Eco. Env. & Cons. 30 (Nov. Suppl. Issue) : 2024; pp. (S223-S228)
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ISSN 0971–765X

DOI No. http://doi.org/10.53550/EEC.2024.v30i07s.041

Aquatic Insects Monitoring and River Basin Water Quality, A study of Wainganga River Basin of Bhandara District (M.S.) India

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(Received 21 April, 2024; Accepted 2 July, 2024)

ABSTRACT

In order to assess the condition of lotic ecosystems in river basins, aquatic creatures are frequently employed as biological models. The abundance analysis Insect population and basin water quality. A commonly used bio monitoring technique to evaluate the effects of sewage, industrial waste, and human waste on aquatic habitats is the use of entomological indicators. This study set out to assess the ecological well-being of the semi-rural and semi- urban Wainganga River watershed using entomological indices. Two specific Waingangai river basin areas- the Ambhora River Basin and the Pauni River Basin- were the sites of seasonal water-based species survey. In order to screen the pollution levels in the Wainganga River basin, the study identified 17 families of aquatic insects in 5 Orders. Along the river basin, there were notable variations in the water quality index (WQI). Nonetheless, the segments of the basin areas that showed a higher level of water contamination from several sources were those with a low frequency of refractory families and an overwhelming percentage of tolerant taxa. To stop future deterioration of this priceless environment, urgent action is required.

Key words: *Water insects, Bio-monitoring, Insect Abundance, Water Quality Index (WQI) Wainganga River basin, Water ecosystem.*

Introduction

The use of invertebrate aquatic insects to evaluate the ecological health of river basins is becoming more and more popular worldwide. The conflicting demands of humanity's impact on water supplies and the essential needs of the freshwater ecosystem in river basins are the driving forces behind this. The entire scope of pollution's effects on aquatic life is frequently not fully captured by conventional chemical tests of water quality. Aquatic system water quality monitoring is greatly aided by the use of bio-indicators, which provide a direct evaluation of the well-being of the species inside a particular ecosystem. The aquatic environment in river basins is incredibly active and restricted by the geomorphic patterns that are seen on the waters of the river bed's gravelface. It differs from vast aquatic ecosystems in a few special ways. Basins are tiny, have distinct borders, and mate with flowing environments. These specialized environments significantly contribute to the distinctive regional variety because of their high species composition and richness (Pinder *et al.*, 2000). Therefore, evaluating the health of rivers is crucial since both organic and inorganic pollution are increasing and have an impact on both human wellness and the diversity of freshwater fauna. According to Oerteland Salanki, (2003), biomonitoring is the "systematic use of living organisms or their responses to determine the condition or changes of the environment." For filling during the flood and monsoon seasons, the riverine potholes' water cycles rely on riverine flow and rainfall (Pinder *et al*., 2000; Eitem *et al.*, 2004). The ecological status of river ecosystems has long been observed in many nations through the use of invertebrates (Hellawell, 1986; Li *et al*., 2010; Birk *et al*., 2012; Carter *et al.,* 2017; Musonge *et al.,* 2020; Akyildiz and Duran, 2021; Eriksen *et al*., 2021). In the summer, they are either dry orpartially filled with water, but during the monsoon they are typically filled with water and submerged in the river environment (Brendonck *et al.,* 2010). According to Ren *et al.* (2015), the river's basin area, water temperature, and water depth are significant factors that determine the makeup of the aquatic insect community in the basin ecosystem. Research on the possible application of macro invertebrates that live in the ocean as biosensors for river ecosystems has also been well documented in the literature (Mustow, 2002; Ganguly *et al.,* 2018; Aazami *et al*., 2019; Mahmoud and Riad, 2020; Rosenberg and Resh, 1993). According to Wahizatul *et al.* (2011), using aquatic insects as biosensors is a useful method for determining the degree of environmental damage. According to Arimoro and Ikomi (2008), aquatic insects exhibit varying degrees of tolerance towards contaminants, making them an excellent means of assessing the water quality of aquatic ecosystems. Comprehensive water quality assessments were carried outover the course of the one-year research duration, which ran from March 2022 to February 2023, to improve our knowledge of important aquatic insect's taxa in a few basin areas of Maharashtra's Bhandara District. It involves evaluating a variety of insects and the quality of the water. The Seasonal aquatic insect's surveillance in the Bhandara districts has two valley areas, the Ambhora River Basin and the Pauni River Basin. These study locations' selection criteria are crucial to ensuring that the water purity indices are continuously assessed and that insects are monitored. Macro invertebrates have long been used by several nations to track the overall health of their river systems. Certain areas of the Wainganga River basin have experienced human-caused changes, including the redirecting of rivers, the building of dams, and the loss of native riparian vegetation. The atmospheric and biological state of the river basin area can be inferred from an evaluation of the number of taxa and the presence or absence of specific insect families. The purpose ofthis study is to evaluate the Wainganga River basin's pollution levels using entomological indicators at two different locations. The goal of the research is to analyze the ecological state of the river basin and identify viable biological metrics for assessing water quality.

Materials and Methods

Research Zone

The river basin portions of Maharashtra's Bhandara District pass through broadleaf and evergreen jungles that are home to a wide variety of animals and plants. The Bhandara District's river basin areas are included in the authorized study sites. Seasonal aquatic insect monitoring was conducted in two basin locations: the Ambhora River Basin (N-21°02'06" E- 79°37'07") and the Pauni River Basin (N-20°46'12"

Fig. 1. Ambhora stream Basin

Fig. 2. Pauni River Basin

E-79°39’48"). The rural landscapes with religious sites, small settlements, and tourist attractions make up the study and research locations along the Ambhora river basin. Due to the river’s fame and religious significance, visitors frequently visit these areas to take advantage of the ecosystem services provided by the river, while the localpopulation mostly depends on the river for income creation through vegetable gardening. The Ambhora and Pauni River basin vicinities are primarily known for their rice and vegetable crop cultivations, which is why riverbanks are used for agriculture. During the monsoon, winter, and summer seasons, aquatic insects were sampled across the Wainganga River basin areas using both the “kick-net method” and the “all-out search method.”

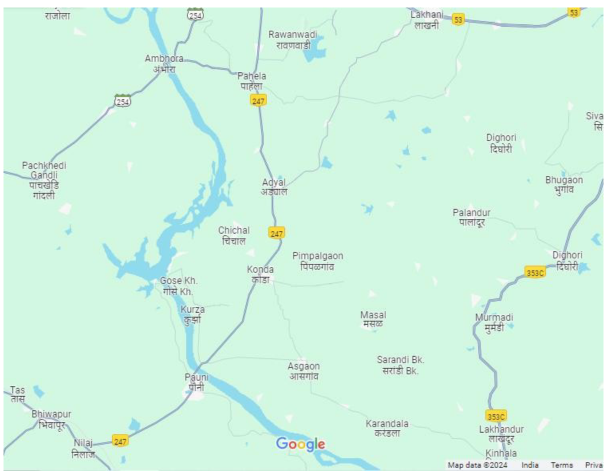


Fig. 3. Map Showing Ambhora and Pauni basin area

Collection of Aquatic Insects and water Sample

Month to month inspecting of water and aquatic insects was finished from the two different stream and basin regions during the review time frame from Feb. 2022 to Feb. 2023, summer, storm, and winter season. Occasional changes in water quality boundaries like temperature, pH, Dissolve oxygen (DO), Biochemical oxygen demand (BoD), free Carbon dioxide (CO_2), nitrate and phosphate were contemplated to comprehend the general condition of soundnessof these water bodies. This is examined by standard techniques (APHA, 2012). The water quality record is a compelling device used to survey surface water quality. You can change over a lot of information in view of various water quality models into a solitary number that addresses the general water quality. The data accordingly created is justifiable and valuable to people in general (Yogendra and Puttaiah, 2008). Aquatic insects were gathered utilizing D- outline water nets with a cross-section size of 500 µm (Santhosh and Ashadevi, 2017). All aquatic insect bugs’ tests were then moved to white holders and pains takingly analyzed (Priyanka and Kakkassery, 2018). The gathered examples were fixed in 70% ethanol and shipped off the research facility. Gathered insects’ tests were inspected under a stereomicroscope and recognized to family level (Morse *et al.*, 1994; Subramanian and Sivaramakrishnan, 2007). Tirumalai, 1999; Short, 2003; Bouchard, 2009; Boonsong and Brasch, 2013)

Data Analysis

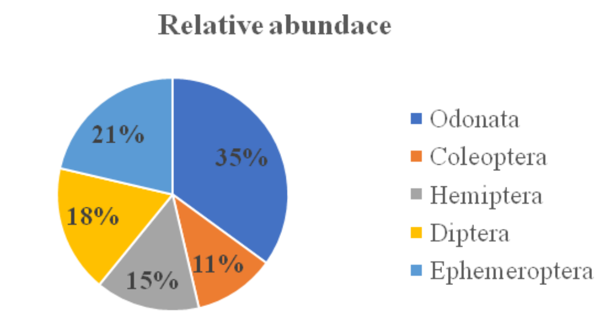
The strength status of various aquatic insect’s families was created by the Engelmann scale in light of their relative overflow (Engelmann, 1978). Variety records, for example, Shannon-Wiener variety list and Margale flavishness file were determined. In this review, 10 significant boundaries to be specific: pH, DO, complete alkalinity, chloride, calcium, magnesium, Body, nitrate, phosphate, and sulphate were examined utilizing drinking water quality norms set by the World Wellbeing Association (WHO).

Results and Discussion

Diversity indices as an important tool for determine the level of environmental strain with in a river basin water body, encompassing various facets of a community such as the count of extant taxa (Richness), the dispersion of individuals (Evenness), and the overall number of extant individuals. According by Wilhm and Dorris (1968). In Order Odonataregistereda relative most abundance 32% with 77 individuals with four families contributed Libellulidae, Gomphidae, Aeshnidae, Coenagrionidae, highest species are recorded in basin ecosystem. 11.01% with 25 individual’s species found of Order Coleoptera, recorded two families viz. Dytiscidae and Noteridae similarly in the seasonal year Order Hemiptera contributed less abundance 14.01% with individual species 32 this order represents two families *viz.* Nepidae and Corixidae. During the year, In Order Diptera showed relative abundance 17.18% with individual six family contributed individual species 39 *viz.* Culicidae, Stratiomyidae, Chironomidae, Ceratopogonidae and Psychodidae. In Order Ephemeroptera showed 20.7% Abundance with 47 individual species namely Baetidae, Heptageniidae, Caenidae. This families shows relative abundance during the march 2022 to February 2023 in one-year, Various diversity indices applied on the collected data of aquatic insect population in the selected basin water bodies of Bhandara District revealed well-marked seasonal variations during the years of investigation (March 2022 to Feb 2023). In basin area of Ambhora, the values of Shannon-Wiener diversity index (H´) varied from 2.77(monsoon), 2.31(winter) and from 2.489 (summer). During the seasons of a year, Similarly, Simpson's diversity (D) fluctuated from 0.92 (monsoon) to 0.87 (winter) and 0.93 (summer). Species richness index (Margalef's index) ranged calculated 4.91 (monsoon) to 3.63 (winter) and 3.56 (summer) in a year of investigation respectively (Graph 1). In basin area of Pauni, the values of Shannon-Wiener diversity index (H´) varied from 2.56 (monsoon), 2.38(winter) and from 2.19 (summer). During the seasons of a year, Similarly, Simpson's diversity (D) fluctuated from 0.97 (monsoon) to 0.92 (winter) and 0.86 (summer). Species richness index (Margalef's index) ranged calculated 3.45 (monsoon), 3.67 (winter) and 2.96 (summer) in a year of investigation respectively (Graph 2). An examination comparing diversity indices utilized on the aquatic insect population within the two basin water bodies, as outlined in (Table 1), unveiled that the Ambhora river basin area boasted the highest species diversity and richness. This may be credited to its significant habitat diversity. Conversely, the lotic characteristics of the Wainganga River basin, coupled with the absence of macrophytic vegetation, dredging effects, human intervention, and untreated discharge from nearby industrial complexes, contribute to the low species diversity and richness observed in the Pauni basin area. Similarly, The WQI serves as a valuable instrument for assessing the quality of surface water. It facilitates the condensation of vast datasets into a singular value, providing a concise representation of the overall water quality, taking into account multiple criteria for water quality assessment. The information

Table 1. Relative population abundance of aquatic insects' species in Ambhora and Pauni River basin district Bhandara.

Order	Family	Name of Species	Monsoon	Winter	Summer	Total	Mean ± SD	%age (R.A)
Odonata	Libellulidae	*Sympetrum* sp.	2	1	1	4	1±0.8	1.76
		Orthetrum sp.	–	4	2	6	1.5± 1.91	2.64
	Gomphidae	*Progomphus* sp.	3	12	16	31	7.75± 3.77	13.66
		Ophiogomphus sp.	–	8	6	13	3.25±2.5	5.73
	Aeshnidae	*Anaxsp.*	1	″	1	2	0.5± 0.57	0.88
	Coenagrionidae	Damselfly *Larvae*	2	12	7	21	5.25± 2.87	9.25
Coleoptera	Dytiscidae	*Cybistertripunctatus*	–	3	″	4	1±1.4	1.76
		Hydroglyphussignatellus	1	9	2	12	3±2.7	5.29
	Noteridae	*Canthydruslaetabilis*	–	4	″	9	2.25±4.5	3.96
Hemiptera	Corixidae	*Micronectaproba*	4	18	8	30	7.5± 7.04	13.22
	Nepidae	*Laccotrephes maculates*	–	2	″	2	0.5±1	0.88
Diptera	Culicidae	*Culexsp.*	–	3	2	5	1.25±0.95	2.2
		Anopheles sp.	1	6	5	12	3± 1.41	5.29
	Stratiomyidae	*Stratiomys* sp.	–	1	1	2	0.5± 0.57	0.88
	Syrphidae	*Eristalis* sp.	–	″	2	2	0.5±1	0.88
	Chironomidae	*Chironomous* sp.	3	7	4	14	3.5± 2.08	6.17
	Ceratopogonidae	*Culicoides* sp.	–	1	2	3	0.75±0.5	1.32
	Psychodidae	*Psychoda* sp.	–	1	″	1	0.25±0.5	0.44
Ephemeroptera	Heptageniidae	*Cinygma* sp.	–	6	2	8	2±2.7	3.52
	Baetidae	*Baetis* sp.	5	21	10	36	9± 4.89	15.86
	Caenidae	*Caenis* sp.	–	–	3	3	0.75±1.5	1.32



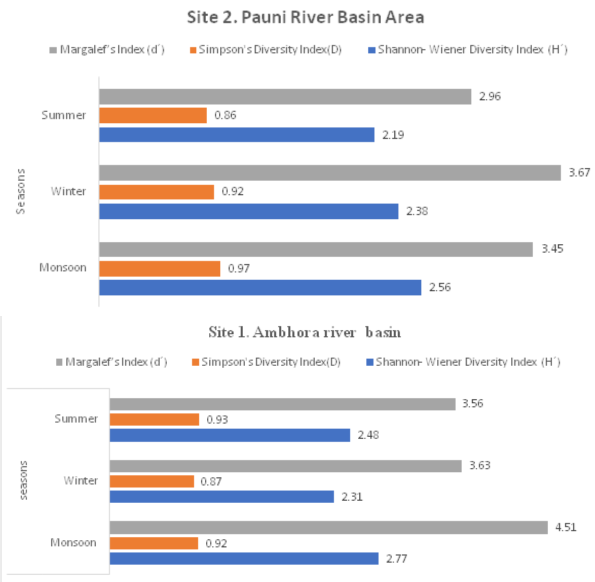


Fig. 4. Graph Showing diversity indices in Ambhora and Pauni basin areas.

produced is comprehensible and accessible to the public.(Yogendra and Puttaiah, 2008). Analysis of water quality status depicted in (Table 2) revealed maximum WQI value in river Ambhora and Pauni showed minimum value of WQI. However, the interpretation of the data clearly suggested that poor water quality of water of river basin was ascribed to be unsuitable for drinking.

Conclusion

This research marks the initial investigation into the aquatic insect population within the Basin River of Wainganga and their contribution to assessing river health and the abundance of aquatic insects. Analysis of various biotic indices indicates water quality is pre-dominantly moderate in the Ambhora basin but poor in the Pauni River basin. The study additionally validates role of aquatic insect's bioindicators in flowing water systems and underscores the importance of employing diverse biotic indices for assessing water quality. It suggests that for Effective River or stream water quality management, the dispersal of aquatic insect communities across different locations and climatic seasons could serve as valuable indicators. Subsequent research on this river is encouraged to identify pollution sources and enhance understanding of its biodiversity.

Conflict of Interest -None

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Table 2. Water Quality Index (WQI) of Ambhora and Pauni river basin of Waingaga

S. No.	Parameters	Observed Values	Standard Values (Sn)	Unit Weights (Wn)	Quality Rating (qn)	Wnqn
1	pH	8.25	8.5	0.219	83.33	18.25
2	DO(mg/l)	9.15	5	0.3723	56.77	21.14
3	Totalalkalinity (mg/l)	141.38	120	0.0155	117.82	1.83
4	Chlorides (mg/l)	19.37	250	0.0074	7.75	0.06
5	Calcium (mg/l)	29.43	75	0.025	39.24	0.98
6	Magnesium(mg/l)	7.47	30	0.061	24.9	1.52
7	BOD (mg/l)	4.64	5	0.3723	92.8	34.55
8	Nitrates (mg/l)	0.44	45	0.0412	0.98	0.04
9	Phosphates(mg/l)	0.39	5	0.0878	7.8	0.68
10	Sulphates (mg/l)	30.5	150	0.01236	20.33	0.25
				Σ5J5[=1.21	**Σ5^5[= 451**	**Σ5J[5^5[=79.3**

Water Quality Index WQI = "5J5[5^5[/"5J5[=65.21

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