International Journal of Entomology Research
www.entomologyjournals.com
ISSN: 2455-4758
Received: 26-10-2025, Accepted: 25-11-2025, Published: 10-12-2025
Volume 10, Issue 12, 2025, Page No. 47-52

Study of seasonal diversity of macrozoobenthic invertebrates of Nirmal Lake, dist. - Palghar (M.S), India

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Abstract
The present study investigates the distribution and abundance of selected freshwater macroinvertebrate species at two sampling stations in Nirmal Lake, located in the suburban region of Mumbai, Maharashtra. A total of six species belonging to molluscs and arthropods were recorded, namely *Filopaludina bengalensis*, *Indoplanorbis exustus*, *Tarebia granifera*, *Melanoides scabra* (*Meiniplotia scabra*), *Barytelphusa cunicularis*, and *Nepa cinerea*. The study aimed to assess species variation between stations and evaluate their conservation status as per the IUCN Red List. Among the recorded taxa, *Barytelphusa cunicularis* is listed as Least Concern, *Indoplanorbis exustus*, *Tarebia granifera*, and *Nepa cinerea* are of Least Concern, whereas *Filopaludina bengalensis* is Not Threatened, and the status of *M. scabra* is currently not available. The abundance of species showed marked spatial variation. Station 1 recorded the highest population of *Filopaludina bengalensis* (60 individuals) and *Tarebia granifera* (55 individuals), whereas Station 2 exhibited a higher abundance of *Barytelphusa cunicularis* (50 individuals) and *Tarebia granifera* (67 individuals). The presence of pollution-tolerant species such as *Indoplanorbis exustus* and *Tarebia granifera* indicates moderate levels of organic enrichment, while the occurrence of the sensitive freshwater crab *Barytelphusa cunicularis* suggests pockets of suitable habitat and relatively stable ecological conditions. Overall, the results highlight the importance of macroinvertebrates as bioindicators for assessing ecological health and biodiversity status of freshwater ecosystems. These findings provide baseline information that may contribute to conservation planning and sustainable management of Nirmal Lake.

Keywords: Macrozoobenthic invertebrate, Mollusca, IUCN

Introduction

Water is essential to life and represents the spirit and optimism of the natural world. Humans need it for a number of purposes, including agriculture, water recharge, industry, transportation, fishing, and navigation. The recent industrial revolution has brought about a sudden yet noteworthy advancement in science, technology, and agriculture that has resulted in the discharge of industrial wastes and untreated (raw) or partially treated effluents into aquatic ecosystems (Bano Z *et al*.2017) [2]. The water quality is expressed in the character and well-being of any aquatic community. The physiological conditions, species composition, quantity, and productivity of aquatic organisms—particularly the native population—are all impacted by water quality (Naik G *et al*.2015). Modernisation, urbanisation, and population growth are creating issues with sewage disposal and lake and surface water contamination. Rock weathering, soil leaching, mining operations, and other processes degrade natural water supplies. A variety of issues that lead to nitrogen enrichment in lakes have been examined (Bhateria R *et al*.2016) [3]. Water is a special element of nature that is essential to biological activities. Due to the scarcity of our natural resources, water has grown increasingly valuable. Water's ability to dissolve and convey a range of compounds by suspension has the unintended consequence of making water easily polluted. The most limited resource in the future will be fresh water. Pollution is an issue in and around aquatic ecosystems due to unplanned and excessive exploitation and growing anthropogenic influence, (Jadhav R *et al*.2013) [7, 8].

A lake is a sizable body of water with land surrounding it that is home to a variety of aquatic species. The hydrological cycle is just one of the many natural processes that affect lakes. Because of the city's fast urbanisation and massive population increase (from little over 0.1 million in 1951 to over 1.8 million in 2007), lakes are experiencing a number of environmental issues that are causing their water quality to deteriorate, (Trivedi S *et, al* 2012) [16]. A number of lakes have been choked to death by humans. The most frequent reason why sewage enters lake water is runoff, (Shirude M *et, al*.2014). The most concerning of all the problems with lake water quality worldwide is eutrophication. A lake's ageing process, known as eutrophication, is brought on by the buildup of nutrients, silt, sediments, and organic matter from the nearby watershed, (Gorde S *et, al*.2013) [5]. It is easier to create management plans to reduce surface water pollution when water quality is regularly monitored and evaluated, (Jadhav A *et al*.2013) [7, 8].

Macrobenthic communities are made up of creatures that reside on or within a body of water. From protozoans to huge macroinvertebrates to vertebrates, the phyla that comprise the benthic animals are incredibly diverse. (Wetzel R *et al*.2001). However, in aquatic environments, benthic invertebrates are crucial in breaking down organic matter sediment at the bottom into its constituent elements, which in turn helps fish with their basic diet. For many vertebrates, including fish, amphibians, reptiles, mammals, and birds, macrobenthic invertebrates provide an essential source of food. Insects like dragonflies, caddisflies, mayflies, stoneflies, water spiders, water striders, and their larvae or nymphs are examples of aquatic invertebrates. Earthworms, snails, worms, and crustaceans (like crabs) are other typical aquatic invertebrate species, (Ojija F et,al.2017), Although they can usually be seen with the naked eye, invertebrates are frequently classified as those that are held by mesh size

more than 0.2 to 0.5 mm. About 95% of benthic macroinvertebrates, both in terms of species richness and individual abundance, are freshwater arthropods, which includes aquatic insects (Bae *et al*., 2005) [1].Because benthic fauna, in contrast to planktonic species, form relatively stable communities in the sediments that do not change over extended periods of time and reflect characteristics of both the sediments and the upper water layer, their composition has generally been regarded as a good indicator of water quality, (Khalil M et, al.2013) [9]. The ecological characteristics of aquatic entomofauna have been the subject of very few studies, and the macrobenthic fauna of Palghar is not well documented

This paper aimed to describe the horizontal distribution of macrozoobenthic invertebrate abundance along a eutrophic gradient in Nirmal Lake. Its coordinates are 19°23′ 29′′ N and 72° 46′ 57′′ E. Located in Palghar district of Maharashtra, roughly 50km away from Mumbai. The two ponds that comprise Nirmal Lake, Vimal and Nirmal, are divided by a public asphalt road. The internal drainage system connects the two ponds. Thus, the diversity of Nirmal Lake's macrozoobenthic populations is relevant to the current study.

However, there is no information available about the macroobenthic invertebrate species found in the Nirmal lakes. This note discusses the seasonal abundance and distribution of macrozoobenthic invertebrates in Nirmal Lake.

Materials and Methods

The present study used random samples to qualitatively investigate the benthic macro-invertebrates from Stations I and II.

Sample collection: By hand-picking larger specimens from the lake when necessary. To construct the collection in the lake, the mud is scooped from the bottom, sieved (0.02mm, 0.2mm) to extract macrozoobenthic organisms, and then washed with water. Samples that were collected were preserved for later analysis in 10% formalin. Photos were clicked from mobile phone with GPS map camera. To identify the species, standard identifying keys were employed. The study was done from 2021-2022 like Post Monsoon, Pre Monsoon, Monsoon. Identification was carried out using the standard taxonomic literature that was accessible from the following sources: Bhusnar *et al*. (2017) [4], Supanekar *et al*. (2021) [15], Patil *et al*. (2021) [12], and Identification and advisory service of Mollusca, Zoological Survey of India (2023).

Observation

Table 1: Checklist of diversity of Macrozoobenthic invertebrate fauna of Nirmal Lake (Pre-Monsoon)

Sr. No	Scientific Name	Common name	Local name	Conservation status according to IUCN	No. of species at station 1	No. of species at station 2
1	*Filopaludina Bengalenesis*	Dharavli	Dharavli	Not threatened.	20	19
2	*Indoplanorbis excustus*	Kaali Chippi	Kaali Chippi	Least Concern	25	30
3	*Tarebia granifera*	Shemba	Kala Shimpada	Least Concern	65	50
4	*Meiniplotia scabra*	Kala Khada	Kala Khada	Not Available	50	51
5	*Barytelphusa cunicularis*	Kuthali	Kuthalya	Least Concern	80	68
6	*Nepa Cinerea*	Water scorpion	-	Least Concern	28	30

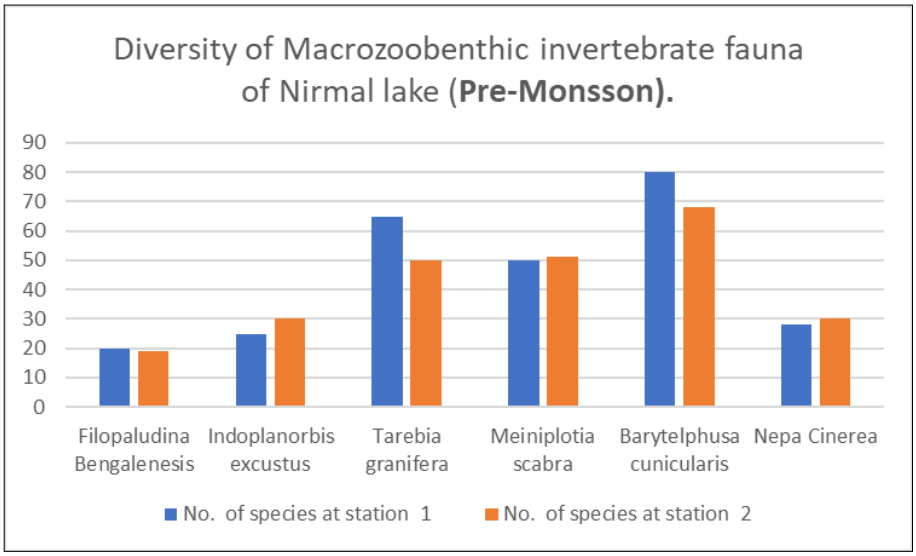

Fig 1: Diversity of Macrozoobenthic invertebrate fauna of Nirmal Lake (Pre-Monsoon).

Table 2: Checklist of diversity of Macrozoobenthic invertebrate fauna of Nirmal Lake (Monsoon)

Sr. No	Scientific Name	Common name	Local name	Conservation status according to IUCN	No. of species at Station 1	No. of species at Station 2
1	*Filopaludina Bengalenesis*	Dharavli	Dharavli	Not threatened.	25	29
2	*Indoplanorbis excustus*	Kaali Chippi	Kaali Chippi	Least Concern	40	47
3	*Tarebia granifera*	Shemba	Kala Shimpada	Least Concern	26	32
4	*Meiniplotia scabra*	Kala Khada	Kala Khada	Not Available	18	22
5	*Barytelphusa cunicularis*	Kuthali	Kuthalya	Least Concern	03	01
6	*Nepa Cinerea*	Water scorpion	-	Least Concern	15	14

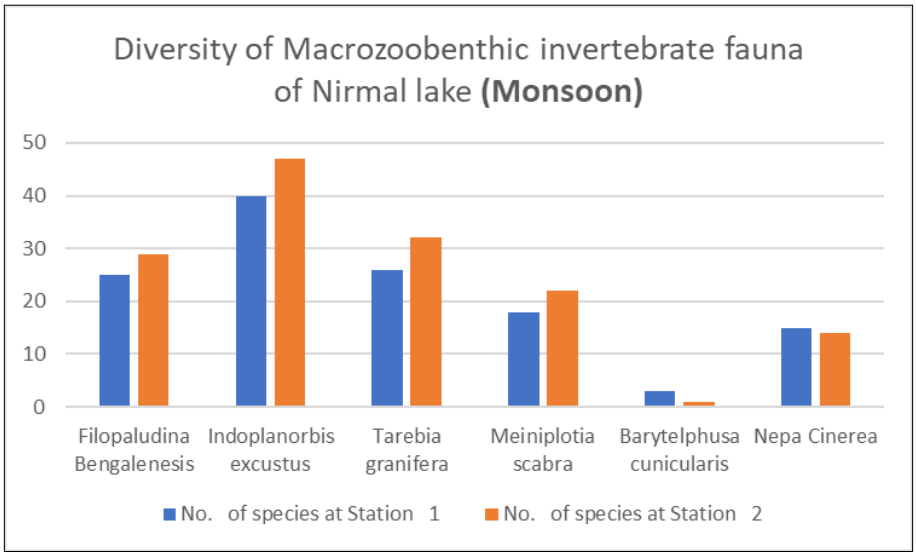

Fig 2: Diversity of Macrozoobenthic invertebrate fauna of Nirmal Lake (Monsoon).

Table 3: Checklist of the diversity of Macrozoobenthic invertebrate fauna of Nirmal Lake (Post-monsoon)

	Scientific Name	Common name	Local name	Conservation status according to IUCN	No. of species at Station 1	No. of species at Station 2
1	*Filopaludina Bengalenesis*	Dharavli	Dharavli	Not threatened.	60	76
2	*Indoplanorbis excustus*	Kaali Chippi	Kaali Chippi	Least Concern	34	20
3	*Tarebia granifera*	Shemba	Kala Shimpada	Least Concern	55	67
4	*Meiniplotia scabra*	Kala Khada	Kala Khada	Not Available	52	58
5	*Barytelphusa cunicularis*	Kuthali	Kuthalya	Least Concern	40	50
6	*Nepa Cinerea*	Water scorpion	-	Least Concern	31	29

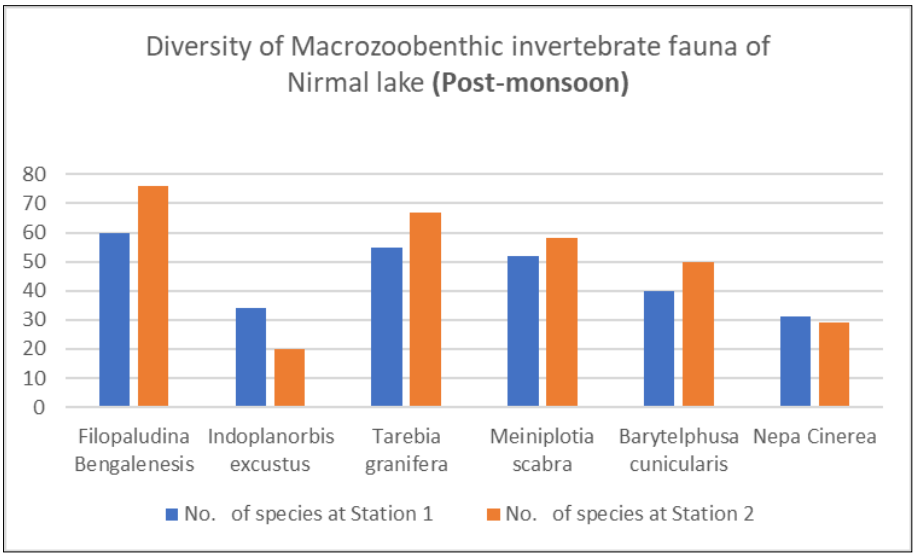

Fig 3: Diversity of Macrozoobenthic invertebrate fauna of Nirmal Lake

(Post-monsoon)

Apart from the macrozoobenthic invertebrate fauna the invertebrate Insect fauna found around Nirmal Lake is as follows.

Sr. No	Species Name	Scientific Name
1	Lake Spider	*Oxyopes macilentus*
2	Red Dragon flies	*Brachythemis contaminate*
3	Dragon flies	*Crocothemis servilia*
4	Asian Pintail,	*Acisoma Panorpoides*

Result and Discussion

An overview of Nirmal Lake's macrozoobenthic invertebrate diversity is given in this paper, which also emphasises the seasonal fluctuations in abundance between two stations. The results show that while aquatic insects were represented in modest quantities, molluscs and crustaceans make up the majority of the faunal components. The predominance of molluscan and crustacean groups is characteristic of freshwater lentic ecosystems that are impacted by eutrophic conditions and mild organic enrichment.

Barytelphusa cunicularis was more prevalent and rich during the pre-monsoon season. This could be explained by the sediments' higher detrital concentration and decreased water volume, which give these benthic crustaceans' ideal microhabitat and feeding ground. Similar cyclical patterns were noted, with higher benthic organism numbers during dry seasons as a result of decreased sediment stability and dilution, (Rolls, R. J., *et al*. 2012) [13].

On the other hand, only a few species, such *Indoplanorbis exustus* and *Filopaludina bengalensis*, maintained reasonable abundance during the monsoon season, which demonstrated a decrease in the overall macrozoobenthic density. Increased water turbulence, sediment resuspension, and runoff from adjacent catchments that momentarily disrupt benthic ecosystems may be the cause of this drop. *Indoplanorbis exustus* is more common during the monsoon, which shows that pulmonate gastropods have a tolerance to heavy organic load and varying oxygen levels.

Post-monsoon recovery of diversity, particularly of molluscs such as *Tarebia granifera* and *Meiniplotia scabra*, indicates recolonisation of the lake bed under stable hydrological conditions. Molluscs are known bioindicators of water quality and sediment chemistry, as their distribution directly responds to nutrient concentration and substrate texture.

Nirmal Lake's intermediate trophic state is further supported by the presence of aquatic insects, including the water scorpion *Nepa cinerea*, the dragonfly *Crocothemis servilia*, and the red dragonfly *Brachythemis contaminata. Nepa cinerea* is a predatory hemipteran that is typically found in freshwater environments that are lentic or slowly moving, have a lot of submerged vegetation, and have a modest amount of organic enrichment (Sharma and Sharma, 2014). This species' year-round existence suggests that the littoral zone has stable habitat and enough prey.

Overall, changes in physicochemical parameters related to rainfall, runoff, sedimentation, and eutrophication are mostly responsible for the seasonal fluctuations in the macrozoobenthic community structure of Nirmal Lake. This study's increased post-monsoon diversity and monsoon decline pattern are consistent with past research in different freshwater habitats in India (Bhusnar *et al*., 2017; Ojija *et al*., 2017) [4]. The findings highlight the ecological importance of macrobenthic invertebrates as useful bioindicators for determining the level of pollution and trophic state in freshwater bodies. Therefore, regular monitoring of these creatures might help develop conservation and management plans for maintaining lake health in areas like Palghar that are quickly urbanising.

Conclusion

The macrozoobenthic invertebrate fauna of Nirmal Lake was studied, and the results showed distinct seasonal variations in both abundance and diversity. Throughout the study period, mollusks—particularly *Tarebia granifera, Filopaludina bengalensis, and Meiniplotia scabra—dominated*, with aquatic insects and crustaceans serving as supporting groups.

The post-monsoon season has the greatest diversity, which is consistent with stable sedimentary and hydrological conditions that promote recolonisation. Due to turbulence and dilution from excessive rains, the monsoon was when the lowest abundance was observed. The organic load and nutrient enrichment characteristic of eutrophic settings are reflected in the presence of tolerant species like *Tarebia granifera* and *Indoplanorbis exustus.*

The ecological significance of Nirmal Lake as a haven for aquatic macrofauna is highlighted by the continuous discovery of *Nepa cinerea* (Least Concern) and *Barytelphusa cunicularis least* concern across stations. In order to preserve the lake's biodiversity and ecological balance, these results can be used as baseline dataset for upcoming ecological assessments, long-term biomonitoring, and restoration projects.

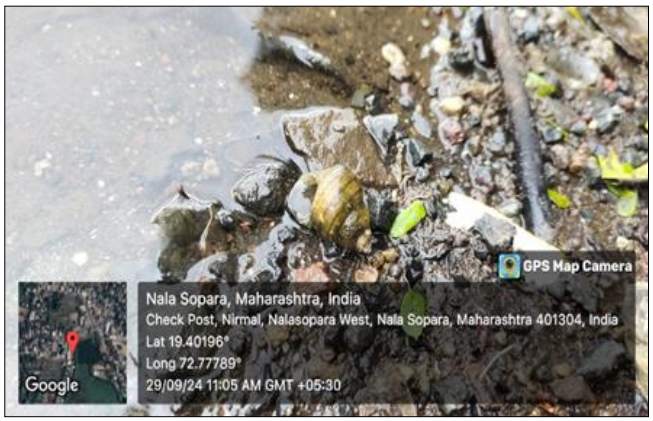

Fig 4: Filopaludina Bengalenesis

Fig 5: Indoplanorbis Excustus

Fig 6: Tarebia granifera

Fig 7: Meiniplotiascabra

Fig 8: Barytelphusa Cunicularis

Fig 9: Lake Spider (Oxyopes macilentus)

Fig 10: Red Dragon flies (Brachythemis contaminate)

Fig 11: Scarlet Skimmer (Crocothemis servilia)

Fig 12: Asian Pintail (Acisoma Panorpoides)

Fig 13: Nepa cinerea

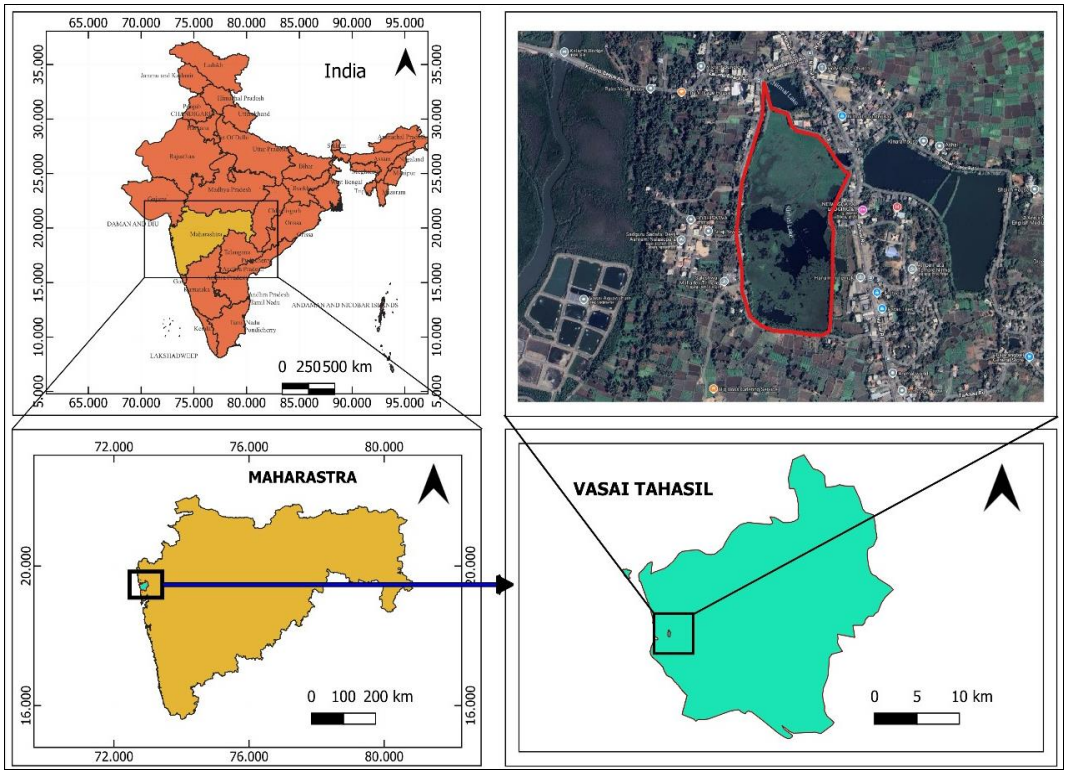

Fig 14: Map of Nirmal Lake

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