotella* | 555.55 | 3.60 |
| | *Fragilaria* | 888.88 | 5.76 |
| | *Frustularia* | 333.33 | 2.16 |
| | *Navicula* | 888.88 | 5.76 |
| | *Surirella* | 444.44 | 2.88 |
| | *Tabellaria* | 111.11 | 0.71 |
| | *Nitzschia* | 111.11 | 0.71 |
| | *Nostoc* | 277.77 | 1.80 |
| Total Bacillariophyceae | | 3611.07 | 23.38 |
| Total Phytoplankton | | 11944.30 | 77.34 |
| Rotifera | *Asplanchna* | 444.44 | 2.88 |
| | *Brachionus* | 333.33 | 2.16 |
| | *Filinia* | 111.11 | 0.72 |
| | *Keratella* | 222.22 | 1.44 |
| | *Polyarthra* | 222.22 | 1.44 |
| | *Trichocerca* | 277.77 | 1.80 |
| | *Notholca* | 222.22 | 1.43 |
| Total Rotifera | | 1833.31 | 11.87 |
| Cladocera | *Daphnia* | 222.22 | 1.44 |
| | *Diaphanosoma* | 222.22 | 1.44 |
| | *Moina* | 333.33 | 2.16 |
| Total Cladocera | | 777.77 | 5.04 |
| Copepoda | *Cyclops* | 444.44 | 2.88 |
| | *Diaptomus* | 111.11 | 0.72 |
| | *Nauplius* | 333.33 | 2.15 |
| Total Copepoda | | 888.88 | 5.75 |
| Total Zooplankton | | 2499.96 | 22.66 |

*P. gonionotus* were also found abundantly in the water of the rice field. These findings indicate that the fish prefers to feed on these genera of Phytoplankton. *Navicula, Fragilaria, Oscillatoria, Tabellaria, Aphanizomenon and Closterium* were found to be preferred food of this fish considering their contribution to the gut contents of this fish. Whereas, *Gonatogygon, Ooscystis, Pediastrum* and *Nostoc* though recorded abundantly in the water of the rice field were not found in the gut contents of this fish, which indicates that the fish does not prefer to feed on them. Among the genera of zooplankton *Notholca* and *Cyclops* were found to be preferred food of this fish as they were found to occur abundantly in water and in the gut contents of this fish. But the genera such as *Asplanchna, Brachionus, Keratella, Filinia, Polyarthra, Moina and Diaptomus* were not recorded in the gut contents of this fish though, they were found to occur more or less abundantly in the water of the rice field which indicates that these genera were not preferred food of this fish.

## DISCUSSION

**Water quality parameters in rice fields:** For good environmental condition the suitable ranges of water quality parameters are essential. The water quality parameters were recorded during the study period were found within the acceptable ranges.

Water temperature is a very important factor, which influences the physico-chemical and biological properties of water body. It also influences the food and feeding habits of fishes to a great extent. The water temperature in the present study was found to lie between 26.96 to 28.30°C in the plot.

The water temperature recorded by Ali[27] was ranged between 27 to 40.90°C in the rice fields of Malaysia. The finding of the present study is quite similar to the findings reported by Ghosh in his study in rice fields which was 27 to 29°C.

Dissolved Oxyen is the most critical chemical factor in water especially in rice fields. The values of dissolved oxygen were found to range form 3.99 to 4.43 mg $L^{-1}$ This finding is more or less similar to the findings reported by Uddin[28] in his study in rice fields and ranges of reported by him was 3.70 to 6.0 mg $L^{-1}$.

pH of water is one of the most important factor, whcih has profound effect the productivity of water body. The pH values of water in rice fields ranged from 6.14 to 7.01. Which is very close to the values 7.6 and 7.3 obtained by Uddin in his experiment in rice fish culture.

In case of aquatic productivity the total alkalinity is also an important factor. In this study the total alkalinity values (36 to 82 mg $L^{-1}$) were recorded.

The concentration of chlorophyll-a was found to range etween 13.02. to 19.20 μg $L^{-1}$ during the period of

Table 4: Generic status of different phytoplakton and zooplankton recorded in the gut contents of fishes

| Food items | Name of genera | Total No. of genera |
|---|---|---|
| Clorophyceae | *Actinastrum, Ankistrodesmus, Creatium, Chlorella, Chrysocoocus, Closterium, Coelastrum, Cosmerium, Gloeocystis, Scendesmus, Micrasterium, Staurastrum, Tetraedron, Volvox, Zygnema, Oedogonium, Ulothrix, Spirogyra.* | 18 |
| Euglenophyceae | *Euglena, Phacus* | 02 |
| Cyanophycese | *Anabaena, Aphanocapsa, Gloeotrichia, Gomphosphaeria, Microcystis, Oscillatoria, Aphanizomenon. Merismopedia.* | 08 |
| Bacillariophyceae | *Cyclotella, Fragilaria, Frustularia, Navicula, Surirella, Tabellaria, Nitzschia, Synedra.* | 08 |
| Total Phytoplankton | | 36 |
| Rotifera | *Trichocerca, Notholca.* | 02 |
| Cladocera | *Daphnia, Diaphanosoma* | 02 |
| Copepoda | *Cyclops, Nauplius* | 02 |
| Total Zooplankton | | 06 |

Table 5: Composition of different food groups recorded in the gut contents of fishes by percentage in number and by percentage of frequency of occurrence.

| Food groups | % in No. | % of occurrence |
|---|---|---|
| Clorophyceae | 31.94 | 100 |
| Euglenophyceae | 3.17 | 26 |
| Cyanophycese | 20.76 | 90 |
| Bacillariophyceae | 36.70 | 100 |
| Total Phytoplankton | 92.57 | |
| Rotifera | 5.65 | 28 |
| Cladocera | 0.38 | 2 |
| Copepoda | 1.40 | 8 |
| Total Zooplankton | 7.43 | |

the present study. The values of the present study were found to lie within the range of the values of chlorophyll-a reported by Uddin[28] which were 14.70 to 5.0 μg $L^{-1}$.

The values of nitrogen ($NO_3$-N) in the water of rice fields ranged between 1.63 to 2.63 mg $L^{-1}$ during the study period.

The values of Phosphate-Phosphorus ($PO_4$–P) ranged from 0.15 to 0.82 mg $L^{-1}$ Alikunhi[29] suggested 0.02 to 0.04 ppm $PO_4$–P for the suitable production of water body. The mean values of the present study are much higher than the values stated by Alikunhi. The higher values may be due to the application of TSP in the rice field.

**Plankton population in the water of rice field:** The Phytoplankton population so far recorded in the present study were divided into 4 groups viz., Chlorophyceae, Euglenophyceae, Cyanophyceae and Bacillariophyceae and zooplankton population into 3 groups viz., Rotifera, Cladocra and Copepoda. A total of 37 genera of phytoplankton were recorded in the plot and in zooplankton 13 genera were recorded. The total number of genera of phytoplankton and zooplankton recorded by Mumtazzuddin *et al.*[30] are more or less close to the present study. Whereas, Dewan *et al.*[31] indentified 27 genera of phytoplankton belonging to Chlorophyceae, Cyanophyceae, Bacillariophyceae and Euglenophyceae and 9 genera of zooplankton belonging to Hydrozoa,

Table 6: Composition of different food items in the gut contents of fishes by percentage in number and by percentage of frequency of occurrence

| Food Items (Phytoplankton) | Name of genera | % in No. | % of occurrence |
|---|---|---|---|
| Chlorophyceae | *Actinastrum* | 0.13 | 2.00 |
| | *Ankistrodesmus* | 0.89 | 14.00 |
| | *Creatium* | 0.38 | 6.00 |
| | *Chlorella* | 0.63 | 12.00 |
| | *Chrysococcus* | 4.13 | 68.00 |
| | *Closterium* | 7.70 | 84.00 |
| | *Coelastrum* | 0.38 | 6.00 |
| | *Cosmerium* | 0.20 | 2.00 |
| | *Gloeocystis* | 0.13 | 2.00 |
| | *Scenedesmus* | 5.97 | 74.00 |
| | *Micrasterium* | 0.13 | 2.00 |
| | *Spirogyra* | 0.38 | 4.00 |
| | *Staurastrum* | 2.00 | 24.00 |
| | *Tetraedron* | 0.13 | 2.00 |
| | *Volvox* | 0.38 | 4.00 |
| | *Zygnema* | 2.54 | 44.00 |
| | *Oedogonium* | 1.90 | 12.00 |
| | *Ulothrix* | 3.94 | 60.00 |
| Total Chlorophyceae | | 31.94 | - |
| Euglenophyceae | *Euglena* | 2.92 | 22.00 |
| | *Phacus* | 0.25 | 6.00 |
| Total Euglenophyceae | | 3.17 | - |
| Cyanophycese | *Anabaena* | 2.35 | 28.00 |
| | *Aphanocapsa* | 0.44 | 8.00 |
| | *Gloeotrichia* | 0.13 | 2.00 |
| | *Gomphosphaeria* | 1.27 | 20.00 |
| | *Microcystis* | 1.14 | 10.00 |
| | *Oscillatoria* | 11.30 | 84.00 |
| | *Aphanizomenon* | 3.56 | 36.00 |
| | *Merismopedia* | 0.57 | 6.00 |
| Total Cyanophycese | | 20.76 | - |
| Bacillariophyceae | *Cyclotella* | 0.38 | 10.00 |
| | *Fragilaria* | 11.17 | 70.00 |
| | *Frustularia* | 1.27 | 4.00 |
| | *Navicula* | 18.11 | 88.00 |
| | *Surirella* | 0.13 | 2.00 |
| | *Tabellaria* | 4.50 | 56.00 |
| | *Nitzschia* | 0.38 | 6.00 |
| | *Synedra* | 0.76 | 12.00 |
| Total Bacillariophyceae | | 36.70 | - |
| Total Phytoplankton | | 92.57 | - |
| Rotifera | *Trichocerca* | 0.32 | 4.00 |
| | *Notholca* | 5.33 | 26.00 |
| Total Rotifera | | 5.65 | - |
| Cladocera | *Daphnia* | 0.32 | 2.00 |
| | *Diaphanosoma* | 0.06 | 2.00 |
| Total Cladocera | | 0.38 | - |
| Copepoda | *Cyclops* | 1.27 | 14.00 |
| | *Nauplius* | 0.13 | 2.00 |
| Total Copepoda | | 1.40 | - |
| Total Zooplankton | | 7.43 | |

rotifera and Crustacea and Wahab *et al.*[32] reported 25 genera of phytoplankton belonging to Chlorophyceae, Bacillariophyceae, Euglenophyceae and Cyanophyceae and 5 genera of Zooplankton belonging to Crustacea and Rotifera in pont water. The total number of genera of phytoplankton and zooplankton recorded by them are less than the present study.

Among 4 groups of phytoplankton Chlorophyceae (6166 cells $L^{-1}$ by number and 39.94 by percentage in number) was the most dominant group, which was closely followed by Bacillariophyceae (3611 cells $L^{-1}$ by number and 16 to 23.38 by percentage in number) and Euglenophyceae (500 cells $L^{-1}$ by number and 3.23 percengage in number) was the least dominant group during the study period. Shaha *et al.* [33] also recorded Chlorophyceae is the most dominant group and Bacillariophyceae is the next dominant group among Phytoplankton. Chowdhury[34] also reported Chlorophyceae was the most dominant group and Bacillariophyceae was the less dominant group. Among the groups of zooplnkton Rotifera was found to be the most dominant group and Cladocera was the least dominant group. However, between the zooplankton and phytoplankton, phytoplanton population was highly dominant 11944 cells $L^{-1}$ by number and 77.34 by percentage in number) over the zooplankton population 3499 cells $L^{-1}$ by number and (22.66 by percentage in number). This finding agree with the finding of Dewan *et al.*[31] and Chowdhury[34].

**Plankton population in the gut contents of fishes:** In the present study the phytoplankton population recorded in the gut contents of *P. gonionotus* were divided into 4 groups viz., Cholorophyceae, Euglenophyeae, Cyanophyceae and Bacillariophyceae and zooplankton population into 3 groups viz, Rotifera, Cladocera and Copepoda.

In *P. gonionotus* 36 genera of Phytoplankton were redorded in the gut contents, out of which, 18 were Cholorophyceae, 2 Euglenophyeae, 8 Cyanophyceae and 8 Bacillariophyceae and 6 genera of zooplankton of which 2 genera were Rotifera, 2 Cladocera and 2 Copepoda. Whereas, Mostakin[35] obtained less number of genera (24) of phytoplankton and higher number of genera (11) of Zooplankton than the present study. But he also recorded the highest number of genera of Chlorophyceae (18) and the lowest number of the same in Euglenophyceae among the 4 groups of phytoplankton similar of present study.

Between the two groups of plankton, phytoplankton was the most dominant food group than the zooplankton which constituted more than 90 by percentage in number in the gut contents of *P. gonionotus*. Food and feeding habits of young *P. gonionotus* and reported higher feeding perference of the fish for plant foods and very less preference for animal foods. These findings conform the finding of the present study. Dev[36] also reported that the fish feeds mainly on phytoplankton, zooplankton and higher plants materials. He also reported that the fish change their food habit from zooplankton to phytoplankton, as they grow big. Haider[37] also reported *P. gonionotus* as a phytoplankton and zooplankton feeder.

In *P. gonionotus* Bacillariophyceae was found to be the most dominant and preferred foods of phytoplankton which was very closely followed by Chlorophyceae. Euglenophyceae was found to be less preferred food both by percentage in number and percentage of occurrence. Mostakin recorded Chlorophyceae and Cyanophyceae almost equally preferred and dominant food groups and Euglenophyceae as the very less preferred food among the phytoplankton food groups. However, among zooplankton food groups Rotifera was the most dominant food groups both by percentage in number and percentage of occurrence. This findings are in conformity with the findings of Mostakin. Among the genera of Zooplankton, *Notholca,* was the most preferred and dominant genera in *P. gonionotus*.

With respect to relative abundance of different food items in the water of rice fields as well as in the gut contents of *P. gonionotus* the highly preferred food items recorded were *Navicula, Fragilaria, Oscillatoria, Tabellaria, Aphanizomenon and Closterium* among phytoplankton and *Notholca and Cyclops* among zooplankton.

The mean values of water quality parameters such as Temperature, Dissolved Oxygen (DO), pH Total Alkalinity, Chlorophyll-a, Nitrrate-nitrogen and Phosphate-phosphorus showed monthly variations and they were within productive range.

With respect of plankton population in the water or rice field a total of 37 genera of Phytoplankton belonging to Cylorophyceae, Euglenophyceae, Chanophyceae and Bacillariophyceae were rrecorded in the water of the experimental plot. Whereas in zooplankton population a total of 13 genera belonging to Rotifera, Cladocera and Coperoda were recorded. Among the phytoplankton population Chlorophyceae was the most dominant group and Euglenophyceae was the least dominant group. Whereas in zooplankton Rotifera was recorded as the most dominant group and Cladocera as the least dominant group. However among the plankton population phytoplankton was highly dominant over zooplankton population in the water of rice field.

Among the genera of phytoplankton *Fragilaria* and *Navicula* were highly dominant which were closely

followed by *Surirella, Chlorella, Chrysococcus, Scenedesmus, Ulothrix, Euglena Cyclotella and Oscillatoria.* Among the genera of zooplankton *Brachionus* and *Nauplius* were the most dominant genera, which were closely followed by *Cyclops* and *Asplanchna.*

The total number of genera of phytoplankto recorded in the gut contents of *P. gonionotus* were 36. And the genera of zooplankton recorded were 6. Among the 4 groups of phytoplakton population Bacillariophyceae was the most dominant and preferred food group. Euglenophyceae was the least dominant group. Among the food groups of zooplankton, Rotifera was found to be the most dominant food group.

However, between the two groups of plankton phytoplankon was the most dominant and preferred food group and zooplankton was found to be the very less preferred food group in *P. gonionotus.*

Among the genera of phytoplankton *Navicula* was the most preferred genus. Besides *Navicula* the relatively more preferred genera were *Oscillatoria, Fragilaria, Closterium, Scenedesmus, Tabellaria, Chrysococcus, Ulothrix and Aphanizomenon* and among the genera of zooplankton *Notholca* and *Cyclops* were the most dominant and preferred genera. From the above findings *P. gonionotus* may be regarded as planktivores

## REFERENCES


1. Pullin, R.S.V., 1985. Time to reapprise rice-fish culture. ICLARM Newslett., 8: 3-4.
2. Taylor, S.R., B. Pakdee and O. Klampratum, 1988. Border Methods and Fish Culture: Synergistic Effect on the Yield of Rice Grain. In: Pullin R.SV., T. Bhukaswan K. Tonguthai and J.L. Maclean, (Eds.). ICLARM Conf. Proc., 24: 91-98.
3. Das, D.N., B. Roy and P.K. Mukhopadhyay, 1991. Rice-Fish integrated farming in an open deepwater rice field. Proc. Nat. Symp. New Harozons freshwater Aquaclt. Bhubaneswar. India, pp: 22-23.
4. Ghosh, A., 1992. Rice-fish Farming Development in India; Past, Present and Future. In: dela Cruz, C.R., C. Lightfoot, B.A. Costa-pierce, V.R. Carnagal and M.P. Bimbao (Eds.). Rice-fish Research and Development in Aisa. ICLARM Conf. Proc., 24: 27-43.
5. Sarkar, U.K., 1993. Integrating fish farming as a component in rice-based farming system of coastal West Bengal. Environ. Ecol., 11: 458-461.
6. DoF (Department of Fisheries), 1998. Fish week (1998) Deparement of Fisheries, Ministry of Fisheries and Livestock. Government of the People's Republic of Bangladesh, Ramna, Dkaha, pp: 110 .
7. Hora, S.L and T.V.R . Pillay, 1962. Handbook on fish culture in the Indo-Pacific region. Fish. Biol. Technol. Paper, 14: 204.
8. Khoo, H.K. and E.S.P. Tan, 1980. Review of Rice-fish Culture in Southeast Asia, pp. 1-14. In: Pullin, R.S.V. and Z.H. Shehedeh, (Eds.). Integated Agriculture-Aquaculture Farming Systems. ICLARM Conf. Proc., 4: 258.
9. Nie, D., Y. Chen and J. Wang, 1985. Recent development of fish culture in rice field in China. Proceedings of Asian Symposium on freshwater fish culture. Beijing, China.
10. dela Cruz, R.C., 1992. Rice-fish systems in Indonesia. In farmers prove integrated Agriculture-Aquaculture: A Technology Information Kit. ICLARM and IRRI, Philippines, pp: 1-4.
11. Kamp. K. and R. Gregary., 1993. Fish cultivation as a mean to increase profitability from rice field: Implication for integrated pest Management. Paper presented in the Third Asian Regional integrated Rice-fish Farming Research and Development Workshop, West Java, Indonesia, pp: 6-11 .
12. Hynes, H.B.N., 1950. The food of freshwater stickle backs *(Gasterosleus aculaetus* and *Pygosteus Pungitius),* with a review of methods used in studied on the food of fishes. J. Anim. Ecol., 19 : 36-48.
13. Singh, V.P, A.C Earcy and T.H .Wickam, 1980. Rice Agronomy in Relation to Rice-fish Culture. In: Pallin, R.S.V. and Z.H. Shehadeh, (Eds.), Integrated Agriculture-Aquaculture Farming Systems, ICLARM.
14. Mazid, M.A., B. C. Bakshi, A. K. Das and N. Bari, 1992. Fish culture in rice field. FSRDP and BARC, pp: 1-27.
15. Hossain, A., A. Hussain, F.A. Chaughtai M. Butt, 1990. Effects of Leucana and Sesbania leaf manuring on crop growth and Physico-chemical properties of soil. Nitrogen Fixing Res. Report, 43: 907.
16. McComish, T.S., 1967. Food habits of big mouth and small buffalow in Lewis and Cark Lakes and Missouri River. Trans. Amer. Fish. Soc., 69: 70-74.
17. McKehni, R.J. and R.B. Penner, 1971. Food habits of white Sturgeons, Acipencer *transmontanus* in San Pablo and Suisan Bays Callifornia, Calif. Fish and Game, 57: 109-212.
18. Dewan, S., 1973. Investigations into the ecology of fishes of Mymensingh lake. Ph. D Thesis. Bangladesh Agricultural University, Mymensingh, Bangladesh, pp: 235 .
19. Dewan, S., M. J.U. Miah, A. L. Sarker and S. N. Shaha, 1979. Seasonal patterns of feeding of juvenile major carp. *Labeo rohita* (Ham). in a Bangaldesh pond. J. Fish Biol., 14: 511-515.

20. Van Someren, V.D., 1946. A note on the food of young blue gill sunfish, *Lepomis macrochirus* in Kenya colony. J. East Afr. Veg. Natl. Hist Soc., 19: 64-66.
21. Pillay, T.V.R ., 1952. A critique of the methods of study of food of fishes. J. Zool. Soc. India, 1: 185-200.
22. Dewan, S., M.M. Ali and M.A. Islam, 1977. Studies on the size and pattern of feeding of fries and fingerlings of three major carps. viz. *Labeo rohita* (Ham.), *Catla Catla* (Ham) and *Cirrhinus mrigala* (Ham). Bangladesh J. Agril., 2: 225-228.
23. Ali, M.M. and M.A. Islam, 1981, Studies on the food of *Labeo rohita* (Ham), M.Sc Thesis, BAU, Mymensingh Bangladesh.
24. Dewan, S., M.J.U. Miah and M.N. Uddin, 1985. Studied on the food and feeding habits of *Cyprinus carpio*. II. Diel and seasonal patterns of feeding of the fish. Bangladesh J. Aquacult., 6-7: 11-18.
25. Miah, M.J.U, S. Dewan and Wahiduzzaman, 1984. Studies on the type and amount of food taken by the silver carp, *Hypophthalminchthys molitrix* (Val.) and its diel paterns of feeding in Bangladesh pond. Bangladesh J. Fish., 7: 49-59.
26. Miah, J.U., S. Dewan and M.N. Uddin, 1985. A study on the seasonal patterns of feeding of fry and fingerlings of *Catla catla* (Ham). Bangladesh J. Agril. Sci., 11:161-165.
27. Ali, A.B., 1990. Rice fish farming in Malaysia: A resource optimization. AMBIO, 19: 404-408.
28. Uddin, J.M. 1998. Effects of fish culture on rice fields of rice and nutrients availability in soil, straw and grain. M.S. Thesis, Bangladesh Agricultural University, Mymensingh, pp: 115.
29. Alikhuni, K.H., 1957. Fish culture in India. Far. Bull. Ind. Coun. Agro. Res., 20: 144.
30. Mumtazuddin, M., M.S. Rahman and G. Mostafa, 1982. Limnological studies of four selected ponds at the Aquaculture Experiment Station. Mymensingh. Bangladesh J. Fish., 2-5: 83-90.
31. Dewan, S., M.A. Wahab, M.C.M. Beveridge, M.H. Rahman and B.K .Sarkar, 1991. Food selection, electivity and dietary over lap among planktivores chinese and Indian major carps fry and fingerlings grown in extensively managed, rain-fed ponds in Bangladesh. J. Aquaculture and Fishers Management, 22: 207-294.
32. Wahab, M.A, Z.F. Ahmed, M.A. Islam and S.M. Rahamatullah. 1995. Effect of introduction of common carp, *Cyprinus carpio* (L), of the pond ecology and growth of fish in polyculture. Aquaculture Res., 16: 19-628.
33. Sah, G.N., K.L. Sehgal, E. Mitra and A.C. Nandy, 1971. Studies on the seasonal and diurnal variations in physico-chemical and biological parameters of a freshwater pond. J. Inland fish. Soc. India, 3:79-102.
34. Chowdhury, F.A., 1999. Effects of *Hypopthalmichthys molitrix* and *Catla catla* on the growth, survival and yields of *Amblypharylgodon mola* in mixed culture. MS Thesis, University, BAU, pp: 131.
35. Mostakin, 1997. Studies on the food and feeding habits of young *Puntius gonionotus* (Bleeker), MS Thesis, BAU pp: 67.
36. Dev, B.C., 1994. Food selection and electivity indies of thai barb *Puntius (=Barbodes) gonionotus* in extensively managemed, rain-fed ponds in Bangladesh MS Thesis., Faculty of Fisheries, BAU, Mymensingh Bangladesh.
37. Haider, A.N.M.A., 1996. Dietary Overlap of Thai sarpunti, *P. gonionotus* (Bleeker) in traditional carp polyculture condition. MS Thesis., BAU, Mymensingh, pp: 50.