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# Bottom Fauna of the Freshwater Fish Ponds in the Tarai Region of Uttarakhand

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**Abstract**

An attempt was made to evaluate the total density, composition and seasonal variation of the benthic invertebrates in the polyculture fish ponds at Pantnagar. The average population of these animals in the ponds varied from 231.25 ± 13.60—698.67 ± 20.60 no./$m^2$. The total density was low during winter whereas peak density was recorded in the May (summer). A total of 14 genera of benthos were recorded including gastropods (4), pelecypods (1), oligochaetes (2) and insects (7). Insects were the major contributors to the macro-benthic community comprising 76.4% of the total population during winter and 78.03% during summer. Oligochaetes with percent composition 10.06 during winter, 13.23 during summer and 13.41 during rainy season were next to the rank. Contribution of molluscs was lower but *Limnaea, Pila* and *Unio* were perennial in all the ponds.

**Key words : Polyculture, Ponds, Benthic invertebrate, Total density.**

Benthic invertebrate community is integral component of aquatic ecosystem. Benthic organisms alter sediment organic content and serve as natural food for crustaceans and fishes (Islam et al. 2001). Freshwater benthic community include some common members of gastropods and bivalves, oligochaete worms and leaches, chironomid and other insects larvae and other adult insects. These benthic species provide a variety of ecosystem services e.g., accelerate detritus decomposition (Wallace and Webster 1996), release bound nutrients into solution by feeding activity and burrowing, serve as food to bottom dwellers, and accelerate nutrient transfer to overlying water of ponds (Blumenshine et al. 1997, Mcinlire and Boyd 1980). Important work on benthos of different aquatic ecosystem has been done by Gupta and Pant (1983), Freimuth and Bass (1994) and Demir et al. (2001). Few workers have investigated benthic invertebrate in fish ponds (Mondal and Moitra 1975, Covich et al. 1999, Wallace and Webster 1996). In the present investigation attempt was made to evaluate the composition and seasonal variation of benthic invertebrates in the polyculture fish ponds so as to get an understanding of their utilization at trophic level.

## Methods

The investigation was carried out in three earthen rectangular ponds at Instructional Fish Farm of College of Fisheries, Pantnagar. The farm has an extensive area in the form of nursery, rearing and grow-out ponds. The ponds under study were grow-out ponds with an area of 0.3—0.5 ha and depth 1.5 m.

Water and sediment samples were collected weekly and fortnightly respectively and estimation of various physical and chemical parameters were made following standard procedures (APHA et al. 1985). Samples for the benthic invertebrate analyses were collected from different places of the ponds with the help of a hand dredge (25 $cm^2$) and then mixed and kept in the enamel trays for analyses in the laboratory. Sediment samples were sieved along with water through sieves. The organisms were picked with the help of forceps and brush and kept separately (group wise) in 5% formalin. Identification of organisms was made with the help of standard literature (Pennack

**Table 1.** Chemical characteristics of the pond sediments. W = winter, S = summer, R = rainy.

| | Ponds | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | P1 | | | P2 | | | P3 | | |
| Parameters | W | S | R | W | S | R | W | S | R |
| pH | 6.7-7.0 | 6.9-7.3 | 6.9-7.3 | 6.7-7.0 | 6.8-7.3 | 6.9-7.2 | 6.7-7.1 | 7.0-7.4 | 7.0-7.4 |
| Organic carbon (%) | 0.8-1.3 | 0.7-1.24 | 0.8-1.06 | 0.92-1.52 | 0.8-1.26 | 0.9-1.34 | 1.06-1.64 | 0.96-1.32 | 1.0-1.56 |
| Nitrogen (mg/ 100g soil) | 18.0-24.6 | 16.8-23.8 | 16.6-24.0 | 18.6-25.0 | 18.0-23.0 | 18.4-24.6 | 24.4-29.4 | 20.0-26.4 | 20.8-27.0 |
| Phosphorus (mg/100g soil) | 5.4-6.0 | 4.5-5.6 | 5.2-6.0 | 6.0-6.8 | 5.6-6.0 | 6.0-6.4 | 6.8-7.8 | 5.6-7.0 | 6.0-6.8 |

1978; Tonapy 1980). The animals were counted group-wise and their density was calculated following APHA et al. (1985).

## Results and Discussion

Observations recorded on various chemical properties of soil are presented in Table 1. The trend of seasonal variation was more or less similar in all the ponds. The pH has direct bearing on production of fish food organisms (Das 2001). The pH range of 6.5—7.5 is optimum for soil. Organic carbon content varied between 0.7—1.64% in the experimental ponds. Organic carbon was in good amount in all the ponds especially in pond $P_3$ (0.96—1.64) where fish cum duck integrated farming was carried out for the past two years (2004—06). The concentration of nitrogen ranged from 16.6—29.4 mg/100 g of soil in the ponds. The phosphate concentration in the ponds ranged from 4.5—7.8 mg/100 g soil, highest being in pond $P_3$ (5.6—7.8 mg/100 g soil). Nitrogen and phosphorus contents in the soil are important as they increase fish food organisms (Akafor and Okafor 1997). A pond having N>25 mg/100 g soil and P>6 mg/100g soil indicate productive for fish culture (Jhingran 1982).

Average values of various physico-chemical parameters of water during the experimental period are given in Table 2. Water temperature fluctuated similarly in all the ponds with a minimum of 14.0 C to a maximum of 31.0C. Temperature of water varied seasonally parallel to atmospheric temperature. Temperature controlling various chemical and metabolic reactions is well documented. Benthic population and faunal diversity was maximum during summer whereas less population and only a few species were recorded during winter. The cause is suitability of temperature which accelerates decomposition of organic matter providing conducive environment for growth and multiplication of benthic organisms (Singh and Singh 1996), since dead organic matter is the main source of energy for benthic species in ponds (Wallace and Webster 1996; Covich et al. 1999).

The range of variation of various factors during the period of study in all the ponds reveals that the physico-chemical condition of the ponds fluctuated within the optimum range of fish production. The values of transparency ranged from 16.5—25.2 cm. In general, ponds showed low values of transparency, this is because of common carp present in the ponds although high values of transparency were found during winter. Poor visibility during rains can be accounted to non-biological turbidity. Total dissolved solid (TDS) values were maximum during the winter months and minimum in October (end of rainy). Pond $P_3$ had maximum TDS.

During the present study mean values of pH of pond water were about the same (6.8—7.8) in all the ponds. Water of all the ponds remained slightly alkaline. It was during winter that a fall in pH was recorded in all the ponds. It is reasonable to suggest that low phytoplankton population (high free $CO_2$) was responsible for decrease in pH. Slightly alkaline water pH indicates productive nature of the ponds. According to Tripathi (1982), best water for support of fish and other aquatic life should have alkalinity between 100—140 mg/liter. In the present study the alkalinity values of 88—137 mg/liter were in this range indicating productive nature of the ponds.

The DO content ranged from 4.9—7.6 mg/liter in the ponds. Seasonal trend in fluctuation was almost similar in all the ponds. DO values were higher during March—April whereas during winter values were low.

**Table 2.** Range of various physical and chemical parameters of pond waters during study period. W=winter, S=summer, R=rainy.

| | Ponds | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | P1 | | | P2 | | | P3 | | |
| Parameters | W | S | R | W | S | R | W | S | R |
| Temperature (C) | 14.0-25.2 | 25.8-31.0 | 29.0-30.2 | 14.0-25.0 | 27.0-31.0 | 29.2-30.4 | 14.0-25.2 | 27.4-31.0 | 29.1-30.4 |
| Transparency (cm) | 18.3-25.0 | 18.7-21.6 | 17.0-23.4 | 17.8-24.8 | 18.5-22.8 | 16.8-23.0 | 18.5-24.0 | 17.6-21.8 | 16.5-22.4 |
| TDS (mg/l) | 70-120 | 62-112 | 68-110 | 80-132 | 80-118 | 90-120 | 100-180 | 86-120 | 100-160 |
| pH | 7.0-7.5 | 7.5-7.8 | 7.5-7.8 | 6.9-7.4 | 7.4-7.8 | 7.5-7.8 | 6.8-7.4 | 7.4-7.8 | 7.4-7.7 |
| Free $CO_2$ (mg/l) | 0.0-7.2 | 0.0-4.0 | 0.0-5.2 | 0.0-6.2 | 0.0-4.0 | 0.0-5.8 | 0.0-8.4 | 0.0-4.6 | 0.0-5.8 |
| DO (mg/l) | 5.2-6.0 | 5.8-7.2 | 5.0-6.4 | 4.9-6.0 | 5.5-7.0 | 5.0-6.6 | 5.2-6.0 | 5.8-7.6 | 5.2-6.2 |
| Alkalinity (mg/l) | 90-110 | 86-108 | 86-110 | 88-112 | 86-108 | 86-102 | 98-1.32 | 92-120 | 90-112 |
| $NO_3$-N (mg/l) | 0.12-0.22 | 0.08-0.14 | 0.08-0.12 | 0.16-0.22 | 0.10-0.16 | 0.08-0.18 | 0.16-0.32 | 0.12-0.24 | 0.10-0.22 |
| $PO_4$-P (mg/l) | 0.06-0.12 | 0.04-0.08 | 0.02-0.08 | 0.07-0.16 | 0.02-0.10 | 0.02-0.08 | 0.08-0.20 | 0.06-0.12 | 0.06-0.18 |

Low values of DO during rainy season justifies the lack of photosynthesis due to cloudy days and rains. Free $CO_2$ content in ponds ranged between 0.0—8.4 mg/liter. It was either in traces or absent during major period (summer) while it was in good amount during winter substantiated by work of Munawar (1970).

Nitrate (0.08—0.32 mg/liter) and phosphate (0.02—0.20 mg/liter) concentrations were in the range indicating good productivity. Not very significant seasonal variation was found due to regular fertilization schedule. However, little increased concentration in water and sediment during winter is required as phytoplankton population was low during winter . Active uptake of nutrients during March is also indicated by little lower values during summer (Tripathi 1982). Both nitrogen and phosphorus are important for benthic productivity (Perrin and Richardson 1997, Dipasquale et al. 2003). Freimuth and Bass (1994) found that an increase in algae due to nutrient augmentation can lead to increase in benthic invertebrate population. Higher population of faunal groups and total population recorded in pond $P_3$ is thus justified.

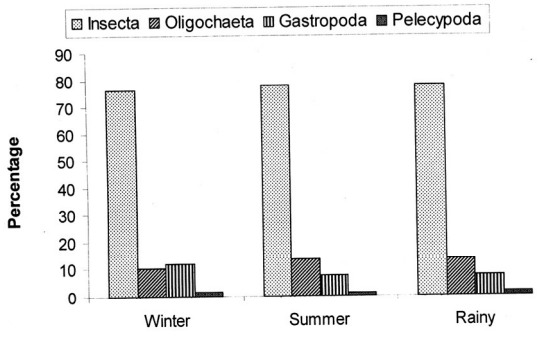


**Figure 1.** Percentage share of benthic invertebrates during different seasons.

Results on composition of benthic fauna in the ponds are presented in Table 3. A total of 14 genera of benthic invertebrates were recorded including gastropoda (4), pelecypoda (1), oligochaeta (2) and insecta (7). Maximum number of the species was observed in the summer months whereas few species were recorded in winter. *Lymnaea, Pila* and *Unio* were perennial in all the ponds. The species composition of the ponds was similar because of similar soil tex-

**Table 3.** Species composition of macro benthic invertebrates in the ponds.

| Groups | Species |
|---|---|
| **Mollusca** | |
| Gastropoda | *Pila* sp., *Limnaea* sp., *Melanoides* sp., *Vivipara* sp. |
| Pelecypoda | *Unio* spp. |
| **Annelida** | |
| Oligochaeta | *Tubifex* spp. |
| **Insecta** | |
| Diptera | *Chironomus* larvae |
| Odonata | Dragon fly nymph |
| Coleoptera | *Dystiscus* sp., *Sternolophus* sp. |
| Ephemeroptera | May fly nymph |
| Hemiptera | *Gerris* sp., *Laccotrephes* sp. |

**Table 4.** Mean values (±SD) of numerical density (no./m²) of various groups of benthic invertebrate fauna in different experimental ponds. Values given in the table are means (n=3).

| Groups | Ponds | Winter | Summer | Rainy |
|---|---|---|---|---|
| Insecta | $P_1$ | 178.90±13.59 | 482.13±16.67 | 412.38±11.14 |
| | $P_2$ | 183.27±12.91 | 502.27±17.00 | 426.09±12.34 |
| | $P_3$ | 221.7 ±13.20 | 539.07±16.15 | 450.5 ± 12.04 |
| Oligochaeta | $P_1$ | 20.75 ± 4.19 | 78.76 ± 5.39 | 71.73 ± 4.11 |
| | $P_2$ | 28.05 ± 3.92 | 82.89 ± 5.18 | 68.32 ± 4.52 |
| | $P_3$ | 34.32 ± 4.21 | 96.6 ± 5.40 | 82.00 ± 3.98 |
| Gastropoda | $P_1$ | 28.00 ± 3.12 | 45.58 ± 2.71 | 36.63 ± 2.39 |
| | $P_2$ | 25.72 ± 2.88 | 47.81 ± 2.90 | 35.23 ± 2.52 |
| | $P_3$ | 36.03 ± 2.96 | 54.60 ± 2.81 | 49.20 ± 2.40 |
| Pelecypoda | $P_1$ | 3.6 ± 0.52 | 6.8 ± 0.46 | 7.32 ± 0.63 |
| | $P_2$ | 4.2 ± 0.66 | 7.6 ± 0.48 | 7.06 ± 0.58 |
| | $P_3$ | 5.4 ± 0.50 | 8.4 ± 0.62 | 9.09 ± 0.94 |
| Total macrobenthic fauna | $P_1$ | 231.25±13.66 | 616.30±19.54 | 528.06±18.56 |
| | $P_2$ | 241.24±15.16 | 640.57±17.91 | 536.70±18.73 |
| | $P_3$ | 297.45±15.34 | 698.67±20.60 | 590.79±17.57 |

ture and same management practices. Covich et al. (1999) registered 10 species of benthos comprising 4 species of gastropod, 2 species of pelecypod and oligochaeta and diptera each from Ganga River. Pahwa (1979) reported 10 species of gastropods and 4 species of pelecypods from Ganga. Mandal and Moitra (1975) recorded 21 species of benthos comprising insects (8 species), ostracods (6 species), oligochaetes (6 species) from freshwater ponds of Burdwan.

Figure 1 reveals that insects were the major contributors to the macro-benthic community comprising 76.4% during winter 78.03% during summer and 77.86% during rainy period. Oligochaetes with percentage contribution of 10.06 during winter, 13.23 during summer and 13.41 of the total macro benthic community during rainy season are next in the rank. Contribution of gastropods (7.31—11.75%) and pelecypods (1.17—1.73%) was lower.

Average population of benthic animals varied from 231.25 ± 13.66—698.67 ± 20.60 no./m² during the experimental period. Contribution of insecta being 78.90 ± 13.59—539.07 ± 16.15 no. /m², oligochaeta 20.75 ± 4.19—96.9 ± 5.40 no./m², gastropoda 25.72 ± 2.96—54.6 ± 2.81 no./m² and pelecypoda 3.60 ± 0.52—9.99 ± 0.94 no./m². Pond $P_3$ had higher density (297.45 ± 15.34—698.67 ± 20.60 no./m²) of the benthic organisms followed by pond $P_2$ (241.24 ± 15.16—640.57 ± 17.91 no./m²) and $P_1$ (231.25 ± 13.66—613.27 ± 19.54 no./m²), this is pertinent due to nutrient enrichment in pond $P_3$.

Seasonal variation indicates that the total density of these animals was lower from August to January (winter), thereafter it started increasing reaching peak in May (summer). The abundance of benthic organisms during February to August has also been reported by other workers (Mondal and Moitra 1975, Pandey et al. 1983, Singh and Singh 1996). The causes are suitability of temperature, pH and accumulation of organic matter (Wallace and Webster 1996, Covich et al. 1999). The present values of macrobenthic fauna are similar to those reported by several workers (Mondal and Moitra 1975, Singh and Singh 1996).

According to Gupta and Pant (1983), water bodies, with > 1000 no. /m² benthic invertebrate density, are considered to be highly productive/eutrophic. According to this statement the ponds in the present study are not eutrophic but are quite productive.

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