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# Comparison of benthic fauna of two *beels* under different management system

**M. Mukhlesur Rahman[1] and Monoranjan Das***
Department of Aquaculture, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
[1]Department of Fisheries, Dhaka
*Corresponding author

**Abstract**
A comparative study of benthic fauna between Rajdhala beel and Padmai beel of Netrakona District under different management system was carried out from July'99 to January'00. An average number of 1113 and 1175 organisms /m$^2$ were obtained from Rajdhala beel and Padmai beel respectively. A total of 22 taxa belonging to 8 diverse groups, Oligochaetes, Chironomids, Molluscs, Ceratopogonids, Diptera (other than Chironomids and Ceratopogonids), Ephemeroptera, Leeches and Crustaceans were recorded. Oligochaetes were dominated and constituted 46% and 49% of the total benthic population in Rajdhala beel and Padmai beel respectively. The next dominant group was the Chironomids, which constituted 31% and 30% of the total benthic population in Rajdhala beel and Padmai beel respectively. The highest number 1279 and 1437 individuals /m$^2$ of benthic fauna was recorded in December from Rajdhla beel and Padmai beel in respectively. The lowest number of benthic fauna 869 and 914 individuals /m$^2$ were found during September and July from Rajdhala beel and Padmai beel respectively. Monthly variation of benthic fauna among two beels were found statistically significant ($p<0.05$). The numerical distributions of benthic fauna was found to be varied with depth ranges. However, the depth wise variation of total benthic fauna between two beels was not found statistically significant. Fish yield of Rajdhala beel (488 kg/ha/yr) was appreciably higher than the Padmai beel (250 kg/ha/yr).

**Key words:** Benthic fauna, Beel

## Introduction

Inland water areas of Bangladesh mainly included network of rivers and canals, flood plains (3-6 months inundated low lying areas), haors (large deeply flooded depression), baors (oxbow lake), beels (depressions often with permanent area of water) and ponds. Recently efforts are being given to study the inland capture fisheries resources by different GO and NGOs to increase fish production. Different approaches have taken to ensure sustainable and increased fish production from open water and to improve the socio-economic condition of the fisherman. As a part of the activities, The Community Based Fisheries Management Project (CBFM) started to work on 19 rivers and beels in late 1995. The project involves a partnership of Department of Fisheries

(DOF), five NGOs and International Center for Living Aquatic Resources Management (ICLARM). The project was designed as an action research project to test and assess alternative model of GO-NGO-fisher collaboration and thereby develop a framework for community based fishery management that might achieve grater efficiency, equity and sustainability (Thompsom *et al.* 1999). Under the CBFM project NGO Caritas is supporting fishery management in Rajdhala beel under Purbadhala thana of Netrakona district in Co-ordination with ICLARM. Another beel namely Padmai beel is also situated within the same ecological region and is under traditional management. Study programme was designed to study the comparative abundance and depth distribution of benthic fauna of Rajdhala and Padmai beels. Hopefully, the findings of this study on abundance, composition and distribution of benthic fauna of two beels can provide benchmark data for beel management in Bangladesh.

## Materials and methods

### *Study area*

The bees under study are located at Purbadhala thana of Netrakona district within $24^0 70'$ $25^0 8'$ N and $90^0 29'$ $90^0 48'$ E. Beels are in the Agro Ecological Zone (AEZ) 9 and subregion 9b of the country, which is under Old Brahmaputra flood plain (FAO 1988).

Rajdhala and Padmai beels is a semienclosed perennial round shaped waterbody. Rajdhala beel has a water depth 4.6-7.7 m and covers about 53 hectares water area. Whereas in Padmai beel water depth was recorded the maximum of 3m and the beel covers around 20 hectares. Rainfall is the main source of water in both the beel. During monsoon months the Rajdhala beel is connected by channel called Kumarkhali khal to the river Dhalai. There are two-outlet channels (khals), run away from the beel, which were fenced to prevent escape of fish, and Padmai beel is connected by a small channel to small river Kani. Watercolour appeared light green and brownish green in Rajdhala beel and Padmai beel respectively. The marginal slope and bottom of the Rajdhala beel was regular. Bottom was formed by clear clay mud. Thickness of the mud ranges from 50 to 80 cm. Physical nature of the bottom was soft and clear. The basin wall slope of the Padmai beel was lower than that of Rajdhala beel. Bottom mud was more soft and darker in colour. Unlike Rajdhala beel the bottom of Padmai beel was full of dead and decaying leaves of aquatic plants and rhizomes and tubers of emergent vegetation, which emitted a foul odour. Thickness of bottom mud ranges 70-120 cm.

### *Sample collection*

Benthic fauna of Rajdhala and Padmai beels were studied for a period of seven months from July'99 to January'00. Benthic samples were collected monthly (15 or 16th day of the month) from each beel from 3 different depths say, shallow (0–1 m), medium deep (1-2 m) and deep (>2 m). Three replicate samples were collected from each depth. For convenience, 9 sampling spot from each beel were marked with the help of bamboo poles to establish the sampling site. An Ekman-dredge covering an area of 225 $cm^2$ was used for sampling of bottom sediments using an anchored country boat. Content of the

dredge, along with any materials caught were transferred to a buket and taken to the shore for washing. Each sample was than washed thoroughly using a series of standard brass seives of mesh size 0.2, 0.92 and 2.0 mm. From the residue the benthic organisms were collected under contrasting background of black and white by means of fine forceps and kept into separate vial containing 5% formaldehyde for preservation (Wetzel and Lickens 1979). The vials were marked properly and taken to the laboratory of Aquaculture Department of Bangladesh Agricultural University, for analysis.

Physico-chemical data such as air temperature and water temperature, transparency (Secchidisc), pH oxygen, carbondioxide, ammonia hardness of water also collected on the sampling date by using Hach kit (DREL 2000).

*Sample analysis*

After 48 hours the preserved animals were transferred to a petridish and washed with tape water to remove the remainder of the washable detritus and mud. Then benthic organisms were separated and counted into different major taxonomic groups by using a magnifying glass. The sorted animals were again preserved group wise into 5% formaldehyde and labeled properly for further study.

On a later date the preserved specimens were identified into possible lower taxa under a dissecting microscope. The worms and larvae were soaked into lactophenol for a period of 24 hours for making them transparent for identification. The specimens were taken from lactophenol with the help of a fine forcep and were placed on a clean slide with a few drops of glycerine and covered with cover slip. A binocular microscope (NOVA 950 ES) with a magnification 16×4 were used to identify the specimens. Identification was done after Pennak (1953), Usinger (1963), Needham and Needham (1966) and Brinkhurst (1971).

The data obtained from the samples were tabulated for statistical analysis. Analysis of variance was done with the help of computer package MSTAT, following Randomized Block Design. The mean values was compared by Least Significant Difference Test (Zar 1996) at 5% level of significance.

## Results and discussion

Abundance of benthic fauna depends on physico-chemical factors. In this study the measured factors were found within the acceptable ranges. There has been no remarkable difference in the value of physico-chemical factors in two beels (Table 1).

A total of 1577 and 1665 benthic organisms were collected from Rajdhala Beel and Padmai Beel respectively, this amounted to an average number of 1113 and 1175 organisms/$m^2$ (Table 2).

In Bangladesh no attempts have been made to classify the beels on the basis the availability of benthic organisms. Thienemann (1925) classified a lakebed producing between 1000-2000 animals/$m^2$ as mesotrophic. On the basis of his classification it can be

concluded that both the beels are mesotrophic *i.e.*, medium productive. A total of 22 taxa belonging to 8 diverse groups were recorded from two beels.

**Table 1.** Physico-chemical parameter of Rajdhala beel and Padmai beel

| Factor/ Beel | Air tem. (°C) | Water tem. (°C) | Trans-parancy (cm) | pH | DO (*mg/L*) | Free carbon dioxide (*mg/L*) | Amonia (*mg/L*) | Hardness (*mg/L*) |
|---|---|---|---|---|---|---|---|---|
| Rajdhala | 27.00 ±4.65 | 26.13 ± 4.13 | 76.40 ±3.86 | 7.73 ±0.35 | 7.30 ±0.21 | 5.14 ±0.61 | 0.22 ±0.01 | 87.10 ±1.42 |
| Padmai | 27.00 ±4.65 | 25.57 ±5.20 | 104.39 ±5.63 | 7.65 ±0.28 | 5.93 ±0.52 | 5.18 ±0.19 | 0.20 ±0.05 | 102.84 ±2.62 |

**Table 2.** Total number, percentage composition and average number/$m^2$ of different groups of benthic fauna recorded from different months in Rajdhala beel and Padmai beel

| Groups of benthic fauna | Beels | Monthly value | | | | | | | Total | % of total nos. | Av. no./ $m^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | July | Aug | Sep | Oct | Nov | Dec | Jan | | | |
| Oligochaeta | Rajdhala | 115 | 150 | 92 | 116 | 80 | 88 | 88 | 729 | 46.23 | 514 |
| | Padmai | 134 | 166 | 141 | 122 | 99 | 74 | 77 | 813 | 48.83 | 574 |
| Chironomidae | Rajdhala | 26 | 36 | 47 | 69 | 79 | 124 | 108 | 489 | 31.00 | 345 |
| | Padmai | 40 | 39 | 53 | 60 | 71 | 144 | 119 | 496 | 29.79 | 350 |
| Mollusca | Rajdhala | 45 | 42 | 23 | 24 | 23 | 20 | 12 | 189 | 11.99 | 133 |
| | Padmai | 0 | 3 | 6 | 18 | 44 | 71 | 50 | 192 | 11.53 | 135 |
| Ceratopogonidae | Rajdhala | 18 | 5 | 0 | 12 | 21 | 22 | 30 | 108 | 6.85 | 77 |
| | Padmai | 6 | 10 | 6 | 21 | 19 | 14 | 14 | 90 | 5.41 | 63 |
| Other Diptera (except chrinomidae & ceratopogonidae) | Rajdhala | 2 | 2 | 1 | 1 | 1 | 1 | 4 | 12 | 0.76 | 8 |
| | Padmai | 1 | 1 | 4 | 3 | 2 | 4 | 0 | 15 | 0.90 | 11 |
| Ephemeroptera | Rajdhala | 0 | 1 | 3 | 2 | 2 | 3 | 4 | 15 | 0.95 | 11 |
| | Padmai | 0 | 2 | 2 | 4 | 1 | 5 | 4 | 18 | 1.08 | 13 |
| Hirudinea | Rajdhala | 2 | 4 | 5 | 3 | 4 | 0 | 3 | 21 | 1.33 | 15 |
| | Padmai | 2 | 3 | 2 | 5 | 3 | 5 | 2 | 22 | 1.32 | 16 |
| Crustacea | Rajdhala | 2 | 1 | 5 | 1 | 2 | 1 | 2 | 14 | 0.89 | 10 |
| | Padmai | 2 | 3 | 1 | 2 | 5 | 4 | 2 | 19 | 1.14 | 13 |
| Total number | Rajdhala | 210 | 241 | 176 | 228 | 212 | 259 | 251 | 1577 | 100 | 1113 |
| | Padmai | 185 | 227 | 215 | 235 | 244 | 291 | 268 | 1665 | 100 | 1175 |
| Average number /$m^2$ | Rajdhala | 1037 | 1190 | 869 | 1126 | 1047 | 1279 | 1240 | - | - | - |
| | Padmai | 914 | 1121 | 1062 | 1160 | 1205 | 1437 | 1323 | - | - | - |

The major groups of benthic fauna recorded from two beels during the present study were Oligochaetes, Chironomids and Molluscs. The dominance of these groups of macrobenthos has been reported earlier by Das and Islam (1983) from tropical freshwater pond, and Kumar and Mitra (1986) from Ox-bow Lake. The probable cause of the occurrence of these dominant groups of bottom fauna may be due to the

favourable ecological condition for their growth. Bottom type and amount of bottom deposits exert a significant influence upon the occurrence of bottom organisms and their kinds. The character of bottom deposits affects the nature and distribution of bottom fauna has been demonstrated by many authors (*e.g.* Reid 1964).

Monthly fluctuation of major groups of benthic fauna was observed during the study period and shown in Fig. 1. The highest number, 1279 organisms/$m^2$ and 1437 organisms /$m^2$ was found in December from Rajdhala beel and Padmai beel respectively. A lowest number 869 organisms/$m^2$ was found during September in Rajdhala beel and 914 organisms/$m^2$ during July in Padmai beel. Monthly variation in abundance of benthic fauna between two beels were found statistically significantly different ($P<0.05$).

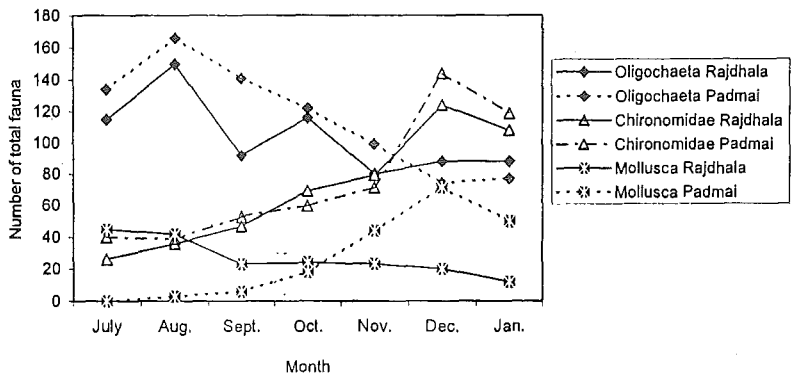


**Fig. 1.** Monthly fluctuation in abundance of major groups of benthic fauna in two beels .

The climatological factors revealed a close relationship with the qualities of soil and water. Moore (1980) pointed out that the diversified physico-chemical conditions of the littoral zone should result in quantitatively diversified littoral fauna. The seasonal abundance of benthic fauna may be due to changes in temperature, periodical changes of water level by the rain and flood water incursion. Sutcliffe *et al.* (1981) stated that the reproductive biology and growth rate of benthic organisms increased with increased temperature. Here in this study higher number of benthos was found in December and similar results was also reported by Dewan (1973), Das and Islam (1983). Perhaps the greater number of benthic fauna in winter months might be due to the less predation by bottom dwelling fish at low temperature or might be due to the complex community interaction.

The numerical distribution of different groups of benthic organisms varies with three depth ranges during the study period. The greater density of benthic population was found to occur in shallow (42%) and medium deep (32%) region of Rajdhala beel, while in Padmai beel greater number of organisms recorded in deep region (43%).

The benthic species are greatly distributed in these habitats according to their suitability, availability of food etc. Ball (1948) concluded that food play an important

role in the distribution of benthic organisms. The higher number of benthic population in deep region of Padmai beel may be due to the flatness of the bottom and comparatively less area of deep region beel bed than the shallow and medium deep region bottom, beel bed perhaps provided suitable substratum for growing benthic fauna. Abundant macrovegetation might support more food and shelter for macrobenthos. The important vegetation being responsible for increasing the number of benthic communities has been stressed by various authors such as Dimitrov (1977). ANOVA indicated that there was no statistically significant difference of depth distribution of total fauna between two beels (Table 3). But major groups of fauna *viz*, Oligochaetes, Chironomids, Molluscs varied significantly ($P<0.05$) between two beels at different depth.

**Table 3.** Summary of ANOVA analysis for depth distribution of total benthic fauna, Oligochaetes, Chironomids and Molluscs of Rajdhala and Padmai beels

| Source of variance | F value | | | |
|---|---|---|---|---|
| | Total fauna | Oligochaetes | Chironomids | Molluscs |
| Replication | 7.33 (20,100$^+$)* | 8.94 (20,100$^+$)* | 27.16 (20,100$^+$)* | 1.18 (20,100$^+$) |
| Factor A (Beel) | 3.74 (1,100$^+$) | 7.38 (1,100$^+$)* | 0.13 (1,100$^+$) | 0.01 (1,100$^+$) |
| Factor B (Depth) | 1.58 (2,100$^+$) | 32.17 (2,100$^+$)* | 13.52 (2,100$^+$)* | 15.28 (2,100$^+$)* |
| AB | 158.08 (2,100$^+$)* | 147.59 (2,100$^+$)* | 49.12 (2,100$^+$)* | 4.26 (2,100$^+$)* |

+ The figures within parenthesis indicate the degrees of freedom
* The figures followed by the mark indicate the significant value

Maximum dominance of Oligochaetes was observed in both the beels and constituted 46% and 49% of the total fauna in Rajdhala beel and Padmai beel respectively. This group represented by 6 species, *Branchiura sowerbyi, Limnodrilus hoffmeisteri, Aleosima* sp., *Chaetogaster* sp., *Dero digtata, Tubifex* sp. *Branchiura sowerbyi* was the most dominant species and account 35% and 41% of the Oligochaetes in Rajdhala beel and Padmai beel respectively. Possibly more ecological suitability, food availability and breeding facilities for Oligochaetesls had prevailed then the other groups. Das and Islam (1983) found more Oligochaetes having more organic matters in the pond mud. The maximum abundance of Oligochaetes was found in August from both beels and minimum in November from Rajdhala beel and in December from Padmai beel. This trend might be due to variation in water temperature. But monthly variation of Oligochaetes fauna between beels were found no statistically significant. The more occurrence of *Branchiura sowerbyi* is probably due to utilization of organic matter in bottom sediments by this species. High occurrence of Oligochaetes in the rainy season is also supported by Dewan (1973), Das and Islam (1983).

Chironomids ranked the second dominant group of benthic fauna recorded during the study period and constitute 31% and 30% of total benthic fauna in Rajdhala beel and Padmai beel respectively. Most dominant species was *Chironomus* sp. and accounted 61% and 57% of the groups in Rajdhala beel and Padmai beel respectively. Other species were

*Procladius*, *Pentaneura*, *Tenypus*. Monthly variation of total fauna of Chironomids between two beels shows statistically significant difference ($p<0.05$) (Table 4). A distinct seasonal variation in the population of Chironomids was observed in the study with the highest number in December form both the beels and lowest in July in Rajdhala beel and in August in Padmai beel. The observed lowest number in July and August might be due to heavy grazing by fish. Which agree with the observation of Brown and Oldham (1984) and Wahab (1988).

**Table 4.** Mean of monthly variation of total benthic fauna, Oligochaetes, Chironomids and Molluscs of Rajdhala Beel ($B_1$) and Padmai Beel ($B_2$)

| Depth | Total fauna | | Oligochaetes | | Chironomids | | Molluscs | |
|---|---|---|---|---|---|---|---|---|
| | $B_1$ | $B_2$ | $B_1$ | $B_2$ | $B_1$ | $B_2$ | $B_1$ | $B_2$ |
| July | $23.33^{bcd}$ | $20.56^{cd}$ | $12.78^{bc}$ | $14.89^{ab}$ | $2.89^{f}$ | $4.44^{ef}$ | $5.00^{b}$ | $0.00^{e}$ |
| August | $26.78^{abcd}$ | $25.22^{abcd}$ | $16.67^{a}$ | $18.44^{a}$ | $4.00^{ef}$ | $4.33^{ef}$ | $4.67^{b}$ | $0.33^{e}$ |
| September | $19.56^{d}$ | $23.89^{bcd}$ | $10.22^{cd}$ | $15.67^{ab}$ | $5.22^{de}$ | $5.89^{cde}$ | $2.56^{c}$ | $0.67^{de}$ |
| October | $25.33^{abcd}$ | $26.11^{abcd}$ | $12.89^{bc}$ | $13.56^{bc}$ | $7.56^{bc}$ | $6.67^{bcd}$ | $2.67^{c}$ | $2.00^{cd}$ |
| November | $23.56^{bcd}$ | $27.11^{abc}$ | $8.89^{d}$ | $11.00^{bcd}$ | $8.78^{b}$ | $7.89^{bc}$ | $2.56^{c}$ | 4.89b |
| December | $28.78^{ab}$ | $32.33^{a}$ | $9.78^{cd}$ | $8.22^{d}$ | $13.78^{a}$ | $12.67^{a}$ | $2.22^{c}$ | $7.89^{a}$ |
| January | $27.89^{abc}$ | $29.78^{ab}$ | $9.78^{cd}$ | $8.56^{d}$ | $12.00^{a}$ | $13.22^{a}$ | $1.33^{cde}$ | $5.56^{b}$ |

*The figures within a group of benthic fauna (Total fauna, Oligochaetes, Chironomids and Molluscs) bearing same letter(s) indicate no differences.

Molluscs were the third dominant groups and contribute 11.93% and 11.53% of the total fauna in Rajdhala beel and Padmai beel respectively. Molluscs were represented by *Viviparus bengalensis*, *Lymnaea* sp., *Planorbis* sp., *Melanoides* sp. The occurrence of *Viviparus bengalensis* was the most dominant and constitute 45% and 56% of the Molluscs in Rajdhala beel and Padmai beel respectively. Variation of Molluscs between two beels during different months of study showed statistically significant difference ($p<0.05$). Monthly abundances of Molluscs in two beels show a diverse pattern. Molluscs were totally absent in July in Padmai beel, possibly due to greater movement of the species to the surrounding inundated agricultural lands. This can be attributed to presence of weeds and suitable water level for their food and shelter. On the contrary, maximum number of Molluscs in July in shallow region of Rajdhala beel might be due to presence of vegetation for shelter in the marginal area of the beel.

Minor groups of benthic fauna Ceratopogonidie, other Diptera (except Chironomidae and Ceratopogonidae), Ephemeroptra, Hirudinea and Crustacea were negligible in number and irregular in occurrence in both beels. Biwas (1977), Das and Islam (1983) have reported similar observation.

Post monsoon luxurious growth of aquatic weed was noticed in Padmai beel. Benthic fauna were more abundant in weed infested bottom substrate than clear open bed (Schramm and Jirka 1989). Padmai beel received agricultural discharge from the surrounding encatchment areas. Nutrient rich discharge and heavy light penetration in shallow depth might have been highly encouraging for prolific growth of weed. Shaha *et*

*al.* (1990) observed that removal of macrovegetation from Kulia beel, West Bengl, India, make the ecosystem highly productive and fish yield increased from 320 kg/ha to 1077 kg/ha.

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