Chapter 08: General Discussion

Chapter – 08

GENERAL DISCUSSION

Physico-chemical parameters

Physico-chemical parameters of water sample collected from selected ponds during different seasons that reflect seasonal changes in water quality. The monthly variation of air and water temperature has been presented in (Table-1 & 2). The air temperature ranges are from 26.3 ^{o}C to 36.18 ^{o}C and mean values are (31.33 ^{o}C and 33.07 ^{o}C) displayed in (Table-3 and Fig.1) during the study period. The monthly variation of water temperature ranges are from (19.2 ^{o}C to 34.8 ^{o}C). The mean values are (19.2 ^{o}C and 27.15 ^{o}C) displayed in (Table-3 and Fig. 2). The water temperature of cultural ponds varies with climatic condition, sunlight and depth. Water temperature always shows lower values than air temperature. p^{H} of the water varies from (6.5 to 8.1) are recorded to be slightly acidic and alkaline in nature in various months. These ranges are favourable for fish culture according to SRSE, reported range (6.5 to 9.0). Salinity of ponds water ranges from 0.07 to 0.47 plays an important role in the growth of fishes through osmoregulation of body minerals of the nature of the exchange system. Dissolved oxygen is a very important parameter to maintain water quality. The mean values are (5.84 and 5.85 mg/l) in both the two years displayed in (Table-3 and Fig. 6). Free CO_2 and alkalinity of water are (1.45 to 8.56 ppm) and (41.71 to 86.22 mg/l). Maximum alkalinity in summer and minimum in monsoon season due to rain water. Similar results has been expressed by Islam (2007) in a pond of Rajshahi, Bangladesh. The ranges of (50 to 150) are eligible for fish culture according to SARC which induce the fish productivity. Total hardness of water increases due to addition of calcium and magnesium ions (Bhatt et al., 1999). In the study period, mean values of total hardness are (73.83 and 143.39 ppm) displayed in (Table-3 and Fig. 9). The ranges of total hardness (30 to 180) are favourable for fish productivity according to ICAR. Chloride, phosphate, total inorganic nitrogen values are very low all over the study period.

Similar observation has been seen by Das, (2000).

Physico-chemical parameters like water temperatures, pH, salinity, DO, free CO_2, alkalinity, hardness, chloride, phosphate, total inorganic nitrogen, calcium ranges are favourable for fish culture (according to ICAR, SRAC, NRPC, Table-3) which induce the fish productivity. Aquatic environment and season of the year are most important to determine the food and feeding habits of different fishes of pond for increasing fish production. Different parameters of freshwater play a vital role for healthy fish production.

Zooplankton density and diversity

Different zooplankton species obtained from the study period. Total numbers of 31 zooplankton species are identifying. Total zooplankton population is contributed in (Table-4 to 7) and abundant species during the study period are shows in Pl. IV. The zooplankton populations (four major groups and two minor groups) are included of Rotifera, Copedoda, Protozoa, Ostracoda, Amphipoda and Cladocera. Zooplankton population is higher in winter season due to low temperature and favourable growth of planktons while low in rainy season due to high current favourable and growth turbidity of water and also low dissolved oxygen content. Zooplankton plankton density is maximum in winter and minimum in monsoon season.

Phytoplankton density and diversity

Seven classes of Phytoplankton are identified and total phytoplankton populations are displayed in (Table-8 to 11) and abundance species of phytoplankton are shown in Pl. V. Among the major groups of phytoplankton population are Chlorophyceae, Bacillariochyceae, Cyanophyceae and Charophyceae and three minor groups are Dinophyceae, Xanthophyceae and Tribiophyceae.

Community Assessment

Diversity indices of Shannon-Weaver biodiversity index (H') is an important comment on the seasonal fluctuation of plankton (Sibel, 2006). The H' is higher in winter and lower in summer. Such type of observation was found by Ali et al., (2003) in Indus River, Pakistan**.** The higher value of Shannon-Weaver index of plankton community indicates greater species diversity and increases the stability of the community (Ludwik and Reynolds, 1998). The Shannon index values are obtained during study period that indicates better water quality.

Berger-Parker dominance index value of planktonic community ranges from 0.105263 to 0.232558. According to Whittaker, 1965, the value of dominant index is always higher where the community is dominated by a fewer number of species. It confirms our investigation. Margalef-richness index is characterized by longer food chain. The higher value of species diversity index suggests the decreasing of species richness with increasing trophic status (Vincent et al., 2012). In these ponds, species richness is very high (4.950636) throughout the year when the condition is more and less stable.

Anatomical parameters

Gastrosomatic index (GaSI), gonadosomatic index (GSI), hepatosomatic index (HSI) and condition factor (K) of male and female, young and adult fishes of *Heteropneustes fossilis, Clarias batrachus* and *Anabas testudineus* are determined separately.

Study of Gastrosomatic index (GaSI)

The mean GaSI values of *Heteropneustes fossilis* of young and adult male are observed. Higher values (15.22±1.14, 1.62±0.09) in the monsoon and post-monsoon and lower values (0.74±0.04, 0.34±0.02) in the post-monsoon and winter might be due to temperature impacts. Similarly young and adult females are observed higher values (2.52±0.03, 2.29±0.14) in post-monsoon and monsoon seasons and lower values (0.40±0.04, 1.09±0.05) in winter and summer.

The mean GaSI values are gradually increasing from monsoon to post-monsoon respectively whereas gradually decreasing in winter and summer in *Heteropneustes fossilis*. In *Clarias batrachus*, the mean GaSI values of young and adult male are observed and higher values (2.04±0.02, 3.42±0.02) in the post-monsoon and lower values (0.98±0.2, 0.8±0.3) in monsoon. Similarly, young and adult female show higher values (3.11±0.05, 2.97±0.01) in winter and post-monsoon and lower values (1.28±0.04, 0.58±0.03) in the monsoon. The GaSI values are gradually increasing from post-monsoon to winter and gradually decreasing in monsoon of *Clarias batrachus.* In *Anabas testudineus,* the mean GaSI values of young and adult male show higher values (3.27±0.03, 3.31±0.04) in monsoon and lower values (0.44±0.02, 0.67±0.02) in summer. Similarly, young and adult female show higher values (1.85±0.13, 2.39±0.15) in monsoon and lower values (0.62±0.04, 0.71±0.02) in winter. The GaSI values are gradually increased in monsoon and decreased in winter to summer in *Anabas testudineus.*

In the present investigation, the maximum GaSI value is found in monsoon to post-monsoon and minimum in summer to winter. Generally gastrosomatic index value is low during the spawning season of fish species (Mohanty et al., 2009). The gastrosomatic index value of the specimen is much lower than the gonadosomatic index. Pillay (1954) expressed that spawning season of *Mugel tade* forskal may start in May to June and continue till September.

Study of Gonadosomatic index (GSI)

Gonadosomatic index (GSI) mean values of *Heteropneustes fossilis* of young and adult male are at peak values (2.70±0.03, 2.03±0.02) in monsoon and lower values (0.45±0.03, 0.41±0.04) in post-monsoon and winter. Similarly adult and young female are observed to be peak values (8.48±0.02, 6.12±0.05) in summer and lower values (0.44±0.02, 0.36±0.02) in winter and post-monsoon and both show the similar trend. The GSI values of male are gradually increasing in summer to monsoon whereas decreasing in post-monsoon.

The GSI values of female are increasing in summer whereas decreasing in post-monsoon. In *Clarias batrachus,* the mean GSI values of young and adult male are observed to be peak values (0.38±0.03, 0.66±0.02) in summer and monsoon and lowest values (0.18±0.03, 0.27±0.02) in post-monsoon and summer. Similarly young and adult female show peak values (6.68±0.02, 12.95±0.08) in summer and lowest values (0.34±0.02, 0.55±0.02) in winter and post-monsoon. The GSI values are gradually increased in summer to monsoon and decreased in post-monsoon to winter.

In *Anabas testudineus,* the mean GSI values of young and adult male are observed to be peak (1.09±0.09, 1.50±0.03) in post-monsoon and lowest values (0.32±0.03, 0.16±0.03) in monsoon and winter. Similarly young and adult female shows peak values (4.45±0.03, 10.94±0.04) in summer and lowest values (0.57±0.02, 0.44±0.13) in winter. The GSI values indicate that the period of maximum growth of male (testis) and female (ovary) fishes. However, the breeding season of air-breathing fishes starts in the month of early June and it is extended till September. During monsoon, the development and growth of gonad occur simultaneously in both male and female. These results indicate the most favourable natural condition. Incidentally Rheman et al., (2002) has indicated the peak of gonadosomatic index. The fishes have yet to attain first maturity as Lal Mohan and Nanda Kumaran (1987) record the body length of mature male and female. In *Clarias batrachus,* it has been observed that the fish attains sexual maturity at body length ranging from 105 to 180 mm at the end of first year. The GSI value increases with the increasing body weight and length during breeding season in female. Another factors responsible for increasing in GSI value in the case of both male and female fishes in May and June are due to high level of temperature in water. Maximum GSI values correspond to the spawning season of this fish. Barnabe, (1994) reports that high GSI in *Sea bass* has been found at peak in spawning season and increases again in the post breeding season. The GSI indicates

gonadal development and maturity of fish declining abruptly thereafter (Parameswaran, 1975). Testis weight and GSI clearly change according to reproductive season in all groups reaching their peak values in the preceding season and decrease with spawning in the breeding season and then increase again in the post breeding season. In males, the decrease in GSI corresponds to the loss of gonad weight which is due to the elimination of the spermatic residual bodies. The temporal change in GSI has been used to provide rough estimation of spawning period for fishes. GSI values are highest in early June and decreases through late September due to spawning period from June to September which is similar to the results of Gaikwad et al., (2009) where the ratio between the body weight and the weight of the gonad shows the status of the ovary in terms of maturity and denotes the phase of reproduction cycle. The GSI of air-breathing fish *Channa gachua* (Ham.) increases with the maturation of the fish and gonad. The maximum GSI value is found in the month of June which indicates the maximum gonadal growth. In the present study, high value of GSI denotes attainment of peak maturity of gonads. Hence the high GSI values indicate that the peak spawning takes place during June to December. Shaikh and Lohar (2011) also report that low GSI in *Labeo rohita*, *Cyprinus mrigala* and carp fish during October to January may be due to dormancy of gonads in post breeding season. The GSI values are the increased amount of protein and lipids in both pre-breeding and post breeding seasons. Most of the fishes show seasonal variations in reproductive physiology. The breeding season falls in the month of June to September and the post breeding season from the month of October to December each year. Allison et al., (2011) studies the GSI, HSI in *Pellonula leonensius*. HSI has a maximum value in the month of June.

Hepatosomatic index (HSI)

The condition of the liver and whole body as measured with the hepatosomatic index (HSI) can provide information on potential pollution impact. The maximum mean values of young

and adult male of *Heteropneustes fossilis* are recorded (1.12±0.13, 2.64±0.03) in monsoon and winter and lowest values (0.41±0.01, 0.68±0.04) in post-monsoon and monsoon. Similarly young and adult female are having peak values (0.99±0.05, 1.32±0.1) in post-monsoon and monsoon and lowest values (0.57±0.03, 0.62±0.02) in winter and summer. The maximum mean values of young and adult male of *Clarias batrachus*, are recorded (0.72±0.03, 0.93±0.03) in summer and post-monsoon and lowest values (0.52±0.01, 0.36±0.02) in post-monsoon and summer. Similarly young and adult female are having peak values (1.17±0.02, 0.89±0.02) in summer and post-monsoon and lowest values (0.41±0.13, 0.41±0.13) in winter and monsoon. The maximum mean values of young and adult male of *Anabas testudineus*, are recorded (1.47±0.11, 1.36±0.03) in winter and lowest values (1.03±0.02, 0.61±0.03) in post-monsoon. Similarly young and adult female are having peak values (1.8±0.05, 1.31±0.03) in winter and lowest values (0.78±0.05, 0.78±0.07) in post-monsoon. The HSI value is increased in monsoon in both male and female. HSI values are increased with increasing of body weight and length during breeding season in female. The peak values of the spawning period indicate to close relationship between GSI and HSI. Low values of HSI are found during recycling and dry period. This result is similar to the scientific report submitted by Awaji and Hanyu, 1987. This finding is similar to that of other species e. g. Asahina et al., 1990, Htun-Han, 1978.

Condition factor (K)

The mean values of condition factor (K) recorded in *Heteropneustes fossilis* young and adult male are having maximum values (1.06±0.11, 0.97±0.02) in winter and minimum values (0.56±0.02, 0.64±0.11) in monsoon and post-monsoon. Similarly, young and adult female show highest values (0.86±0.09, 1.00±0.04) in winter and lowest values (0.46±0.08, 0.51±0.03) in summer and monsoon.

In *Clarias batrachus*, the condition factor (K) of young and adult male are observed to be peak values (2.54±0.03, 2.46±0.03) in winter and lowest values (0.96±0.2, 0.74±0.03) in monsoon period. Similarly, young and adult female show peak values (2.1±0.08, 2.87±0.11) in winter and lowest values (0.86±0.04, 0.83±0.04) in post-monsoon and monsoon.

In *Anabas testudineus*, the mean condition factor (K) of young and adult male are observed to be peak values (2.79±0.11, 3.03±0.12) in winter and lowest values (1.95±0.14, 2.35±0.11) in summer. Similarly, young and adult female show peak values (2.70±0.11, 0.99±0.14) in winter and monsoon and lowest values (2.09±0.12, 2.15±0.14) in summer and winter. The condition factor (K) values for the weight of specimen (31.14-190.41 gm.) are also on the higher size. Total body length of the three females range from 12.5 to 29.7 cm. Sommer et al., (1996) reports that female *Johnius* sp. in South-West Coast of India mature at 10.5 to 11.5 cm of total length. In the species of *Johnius dussumieri*, the size of first maturity is from 130 to 140 mm (Dholakia, 2004). In two years, of study periods the condition factor (K) are (0.46±0.08 to 3.03±0.12) of the entire specimen are lower than the gonadosomatic index values (0.16±0.03 to 12.95±0.08). The condition factor (K) are (0.46±0.08 to 3.03±0.12) of the entire specimen are lower than the gastrosomatic index values (0.34±0.02, 15.22±0.14).

Biochemical parameter of protein in body muscle

In *Heteropneustes fossilis*, protein level increases in male and female in monsoon and winter and decreases in winter and summer. In *Clarias batrachus* the protein level increases in monsoon and winter and decreases in summer. In *Anabas testudineus*, protein level increases in adult male in monsoon and young male in winter and decreases in adult male in post-monsoon and young male in monsoon whereas protein level of adult and young female increase in summer and decrease in monsoon. Both are same in the case of female.

These finding of major changes in the body composition of fishes have been brought by the changes in the ponds water in different seasons, nutritional states and breeding period of fish (Ali et al., 2003).

In *Clarias batrachus,* protein depends on the seasonal variations in dissolved oxygen content of aquatic ecosystem. The protein contents are (63.14 to 74.43%) in *Clarias batrachus* which is reported by Jindal (2008).

In *Anabas testudineus* shows higher protein content to greater concentration in enzyme. Kilinger also reports the facts behind it due to their carnivorous feeding nature. The protein content of dry muscle increases gradually to reach the highest in spring in both the sexes of fishes whereas the lowest value is in the rainy season. It has been found that the spawning period of fishes falls in the rainy season. Siddiqui et al., (2010) examines the highest protein level of *Mystus tangara* in pre-monsoon and lowest in monsoon in cat fish. Islam et al., (2005) studies that the mean protein content of female is lower than that of the male. Pilla (1979), Adewumi (2014) examines the crude protein (65.94 to 67.77%) in wild and cultured *Clarias gariepinus.* As per Elagba et al., (2013) studies on *Heterotis niloticus* the protein content is (78.8%).