Iranica Journal of Energy & Environment 2 (3): 244-249, 2011
ISSN 2079-2115
IJEE an Official Peer Reviewed Journal of Babol Noshirvani University of Technology
doi: 10.5829/idosi.ijee.2011.02.03.958

BUT

Macrozoobenthic Taxocoenosis in a Cultivators' Rice Field of North West Kashmir, (J and K) India

Shahzadi Wufai Naw Bahaar and G.A. Bhat

P.G. Department of Environmental Science, University of Kashmir, Srinagar-190 006, JandK, India

(Received: April 14, 2011; Accepted: August 20, 2011)

Abstract: This paper presents the attempt to investigate the community composition and density of macro-zoobenthos in a cultivator's field. The study carried out in the rice fields of north-western district Kupwara (34°02'N; 74°16E') of Kashmir province revealed the presence of 7 taxa of macrozoobenthos belonging to Annelida, Arthropoda and Mollusca. Phylum Annelida formed the most dominant group represented by 5 taxa. Diversity calculated by employing Simpsons' Index (D), Simpsons' Index of Diversity (1-D), Simpsons' Reciprocal Index (1/D), Shannon-Weiner Index (H'), Margalef Richness Index (d) Evenness Index (e) indicated low but significant assemblage of zoobenthos. Agronomic practices seemed to influence the occurrence and distribution of various benthic organisms to a greater degree. The results pressed the need for recognizing and preserving rice fields as potential habitats for organisms that have successfully adapted to the highly manipulated and eutrophic conditions of rice paddies

Key words: Community composition % Diversity % Kashmir % Macrozoobenthos % Rice fields

INTRODUCTION

Rice fields are highly dynamic temporary wetland agro-ecosystems that hold extreme ecologic and economic importance. These forms are indispensable component of the landscape and culture of Kashmir valley. Irrigated rice fields can be scientifically defined as agro economically managed temporary and seasonal aquatic habitats managed with a variable degree of intensity. These temporary wetlands are the most extensive aquatic ecosystems on earth covering an area of 1.5 million hectares approximately [1]. Rice fields are included in the Ramsar Classification System for Wetland Type as a human-made wetland. These typical agricultural landscapes have provided large areas of open water for centuries that support biodiversity including medicinal plants, reptiles, amphibians, fish, crustaceans, insects, molluscs and water birds [2]. Being the most manipulated and frequently disturbed ecosystem, a curious mixture of flora and fauna can be observed within the rice field. The periodic disturbance resulting from cultural operations and agrochemical use have a profound effect on the nutrient status, pH, O_2 concentration and the community composition of aquatic and terrestrial biota inhabiting these rice fields. Mans activities including ploughing, irrigation, weeding, application of fertilizers and pest control practices influence both the biotic and abiotic components of agro ecosystem [3].

Macrozoobenthos comprise of an important group of aqua fauna by way of their contribution to ecosystem stability. Being efficient energy converters, they constitute an important link in the aquatic food web. Their composition, abundance and distribution pattern acts as an ecosystem index, thereby indicating trophic structure, water quality and eutrophication level of the ecosystem [4]. Benthic macro invertebrates are a key ecological feature in aquatic ecosystems. The organisms process organic materials are contributing energy and nutrient recycling. They are vital links in wetland food chains. Benthic macro invertebrates not only process living and dead organic matter channelling it to producer and detrital food chains but they physically modify wetland habitats enhancing wetland values for other wildlife species [5]. Only a limited range of organisms that have adapted themselves to extreme fluctuations in physical and chemical environment have successfully colonized rice fields. The present study was carried out with the main objective of working out the macro-zoobenthic diversity

Corresponding Author: Shahzadi Wufai Naw Bahaar, Terrestrial Ecology Lab. Department of Environmental Science, University of Kashmir, Srinagar, J and K, 190 006, India. Mob: +91-9797792071.

of the rice fields of north-west Kashmir which have not been yet explored for their biodiversity potential. The bio-ecological studies on the rice fields of Kashmir are negligible. The diversity of macro-zoobenthic in the rice fields has not been documented earlier. The present investigation being a maiden one in the region was carried out in the same backdrop.

MATERIALS AND METHODS

Samples were randomly collected by carefully driving a high-sided square frame (20x20 cm) into the sediment [6]. During the aquatic phase, the sample was taken by digging out the sediment up to a depth of 10 cm. The sediment was sieved through a 0.5 mm sieve. During the dry phase soil macro fauna was collected following [7]. Five soil monoliths of 15x15x10 cm were excavated manually at the study site. The soil block was placed in a tray, broken softly with hand and organisms sorted manually. The organisms were placed in a tray; hand sorted and kept in separate labelled containers. Soft bodied organisms were preserved in 4% formalin, where as, hard bodied organisms were preserved in 70% ethanol. Density was calculated in terms of individuals/m^2. Identification of the samples was done following [8,9]. Simpsons Index (D), Simpsons Index of Diversity (1-D) and Reciprocal Index were performed following [10]; H’ was calculated as per Shannon-Wiener [11]; Margalefs’ Richness Index was obtained as prescribed by [12]; Evenness Index was calculated as per Pielou [13]. Physico-chemical characteristics of flood waters were determined following APHA [14].

RESULTS

The present investigation conducted in the representative rice fields of north-west Kashmir depicted the presence of a varied combination of benthic organisms. A total of 7 species spread over 3 phylas including *Allolobophora rosea, Branchiura sowerbyi, Hirudo* sp. *Lumbricus terrestris, Tubifex tubifex* belonging to Annelida; Chironomous larva representing Arthropoda; and, *Bithynia tentaculata* from Mollusca were registered (Table 1). Peak population densities were noticed during the earlier part of aquatic phase, where as occasional presences were detected during the fallow season (Fig. 2). Among the annelids, the earthworm *Allolobophora rosea* registered its presence only 5 times during the dry phase maintaining a complete absence during the wet phase. It showed an average population density of 0.61ind/m^2 with highest density recorded as 4ind/m^2 (Apr; 2nd crop cycle). The common earthworm *Lumbricus terrestris* registered an average density of 2.33ind/m^2. It was noticed during 6 observations only with a complete absence registered during the dry phase. *Branchiura sowerbyi* formed the most dominant taxa registering an average density of 34ind/m^2. It was recorded during the first 2 months of aquatic phase (May, Jun) in both the crop cycles. A highest density of 300ind/m^2 was recorded in the first month of submersion maintaining a complete absence during the rest of aquatic phase and fallow season. *Hirudo* sp. registered an average density of 0.85ind/m^2 with a highest density of

Table: 1: Population density (ind/m^2) of macrozoobenthos at study site

S. No.	Taxa	Range	Average density	Total density
I.	Annelida			
1.	Allolobophora rosea	0-3	0.61	13
2.	Branchiura sowerbyi	0-300	34.28	870
3.	Hirudo sp.	0-7	0.85	18
4.	Lumbricus terrestris	0-14	2.33	49
5.	Tubifex tubifex	0-270	28.57	600
II.	Arthropoda			
6.	Chironomous larva	0-158	16.09	338
III.	Mollusca			
7.	*Bithynia tentaculata*	0-46	25.09	527

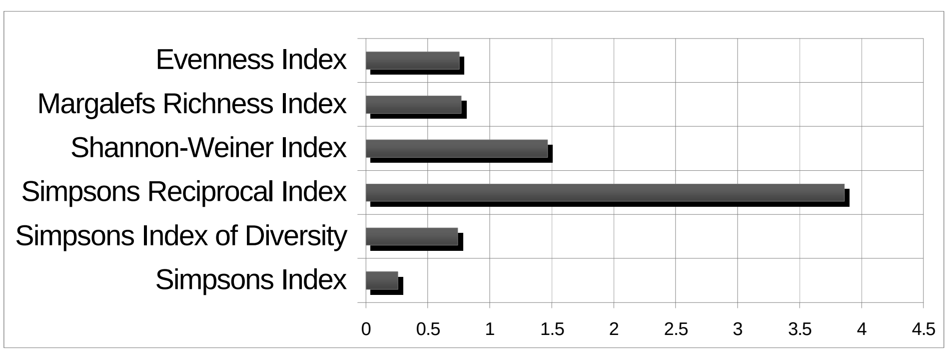

Fig. 1: Biodiversity indices of macro-zoobenthic fauna registered at the study site

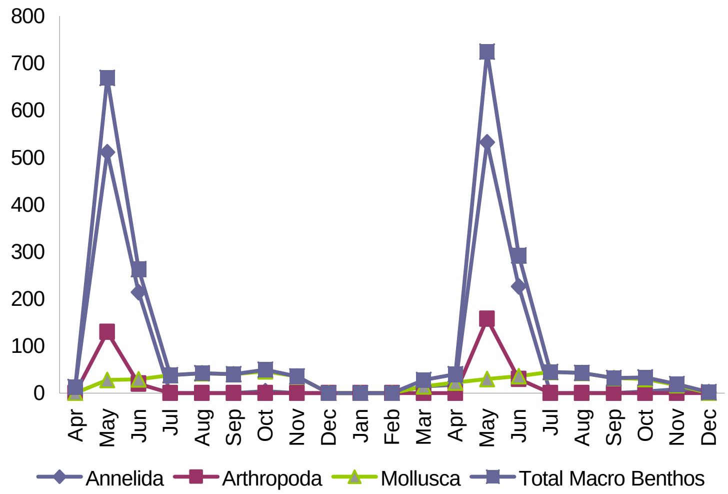

Fig. 2: Population density (ind/m^2) of various benthic groups recorded at the site.
(* 2nd crop cycle)

7ind/m^2 (May). It was noticed during 4 observations only in the first 2 months of submersion. *Tubifex tubifex* was the moderately dominant taxa registering an average density of 29ind/m^2. Chironomous larva the sole representor of Arthropoda registered an average density of 16ind/m^2. The mollusc *Bithynia tentaculata* registered a fairly cosmopolitan distribution with absence registered only during winter and mid spring depicting an average density of 25.09ind/m^2. Total macrozoobenthos registered a complete absence during the winter season. Population density attained peak values during late spring (May) followed by a gradual decline. Lowest density was recorded as 2ind/m^2 during early winter (Dec; 2nd crop cycle). Organic matter showed maximum values during the onset of aquatic phase as 8.51% (May; 1st crop cycle). Lowest values were recorded in the dry phase as 4.48%. The values for various biodiversity indices were obtained as follows: Simpsons Index (D) = 0.258; Simpsons Index of Diversity (1-D) = 0.741; Simpsons Reciprocal Index (1/D) = 3.862; Shannon-Weiner Index (H’) = 1.465; Margalef Richness Index (M) = 0.770; Evenness Index (e) = 0.753 (Figure 1). Maximum index value is related to Simpsons reciprocal index and minimum value is devoted to Simpsons index.

DISCUSSION

The overall analysis of the macro-zoobenthic fauna of the representative study site exhibited peak populations during late spring probably in response to thick populations of dipteran larvae that formed quantitatively the most dominant macro benthic component in this particular period. The abrupt fall that was registered there after continued in similar fashion till winter. In the representative rice fields of Kashmir, Oligochaeta formed the most dominant group being composed of 4 taxa. This is in agreement with the findings of Simpson *[15]* who stated that the aquatic Oligochaeta occur widely in the soil of flooded rice fields and is the dominant macro invertebrate group. As the organic matter content of the submerged soils decreased considerably, *B. sowerbyi* also showed a decline in its density. According to Simpson et al. [15] the organic matter, a substrate for decomposers, represents a potential food sources of oligochaetes, hence, limiting their population density. Similar explanation seemed true for the tubificid *Tubifex tubifex registering* a decline along with the receding concentrations of organic matter. Distribution and abundance of aquatic oligochaetes particularly tubificids has been associated with the organic enrichment of habitats ([16]. According to Wetzel [17], under aerobic conditions, a rich supply of food coupled with limited competition with other benthic animals permit rapid growth of oligochaetes adapted to these conditions. It has been found that food supply is of major importance in the regulation of the population dynamics of detritivorous organisms [18]. pH and dissolved oxygen concentration also seemed to play a decisive role in the distribution of benthic tubificids which depicted a clear decline with the reducing soil conditions accompanied by a decline in dissolved oxygen in the overlying flood waters (Figure 3). As per Wetzel ([17] tubificids are sensitive to changes in oxygen concentrations, at saturation values below 10 to 15% feeding and defecation

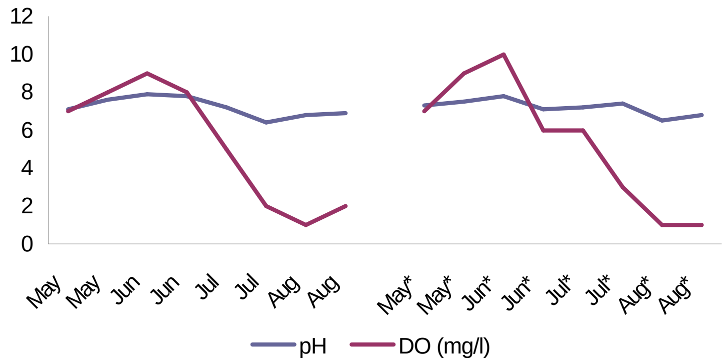

Fig. 3: Dissolved Oxygen (mg/l) and pH of flood waters at the study site.

are greatly reduced or cease. The compaction of underlying sediments also appeared to act as a limiting factor for the growth of *T. tubifex*. Diptera was represented by Chironomous larva which reduced drastically after attaining peak populations. Chironomid larvae are ubiquitous and dominant component of benthic invertebrate communities in many standing and running waters [17]. During the earlier stages of crop cultivation, the soft sediments provided conductive conditions for their growth. However, as the soft mud started hardening the densities of many invertebrates including chironomids declined significantly. The preference for soft porous sediments by macro invertebrates particularly chironomids, oligochaetes, amphipods and micro-crustaceans has earlier been established by many workers [19,20]. As per Shah and Pandit [21] the nature of sediment plays an important role in the distribution of chironomid larvae. High population densities recorded in the initial stages of aquatic phase seem to coincide with the higher availability of organic nutrients as these organisms have a liking for polluted habitats [22]. During the aquatic phase the earthworms registered a complete absence. The decrease in soil and the super saturation of soil seemed to have limited the growth and distribution of these organisms. Although, earth worms are slightly tolerant to fluctuations in soil acidity yet a pH below 6 in not favourable for the survival of earth worms. According to Lofs-Holmin [23], most species of earth worms in cropland are commonly found at about PH 6-7. Despite being rich in organic matter, the rice field soils could not support earthworm populations during the aquatic phase. This may be attributed to the prevailing super saturated conditions that interfere with the respiration of earth worms as these organisms respire through their skin. In addition, the puddling of soil renders it soft thus making it difficult for the earth worms to dig more or less stable pores. According to Edwards and Bohlen [24], soil moisture can influence earth worm number and biomass. Cultivation in paddy field soil seems to have negative effects earth worm population as a consequence of changes in the physicochemical status of soils [25]. Earth worms tend to avoid soils that face a greater intensity and frequency of disturbance [26]. The disturbance of soil by tillage, cultivation and use of pesticides along with the availability of food acts as the major determinants in the earthworm abundance and activity in agricultural soils [27]. Moreover, the pesticides applied to the agricultural soils at the time of transplantation persist for longer periods and in turn could be detrimental to the growth and abundance [28]. Leeches were noticed only during the months of May and June i.e. when they usually breed. Their reduced density and distribution may be attributed to limited activity during daytime. According to Davies *et al*. [29] swimming activity of leeches is much greater during darkness, presumably to minimize access by visual predators. Oxygen concentrations have also been reported to influence leech distribution and density [30]. The mollusc *B. tentaculata* commonly known as mud Bithynia or faucet snail has been reported by Rajagopal and Rao [8] from the rice fields of Kashmir in significant numbers as a probable consequence of their liking for calcium rich alkaline waters. Peak populations were reported during Jul and Oct when egg laying takes place usually in summer and sometimes in late autumn by females born early in the year [31]. Biodiversity indices depicted significant values indicating the favourable set of conditions provided by rice fields to this particular set of benthic organisms.

REFERENCES

1. Valiente, E.F. and A. Quesada, 2004. A shallow water ecosystem: The relevance of cyanobacteria in the ecosystem. Limnetica. 23(1-2): 95-108.

2. Anonymous, 2008. Resolution X. 31. Enhancing biodiversity in rice paddies as wetland systems. 10th meeting of the conference of the parties to the convention on wetlands (Ramsar, Iran, 1971).
3. FAO, 1979. Guidelines for integrated control of rice insect Pests. Plant Production and Protection Paper - 14. FAO, Rome.
4. Mehdi, M.D., F.A. Bhat and A.R. Yousuf, 2005. Ecology of macrozoobenthos in Rambiara Stream, Kashmir J. Res. Dev., 5: 95-100.
5. Feieraband, J.S., 1989. Wetlands: the lifeblood of wildlife. In: (D. A. Hammer ed.) Constructed Wetlands for Wastewater Treatment; Municipal, Industrial and Agricultural. Lewis Publishers Chelsea.
6. Southwood, T.R.E. and P.A. Henderson, 2000. Ecological Methods, 3rd ed. Blackwell Science Ltd.
7. Folgarait, P.J., F. Thomas, T. DesJardins, M. Grimaldi, I. Tayasu P. Curmi and P.M. Lavelle, 2003. Soil properties and the macrofauna community in abandoned irrigated rice fields of northeastern Argentina. Biol. Fertil. Soils, 38: 349-357.
8. Rajagopal and S. Rao, 1955. Aquatic and amphibious mollusks of the Kashmir valley, India. In: The Proc. Symp. Mollusca - Part I., pp: 94-121.
9. Edmondson, W.T., 1959. Freshwater biology John Wiley, N.Y.
10. 8Simpson, E.H., 1949. Measurement of diversity. Nature. 163: 688.
11. Shannon, C.E. and W. Wiener, 1949. The mathematical theory of communication. Urbana. Univ. Illinois press. pp: 177.
12. Margalef, R., 1958. Temporal succession and spatial heterogeneity in phytoplankton. In: Perspectives in Marine Biology, (Buzzati-Traverso eds.) Univ. Calif. Press, Berkeley, pp: 323-347.
13. Pielou, E.C., 1966. The measurement of diversity indifferent types of biological collections. J. Theoret. Biol., 13: 131-144.
14. American Public Health Association (APHA) and American Water and Wastewater Association (AWWA), (2005), Standard methods for the examination of water and wastewater, 20th Edition, APHA, Washington DC.
15. Simpson, I.C., P.A. Roger, R. Official and I.F. Grant, 1994. Effects of nitrogen fertilizer and pesticide management on flood water ecology in a wetland rice field: II. Dynamics of micro crustacean and dipteran larvae. Biol. Fertil. Soils, 17: 138-146.
16. Brinkhurst, R.O. and D.G. Cook, 1980. Aquatic Oligochaete Biology. Plenum Press, New York.
17. Wetzel, R.G., 2001. Limnology Lake and River Ecosystems 3rd Edition Academic Press, California, USA.
18. Iyengar, V.K.S., D.M. Davies and H. Kleerekoper, 1963. Some relationships between Chironomidae and their substrate in nine fresh water lakes of southern Ontario, Canada. Arch. Hydrobiol., 59: 289-310.
19. Williams, D.D., 1984. The hyporheic zone as a habitat for aquatic insects and associated arthropods. In: (V. H. Resh and D. M. Rosenberg eds.) The Ecology of Aquatic Insects. Praeger Scientific, New York. pp: 430-455.
20. Brunke, M. and T. Gonser, 1999. Hyporheic invertebrates-the clinal nature of interstitial communities structured by hydrological exchange and environmental gradients. J. N. Am. Benthol. Soc., 18: 344-362.
21. Shah, K.A. and A.K. Pandit, 2001. Macro-invertebrates associated with macrophytes in various fresh water bodies of Kashmir. J. Res. Dev., pp: 44-53.
22. Bay, A.E.C., A.A. Ingham and L.D. Anderson, 1966. Physical factors influencing chironomids infestation of water spreading basins. Ann. Entomol. Soc. Am., 59: 714-717 .
23. Lofs-Holmin, A., 1983. Influence of agricultural practices on earth worms (lumbricidae). Acta agricultural Scandinavica. 33: 225-234.
24. Edwards, C.A. and P.J. Bohlen, 1996. Biology and Ecology of Earthwor ms. Chapman and Hall, London.
25. Churchward, H.W., 1986. The Mediterranean southwest. In: Australian soil: The Human impact (J.R. Russel and R.F. Isbell, eds). University of Queensland press, St. lucid Queensland. pp: 65-89.
26. Haukka, K., 1988. Effect of various cultivation earthworm biomass and communities on different soil types. Annals Agriculture Fenniae. 27: 263-269.
27. Hulugalle, N.R., 1992. Amelioration of a highly degraded tropical Alfisol by plantiny: I. changes in soil physical and chemical properties. Land Deg. Rehab., 3: 141-151.

28. Panda, S. and S.K. Sahu, 1996. Effects of malathion on earthworm, Drawida willsi Michaelson. J. App. Zoo., 7(2): 171-172.
29. Davies, R.W., E. Dratnal and L.R. Linton, 1996. Activity and foraging behavior in the predatory freshwater leech Nephelopsis obscura (Erpobdellidae). Funct. Ecol., 10: 51-54 .
30. Davies, R.W., 1991. Annelida: Leeches, polychaetes and acanthobdellids. In: (J. H. Thorp and A. P. Covich, Eds.) Ecology and Classification of North American Freshwater Invertebrates. Academic Press, San Diego., pp: 437-479.
31. Korotneva, N.V. and I.N. Dregol'skaya, 1992. Effect of elevated temperature in the habitat of freshwater mollusc Bithynia tentaculata L. on its oogenesis. Tsitologiya, 34(2): 30-36.