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RESEARCH ARTICLE

Aquatic Coleopteran diversity and species composition in various Lentic Waterbodies of Maharashtra, India

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Abstract

Insects are the most diverse group among freshwater fauna. The present investigation deals with the diversity of aquatic beetles in six different lentic water bodies (reservoirs) in Maharashtra, India. A total number of 22 species belonging to 13 genera, 5 families of order Coleoptera of Class Insecta was recorded. Among all stations, the highest species diversity was recorded at Station-5 (at Ujani Dam); while the lowest value was recorded at Station-1 (at Mula Dam) and Station-2 (at Bhandardara Dam). The Shannon-Weiner Diversity Index recorded less diversity from Station-1 (at Mula Dam) to Station-4 (at Dhom Dam); whereas Station-5 (at Ujani Dam) and Station-6 (at Jayakwadi Dam) showed moderate diversity. Moderate pollution status of water was observed at all the six sampling stations. Simpson's Diversity Index indicated moderate diversity from Station-1 (at Mula Dam) to Station-4 (at Dhom Dam); while Station-5 (at Ujani Dam) and Station-6 (at Jayakwadi Dam) showed high diversity. The Margalef's Diversity Index showed highest value at Station-5 (at Ujani Dam); whereas lowest value was observed at Station-2 (at Bhandardara Dam). The Generic Richness of aquatic beetles was highest at Station-5 (at Ujani Dam); whereas lowest value was recorded at Station-1 (at Mula Dam) and Station-2 (at Bhandardara Dam). Total Abundance was recorded highest at Station-5 (at Ujani Dam); whereas lowest value was found at Station-1 (at Mula Dam). Thus, diversity status of aquatic beetles from the surveyed reservoirs is moderate, but in the coming days, rising pollution may negatively impact the overall biodiversity of the waterbodies.

Keywords: Aquatic Insects; Coleoptera; Distribution; Diversity; Reservoirs; Maharashtra.

1. Introduction

Aquatic insects are the most diversified group among the living organisms in the freshwater ecosystem and approximately about 45000 insect species are found all around the world in such ecosystems (Balaram, 2005). Inland wetlands in India are home to approximately 5000 species of aquatic insects (Subramanian and Sivaramakrishnan, 2007). With almost 25% of all known living forms, the order Coleoptera (aquatic beetles) includes more species than any other order of insects (Thakur, 2003). In any waterbody or wetland, water beetles are an integral part of the biotic component and they play an important role as indicators of ecological diversity and habitat diversity (Eyre and Foster, 1989). Water beetles are a diversified group of insects, which act as an excellent indicator of habitat, quality of water, age, and naturalness of waterbody (Bilton, 2009).

The predatory and scavenger species include the aquatic beetles (Coleoptera) and bugs (Heteroptera) among freshwater macroinvertebrates. They also occur in any type of freshwater ecosystem such as lakes, streams, pools, rivers, puddles, wet rock surfaces, wetlands, and groundwater often with high Species Richness (Franciscolo, 1979; Nilsson and Holmen, 1995; Ribera et al., 2007). Aquatic beetles are most diverse in lentic water habitats or environments like wetlands and pond edges (Dash and Roy, 2017).

Biswas et al (1995) conducted a comprehensive study of the Dytiscidae, Gyrinidae, and Hydrophilidae families in West Bengal, which generated significant interest in Indian aquatic Coleoptera. Pahari et al (1997, 1999) examined the taxonomic classification of aquatic beetles in two wetlands located in the West Midnapore District, West Bengal, India. The determination of aquatic beetle species composition, abundance, and diversity in the Kolkas region

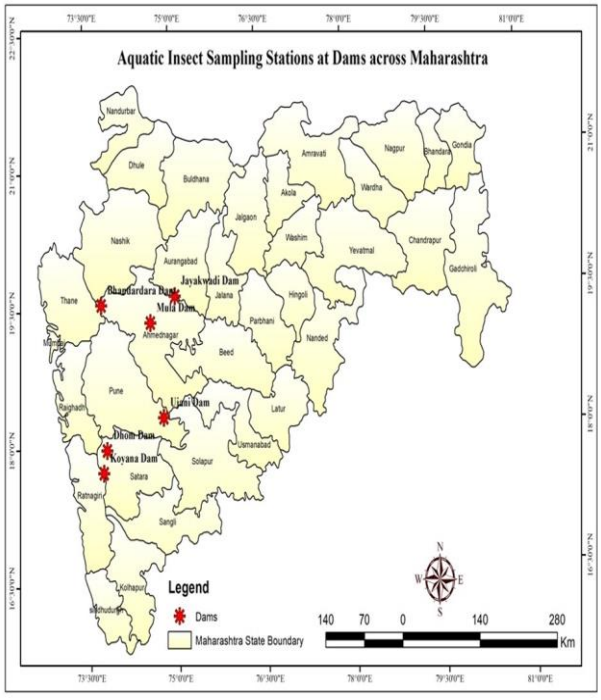

Figure 1. Location Map of Aquatic Coleoptera Sampling Stations across Maharashtra

of Tiger Reserve, Melghat, Amravati District, Maharashtra, India; was studied by Thakare and Zade (2011). Forty-one species of aquatic beetle fauna belonging to four families of order Coleoptera such as Dytiscidae, Hydrophilidae, Gyrinidae, and Noteridae; were documented from the Kawal Tiger Reserve, Telangana, India (Jaiswal et al., 2022). Forty-two species belonging to four families of aquatic beetles were recorded in the Koundinya Wildlife Sanctuary for the first time, with 9 species being new to Andhra Pradesh and the family Dytiscidae had the highest number of species, followed by Hydrophilidae, Gyrinidae, and Noteridae (Shankar et al., 2023).

In the present study, we have assessed the diversity of aquatic Coleopteran insects from six reservoirs (dams) in four districts of Maharashtra, India. Considering the significance of beetles in the freshwater ecosystems, the present work was conducted to determine the diversity, abundance, and species composition of the water beetles.

Table 1. Geographical Details of Aquatic Coleoptera Sampling Stations across Maharashtra

Sl No	Sampling Station	Location	Reservoir	Latitude	Longitude
1	Station-1	Rahuri, Ahmednagar	Mula Dam	19° 20' 32.6472" N	74° 35' 51.6012" E
2	Station-2	Akole, Ahmednagar	Bhandardara Dam	19° 33' 16.4052" N	73° 45' 11.0844" E
3	Station-3	Bamnoli, Satara	Koyna Dam	17° 43' 35.8788" N	73° 45' 24.6204" E
4	Station-4	Wai, Satara	Dhom Dam	17° 58' 25.6188" N	73° 49' 4.6956" E
5	Station-5	Bhigwan, Pune	Ujani Dam	18° 18' 27.4536" N	74° 47' 51.3132" E
6	Station-6	Dahigaon, Aurangabad	Jayakwadi Dam	19° 31' 52.7196" N	75° 11' 46.5812" E

Table 2. Diversity Indices of Coleoptera in various Reservoirs in Maharashtra

Sampling Station	Shannon-Weiner Diversity Index	Simpson's Diversity Index	Margalef's Diversity Index	No. of Species	Total Abundance
Station-1 (Mula Dam)	1.01	0.67	0.78	3	13
Station- 2 (Bhandardara Dam)	1.01	0.65	0.67	3	20
Station -3 (Koyna Dam)	1.06	0.62	0.97	4	22
Station -4 (Dhom Dam)	1.39	0.73	1.28	5	23
Station -5 (Ujani Dam)	2.28	0.91	2.79	11	36
Station -6 (Jayakwadi Dam)	2.33	0.84	1.84	7	26

2. Material and method

2.1. Period of investigation

The study was conducted from June 2021 to May 2022, during which sampling was done, followed by taxonomic inspection of the collected specimens.

2.2. Study area

Six sampling stations located at the six different lentic water bodies (reservoirs) of Maharashtra, India; were selected for the present study (Table 1 and Figure 1).

2.3. Sample collection

The sampling of aquatic insects was done randomly according to standard sampling protocol. The entomofauna were collected with the help of a 500 µm mesh size D-frame dip net, which were trapped in water or attached to the vegetation along the banks of water bodies; as per Merritt and Cummins (1988). Aquatic beetle samples were sorted and counted from the collection. Sampling was done from the six sampling stations, during the sampling seasons: Monsoon (June to September), Post-monsoon (October to January), and Pre-monsoon (February to May). Sampling was conducted in the morning hours: from 8.00 a.m. to 11.00 a.m., according to local time.

2.4. Sample preservation

The collected and trapped aquatic beetle specimens were preserved in 70% ethanol in sample bottles, each carrying label denoting 'code of sampling station', 'date of visit', and 'initials of collector'. The samples were kept in the laboratory for further identification.

2.5. Sample identification

The preserved specimens were identified on the basis of morphological characteristics, using standard identification keys/manuals/guides/reference books by Subramanian and Sivaramakrishnan (2007), Richards and Davis (1977), McCafferty (1981), etc. Confirmation of identification was done with the taxonomical support of entomology experts from Zoological Survey of India (ZSI), Freshwater Biology Regional Centre, Hyderabad (Telangana), India.

2.6. Data analysis

Simpson's Diversity Index and Margalef's Diversity Index was worked out for indicating species diversity; whereas 'Species Richness' and 'Species Abundance' were also calculated. The Shannon-Weiner Diversity Index was calculated to understand the diversity of aquatic beetles as well as the pollution status of water at each sampling station.

3. Result

Denoted sampling stations at selected six reservoirs (dams) located in various regions of Maharashtra, were surveyed to study the diversity of aquatic beetles. The present study recorded a total number of 22 species of aquatic beetles which belonged to 13 genera and 5 families (Gyrinidae, Dytiscidae, Staphylinidae, Hydrophilidae and Noteridae) of order Coleoptera (Table 3). The study found that Station-1 (at Mula Dam) recorded 3 species of 3 genera and 2 families; Station-2 (at Bhandardara Dam) recorded 3 species of 3 genera and 2 families; Station-3 (at Koyna Dam) recorded 4 species of 3 genera and 3 families; Station-4 (at Dhom Dam) recorded 5 species of 5 genera and 4 families; Station-5 (at Ujani Dam) recorded 11 species of 8 genera and 3 families and Station-6 (at Jayakwadi Dam) recorded 7 species of 5 genera and 2 families.

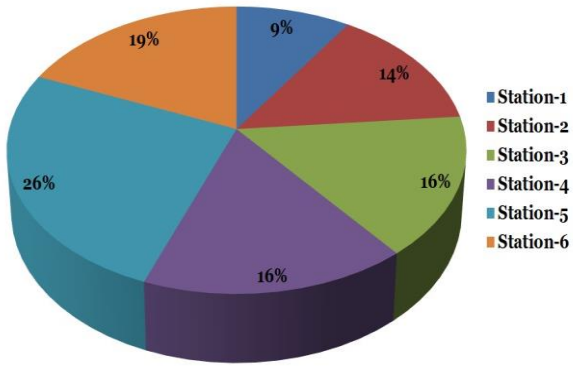

Figure 2. Station-wise Percent Composition of Coleopteran Species.

Table 3. Diversity and Distribution of Coleoptera in Reservoirs of Maharashtra

Sampling Station	Order	Family	Taxa
Station-1 (Mula Dam)	Coleoptera	Gyrinidae	*Orectochilus neglectus*
		Dytiscidae	*Peschetius quadricostatus*
		Dytiscidae	*Laccophilus spp.*
Station- 2 (Bhandardara Dam)	Coleoptera	Staphylinidae	*Paederus spp.*
		Hydrophilidae	*Sternolophus spp.*
		Hydrophilidae	*Helochares spp.*
Station -3 (Koyna Dam)	Coleoptera	Gyrinidae	*Orectochilus orissaensis*
		Staphylinidae	*Paederus spp.*
		Dytiscidae	*Peschetius spp.*
		Dytiscidae	*Peschetius quadricostatus*
Station -4 (Dhom Dam)	Coleoptera	Staphylinidae	*Paederus spp.*
		Dytiscidae	*Laccohilus spp.*
		Noteridae	*Canthydrus flavus*
		Gyrinidae	*Dineutus spinosus*
		Gyrinidae	*Gyrinus spp.*
Station -5 (Ujani Dam)	Coleoptera	Gyrinidae	*Dineutus unidantatus*
		Dytiscidae	*Laccophilus flexuosus*
		Dytiscidae	*Hydaticus spp.*
		Gyrrinidae	*Dineutus spp.*
		Gyrinidae	*Dineutus spinosus*
		Hydrophilidae	*Sternolophus rufipus*
		Dytiscidae	*Rhantaticus congestus*
		Dytiscidae	*Laccophilus spp.*
		Dytiscidae	*Hydaticus spp.*
		Dytiscidae	*Hydroglyphus flammulatus*
		Hydrophilidae	*Helochares spp.*
Station -6 (Jayakwadi Dam)	Coleoptera	Dytiscidae	*Laccophilus spp.*
		Hydrophilidae	*Helochares pallens*
		Hydrophilidae	*Paracynus spp.*
		Hydrophilidae	*Sternolophus rufipes*
		Hydrophilidae	*Helochares spp.*
		Hydrophilidae	*Helochares spp.*
		Hydrophilidae	*Hydraena spp.*

Maximum number of species was recorded at Station-5 (at Ujani Dam), while the minimum number was recorded at Station-1 (at Mula Dam) and Station-2 (at Bhandardara Dam). 'Percent Composition' of order Coleoptera at the six sampling stations at different reservoirs of Maharashtra are given in Figure 2. The highest number of Coleopteran insects were recorded from Station-5 and the lowest number of Coleopteran insects were recorded from Station-1. The values of Shannon-Weiner Diversity Index of Station-1 to Station-4 showed less diversity; whereas Station-5 and Station-6 recorded moderate diversity. Moderate pollution status of water was observed at all the sampling stations. The Simpson's Diversity Index of Station-1 to Station-4 showed moderate diversity, while Station-5 and Station-6 showed high diversity. The Margalef's Diversity Index was recorded highest at Station-5; whereas lowest value was observed at Station-2. The Generic Richness of aquatic beetles (Figure 3) was highest at Station-5; whereas lowest value was recorded at Station-1 and Station-2. Total abundance i.e. the number of individuals of all species in the given area, was highest at Station-5; whereas, lowest value was observed at Station-1 (Figure 4 and Table 2)

4. Discussion

Cox and Cox (1982) studied the aquatic beetles of the families including Dytiscidae, Hydrophilidae, Gyrinidae, and Haliplidae of order Coleoptera in Amir-Kolayeh and the part of Anzali, Gilon Province of Iran. Aland et al (2012) investigated 152 species of aquatic beetles from 101 genera belonging to 25 families of Coleoptera in the Amba Reserve Forest of Western Ghats, Kolhapur. Jaiswal (2012) conducted a preliminary study on water beetles in Ameenpur lake and their study reported the presence of 26 species of aquatic beetles belonging to four different families: Gyrinidae, Dytiscidae, Hydrophilidae and Haliplidae. Ostovan et al. (2004) investigated the aquatic beetles diversity, abundance, and aquatic insect biology in the Southern and Northern shores of Fars provinces of Iran. They found total of 18 species belonging to 5 families and out of these, one family, 3 genera and 10 species which are marked with new records for Iran. In the present work, 22 species of water beetles were recorded which belonged to 13 genera and 5 families (Gyrinidae, Dytiscidae, Staphylinidae, Hydrophilidae and Noteridae) of order Coleoptera of class Insecta.

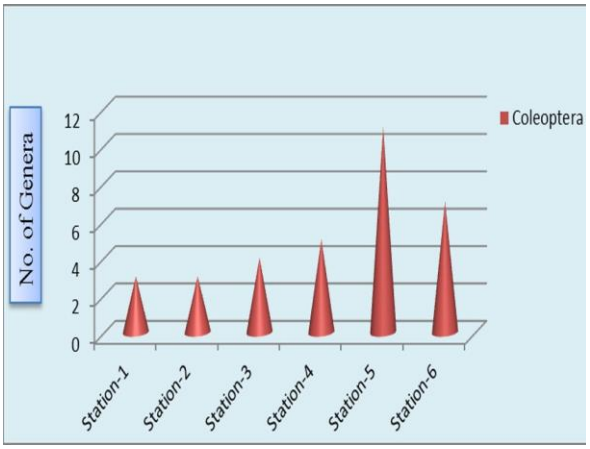

Figure 3. Generic Richness of Coleoptera from various Reservoirs in Maharashtra

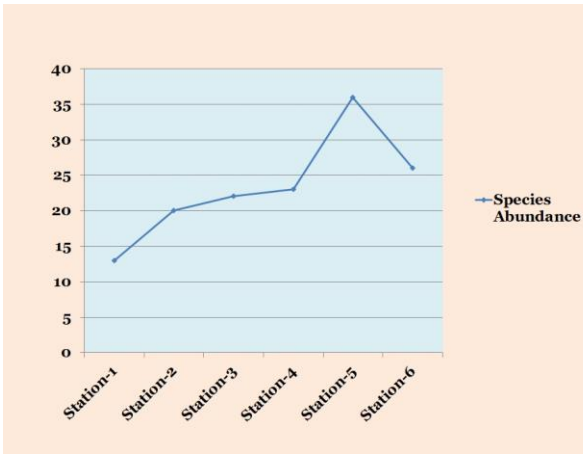

Figure 4. Species Abundance of Coleoptera from various Reservoirs in Maharashtra

Sanchez-Fernandez et al. (2006) found that the correlation values and the percentage of species represented by family, genus, and species complementary networks were similar while investigating the indicator value of water beetle fauna. They suggested that the higher taxa of aquatic beetles (genera or families) can be used as biodiversity under study for cost-effective practical surveys. The present study too suggests that generic or family-level diversity study of aquatic beetles is reasonable in terms of time, efforts, and expenses.

In 2009, Fauziah conducted a study on the diversity of water beetles in the Kenyir water catchment of Terengganu, Malaysia. The study found that both the diversity and abundance of water beetles were low, with only four species of water beetles present, indicating that the ecosystem is under stress. The present study re-established the fact that aquatic insects, may it be beetles, and are 'bioindicators' of water quality. As an outcome of the present investigation, moderate pollution stress was indicated at all the sampling stations, which showed comparatively less diversity and abundance of water beetles than other works.

Shannon-Weiner Diversity Index value less than 1 indicates extremely polluted status of water; while values between 1-3 indicate moderate pollution; and more than 4 score indicates non-

polluted water. Simpson's Diversity Index shows increasing values from 0-1. Values below 0.50 indicate low diversity; 0.50-0.75 indicate moderate diversity; while 0.75-1 indicate high diversity. The Margalef's Diversity Index has no limit value and it shows variation depending upon the number of species (Choudhary, 2016). Generic Richness is the number of different genera found in one site. All population counts at the species level are aggregated to the generic level (Davies and Tsomides, 2014).

5. Conclusion

The present study focussed on investigating the diversity of aquatic Coleoptera in various reservoirs surveyed from Maharashtra. These reservoirs are manmade lentic waterbodies created by impounding rivers flowing through different regions of the State. They exhibit variable gradients of hydrological compartments with diverse ecological niches. The habitat heterogeneity provides different strata at which the aquatic beetles reside and flourish. The water beetles, as constituents of the macroinvertebrates, in the fluvial as well as static parts of the water body, are important in the aquatic food chains as predators at the lower trophic level, and as scavengers responsible for the clean-up of the aquatic system. In the present work, 22 different species of aquatic coleopteran fauna were recorded. As every study has its own spatial and temporal limitations, in conclusion, it is suggested to explore the aquatic beetles from remaining reservoirs within the State of Maharashtra, India; which will help to give a better picture of their diversity and distribution status. In future, comprehensive studies to document increased number of taxa of the faunal group under investigation are required.

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Contribution of the authors

The first author carried out the field work, species identification and preparation of the manuscript. The second author was involved in the planning, design, and follow-up of the research work.

Declaration of conflict of interest

The authors declare no conflict of interest.

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