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A preliminary report on the diversity of selected higher macroinvertebrate groups of some freshwater bodies from Western Maharashtra

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Abstract
The present investigation provides an account of the diversity of some groups of higher macroinvertebrates of a few selected freshwater bodies from western Maharashtra. The macroinvertebrate specimens were collected from 12 freshwater bodies from Ahmednagar, Pune and Solapur districts. The water bodies surveyed included: Ujani backwater, Kapurwadi pond, Adhalgaon reservoir, Mula canal, Bhima river site-I and Site-II, Garden tank, Mula dam, Dongargan KT Bandhara, Nira river, Nira-Bhima confluence, and a small Cement tank. A total of 51 taxa (genera/species) of macroinvertebrates were recorded. The macroinvertebrate fauna recorded represents 43 genera and 29 families. It includes 31 insect genera representing 20 families. The mollusk fauna includes 10 genera representing 7 families. In addition to this, crustaceans representing 2 genera and 2 families were also recorded. Insect fauna includes 8 bugs, 5 beetles, 7 dipteran larvae and 12 odonate larvae. The mollusks recorded includes 10 gastropod species and 6 bivalve species. The results obtained will help to update data on the faunal resources of Maharashtra state. The data is indicative of the faunal richness of water bodies studied and hints at necessity of more in-depth faunal surveys in future to explore the diversity of freshwater fauna from the region.

Keywords: diversity, freshwater, macroinvertebrates, entomofauna, and malacofauna

1. Introduction
Aquatic invertebrate fauna forms the ubiquitous and diverse group of seasonal freshwater bodies of tropical and subtropical regions having an important role in the biological assessment of human impacts on water bodies [1, 2, 3, 4]. The macroinvertebrates play important roles in the aquatic ecosystem and as a functional group, they may serve as grazers, shredders, gatherers, filterers, and predators [5]. The account of aquatic insect species associated with freshwater habitats of Maharashtra is available from different localities: Nathsagar wetland [6, 7], Ujani wetland [8, 9, 10], Vidarbha region [11, 12, 13, 14, 15, 16], Pune district [17, 18, 19, 20, 21, 22]. India has about 487 species of odonates [23] which includes 134 species from Maharashtra state [24, 25]. All the 6256 confirmed species of odonates of the world pass their larval stages in freshwater [23]. The odonate fauna of Maharashtra has been well documented [26, 11, 13, 12, 27, 20, 21, 16]. There are about 53 genera and 190 species of aquatic and semiaquatic Hemiptera under 14 major families in the Indian region [9]. The freshwater malacofauna of few water bodies from Pune has been documented [28, 29, 30] and the checklist of the malacofauna of Maharashtra is also available [31]. However, there are no recent updates on the malacofauna of the Pune district.
In the state of Maharashtra, the western Maharashtra region is known for the rich network of irrigation projects, sugarcane factories, and a number of industrial units. This region is drained by many rivers such as the Bhima, Ghod, Kukadi, Mula, Mutha, and Nira, and has a substantial number of minor, medium, and major irrigation projects. Although there are some sporadic studies on macroinvertebrate fauna of few selected freshwater bodies of Pune district [17, 18, 19, 32, 21, 22], a large number of water bodies have yet not been studied with respect to their faunal resources. Except for a few selected water bodies, macroinvertebrate fauna of most of the water bodies from Solapur and Ahmednagar districts are still not reported. The presence or absence of macroinvertebrates can tell us a great deal about the state of health of freshwater bodies [33]. The pollution of water bodies due to agricultural activities, effluents from the industrial sector and other human activities is a matter of concern in this region of Maharashtra [34, 35, 36]. Water pollution has a detrimental effect on the fauna of inland water bodies [37, 33]. This study was undertaken to fulfill the need to make available the baseline information on the diversity and distribution of macroinvertebrate fauna of the study area, in order to facilitate future biological monitoring of impacts associated with the pollution of water bodies.

2. Materials and Methods
2.1 Study Area: The animal specimens were collected from some water bodies of Ahmednagar, Pune and Solapur districts. The list of water bodies is as follows:

a. Ujani backwater, Bhigwan. At: Bhigwan, Pune [N 18°17'30.0" E 74°46'28.1"]
b. Kapurwadi Pond. At: Kapurwadi, Ahmednagar [N19°06'39.8" E 74°47'21.8"]
c. Adhalgaon reservoir. At: Adhalgaon village, Srigonda, Ahmednagar. [N 18°36'58.1 E 74°45'05.1]
d. Mula canal: At: Mula dam, Rahuri, Ahmednagar. [N19°20'17.4" E74°38'39.0"]
e. Bhima river-Site I. At: Siddhtek, Karjat, Ahmednagar [18°26'43.3"N 74°43'25.8"E]
f. Bhima river-Site II. At: Ujani Bridge Indapur, Pune [N 18°04'15.9" E 75°06'00.7"]
g. Garden tank: Ahmednagar college botanical garden, Ahmednagar city [N19°05'26.3" E74°44'46.9"].

h. Mula dam. At: Rahuri, Ahmednagar [N 19°19'56.5" E74°36'34.4"].
i. Dongargan KT Bandhara. At: Dongargan village, Near Rameshwar temple, Ahmednagar [N19°14'51.6" E74°45'36.5"]
j. Nira River. At: Aklai Temple, Akluj, Solapur. [N 17° 53' 42.8604" E 75° 1' 38.7264"]
k. Nira-Bhima confluence. At: Nira-Narsingpur, Pune. [N17°58'15.276" E75°8' 2.5332"]
l. Cement tank. Cantonment area, Ahmednagar city. [N19°05'30.8" E 74°45'28.7"]

The garden tank, Ahmednagar college (5m in diameter; 1m deep) and Cement tank (2×5×1m) are small structures but have water throughout the year as they are regularly refilled with water to maintain algal and lotus vegetation. The GPS coordinates of collection sites in the water body were recorded with the Garmin GPS unit: eTrex 30. The mollusk specimens were collected only from Garden tank, Mula canal, Bhima river site-I, Ujani backwater, and Adhalgaon dam. The common insect groups' specimens were collected only from Garden tank, Mula dam, Mula canal and Dongargan KT Bandhara. The collection from Bhima river site-II, Nira river, and Nira-Bhima confluence included odonates exclusively. Most of this research work was part of research projects carried by PG students from 2010 to 2019 as a requirement for fulfillment of the award of PG degree by SP Pune University, Pune, MS, India.

2.2 Collection and Preservation

The methodologies used for collection and preservation of different groups of macroinvertebrate specimens were adopted from the publications by distinguished taxonomists [38, 39, 40, 41]. The specimens were collected from water bodies with the help of an aquatic net of mesh size less than 500µm. The large-sized specimens of macroinvertebrate were collected by handpicking. The collection was done randomly during sporadic visits to water bodies. The collected specimens were preserved in 70% alcohol. The specimen vials were labeled with respect to date of collection, locality, name of the collector, etc.

2.3 Identification

Identification of most of the insect specimens to the level of family and genus was performed with the identification keys by Bouchard [41], Subramanian and Sivaramkrishnan [38], and Epler [40]. The freshwater crabs were identified using keys by Srivastava [42] and Pati and Sharma [43]. The mollusk specimens and odonate larvae were identified at the Zoological Survey of India using identification keys by Ramakrishna and Dey [39] and Nesemann *et al.* [44] respectively.

3. Results

A total of 51 taxa (genera/species) of macroinvertebrates were recorded. The 22 of the taxa were identified to the level of species and remaining were identified to the level of genus. The macroinvertebrate fauna recorded represents 43 genera and 29 families. It includes 31 insect genera representing 20 families. The mollusk fauna includes 10 genera representing 7 families. In addition to this, crustaceans representing 2 genera and 2 families were also recorded. Insect fauna includes 8 bugs, 5 beetles, 7 dipteran larvae, and 12 odonate larvae. The mollusks recorded include 10 gastropod species and 6 bivalve species. This work includes mainly the entomofauna and malacofauna except 3 crustaceans. The insects recorded represent 5 hemipteran families (Belostomidae, Corixidae, Hydrometridae, Nepidae, and Gerridae), 4 coleopteran families (Dytiscidae, Hydrophilidae, Haliplidae, and Elmidae), 5 dipteran families (Syrphidae, Simuliidae, Culicidae, Chironomidae, and Tabanidae), and 5 odonate families (Aeshnidae, Libellulidae, Gomphidae, Macromiidae and Co enagrionidae). Among insects, odonates top the list with 12 taxa, followed by hemipterans (8 taxa), dipterans (7 taxa), and coleopterans (5 taxa). Among the mollusks, gastropods top the list with 10 species from five families (Lymnaeidae, Planorbidae, Physidae, Viviparidae, and Thiaridae) followed by bivalves with 6 species from 2 families: Unionidae and Corbiculidae.

The analysis of the results obtained shows that the insects of the order Hemiptera, Diptera, Odonata and Coleoptera are the most common and dominant groups among aquatic insects studied. A similar pattern of dominance was also recorded by Sivaramkrishnan *et al.*[45] and Kulkarni *et al.* [22]. The family Libellulidae dominated the collections with the maximum number of species. A total of 16 macroinvertebrates, the most among all water bodies, were recorded from the Mula dam which mainly includes the insects.

The Bhima river site-I recorded the highest number of mollusk species among all water bodies studied. Only odonate specimens were collected from Bhima river site-II, Nira river, and Nira-Bhima confluence. Hence in-depth surveys are needed to map the biodiversity of all macroinvertebrate groups from these three sites (Table 1).

Table 1: List and locality record of macroinvertebrates from different water bodies within study area*.

Crustacea: DECAPODA Palaemonidae *Palaemonetes* sp. [*H] Gecarcinucidae *Barytelphusa cunicularis* (Westwood, 1836) [E, H, I] *Barytelphusa guerini* (Milne Edwards, 1853) [D, E, H] INSECTA: Hemiptera Belostomatidae *Diplonychus* sp. [G, I] Corixidae	INSECTA: ODONATA: ANISOPTERA Aeshnidae *Anax guttatus* (Burmeister, 1839) [J] Libellulidae *Bradinopyga geminata* (Rambur, 1842) [G, K] *Crocothemis servilia* (Drury, 1773) [F, G, J, K] *Pantala flavescens* (Fabricius, 1798) [K] *Trithemis aurora* (Burmeister, 1839) [G, K] *Trithemis pallidinervis* Kirby, 1889 [G, K] Gomphidae *Paragomphus* sp. [H] Macromiidae *Macromia* sp. [G, I]

Sigara sp. [H] Hydrometridae *Hydrometra* sp. [L] Nepidae *Nepa* sp. [E] *Ranatra* sp. [E] Gerridae *Limnogonus* sp. [G, H, I] *Trepobates* sp. [G] Notonectidae *Notonecta* sp. [E, G, H, I, L] INSECTA: Coleoptera Dytiscidae *Cybister* sp. [E, G, H, L] *Hydaticus* sp. [E, H, I] Hydrophilidae *Hydrophilus* sp. [E, G, H, I, L] Haliplidae *Haliplus* sp. [E, H, I, L] Elmidae *Stenelmis* sp. [G, H, I, L] INSECTA: Diptera Syrphidae *Eristalis* sp. [I] Simuliidae *Simulium* sp. [E] Culicidae *Anopheles* sp. [E, I] *Aedes* sp. [H] *Culex* sp. [H] Chironomidae *Chironomus* sp. [G] Tabanidae *Tabanus* sp. [H]	INSECTA: ODONATA ZYGOPTERA Coenagrionidae *Agriocnemis* sp.[K] *Ceriagrion* sp. [F] *Ischnura* sp. [D, E, H, K] *Pseudogrion* sp. [F] MOLLUSCA: GASTROPODA Lymnaeidae *Radix acuminata* (Lamarck, 1822) [A, B, E, G] *Radix luteola* (Lamarck, 1822) [A, B] Planorbidae *Indoplanorbis exustus* (Deshayes, 1834) [G, L] Physidae *Physella acuta* (Draparnaud, 1805) [E, G] Viviparidae *Bellamya bengalensis* (Lamarck, 1822) [A, C, E] *Bellamya dissimilis* (Mueller, 1774) [A, B, E] Thiaridae *Tarebia lineata* (Gray,1828) [A, D, E] *Tarebia granifera* (Lamarck, 1822) [A, C, D, E] *Melanoides tuberculata* (Mueller, 1774) [A, D, E, G] *Thiara scabra* (Mueller, 1774) [A, C, D] MOLLUSCA: BIVALVIA Unionidae *Lamellidens marginalis* (Lamarck, 1819) [A, E] *Lamellidens corrianus* (Lea, 1834) [D] *Parreysia caerulea (Lea, 1831)* [4] *Parreysia corrugata* (Mueller, 1774) [A, D] Corbiculidae *Corbicula striatella* Deshayes, 1854 [A, D, E] *Corbicula peninsularis* Prashad, 1928 [D]
*Letters in squared brackets denote water body as follows: [A] =Ujani backwater, [B]=Kapurwadi pond, [C] = Adhalgaon reservoir, [D]= Mula canal, [E]= Bhima river site-I, [F]= Bhima river site-II, [G] = Garden tank, [H]=Mula dam, [I]= Dongargan KT Bandhara, [J]= Nira river, [K]= Nira-Bhima confluence, [L]= Cement tank.	

4. Discussion

The results obtained present only a preliminary picture of aquatic entomofauna, malacofauna, and crustaceans from the water bodies studied. As the collection of macroinvertebrate specimens was performed during a few sporadic visits to the water bodies and exhaustive surveys in the future will reveal the existing biodiversity of the fauna. There are only a few reports on aquatic bugs and beetles of Maharashtra [18, 19, 15, 46, 22]. The common aquatic bug families such as Corixidae, Hydrometridae, Notonectidae, Gerridae, and Nepidae are represented from water bodies studied. The records for members of these families of aquatic bugs can be found in other studies dealing with aquatic entomofauna [32, 22]. Thirumalai and Sharma [46] reported 31 species of bugs and Sharma [10] reported 44 species of aquatic beetles from the Ujani backwater. Thirumalai *et al*. [7] recorded 9 species of Hemiptera from Nathsagar wetland. The coleopterans from families Haliplidae, Dytiscidae, Hydrophilidae and Elmidae are recorded from the present study which shows similarity with the findings of other studies in Maharashtra [10, 15, 22]. A total of 16 mollusks were recorded from some of the water bodies studied during this investigation. This result broadly conforms to findings of other studies on malacofauna [28, 29, 30]. The list of macroinvertebrates recorded is not exhaustive as the number of macroinvertebrates existing in the water bodies studied could certainly be much higher than that recorded here. More intensive surveys are needed that might result in the true picture of the diversity. The aquatic macroinvertebrates are good indicators of the state of health of water bodies [33]. A water body that lacks any invertebrate animal is usually polluted to the level that does not support life. The aquatic macroinvertebrates are put under threat due to habitat loss, and pollution caused by both man-made and natural activities. Hence, the study of macroinvertebrates is highly important to know the pollution status and to boost the efforts made to restore the health of water the body.

5. Conclusions

The macroinvertebrates survey of some freshwater bodies within Western Maharashtra made it possible to have an idea of the diversity of the aquatic entomofauna and malacofauna of the region. A total of 51 macroinvertebrate taxa were recorded under 43 genera and 29 families. It includes 31 insect genera representing 20 families and 16 mollusk species representing 10 genera representing 7 families. This is only the preliminary study and exhaustive surveys in the future are needed to explore all existing macroinvertebrates in the water bodies studied.

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7. Conflict of interest

Authors declare that there is no conflict of interest.

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