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Diversity and its Indices of Macroinvertebrates from Dynaneshwar Water Rahuri, Ahmednagar, Maharashtra, India

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ABSTRACT

In the present study tried to assess indices macroinvertebrates species as Shannon-Weaver index, Shannon index, Species richness, Simpson's index, Index of Dominance, Index of Evenness of Dynaneshwar water and predict the state of water according to species and physico-chemical parameters. The indices were evaluated at individual species level and varied species to species. In the study 17 species from three phylla and five classes were observed. The density of Mollusca, Arthropoda and Annelida were 46.9%, 38.3% and 14.8% respectively. The class wise densities were as Polycheta [14.8%], Malacostraca [15.1%], Bivalve [20.4%], Insecta [23.2%] and Gastropoda [26.5%].

Key words: Macroinvertebrates, Shannon-Weaver Index, Species Richness, Simpson's Index, Index of Dominance, Index of Evenness, Dynaneshwar reservoir.

INTRODUCTION

Macroinvertebrate community and biological indices based on them have a number of features that promoted and being widely used to assess quality. They are relatively easy to sample quantative or semi-quanatatively [Zamora-Munoz et al., 1995]. There is an extensive range of identification keys available [Tachet et al., 2000]. They tolerance to pollutant and many macro invertebrates' taxa is well documented with biological indices [Mason, 1981; Hellawell, 1986; Jeffries & Mills, 1990]. The state of macroinvertebrates community integrated the state of environment over season [Rosenberg & Resh, 1993].

Macroinvertebrates have been attraractive targets of biological monitoring efforts because they are diverse group of longed lived, sedentary and used to predicting human influence on aquatic ecosystem [Rosenberg & Resh, 1993]. Macroinvertebrates and water quality are interrelated and indicators of water quality [Sharma and Rawat, 2009] and easy to respond to organic and inorganic pollution load [Kazanci & Dugal, 2000]. They have sensitive life stages and respond to

short and long term environmental stressors and important for maintaining biodiversity [Mayer et al., 2007; Richardson & Danehy, 2007; Latha et al., 2008].

This study was done to find out the spatial and temporal variation in diversity and distribution pattern in benthic macroinvertrbrates in Dynaneshwar dam water so as to estimate the diversity and indices as Shannon-Weaver index, Species richness, Simpson's index, Index of dominance and Index of evenness.

Study Area

Dynaneshwar reservoir N latitude $19^0$20' to $19^0$35' and E longitude $74^0$25' to $74^0$36' at 572 m MSL and the capacity is 26 TMC located at Rahuri, Ahmednagar district MS. The dam was artificially built in 1971 across the Mula River and contains natural water. The area is about 30320 m^2 and lies in Godavari [Tributary Mula] basin. It experiences an average rain fall 58 cm. The maximum depth is 67.97 m. The reservoir bottom is composed of detritus-mud layer in the littoral zone. The physiographic of basin is semi-agricultural and semi-arid with cultivated top soil bank. The dam water has been used for drinking and irrigation by the people of the Ahmednagar city and districts.

MATERIALS AND METHODS

Samples collection and identification: Benthic microinvertibrates were collected from ten sites during January 2008 to December 2009. These organisms were collected using a hand net [0.5 mm mesh] and preserved in 70% alcohol [Winterbourn et al., 2000]. These organisms were sorted and were identified using standard key [Edmondson, 1993; Pennak 1989]. The quantative analysis of organism was carried out and data is presented in Table 1. To evaluation the distribution and diversity indices between observed species diversitry indices as Shannon-Weaver index, Simpson's Index, Species Richness, Index of Evenness and Index of Dominance were worked out.

Physico-chemical analysis: The pH and temperature of water samples were recorded on the spot with the help of gun [pen] pH meter and thermometer respectively. The analysis of filtered water samples was carried out for the parameters, as Electrical Conductivity [EC], Total Dissolved Solids [TDS], Total Hardness [TH], Major Constituents [cationic- Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K) and anionic- Chloride (Cl), Total Alkalinity (TA), Sulphates (SO_4)], Minor Constituents [Phosphate (PO_4) and Nitrate (NO_3)], indicator parameter [Dissolved Oxygen (DO), Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD)]. The samples were done according to standard methods APHA [1998].

Diversity indices analysis: To evaluate the diversity indices of macroinvertebrates species were calculated by respective formula or equation as Shannon-Weaver Diversity Index [Shannon-Weaver, 1945], Simpson Diversity Index [Simpson, 1949], Species Richness [Menhinick, 1964], Index of Evenness with Shannon index and Index of Dominance [Chaudhri and Sarkar, 2002] were used. These indices were used to obtain the estimation of species diversity, species richness and species evenness using respectively equations/formulae. All individual species indices were also evaluated.

RESULTS AND DISCUSSION

A total of 17 individuals representing three phylla such as Mollusca, Arthropoda and Annelida were noticed. Of these 17 were Mollucans represents 8 from classes as Bilvalvea and Gastropoda, 7 individuals belonged to Arthropoda, encompassing 2 classes as Insecta and Malacostraca and 2 individuals belonged to Annelida representing a single class Polycheta. The dominants class was Gastropoda representing 5 species and class Insecta 5 species, where lower Polycheta and Malacostraca including 2 species each.

The results of the present investigation are depicted in Table 1. In the study macroinvertebrates density in the reservoir showed higher magnitude during winter and lower in rainy. The density of macroinvertebrates were recorded vary between 0.4 to 2.1 individuals per liter of water. From the observed data it constitute increasing order such as Polycheta [14.8%] < Malacostraca [15.1%] < Bivalve [20.4%] < Insecta [23.2%] and < Gastropoda [26.5%]. Among the observed species the Gastropoda was dominated through the study period. The observed data revealed that monthly average and density of macroinvertebrates varied from 6.5 % [June] to 9.9% [April] individuals per liter of water. The percent value of macroinvertebrates recorded in three seasons in order such as rainy [31.6%] < winter [2.6%] and < summer [35.7%]. In the rainy surface runoff collects soil and get settlement and in winter decaying of organic matte get increased might be a case of lower and higher density of macroinvertebrates.

The Shannon-Weaver Diversity Index [S-WDI] which takes account of individual species as well as distributions. S-WDI of macroinvertebrates species noticed 23.5% species S-WDI above the 0.10 bits ind^{-1}, 70.6% species above 0.20 bits ind^{-1} and 5% species above 0.30 bits ind^{-1}. It showed maximum value of indices 0.30 bits $indi^{-1}$ in Gastropoda and lowest value was 0.16 bits ind^{-1} in Insecta. The S-WDI values are in between 0 to 1 bits ind^{-1}. Phylum Annelida showed higher values in S-WDI among others. This might be due to water and seasonal changes. Nandan [2003] showed similar diversity index from different species with pollution load. Seasonal variation showed lower S-WDI during October and higher during July. Boss & Potts [2001] reported the decrease in diversity indices was not statistically significant in previous study. Hence in the study seasonal indices were not encountered but individual species indices were evaluated.

During ecological sampling Simpson's Diversity Index [SDI] in measuring distributed area found total 17 species in three groups of macroinvertibrate. The SDI number of species per liter was 0.03 to 0.12 bits ind^{-1}. The SDI remains in between 0.03 to 1.12 bits ind^{-1}. The SDI of macroinvertebrates revealed 23.5% species were less than 0.10 bits ind^{-1} and 42% species more than 0.10 bits ind^{-1}. The minimum value observed in Robertsiella species and maximum in *Bulimus* species of Gastropoda class. All Annelida species mostly showed higher SDI [011 to 0.12 bits ind^{-1}].

In the study Index of Dominance [ID] in measuring distributed area was found to be maximum [100%] in *Bulimus* species [Gastropoda] and minimum [30.65%] in Robertsiella species [Gastropoda]. The percent ID varies species to species and group of macroinvertebrates because their number is varied in population.

In macroinvertebrates species, Species Richness [SR] was found high [1.05 bits ind^{-1}] *in Modiolus metcalfei* species [Bivalvae]. Mostly Polycheta species revealed higher values of SR than other group. The lowest [0.028 bits ind^{-1}] value noticed from Gastropoda as Robertsiella species. The SR of macroinvertebrates species showed 82.3% species SR less than 0.10 bits ind^{-1} and 17.6% species had SR more than 0.10 bits ind^{-1}. Rajagopal et al. [2010] focused SR index on zooplankton and reported similar pattern of study but the SR values varies species to species. It might be due to Limnological and geographical condition of water.

Table1. Diversity indices in macroinvertebrates from Dynaneshwar reservoir

Macroinvertibrates	S-WDI	SDI	SR	IE	ID
Bivalea 1. *Pholas orientalis*	0.27	0.11	0.99	0.22	83.39
2. *Modiolus metcalfei*	0.28	0.12	1.05	0.23	92.13
3. *Meretrix meretri*	0.22	0.08	0.70	0.18	83.34
Gastropoda 1. *Robertsiella sp.*	0.11	0.03	0.028	0.09	30.65
2. *Bithynia sp.*	0.21	0.07	0.65	0.17	52.65
3. *Iravadia sp.*	0.18	0.06	0.42	0.15	74.56
4. *Bulimus sp.*	0.30	0.13	0.93	0.24	100.91
5. *Lymmnaea sp.*	0.27	0.11	0.95	0.22	92.13
Insecta 1. *Culex & Anaphels sp*	0.25	0.10	0.85	0.20	83.39
2. *Chironomous sp.*	0.17	0.05	0.49	0.14	78.91
3. *Rnatra sp.*	0.23	0.08	0.69	0.18	57.04
4. *Diplonychus sp.*	0.16	0.05	0.37	0.13	52.56
5. *Agriocnemis sp.*	0.20	0.07	0.62	0.16	92.13
Malacostraca 1. *Asellus sp.*	0.28	0.12	1.01	0.23	87.78
2. *Gemmarus sp.*	0.28	0.12	1.02	0.23	87.73
Polycheata 1. *Cepitella sp.*	0.28	0.11	0.99	0.23	92.13
2. *Namalycastis sp.*	0.27	0.11	0.99	0.22	92.13

SWDI = Shannon and Weaver's Diversity Index
SDI = Simpson's Diversity Index
SR = Species Richness
IE = Index of Evenness
ID = Index of Dominance

Index of Evenness [IE] of macroinvertebrates species showed that 52% of the species had IE more than 0.20 bits ind^{-1}, 41% species had IE more than 0.10 bits ind^{-1} and single species i.e. *Robertsiella* revealed lowest as 0.09 bits ind^{-1}. IE is influenced by environmental condition [Marchese et al., 2008] and distribution caused due to human activities. The deterioration of water quality can be attributed main reason for depletion of several species or group in the production zone [Nandan, 2003].

Water samples ranged temperature from 20.9 ^{0}C in winter to 25.9 ^{0}C in summer. The decrease in water temperature from summer, rainy and winter allows well mixing of water column. The pH ranged from near neutral [7.1] during rainy to alkaline [8.1] during the winter, with maximum value of 8.2 in summer. The reduced buffering capacity of this system total alkalinity [55.6 ppm]

allows strong changes in pH [Merino, et al. 2008]. High and low values of DO and pH are associated with pulses and decrements of Macroinvertebrates.

The Dissolved Oxygen [DO] ranged between 4.0 to 6.5 ppm. Relatively low concentration of DO detected in October to January must be liked to the stage and overturn, when the mixing goes deeper to anoxic area [Mastha et al. 2011]. Thus the DO is redistributed in water which provokes in the upper layer of the water.

Electric conductivity [EC] ranged from 68 to 118 µmho cm^{-1}. This ionic concentration can be ranged as being intermediate. According to Talling & Talling [1965] classification, it belong to class-I [<600 µmho cm^{-1}]. COD values were from 18.3 to 31.3 ppm, with minima value during rainy and minimum in summer. It coincided with a period of low macroinvertebrate densities.

Nitrates were detected in low concentration [<1 ppm] during study period with minimum value in rainy [0.51 ppm] and reaching maximum in summer [0.91 ppm]. Orthophosphate were highest [1.22 ppm] in summer and lowest value [0.58 ppm] during rainy. The magnitude of N and P values in Dynaneshwar dam indicates a distributed environment that receives a nutrient overload of anthropogenic activities. Based of PO_4 concentration the water body could be classified as mesoeutrophic water body [Monbet & McKelvie, 2007].

CONCLUSION

The data showed on diversity and indices of macroinvertebrates as is commonly collected in routine biomonitoring for the calculation of indices showed usefulness for the understanding of distribution trends of the species in water. The species indices and distribution were greatly influenced by seasonal and species to species due to various factors. From the aforesaid result it could be made out that the availability of water, safe habitat and food sources for macroinvertebrates in reservoir are important for the occurrence and abundance. Also water quality is the important habitat characteristics that influence the distribution indices. The proper and regular maintenance of dam would further increase the population. The study helps to conserve the organisms which are useful in aquaculture due to food web in reservoir.

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