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Full Length Research Paper

Correlation of molluscan diversity with physico-chemical characteristics of water of Ramsagar reservoir, India

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Molluscan diversity, seasonal variations and their correlation with the physico-chemical characteristics of Ramsagar reservoir has been done during March, 2003 to April, 2005. A total of 13 species of molluscs were recorded in the reservoir. Out of which *Melania (Plotia) scabra, M. scabra var elegans, Melania striatella* and *Faunus ater* belong to family Melaniidae, *Vivipara dissimilis* to family Viviparidae, *Zootecus chion* and *Opeas gracile* to family Subulinidae, *Planorbis (Indoplanorbis) exustus*, *Anisus (Gyraulus) convexiusculus* to family Planorbidae, *Lymnaea (Pseudosuccinea) acuminata, L. luteola, L. pinguis* to family Lymneidae and *Lamellidens corrianus* to family Unionidae. The dominant class, Gastropoda was represented by 12 species, which were observed throughout the year. Amongst the Gastropoda *Vivipara dissimilis* was most dominant species in the reservoir. The density of Gastropods ranged from 48 (monsoon) org/m^2 to 251 org/m^2 (summer). Class Pelecypoda, represented by only a single (*Lamellidens corrianus*), had its minimum population (3 org/m^2) in monsoon and maximum population (22 org/m^2) in summer. The physico-chemical characteristics of water suggest that the Ramsagar reservoir is a mesotrophic water body (Garg et al., 2008). The values of coefficient of correlation (*r*) indicate that there is a moderate positive correlation between the gastropods and electrical conductivity, pH, total alkalinity, phosphates, sodium and potassium, while the pelecypods are positively correlated with electrical conductivity, total alkalinity, chlorides, calcium, nitrate-nitrogen, phosphates and potassium. A moderate negative correlation exists between molluscs population with free carbon dioxide in water.

Key words: Molluscan diversity, correlation coefficient, Ramsagar reservoir, water quality.

INTRODUCTION

Macrobenthic organisms occupy the bottom of water body. The functional role of macrobenthic communities in the trophic dynamics of reservoir ecosystems is well acknowledged. The composition, abundance and distribution of benthic organisms over a period of time provide an index of the ecosystem. In recent years, there is a greater emphasis world over for better understanding of benthic environment, its communities and productivity and this has led to increased exploitation of many inland water bodies. Clarke (1979) attempted to show the utility of molluscs in primary classification of the lakes in their various trophic status stages. Choubisa (1992) has collected 22 species of molluscs from various freshwater habitats of southern Rajasthan and considered these as indicator for oligotrophic lakes based on their distribution and relative abundance. Harman (1974) has also pointed out that molluscs are bio-indicators of freshwater pollution.

Though, the studies on aquatic macro-organisms and their fluctuations in relation the chemical and physical characteristics of the freshwater environment in Madhya Pradesh have been taken up by several authors (Ganapati, 1956; Tonapi, 1959, 1980; Nasar and Munsi, 1974; Sharma et al., 1978; Das and Bhist, 1979; Krishnamoorthi and Sarkar, 1979; Kaushik et al., 1991; Saksena and Kaushik, 1994; Prasad and Singh, 2003;

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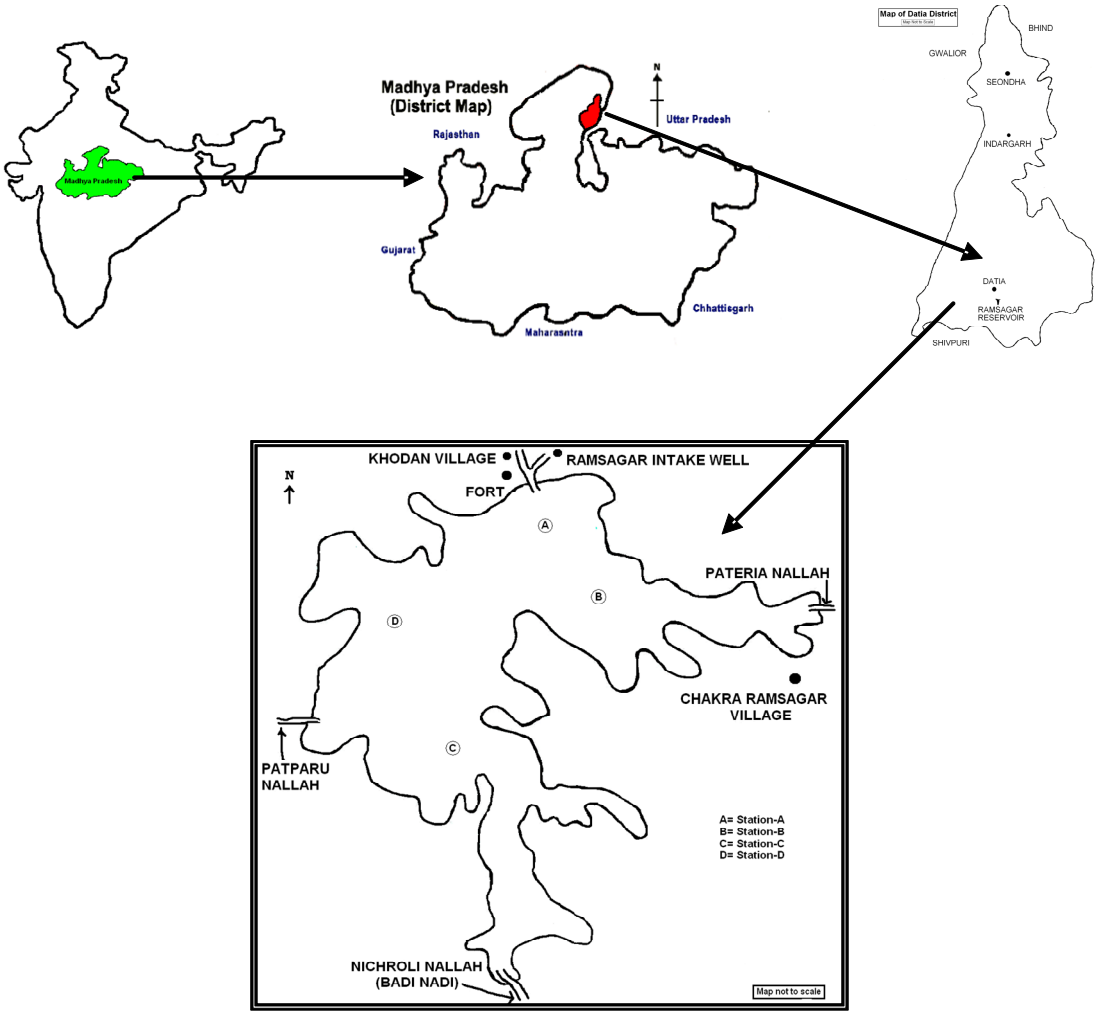

Figure 1. Map showing study area with sampling stations

Anitha et al., 2004; Jindal and Singh, 2005; Gorai et al., 2005). Not much work has been done on the hydrological and macrobenthic faunal aspects though there are many large and small freshwater bodies and impoundments in northern Madhya Pradesh. In the present paper, some of the basic observations on the molluscan diversity with relation to water quality of Ramsagar reservoir, district Datia, Madhya Pradesh have been presented.

MATERIALS AND METHODS

The reservoir is located approximately 8 km North-West of Datia city in district Datia, Madhya Pradesh and approximately 80 km South of Gwalior, which is constructed on Nichroli nallah of Basin of Sindh River. Geographically, it lies between 25^0 40' N latitude and 78^0 23' E longitude and altitude of 229 msl. Reservoir is basically used for drinking water supply to the Datia city, irrigation, and fisheries (Garg et al., 2008).

The studies were carried out form April, 2003 to March, 2005. 4 sampling stations were selected namely sampling station-A near sluice, sampling station-B near Chakra Ramsagar village, sampling station-C and sampling station-D (Figure 1). Seasonal collection of molluscan fauna has been made from the profundal zone by using Ekman dredge. The samples from littoral zone have been collected by scoop net. The samples have been washed and shifted through a grade 40 mesh size sieve. 3 samples were taken from each station to minimize the sampling error. The collected organisms were fixed in 5% formalin solution and enumerated group wise and preserved organisms were identified standard keys provided by Ward and Whipple (1959), Tonapi (1980) and Adoni et al. (1985). Numbers of each species were expressed as organisms/m^2. Water samples were collected every month for physico-chemical analyses. Some of the parameters, that is, water temperature, transparency, pH, dissolved oxygen, free carbon dioxide, total alkalinity, total hardness, chlorides, calcium and magnesium were analyzed at different sampling stations while other parameters, that is, electrical conductivity, turbidity, nitrates, phosphates, sodium and potassium were analysed within 4 - 6 h in the laboratory at the School of Studies on Zoology, Jiwaji University, Gwalior following standard methods prescribed for water quality assessment (APHA, 1985; Trivedy and Goel, 1986).

RESULTS

Considerable seasonal variations among molluscs in

Table 1. Seasonal fluctuations of molluscan fauna (organisms/m^2) recorded in Ramsagar reservoir, during April, 2003 to March, 2005.

Class	Order	Family, Genus and species	2003 - 2004			2004 - 2005		
			Winter season	Summer season	Monsoon season	Winter season	Summer season	Monsoon season
Gastropoda	Mesogastropoda	**Melaniidae (Tiaridae)**						
		Melania (Plotia) scabra (Muller)	8	16	3	2	12	2
		M. striatella (Muller)	10	22	4	4	12	6
		M. scabra var elegans (Hutton)	6	16	4	8	14	2
		Faunus ater (Linnaeus)	12	18	6	16	20	2
		Viviparidae						
		Vivipara dissimilis (Muller)	36	58	12	24	32	8
	Basommatophora	**Subulinidae**						
		Zootecus chion (Pfeiffer)	16	24	4	6	10	2
		Opeas gracile (Hutton)	12	21	2	10	14	-
		Planorbidae						
		Planorbis (Indoplanorbis) exustus (Deshayes)	8	24	2	2	12	7
		Anisus(Gyraulus) convexiusculus (Hutton)	6	18	2	2	12	4
		Lymneidae						
		Lymnaea (Pseudosuccinea) acuminata (Walker)	10	18	6	12	19	7
		L. luteola (Walker)	3	8	1	6	14	3
		L. pinguis (Walker)	2	8	2	6	14	8
Pelecypoda	Eulamellibranchia	**Unionidae**						
		Lamellidens corrianus (Lea)	6	18	3	12	22	-

Ramsagar reservoirs were observed. Total 13 species of molluscs belonging to class-Gastropoda and Pelecypoda were recorded during study period (Table 1). The population of Gastropoda was recorded throughout the year and represented by 12 species. The density of order Gastropoda ranged between 48 to 251 organisms/m^2 with maximum density in summer and minimum in monsoon season. Amongst the Gastropoda group *Vivipara dissimilis* was most dominant followed by *Faunus ater*, *Lymnaea (Pseudosuccinea) acuminata*, *Zootecus chion*, *Melania (Plotia) striatella*, *Opeas gracile*, *Planorbis (Indoplanorbis) exustus*, *Lymnaea (Pseudosuccinea) pinguis*, *Melania (Plotia) scarba var elegans*, *Lymnaea (Pseudosuccinea) luteola*, *Melania (Plotia) scarba* and *Anicus (Gyraulus) convexiusculus,* while, one species (*Lamellidens corrianus*) of order Pelecypoda (Bivalvia) was recorded and density of this group represented by 3 to 22 organisms/m^2 with maximum density in summer and minimum in monsoon season (Figures 2 and 3). 16 physico-chemical parameters namely water temperature (15.92 – 31.87°C), transparency (66.59 - 116.00 cm), electrical conductivity (108.00 – 246.30 µS/cm), turbidity (2.17 - 16.72 NTU), pH (7.41 - 8.95), dissolved oxygen (6.78 - 11.59 mgL^{-1}), free carbodioxide 0.00 - 6.32 mgL^{-1}), total alkalinity (64.25 - 146.25 mgL^{-1}), total hardness (34.00 –75.25 mgL^{-1}), chlorides (13.13 - 22.36 mgL^{-1}), calcium (11.21 - 33.81 mgL^{-1}), nitrates (0.011 - 0.033 mgL^{-1}), phosphates (0.013 - 0.054 mgL^{-1}), magnesium (1.17 - 5.60 mgL^{-1}), sodium (16.75 - 34.30 mgL^{-1}) and potassium 1.97 - 4.86 mgL^{-1}) were studied during 2 years (Table 2).

The values of coefficient of correlation (r) indicate that there was a moderate positive correlation between the Gastropods and electrical conductivity, pH, total alkalinity, phosphates, sodium and potassium, while the pelecypods were positively correlated with electrical conductivity, total alkalinity, chlorides, calcium, nitrate-nitrogen, phosphates and potassium (Table 3). A moderate negative correlation exists between molluscs population with free carbon dioxide in water (Table 3).

DISCUSSION

Molluscs are represented in freshwater bodies by only 2 classes, Gastropoda and Pelecypoda (Mackie, 1998) and a group of most diverse and dominant benthic fauna in water bodies. They perform a key role in the functioning of aquatic ecosystems. The availability of maximum molluscs during summer months could be related to 2 impor-

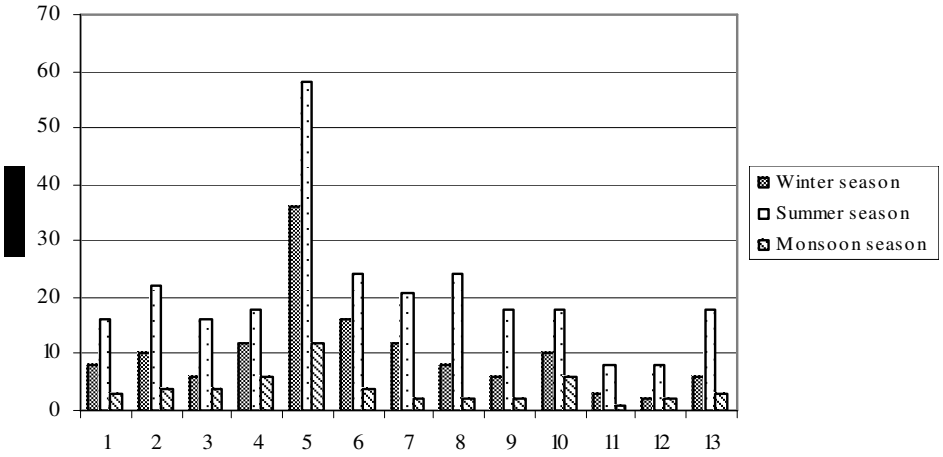

Figure 2. Seasonal diversity of molluscan fauna during 2003 - 2004.

1- *Melania scaba*, **2**-*M.striatella*, **3**- M. *elegans*, **4**-*Fanus ater*, **5**- *Vivipara dissimilis*, **6**-*Zootecus chio*, **7**- *Opeas gracile*, **8**-*Pianorbis exustus*, **9**- *Anicus convexiusculus,* **10**-*lymnaea acumainata,* **11**-*L luteola,* **12**-*L. piguis,* **13***, Lemellidens corianus.*

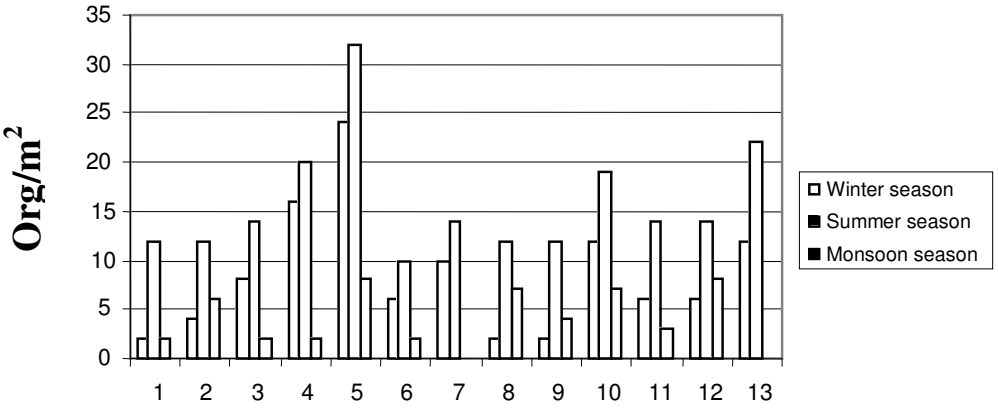

Figure 3. Seasonal diversity of molluscan fauna during 2004 - 2005.

1- *Melania scaba*, **2**-*M.striatella*, **3**- M. *elegans*, **4**-*Fanus ater*, **5**- *Vivipara dissimilis*, **6**- *Zootecus chio*, **7**- *Opeas gracile*, **8**-*Pianorbis exustus*, **9**- *Anicus convexiusculus,* **10**-*lymnaea acumainata,* **11**-*L. luteola,* **12**- *L. piguis,* **13***, Lemellidens corianus.*

tant ecological phenomena:

i) The maximum abundance of decomposer settled organic matter and macrophytes on the bottom of the water body and
(ii) Increased water temperature activating the process of decomposition of these organic sediments (Malhotra et al., 1996).

It seems true that the fluctuation brought about by these processes in that water body study, create a very conducive micro as well as macro environment for the healthy growth and multiplication of the molluscan fauna. Higher abundance of molluscs with increased water temperature and decomposed organic matter has been also reported by Bath et al. (1999).

The richness of molluscs presently observed may be attributed to the cumulative effect of alkaline nature of water, high calcium contents and macrophytic vegetation which provide both food and shelter, because some of these forms are of periphytic in nature as it has earlier been documented by Tonapi (1980). Pennak (1989) also supported this point of view by observing the greater molluscan population in alkaline lakes as compared to acidic lakes.

Water temperature exhibited a positive correlation with molluscs during 2 years of present study. This shows that increase in temperature within the observed range favors

Table 2. Range of variation, mean and standard deviation of the physico-chemical characteristics of water of Ramsagar reservoir during April, 2003 to March, 2005.

S. No.	Parameters	Unit	2003 - 2004			2004 - 2005		
			Range of variation		Mean and standard deviation	Range of variation		Mean and standard deviation
			Min.	Max.		Min.	Max.	
1	Water temperature	^{0}C	17.87	31.87	25.53 ± 4.74	15.92	27.92	22.20 ± 3.95
2	Transparency	cm	66.59	116.00	96.80 ± 13.10	76.25	91.71	85.02 ± 5.50
3	Electrical conductivity	µS/cm	140.00	219.04	179.13 ± 30.46	108.00	246.30	183.85 ± 43.77
4	Turbidity	NTU	2.17	8.52	6.05 ± 2.49	4.42	16.72	8.60 ± 3.52
5	pH	-	8.20	8.77	8.40 ± 0.18	7.41	8.95	8.13 ± 0.55
6	Dissolved oxygen	mgL^{-1}	6.88	10.99	8.67 ± 1.51	6.78	11.59	8.48 ± 1.55
7	Free carbon dioxide	mgL^{-1}	Nil	6.32	0.80 ± 2.75	Nil	4.67	1.63 ± 1.32
8	Total alkalinity	$mg.L^{-1}$	83.87	133.25	104.22 ± 15.27	64.25	146.25	104.65 ± 25.36
9	Total hardness	mgL^{-1}	34.00	75.25	53.30 ± 13.89	43.50	66.00	53.19 ± 6.49
10	Chlorides	mgL^{-1}	14.09	17.93	15.98 ± 1.23	13.13	22.36	17.40 ± 2.57
11	Calcium	mgL^{-1}	11.21	26.55	17.86 ± 5.49	13.36	33.81	20.32 ± 6.12
12	Nitrate-nitrogen	mgL^{-1}	0.011	0.033	0.019 ± 0.006	0.015	0.032	0.022 ± 0.004
13	Phosphates	mgL^{-1}	0.013	0.054	0.022 ± 0.011	0.015	0.047	0.025 ± 0.009
14	Magnesium	mgL^{-1}	1.33	3.59	2.19 ± 0.71	1.17	5.60	3.06 ± 1.18
15	Sodium	mgL^{-1}	21.07	34.30	27.75 ± 3.02	16.75	31.27	24.30 ± 4.69
16	Potassium	mgL^{-1}	1.97	4.75	3.07 ± 0.65	2.10	4.86	3.25 ± 0.86

Table 3. Correlation coefficient (r) between physico-chemical parameters and molluscan abundance in the Ramsagar reservoir*.

	Parameters	Gastropod	Pelecypod
1	Water temperature	0.597	0.333
2	Transparency	0.528	-0.240
3	Electrical conductivity	0.861	0.876
4	Turbidity	-0.524	0.072
5	pH	0.711	0.530
6	Dissolved oxygen	-0.488	-0.705
7	Free carbon dioxide	-0.812	-0.452
8	Total alkalinity	0.800	0.956
9	Total hardness	-0.329	-0.462
10	Chlorides	0.399	0.728
11	Calcium	0.613	0.795
12	Nitrate-nitrogen	0.454	0.864
13	Phosphates	0.800	0.974
14	Magnesium	-0.148	0.252
15	Sodium	0.792	0.693
16	Potassium	0.742	0.861

*The values (*r*) ranged from 0.400 to 0.520 and 0.530 to above are significant at $P < 0.05$ and $P < 0.01$, respectively.

the growth of molluscs. Michael (1968), Dutta and Malhotra (1986) and Malhotra et al. (1996) also recorded a positive correlation between molluscs and temperature, while Ricker (1952), Shrivastava (1956) and Vasisht and Bhandal (1979) noticed a negative correlation between temperature and molluscs. Michael (1968) has, however,

suggested that high temperature, alkalinity and food were probable causes for the peak in abundance of zoobenthos during summer months.

Molluscs were found to be independent of fluctuations with respect to pH value, since, a very weak and insignificant negative correlation was obtained between these 2. Similarly, fluctuations in dissolved oxygen contents also did not have any affect on the molluscs populations. Cheatum (1934) and Sharma (1986) have reported some molluscs can survive in very low oxygen conditions and have noted an inverse relationship between the 2. Chloride was found to be positively related to the molluscs, but not to any the significant extent.

Total hardness has show a significant positive correlation to the molluscs' population in Ramsagar reservoir. The increase in hardness in water favors the growth of molluscs. Dutta and Malhotra (1986) also found the predominance of molluscs, fauna in a fish pond at Jammu due to higher concentration of calcium. Total alkalinity was also to be positively related to the molluscs and close to a significant value in Ramsagar reservoir as our observations has have also supported by Dutta and Malhotra (1986). Available nutrients such as nitrates and phosphates were also found to be positively correlated with the molluscan. It seems that the fluctuations in the values of these 2 nutrients had very little influence on abundance the population of molluscs in the reservoir. Some other factors such as organic matter, food, vegetation and silt, might also play significant role in the increase or decrease of molluscs population density and diversity in lentic water bodies. From above observations, it can inferred that most of the physico-chemical parameters, that is, temperature, hardness, alkalinity and calcium play significantly role in growth and survival of molluscs population in Ramsagar reservoir.

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