

AQUATIC MACROPHYTES ASSOCIATED MOLLUSCAN SPECIES IN THE EAST KOLKATA WETLANDS.

Science

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ABSTRACT

About 9 species of freshwater molluscs were recorded to be associated with floating and submerged macrophytes of the sewage fed ponds of East Kolkata Wetlands. *Bellamya*, *Bithynia*, *Gabbia*, *Melanoides* and *Tarebia* feed on succulent vegetations. Among the macrophytes surveyed, *Pistia*, *Lemna* harbor 1909 individuals among which *Lymnae*, *Bellamya*, *Bithynia*, *Tarebia* and *Gabbia* are abundantly found. These species although common among the *Eichhornia* strands are represented in lower numbers. However, population of *Melanoides* and *Indoplanorbis* has been recorded to be high among *Eichhornia*. Among this bed, about 1031 individuals of molluscs have been sampled. Occurrence of *Pila* is very rare. Species diversity indices calculated for each site show similar trends. The values are closely invariant which shows that diversity does not vary much between the two macrophytic communities. Jaccard's index of Community Similarity and Sorenson's index indicates almost complete overlap of the communities or presence of almost common species among them.

KEYWORDS:

Mollusca, East Kolkata Wetlands, Macrophytes.

Introduction.

Molluscs are the most diverse, dominant and second largest phylum next to the arthropods that comprise of eight living and two extinct classes. These have adapted to all types of habitats ranging from deepest ocean, intertidal zones, besides freshwater and even on terrestrial system. Approximately, 50,000 living species and 60,000 fossil records are known from the group. (Rao, 1989) Among the living eight classes, six are exclusively marine with the exception of gastropoda and bivalves or Pelecypoda. The most diverse and widely adapted class is gastropoda comprising more than 80% of all living molluscs. These occur in marine, freshwater and terrestrial habitats. The bivalves on the other hand occur only in the aquatic system but are represented both in freshwater as well as in the sea. (Mackie, 1998). Molluscs are highly adaptable and ecologically important organisms that help in recycling of nutrients. (Waghmare, 2012) These have attractive shells that are often commercially used. Besides, freshwater molluscs are widely consumed as food hence they play a vital role in the economy and tradition in many parts of the world. (Mangare, 2016) Their diversity is highest in the sea.

From India, about 1488 species of molluscs belonging to 26 families and 140 genera have been recorded (Ramakrishna and Mitra, 2002; Madhyastha, *et al.*, 2004) of which 270 species are freshwater forms. From the Malacological point of view, India can be divided into 5 (five) zones namely Insular zone of Andaman and Nicobar Islands, Lakshadweep, North East India, Western Ghats, Plains of Peninsular India and North West India (Rao, 1989). Benson (1803-1870) was the pioneer of Indian Malacology while Blanford (1863; 1870 and 1880) worked extensively on Indian mollusca and Annandale and Prasad (1919) described most of the freshwater species.

The identification of the freshwater mollusc is primarily based on shell characters as the individual characters of the shell are important for species recognition. The shell shape is usually constant excepting individual differences and the minor clinal, populational and ecophenotypic variations exhibited by some species.

Nearly all freshwater molluscs are common in lotic and lentic water system. The primary fresh-water molluscs are confined exclusively to the freshwater habitats while secondary fresh-water species are distributed in both freshwater as well as in brackish water.

Aquatic macrophytes determine the population density of mollusca by providing a stable habitat or physical structure, to these macroinvertebrates besides providing food (Gregg and Ross, 1985) and shelter from predators. These also act as spawning and attachment sites for eggs and juveniles. Plants increase habitat complexity or heterogeneity and affect richness and composition of molluscan assemblage positively (Ohtaka *et al.* 2011)

In the present study, the general distribution and diversity of mollusca associated with the aquatic macrophytes of the sewage fed ponds of East Kolkata Wetlands have been dealt in details. Besides, their taxonomic and functional diversity, feeding habit or trophic status has also been determined.

Functional feeding group analyses are used in water quality assessment, energy transfer studies, food chain modeling (Uwadia, 2010) and also for studies at the community level (Rempel *et al.* 2000). Species with similar functional feeding group reflects both convergent and parallel evolution leading to functionally similar organisms which form guilds in a community (Rawer-Jost *et al.*, 2000).

The primary aim of the study is to determine the species composition of freshwater molluscs among the various species of macrophytes in the study area. The faunistic survey provides crucial information about ecology and food web pattern of the ecosystem.

Study Site.

East Kolkata Wetlands (22°25' N to 22°40' N latitude and 88°20' E to 88°35' E longitude) situated on the peri-urban interface of eastern part of Kolkata, constitute the largest system of salt water marshes which is actually the spill area of Bidhyadhari river. This Ramsar site, spread over an area of 12,500 ha, represents one of the largest assemblages of sewage fed fisheries of the world where city sewage is efficiently utilized for fish culture. (Bhattacharya *et al.* 2007: Conservation of wetlands, GOI).

The molluscan specimen were collected from among the aquatic macrophytes of the sewage fed ponds of this Wetland. The sampling was done at various locations such as Bantala, Bamanghata, Baishtala and Anandapur fish farm of the East Kolkata Wetlands.

Research Elaboration.

Several species of macrophytes were sampled. Collection of macrophytes was done using plastic containers. (20x20x40cm). Collected plants were submerged in water after which the plants were rinsed vigorously. Molluscan specimens were handpicked as these cling on the macrophytes. The water is then filtered through a sieve (0.5mm mesh) where the sorted animals were retained. These were stored in vials, counted and the process is repeated several times. (Pal and Nandi, 1997)

Animals were fixed in 5% formaldehyde and identified to the lowest possible taxonomic category by standard keys and also with the help of the experts from Zoological survey of India. Macrophytes were identified by the experts from Botany department.

Total number of specimen collected from each macrophytic bed and

the relative abundance of each species were calculated. Diversity was estimated by counting the total number of species per square meter for each sample.

A Diversity Index is a mathematical measure of species diversity in a given community. It is based on the species richness and species abundance.

The various indices used in our study include,

i. Shannon Index (Shannon H' Log Base) or information statistic index.

$$H' = - \sum_{i=1}^R p_i \ln p_i$$

P is the proportion (n/N) of individuals of one species (n) divided by the total number of individuals. (N). \ln is the natural log, Σ is the sum of the calculations, s is the number of species. It assumes that all species are represented in a sample and they are randomly sampled. Values of this index generally remain between 1.5 and 3.5 in most ecological studies, and rarely exceeds 4. The value of Shannon index increases with the richness and the evenness of the community.

ii. Fisher's alpha (α) describes the relationship between the number of species and the number of individuals of those species with a logarithmic distribution. It represents a species abundance model (Magurran, 2004). Alpha is low when the number of species is low and, therefore, smaller samples have low values of α . The index is less affected by the abundance of the rarest or commonest species than either H' or λ respectively and depends more on the number of species of intermediate abundance.

iii. Jaccard's index have been used for comparing biodiversity level across microhabitats. This is an intuitive measure of similarity between two samples that summarize the fraction of species they share.

Jaccard's index (J) = $sc/sa \times sb \times sc$ where sa and sb are the numbers of species unique to samples a and b , respectively, and sc is the number of species common to the two samples. Jaccard's index of similarity represents the fraction of species shared between the samples and only utilizes the richness component of diversity. It does not entail any information on abundance. (Magurran, 2004).

The other indices used are

iv. Sorenson's index

v. Evenness Index Shannon (J') The evenness index is a measure of how evenly species are distributed in a sample. When all species in a sample are equally abundant, an evenness index will be at its maximum, decreasing towards zero as the relative abundance of the species diverges away from evenness.

vi. Berger-Parker Dominance (d)

vii. Brillouin index is much like Shannon function and sensitive to rare species in the community.

Results or Findings

Several species of aquatic macrophytes were sampled in the East Kolkata Wetlands. However, it was observed that free floating *Pistia/Lemna* and *Eichhornia* harbour rich faunal assemblage that includes arthropods, molluscs and others. Often *Pistia* and *Lemna* occur together in water body that forms a continuous bed, congenial for macroinvertebrate colonization. The analysis of biocoenosis associated with macrophytes has been studied in detail. **Table (1)** show the species richness, habitat, conservation status and taxonomic categories of the sampled molluscan species while **Table (2) Fig (1, 2, 3)** shows the relative abundance of these organisms among the various macrophytic beds. Their conservation status is established by IUCN Red List Categories and Criteria are intended for classifying species at high risk of global extinction.

In the present investigation, *Pistia/Lemna* bed harbour 1909 individuals of which *Lymnae*, *Bellamya*, *Bithynia*, *Tarebia* and *Gabbia* are abundantly found. These species although common among the *Eichhornia* strands are represented in low numbers. However, *Melanoides* and *Indoplanorbis* have been recorded to be high among *Eichhornia*. Among this bed, about 1031 individuals of molluscs have been sampled. Occurrence of *Pila* is very rare. Only 8 individuals among the *Pistia* and *Lemna* have been found. Among the bivalves only one specimen of *Lamellidens* has been recorded from the pond

bottom.

Indices of diversity or heterogeneity incorporate measures of species richness and evenness into a single value and are based on the proportional abundance of species in a sample. (Magurran, 2004)

Observations reveal that Shannon (**H'**) value for mollusca in *Eichhornia* is 1.724788 and for *Pistia/Lemna* is 1.30268. **Berger-Parker Dominance (d)** value for mollusca among *Eichhornia* strands is 0.868338 (Table 4), for *Pistia/Lemna* is 0.954586. (Table 3)

Species diversity indices calculated for each site show similar trends. The values are closely invariant which shows that diversity does not vary much between the two macrophytic communities.

The evenness (J') values are also very similar. Moreover, Jaccard's index of Community Similarity and Sorenson's index indicates almost complete overlap of the communities or presence of almost common species in them. (Table 5) However, molluscan abundance varied for taxonomic groups among the two macrophytic communities.

In this aquatic system, gastropods or snails are generally found attached to submerged vegetations, rocks or other objects. These may hide under damp and dense vegetations during day and forage after dusk. Thus, feeding, reproduction and locomotory activities are at the peak in the night (Yoloye, 1994). All the members of mesogastropoda order such as *Bellamya bengalensis*, *Bithynia*, *Gabbia orcula*, *Melanoides tuberculata*, *Tarebia granifera* feed on succulent vegetations. This accounts for the higher abundance of these phytophilous species among the macrophytes of the wetlands. (Ramakrishna and Dey, 2007). Moreover, according to Wilson and Ricciardi, (2009), the magnitude of macroinvertebrate density and diversity is reported to be higher in the combined mixed vegetation than in single species dominant beds as observed in the present study.

Fig (1,2,3) In freshwater ecosystems, abiotic factors such as temperature, salinity, oxygen, acidity and pollutant level influence the occurrence of this group.

The identified specimen were assigned respective functional feeding group analysis (FFGs) which is a classification approach that is based on behavioral mechanisms of food acquisition rather than taxonomic grouping. Individuals are categorized based on their mechanisms for obtaining food, mode of feeding, type, origin and size of the food particle. This method of analysis establishes linkages to basic aquatic food resource categories such as coarse particulate organic matter (CPOM), and fine particulate organic matter (FPOM), which require different adaptations for their exploitation.

The major functional feeding groups are scrapers (grazers), which consume algae and associated materials, shredders, which consume leaf litter or other CPOM, including wood. Collectors (gatherers), collect FPOM from the pond bottom while filterers collect FPOM from the water column using a variety of filters. Predators feed on other animals.

Study on the functional feeding group analysis shows, that the most commonly recognized functional feeding groups among the freshwater mollusks are the scrapers. The gastropods are scrapers (grazers), which use their radula to scrape algae. In the present investigation, the gastropods dominated the molluscan community in the wetlands. About 10 species of freshwater molluscs were recorded of which most 9 are gastropods. The latter is distributed in 2 orders such as Mesogastropoda and Basommatophora under 7 families. The abundance of scrapers or grazers could be attributed to the shallowness of water body and presence of abundant sun light that provide for periphyton growth (Lindstrom *et al.*, 2004).

Lamellidens marginalis occur in pond bottom although only one specimen has been recorded in the entire study period. These benthic bivalves are filtering collectors and occur in sediments with high percentage of sand fractions with interstitial spaces which favour oxygenation of sediment. Aquatic areas with sandy sediments are generally associated with high water current which influences water oxygenation facilitating their filter feeding process. (Allen 1914) East Kolkata wetlands with clay soil and stagnant water are thus unsuitable for supporting *Lamellidens*.

The following is a short description of the sampled molluscs among the aquatic macrophytes.

Lymnae luteola. The species is widely found in the East Kolkata Wetlands and is considered as a habitat generalist. It generally occurs in the temporary water bodies, which dry up in summer. During unfavourable conditions it keeps itself buried in the mud. Although a freshwater species, it can also tolerate a salinity of 0.3 mg/l (Rao *et al.* 1985).

Bellamya bengalensis or common banded snail, is an abundant species found in almost all types of lowland water bodies, such as rivers, streams, lakes, ponds, wetlands, marshes, ditches, paddy fields and even in low saline water resources. According to Ramakrishna and Dey (2007), it can tolerate a maximum salinity of 0.2mg/l. *Bellamya bengalensis* is commonly used as food in Nepal, Bangladesh, and India. (Goswami, *et al.*, 2010) In our study, *Bellamya* is maximally abundant among the *Pistia/Lemna* community. However, these have a commendable population size in the *Eichhornia* as well as in the pond bottom. (Table 1,2)

Melanoides tuberculatus is a globally distributed species found mainly in the subtropical and tropical Africa and southern Asia. During the 20th century it was introduced, by rice cultivation, to many other regions (Liu *et al.* 1979, Ramakrishna and Dey, 2007). This species is found in all types of permanent water bodies, from small springs to vast lakes and even in rice fields and canals. It is a browser of microalgae and a detritivore that feeds on detritus, leaves or dead animals, and is able to survive in relatively alkaline and saline waters. This species is parthenogenetic and is spread by birds. Besides, it is an intermediate host of several trematodes. It can even thrive in aquatic habitats strongly impacted by human activities and tolerant towards pollutants. It is thus a resistant species. (Table 1,2)

Gyraulus convexiusculus is a habitat generalist freshwater species, found among aquatic weeds in the littoral zones of lentic and intermittent ecosystem, including streams, ponds, lakes, reservoirs and marshes . It has an annual life cycle, showing a peak in biomass during August (Hann *et al.* 2001). Decline in this species have been observed in areas impacted by human influence. (Table 1,2)

Indoplanorbis exustus, or mud snails, is a freshwater hermaphroditic, invasive, widely distributed, monotypic snail with high rate of fecundity. The shell is dorso-ventrally flattened with sinistral coiling, but is carried upside down which appears to be dextral. The shell of *Indoplanorbis exustus* is discoid with rapidly increasing whorls. Each whorl is higher than it is wide. (Ramakrishna and Dey, 2007). The species has a widespread distribution in the Indo-Malayan and Oceania realms but have been introduced to many parts of the world. Being an adaptable species these are ubiquitous in rivers, pools, canals, lakes and even in tidal areas, although it cannot tolerate high levels of salinity (Brandt 1974). Water pollution is its main threat. The snail is of medium size with a characteristic shell calcareous lid (operculum) with concentric growth lines. Observations reveal that that mud snails are associated with more with the *Eichhornia* strands. (Table 1,2)

Bithyninia cerameopoma, a cosmopolitan species has a global distribution except in the America. These are abundant in streams and lakes and more sensitive species hence act as an indicator for eutrophic conditions. Their occurrence in this wetland is slightly higher among the *Pistia / Lemna* community. (Table 1, 2)Their presence reveal that sewage fed ponds maintains relatively good water quality.

Pila globosa occurs in Nepal, southwestern Asia, Africa, North and South America (Rao 1989). It is a common species in India except southern India and Punjab occurring in permanent and temporary stagnant water bodies. It uses dry areas for breeding and reported to be tolerant toward saline water (Pal and Dey, 2011). The species is almost absent in the sewage fed ponds of the study area. Decrease in their population is probably due to habitat loss, agricultural intensification overexploitation and fish poisoning. (Rao 1989; Ramakrishna and Dey, 2007).

(Table 1,2)*Tarebia granifera* is widespread throughout the Ganges-Brahmaputra rivers systems. It is recorded from Bangladesh, Bhutan, Sri Lanka, Myanmar, Nepal (Rao 1989), eastern and northern India. (Table)

Gabbia orcula are common in freshwater streams, stagnant pools and also in the paddy fields. These remains attached to vegetation or crawls on muddy bottoms in organically polluted system and considered to be a pollution tolerant species (Nesemann *et al.* 2007). In our observation, these two species are quite abundant among the three species of macrophytes. (Table 1,2)

Conclusion.

Several species of snails such as *Lymnae*, *Melanoides* are highly stenotopic or habitat specific hence they may be considered as bio-indicators of biologically diverse aquatic habitats. (Choubisa, 1992)

Molluscan species richness was only slightly correlated with pH, but was significantly correlated with hardness across the habitats.

All aquatic macrophytes do not support invertebrate assemblage equally. However the sampled floating vegetations that support faunal diversity show similar invertebrate assemblage, suggesting relatively little habitat specificity. Species richness of mollusca did not vary among *Pistia/Lemna* and *Eichhornia* although their abundance varied. **Fig (1,2,3)**

Freshwater molluscs are 'Ecosystem Engineers' that help in improving the water quality population decline of which affect ecosystem service. (Pasupuleti and Rao, 2015) Wetlands support rich molluscan diversity (Pal and Dey, 2011) but are currently subject to problems of pollution, reclamation and sedimentation. Widespread anthropogenic activities such as clearance of aquatic macrophytes, increase in pollutants and overexploitation of some species for food have led to massive decline in molluscan population. (Ramkrishna and Dey, 2007)

The impact of these potential threats on the species needs to be better understood. Surveys and research on population size and community of these species is thus essential. Conservation of freshwater mollusc can be supported when the vital role of invertebrates within aquatic ecosystems will be realized, better understood and appreciated. Moreover, maintenance of macrophytic beds that support them and pollutant free pond bottom can enhance the population size of these bioindicators. Public awareness is a keystone of conservation.

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Table 1. Diversity and Functional feeding Groups of Molluscs collected from East Kolkata wetlands.

Order-	Family	Species	Feeding Groups	Habitat	Conservation Status
Trigoinoidea	Unionidae	<i>Lamellidens marginalis</i> (Lamarck)	Collector /filterer	Benthic Clinger/burrower	Least Concern
Mesogastropoda	Viviparidae	<i>Bellamya bengalensis f. typica-</i>	Scraper. Feed on succulent vegetation	Freshwater pools, streams. feeds on detritus. Clinger/crawler	Least Concern
	Bithyniidae	<i>Bithynia</i> (<i>Digoniostoma cerameopoma</i> (Benson)	Scraper.	Freshwater pools, streams. Clinger/crawler.	Least Concern
		<i>Gabbia orcula</i> var. <i>producta</i>	Scraper	Freshwater pools, streams even of paddy fields. Clinger/crawler;	Least Concern
	Thiaridae	<i>Melanoides tuberculata-</i> (Mueller)	filter feeders CG	Inhabits both freshwater and brackish water. Fine sediment Clinger/crawler;	Least Concern
		<i>Tarebia granifera</i> (Lamarck, 1822	Scraper	Lotic and lentic system	Least Concern
	Ampullaridae	<i>Pila globosa</i> <i>Aple snail</i>	Scraper.	Amphibious in habit. Banks of Freshwater ponds stream Clinger/crawler;	Least Concern

BASOMMATOP HORA	Planorbidae	<i>Gyraulus convexiusculus</i> (Hutton)	Scraper	Shallow littoral zone of ponds and lakes. Clinger/burrower	Least Concern
	Lymnaeidae	<i>Lymnae</i> (<i>Pseudosuccinea</i>) <i>luteola</i> f. <i>typical</i> Lamark	Scraper	Freshwater habitat with or without vegetations. Clinger	Least Concern
	Bullinidae	<i>Indoplanorbis exustus</i> (Deshayes)	Scraper	Common in pools, canals, ditches with or without vegetations Clinger	Least Concern

Table.2. Relative Abundance of Molluscs among *Pistia/Lemna*, *Eichhornia* and Benthic Community of the East Kolkata Wetlands.

	Pista/Lemna	Eichhornia
<i>Lymnae</i>	978	250
<i>Bellamya</i>	379	228
<i>Melanoidea</i>	59	294
<i>Indoplanorbis</i>	130	198
<i>Gyraulus</i>	60	34
<i>Pila</i>	8	0
<i>Lamellidens</i>	0	0
<i>Tarebia</i>	100	75
<i>Gabbia</i>	72	71
<i>Bithynia</i>	115	80
Total	1909	1259

Table 3 : Mollusca Community among *Pistia/Lemna*

	S	N	d	J'	Brillouin	Fisher	H'(log _e)	1-Lambda'
	8	1530	0.95458 6	0.62645 7	1.28918 3	1.10604 9	1.30268 8	0.56884 8

Table 4 : Mollusca Community among *Eichhornia*

	S	N	d	J'	Brillouin	Fisher	H'(log _e)	1-Lambda'
	7	1002	0.86833 8	0.88636 6	1.70626 9	1.01511 6	1.72478 8	0.79525 5

S = number of species
 N= total number of individuals
 d= Berger Parker Dominance
 J'= Evenness Index Shannon
 Brillouin index
 Fisher index

H'(log_e) = Shannon Weiner function (calculated with base e logs)
 1-Lambda

Table 5: Jaccard's index of Community Similarity, Sorenson's co efficient

Jaccard's index of Community Similarity		
Macrophytes in <i>Pistia / Lemna</i> and	Mollusca in <i>Pistia/Lemna</i> and <i>Eichhornia</i>	Spider in <i>Pistia / Lemna</i> and <i>Eichhornia</i>
.0833	8	12
Sorenson's co efficient		
.0.944	0.9411	0.9230

Fig 1: Relative Abundance of Molluscan Species among the *Pistia/Lemna* Community

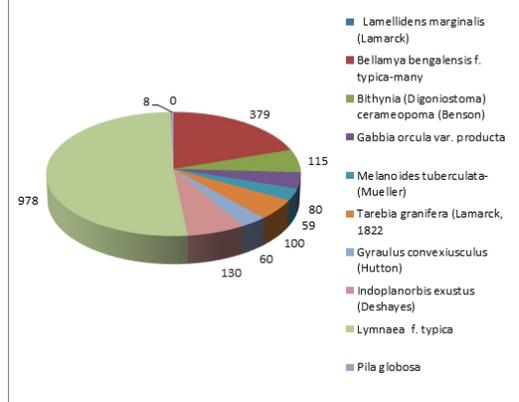
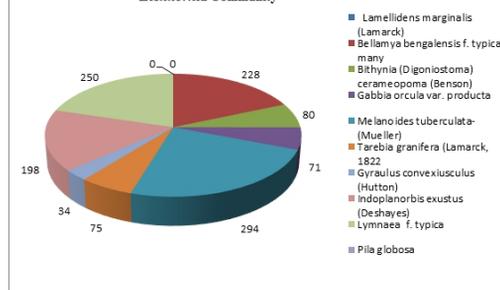


Fig 2 : Relative Abundance of Molluscan Species among the *Eichhornia* Community



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