

# COMMUNITY STRUCTURE OF BENTHIC MOLLUSCS IN CONTRASTING ECOZONES OF A TRANSBOUNDARY RIVER IN INDIA: AN ECOLOGICAL INTERPRETATION

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**Abstract:** Benthic molluscan fauna from littoral zones of Subarnarekha river, India was surveyed and ecologically interpreted based on their changing community structure in temporal and spatial scales during the period of July, 2012 – June, 2014. A total of 23 species of benthic molluscs belonging to 13 families and 11 genus were recorded from different sites of this river. Several biotic indices such as dominance, diversity, richness and evenness indices pertaining to community structure were worked out based on the seasonal population dynamics to assess the mode of seasonal variations of the studied community in changing ecological gradients. Spatial and temporal variabilities of benthic molluscan community as recorded in this study, have revealed differential trends not only among different ecologically contrasting study sites (five) but among different seasons determined mostly by the fluctuating and unstable ecological gradients

**Keywords:** Benthic molluscs, Community analysis, Subarnarekha river, Ecological gradients, Biotic indices.

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## 1. INTRODUCTION

Community being a natural assemblage of different species which inhabit in similar environmental set ups but enjoy and utilise same or different ingredients for their survivability (food, shelter, reproduction etc) through direct or indirect interactions among themselves. In a lotic riverine ecosystem, the benthic molluscan community representing a heterotrophic faunal components, mainly depend on the autotrophic contributions by green plants and transfer energy and circulate nutrients by way of their foraging and decomposing activities respectively [1].

Besides, the structure, distribution and functional relationships of aquatic communities are regulated by ecological properties of the habitat structure and variations of environmental factors [2], [3]. Fresh water biodiversity patterns are closely related to local geographic features and physicochemical structures of the environment of the aquatic system [4]. The Subarnarekha river, a major transboundary river in the Eastern India which traverses through a distance of 393 km on its origin from Chotanagpur plateau and after crossing three states of India viz. Jharkhand, West Bengal and Odisha before finally ending to the Bay of Bengal at Talsai of Odisha about 15 km west of Digha of West Bengal. Several researchers have so far been carried out different studies on macrobenthic molluscan faunal abundance, their ecology and pollution dynamics in different parts of India [5], [6], [7], [8], [9]. Use of biological organism as an indicator of community or environmental changes has been proved most effective giving for the cause and effect of pollution in recent years [10]. The present long term study covering two consecutive years and six seasons was undertaken to understand seasonal eco-dynamics of benthic molluscan community of Subarnarekha river and also to assess the role of determining ecological factors with the help of some mathematical formulations.

## 2. MATERIALS AND METHODS

### A. Selection of study sites:

The present study was carried out at five study sites in the stretch of Subarnarekha river mostly within West Bengal, India including two at two neighbouring states—first one is Jharkhand and last one is Odisha. Study site-I (Muri)(23°22'12" N, 85°51'36" E) is located in the border of Jharkhand and West Bengal, characterised by scarcity of water flow, hard rocky exposed bottom soil which are also subjected to the inflow of industrial waste water from Aditya Birla Industry at Muri; study site – II (Ghatshila) (22°36'15" N, 86°28'48" E) is also situated in Jharkhand are endowed with rocky bottom sediment which are being contaminated by the effluents of Indian Copper Mining Industry at Ghatshila; study site – III (Gopiballavpur) (21°57'28" N, 86°44'50" E) is located in Midnapore West district of West Bengal having sandy bottom in the middle stream of this river and also experience the contaminated water flow from the upstream; study site – IV (Sonakonia) (21°86'25" N, 87°25'51") located at the border of Odisha and West Bengal is also with sandy river basin in the middle stream of the Subarnarekha river; study site – V (Talsari) (21°35'48"N, 87°27'17"E) is located in Odisha where Subarnarekha river meets with Bay of Bengal exhibiting brakish water environment (Fig - 1).

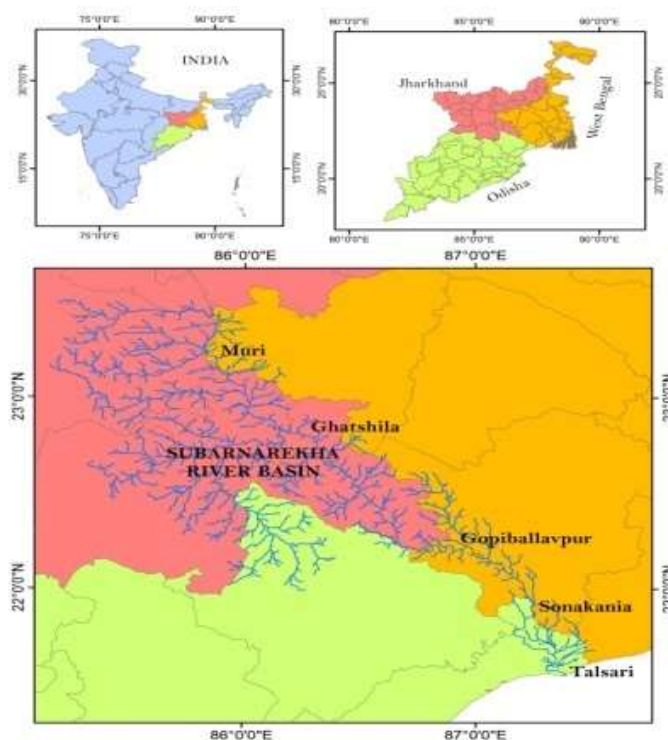


Figure 1: Location map showing the study sites ( I-V) of Subarnarekha river

### B. Collection and preservation of benthic molluscs:

Molluscs were collected at bimonthly intervals (July, 2012 to June, 2014) from the littoral zone of either sides of the river at five contrasting study sites with the quadrat having 0.5m<sup>2</sup> area and four such sub samples (0.5m<sup>2</sup>) from each bank were collected randomly . Different molluscan species present within the quadrat were removed from the attached sediments by hand and subsequently by a sieve having a mesh size of 0.5 mm and were preserved in 5% buffered solution. The average population density of molluscs collected from the used quadrates was expressed in No/m<sup>2</sup>. Collected molluscs were identified following standard literature [11], [12].

### C. Analysis of different community indices:

Effect of environmental factors was assessed by comparing the community structure of different molluscs from different study sites. Relative abundance is expressed as abundance of a species in relation to other species in the community. The species were ranked in order of abundance and the most numerically abundant species was ranked as one [13]. Different mathematical formulae were followed in order to calculate the relative abundance [14], index of dominance [15], species richness index or variety indices [16], species diversity index [17] and species evenness index [18].

### 3. RESULTS AND DISCUSSION

#### Relative Abundance (RA):

The present study has shown the occurrence of twenty three macrobenthic molluscan species from five selected study sites during July, 2012 to June, 2014. The maximum number of species (14 species) were recorded from the study site –V followed by study site- III & IV (9 species), study site- II (7 species) and study site- I (5 species). Relative abundance and rank of different species constituting the molluscan community are shown in Table – 1. It was found that *Thiara scabra* was the dominant species at study sites –I & II and ranked one for these study sites. *Bellamya bengalensis* was the dominant species at study sites –III & IV and therefore ranked one. At study site – V, *Cerithidea cingulata* secured rank one and was dominant species for this study site.

**Table 1: Distribution and relative abundance of molluscan species in selected study sites of Subarnarekha river.**

Sl. No.	Family	Species	Study site - I		Study site - II		Study site - III		Study site - IV		Study site - V	
			RA	Rank	RA	Rank	RA	Rank	RA	Rank	RA	Rank
1	Viviparidae	<i>Bellamya bengalensis</i> (Lamarck,1822)	13.06***	2	12.21***	2	33.01***	1	35.39***	1	0.88*	14
2		<i>Bellamya dissimilis</i> (Muller 1774)	-	-	-	-	8.05***	6	13.51***	3	-	-
3	Thiaridae	<i>Taberia granifera</i> (Lamarck, 1822)	8.67***	3	9.86***	3	9.76***	5	-	-	-	-
4		<i>Thiara scabra</i> (Muller, 1774)	69.47***	1	51.03***	1	13.66***	2	15.39***	2	2.47*	6
5		<i>Thiara lineate</i> (Gray)	-	-	8.33***	6	8.03***	7	8.37***	5	-	-
6	Lymnaeidae	<i>Lymanea acuminata</i> (Lamarck,1822)	6.80***	4	8.61***	4	10.03***	3	-	-	-	-
7		<i>Lymanea luteola</i> (Lamarck,1822)	-	-	8.39***	5	9.91***	4	12.21***	4	-	-
8	Unionidae	<i>Lamellidens corvianus</i> (Lsa, 1834)	-	-	-	-	3.87**	8	3.52**	8	-	-
9		<i>Lamellidens marginalis</i> (Lamarck, 1819)	1.98*	5	1.51*	7	3.65**	9	3.53**	7	-	-
10	Corbiculidae	<i>Corbicula peninsularis</i> (Prashad 1928)	-	-	-	-	-	-	5.64***	6	1.65*	-
11		<i>Corbicula striatella</i> (Deshayes, 1854)	-	-	-	-	-	-	2.41*	9	1.66*	-
12	Assimineidae	<i>Assiminea brevicula</i> (Pfeiffer)	-	-	-	-	-	-	-	-	9.9***	3
13	Littorinidae	<i>Littorina (Littoraria) melanostoma</i> Gray	-	-	-	-	-	-	-	-	2.87**	4
14	Potamididae	<i>Telescopium telescopium</i> (Linnaeus)	-	-	-	-	-	-	-	-	30.40***	2
15		<i>Cerithidea cingulata</i> (Gmelin)	-	-	-	-	-	-	-	-	34.47***	1
16		<i>Cerithidea obtusa</i> (Lamarck)	-	-	-	-	-	-	-	-	2.40*	7
17	Naticidae	<i>Natica tigrina</i> (Roeding)	-	-	-	-	-	-	-	-	2.71**	5
18	Onchidiidae	<i>Onchidium tigrinum</i> (Stoliczka)	-	-	-	-	-	-	-	-	1.72*	12
19	Arcidae	<i>Anadara granosa</i> (Linnaeus)	-	-	-	-	-	-	-	-	1.79*	9
20	Mytilidae	<i>Perna viridis</i> (Linnaeus)	-	-	-	-	-	-	-	-	1.76*	10
21		<i>Modiolus undulatus</i> (Dunker)	-	-	-	-	-	-	-	-	1.75*	11
22		<i>Modiolus striatulus</i> (Hanley)	-	-	-	-	-	-	-	-	1.97*	8
23	Veneridae	<i>Meretrix meretrix</i> (Linnaeus)	-	-	-	-	-	-	-	-	1.57*	13

\*\*\* = Dominant (>5%), \*\* = Subdominant (>2.5%), \* = Rare (<2.5)

#### Species diversity index (H')

Species diversity index (H') is a measurement between number of individuals and number of species. Species diversity tends to be high in biologically ecosystems and low in physically controlled ecosystems [19]. The present study showed that the species diversity index was highest in study site- V followed by study sites – III, IV, II & I (Table- 2). The measures of diversity are frequently seen as indicators of well being of ecological system. The lower value of diversity index is considered as an indicator of higher pollution [20]. Maximum species diversity was found during monsoon periods in all the five study sites and in two consecutive years followed by post monsoon for the study sites I to IV while premonsoon ranked second position after monsoon at study site-V. Comparatively higher species diversity index at study site-V than study sites – IV, III, II and I were supposed to be due to occurrence of more dominant species as it is brackish water zone in comparison to others study sites (I - IV) having freshwater influences .

**Table 2: Seasonal variation of Species Diversity Index of five study sites during the study period (July, 2012 to June, 2014)**

Study site	MON 12	POM 12-13	PREM 13	MON 13	POM 13-14	PREM 14
Study site-I	0.5122	0.3697	0.4147	0.4852	0.3705	0.3977
Study site-II	0.6649	0.6748	0.6577	0.6362	0.6609	0.6479
Study site-III	0.8602	0.8501	0.8387	0.8835	0.8524	0.8308
Study site-IV	0.7332	0.8649	0.8173	0.7759	0.8556	0.7870
Study site-V	0.9076	0.8123	0.8502	0.9589	0.8200	0.8599

**Index of dominance:**

In an intra-community assemblage, species or species groups normally controlling the energy flow and strongly affecting the prevailing environment of all other species in a community are known as ecological dominant [21]. The degree to which dominance concentrates in any species or species groups can be expressed by an appropriate index of dominance [19]. The dominant index value is always higher where the community is dominated by less number of species and lower when the dominancy is shared by large number of species [22]. Among the five study sites, the dominance index was maximum at study site- I followed by study sites – II, III, IV and V which endorses the above statement (Table - 3). Maximum values of dominant indices were found during postmonsoon seasons for study sites- I & V; premonsoon for study sites- II & III and monsoon at study site -IV whereas minimum values were recorded during monsoon season in all study sites except study sites- II and IV where the minimum values were observed in postmonsoon season.

**Table 3: Seasonal variation of Dominance Index of five selected study sites during the study period (July, 2012 to June, 2014)**

Study site	MON 12	POM 12-13	PREM 13	MON 13	POM 13-14	PREM 14
Study site-I	0.3956	0.5989	0.5370	0.4386	0.5915	0.5529
Study site-II	0.3073	0.2842	0.3116	0.3265	0.2980	0.3200
Study site-III	0.1636	0.1814	0.1913	0.1518	0.1773	0.1943
Study site-IV	0.2464	0.1613	0.1969	0.2232	0.1683	0.2116
Study site-V	0.1886	0.2219	0.2019	0.1609	0.2178	0.1995

**Species Richness Index:**

Species richness index is expressed simply by the ratio between total species and total number of individuals in all species. Species richness index increases with increased complexity of community and decreases where simplification occurs within the community [23]. The maximum richness index was found at study site- V (1.83) followed by Study site-III (1.48), IV (1.28), II (1.04) and I (0.67). Seasonal species richness fluctuated from a minimum of 0.542 to a maximum of 1.833 (Table-4). The maximum species richness was recorded during monsoon and minimum during premonsoon for all study sites.

**Table 4: Seasonal variation of species richness index of five selected study sites during the study period (July, 2012 to June, 2014)**

Study site	MON 12	POM 12-13	PREM 13	MON 13	POM 13-14	PREM 14	Mini.	Max.
Study site-I	0.663	0.556	0.613	0.675	0.542	0.593	0.542	0.675
Study site-II	1.028	0.782	0.883	1.046	0.767	0.908	0.767	1.046
Study site-III	1.482	1.204	1.409	1.472	1.160	1.430	1.160	1.482
Study site-IV	1.272	0.984	1.237	1.249	0.979	1.283	0.979	1.283
Study site-V	1.833	1.540	1.750	1.800	1.526	1.717	1.526	1.833

**Species Evenness Index:**

Species populations or individual species organisms do not exist in nature by themselves only; instead they form a part of assemblage of species population living together in a definite habitat enjoying the impact of certain ecological parameters of locality [24], [9]. Dynamic events like recruitment and mortality, occurring at the population level [25]. Species evenness index is the expression of abundance i.e. how equally the species are abundant. High evenness occurs when species are equal or virtually equal in abundance. The maximum evenness index was found at study site - III (0.925) and minimum at study site – I (0.592). Seasonal variation of evenness index displayed maximum during monsoon season for study sites –I, III & V and postmonsoon for study sites – II & IV whereas the minimum was recorded during postmonsoon in all study sites except study sites – II & IV where monsoon registered the minimum value (Table - 5).

**Table 5: Seasonal variation of species evenness index of five selected study sites during the study period (July, 2012 to June, 2014)**

Study site	MON 12	POM 12-13	PREM 13	MON 13	POM 13-14	PREM 14
Study site-I	0.732	0.528	0.592	0.694	0.529	0.568
Study site-II	0.786	0.798	0.778	0.753	0.781	0.766
Study site-III	0.901	0.891	0.878	0.925	0.893	0.870
Study site-IV	0.768	0.905	0.856	0.812	0.896	0.825
Study site-V	0.753	0.674	0.706	0.796	0.681	0.713

#### 4. CONCLUDING REMARK

The present study has unearthed some interesting findings on the distribution and seasonal dynamics of benthic molluscs and their community structures within an important trans-boundary river in the eastern India, the Subarnarekha River which are supposed to add better insights on the differential survival strategies of an important faunal group of an lotic aquatic ecosystem in different ecological conditions ( ranging from fresh water to brackish; from pollution stressed to clean water; from eutrophic to oligotrophic condition; from higher volume and depth of water to least volume and depth of water; from sandy to clay sediments) especially in view of ongoing environmental perturbations.

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