ZIBELINE INTERNATIONAL™ PUBLISHING

ISSN: 2521-0912 (Print)
ISSN: 2521-0513 (Online)
CODEN: JCOLBF

Journal CleanWAS (JCleanWAS)

DOI: http://doi.org/10.26480/jcleanwas.01.2024.45.49

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RESEARCH ARTICLE

AN ASSESSMENT OF THE WATER QUALITY OF RIVER ERUVBI USING AQUATIC INSECTS AS BIO-INDICATORS

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ARTICLE DETAILS

Article History:

Received 15 November 2024
Revised 22 December 2024
Accepted 30 December 2024
Available online 15 January 2025

ABSTRACT

A study to ascertain the water quality and species composition of the aquatic insect of Eruvbi River flowing through Ekosodin Village, Nigeria was conducted between June and August 2009. Four locations were selected with physical and chemical parameters determined along with the insect fauna collected using general purpose net and sweep net; captured insects were identified and classified into taxonomic groups. The result obtained for the condition of the water revealed dissimilarities in all except pH and Total Dissolved Solids which were similar in all stations. A total of 311 individuals from 7 orders across 20 families and 27 taxa were encountered. The highest abundance in species and family was found in station 4 (110 and 18) while the least was found in station 1 (61 individuals) and station 3 (13 families). The dominant orders were Odonata, Diptera and Ephemeroptera in all stations. Trichoptera, Coleoptera. Hemiptera were subdominant while Plecoptera was scarcely found in stations 2 and 4. The diversity and biotic indices showed that the water had good quality, which was the inference from the abundance of indicator species denoting the water was free from pollution with the nature of the substratum and presence of aquatic macrophytes influencing the insect composition and diversity.

KEYWORDS

Aquatic insects, Bio-indicators, chemical condition, Physical, Pollution.

1. INTRODUCTION

The use of aquatic insects as bio-indicators in the assessment of water quality has been frequently used worldwide (Chon et al., 2013). They offer a spectrum of responses to different degrees of environmental stress and change over time (Hawkes, 1997). The quality of the site from which aquatic insects are collected are reflected by the number and type of insects present and provides a more accurate understanding of the changing water body or river system than chemical data (Boonsoong et al., 2009; Ravera, 1998). Studies by using aquatic insects as bio-indicators of anthropogenic impacts on aquatic ecosystem have shown a general decrease in aquatic insect population and the reduction in species diversity and richness. They possess a higher ability to tolerate pollution-induced environmental stress than fish and plankton (Andem et al., 2012). The response of the aquatic insect to pollution gives an early warning to possible harm of the water resources because the aquatic insect spends nearly its entire life in a water body and they show the effects of physical habitat alteration, point and nonpoint contaminants over their life cycles.

This is because aquatic insect assemblages are sensitive to disturbance and water pollution, making them the most frequently used biological parameters in monitoring water quality (Morse et al., 2007). In Nigeria, studies on the physical and chemical quality of water bodies have been reported extensively in relation to the aquatic fauna assemblage (Jonnalagadda and Mhere, 2001; Omoigberale and Ogbeibu, 2007; Yusuf and Osibanjo, 2006; Asonye et al., 2007; Arimoro et al., 2007; Edegbene and Arimoro, 2012; Rotimi, 2000; Rotimi and Iloba, 2002a, b; Ogbeibu and Oribhabor, 2002). The objective of this study was to determine the species composition, distribution, taxa richness, dominance, evenness and biotic index of the insect fauna of the river in relation to the physical and chemical parameters of river Eruvbi flowing through Ekosodin Village.

2. MATERIALS AND METHODS

2.1 Study area and Sampling Stations

The study was conducted in River Eruvbi located 15km North of Benin City, an heterotrophic stream with a low altitude of 265m above sea level, it is a tributary of Ikpoba river about 5km in located in the Eastern end of Ovia North East, Benin city, Nigeria (Longitudes 06°23′- 06°25′ and Latitudes 05°38′ - 05°39′) flowing through Ekosodin village. Sampling was carried out between the months of June and August 2009. Four sampling stations were selected, 3 stations were undisturbed by human activities throughout the period while 1 station witnessed the most anthropogenic activities.

2.2 Sampling Methods

Water samples used for determining physical and chemical parameters were collected from four stations monthly from June to August 2009. This was done between the hours of 09.00h and 11.00h on each sampling day.

Quick Response Code	Access this article online	
	Website: www.jcleanwas.com	**DOI:** 10.26480/jcleanwas.01.2024.45.49

Cite the Article: Opoggen, Love, Rotimi, Johnny (2024). An Assessment Of The Water Quality Of River Eruvbi Using Aquatic Insects As Bio-Indicators. *Journal CleanWas, 8(1): 45-49.*

Water, bank root and sediment were collected from the established sampling stations. Only surface water samples were collected by immersing sterilized water bottles into the river at each sampling station and tightly covered with the lid. Water samples for Dissolved oxygen were collected according to standard procedures (APHA, 2005).

2.3 Entomological Methods

Aquatic insect were collected by combining the kick-sampling technique the hand net (Armitage, 1978; Rotimi and Iloba, 2003). Collected samples were treated in 10% formalin to avoid cannibalism and preserved in 4% formalin for subsequent identification and enumeration in the laboratory. Identification of insect species was done using keys provided in (Pennak, 1953; Macan, 1959; Mellanby, 1965).

2.4 Statistical Analysis

Values of physical and chemical parameters obtained were statistically analyzed using measures of central tendency and Analysis of Variance (ANOVA). Ecological statistics and biotic index were calculated using PAST software v 4.03 to determine the water quality, species diversity and abundance according to (Chapman and Jackson, 1996; Ogbeibu, 2010).

3. Results

3.1 Physical and Chemical condition of the water

The physical and chemical condition of the water which were tested include the temperature, turbidity, Dissolved oxygen, conductivity is presented in Table 1.

Table 1: Physical and Chemical Parameters of River Eruvbi

Parameters	Station 1	Station 2	Station 3	Station 4	Significance
pH	6.74±0.02	6.75±0.01	6.74±0.01	6.77±0.01	P>0.05
Conductivity	12.27±0.07	10.72±0.06	11.17±0.09	10.42±0.13	P<0.05
Turbidity	0.18±0.02	4.5±0.06	0.25±0.03	0.13±0.04	P<0.05
Total solids	10.1±0.12	9.6±0.12	9.9±0.03	8.87±0.04	P<0.05
Total Suspended Solids	0.47±0.09	1.18±0.14	1.21±0.07	0.54±0.08	P<0.05
Total Dissolved Solids	9.83±0.20	8.67±0.44	8.87±0.52	8.5±0.25	P>0.05
Total Alkalinity	11.57±0.35	11.73±0.37	12±0.12	17.8±0.29	P<0.05
Total Hardness	3.67±0.35	9.07±0.23	12.27±0.15	3.5±0.29	P<0.05
Chloride	28.2±0.12	26.78±0.12	24.63±0.13	24.63±0.13	P<0.05
Dissolved Oxygen	5.1±0.06	5.5±0.09	5.85±0.09	5.4±0.06	P<0.05
Calcium	0.87±0.09	1.47±0.15	1.3±0.15	2.23±0.15	P<0.05
Magnesium	0.98±0.06	2.38±0.09	2.92±0.04	0.42±0.02	P<0.05
Phosphate	0.17±0.01	0.016±0.00	0.016±0.00	0.017±0.00	P<0.05
Nitrate	0.15±0.02	0.25±0.02	0.35±0.02	0.25±0.02	P<0.05

3.2 Composition and Distribution of Aquatic fauna

A total of 311 individuals from 7 orders across 20 families and 27 species were encountered in this study. Significantly more aquatic insects were found in station 4 (110 individuals) compared to station 2 (76 individuals), Station 3 (64 individuals) and station 1 (61 individuals). A higher number of families were recorded in station 4 (18), followed by station 2 (17), station 1(16) while station 3(13) had the least. Orders Odonata, Diptera, Ephemeroptera, Trichoptera, Coleoptera and Hemiptera were the taxonomic groups occurring in all stations while Plecoptera were not found in stations 1 and 3 (Table 2). In all the stations, the highest percentage of individuals collected were from the order Odonata, followed by Ephemeroptera, Diptera, Trichoptera, Hemiptera, Coleoptera and Plecoptera, showing a high dominance index (Table 3). The abundance of the species in the orders are Odonata (152), Ephemeroptera (59), Diptera (42), Trichoptera (20), Coleoptera (15), Hemiptera (19) and Plecoptera (4). The dominant and subdominant groups are shown in Table 3, were Odonata was the most dominant species in all the study stations, and Plecoptera was least dominant in all the study stations.

Table 2: Aquatic Insect Composition and Distribution in the study stations

Order	Family	Genera	Station1	Station2	Station3	Station4
Odonata	Aeshnidae	*Aeshna* sp	1	4	12	9
Suborder Anisoptera	Cordulidae	*Cordulid* sp	1	4	0	6
	Gomphidae	*Aphylla* sp	8	5	9	18
	Libellulidae	*Libellula* sp	6	2	5	9
	Macromidae	*Macromia* sp	8	6	2	3
Suborder Zygoptera	Coenogrionidae	*Coenogrion* sp	2	5	0	5
		Enallagma sp	2	4	0	6
	Lestidae	*Lestes* sp	4	3	0	3
Diptera	Chironomidae	*Chironomus* sp	4	8	5	8
		Pentaneura sp	1	1	2	0
	Culicidae	*Anopheles* sp	0	1	0	1
		Culex sp	0	1	0	2
	Tabanidae	*Tabanus* sp	2	2	3	1
Ephemeroptera	Baetidae	*Baetis* sp	4	6	0	6
		Baetis tricaudalis	2	1	8	4

Table 2 (Cons): Aquatic Insect Composition and Distribution in the study stations						
		Caenis sp	1	3	0	2
		Cloeon sp	0	2	1	3
	Ephemerillidae	*Ephemerella* sp	1	0	2	2
	Heptageniidae	*Ecdyneurus* sp	3	4	2	2
Tricoptera	Lepidomastidae	*Lepidomaste* sp	4	4	0	5
	Rhyacophilidae	*Rhyacophila* sp	1	3	1	2
Plecoptera	Capnidae	*Capnia* sp	0	1	0	3
Coleoptera	Hydro	*Heterlinus* sp	2	1	8	4
Hemiptera	Notonectidae	*Buenoa* sp	2	0	3	4
		Notonecta sp	0	2	1	1
	Gerridae	*Gerris* sp	2	2	0	0
	Nepidae	*Ranatra* sp	0	1	0	1
Total	**20**	**27**	**61**	**76**	**64**	**110**

Table 3: Percentage Composition of Fauna in River Eruvbi					
Order	**Station 1**	**Station 2**	**Station 3**	**Station 4**	**Total %**
Odonata	52.46**	43.42**	43.75**	53.64**	48.9
Diptera	11.48*	17.11**	15.63**	10.91*	13.5
Ephemeroptera	18.03**	21.05*	20.31**	17.27**	19.0
Trichoptera	8.19*	9.21*	1.56	6.36*	6.4
Plecoptera	0.00	1.32	0.00	2.73	1.3
Coleoptera	3.28	1.32	12.5*	3.64	4.8
Hemiptera	6.56*	6.56*	6.25*	5.45*	6.1

** Dominant species, * Subdominant species

3.3 Diversity and Biotic Indices

The diversity indices are presented in table 4 these indices evaluate the variety of data in their richness, evenness, similarities and dominance, it is also used in measuring environmental stress (Hawkes, 1997). Shannon-Weiner index higher than 1 indicates a non-polluted water, while Margalef's values greater than 3 indicates good quality water. From the results all stations had good quality of water as the H' and d values were higher than stated values. The biotic index of the water showed that the water had good quality with little presence of organic pollution as shown in table 5.

Table 4: Diversity and Species Richness Indices of River Eruvbi				
	Station 1	**Station 2**	**Station 3**	**Station 4**
Number Of Taxa	21	25	15	25
Number Of Individuals	61	76	64	110
Taxa Richness(D)	4.865	5.541	3.366	5.106
General Diversity(H)	1.221	1.316	1.052	1.278
Shannon (H')	2.817	3.031	2.423	2.943
Evenness(E')	0.924	0.942	0.895	0.914
Simpson's Dominance (C)	0.073	0.055	0.107	0.067

Table 5: Biotic Indices of River Eruvbi				
	Station 1	**Station 2**	**Station 3**	**Station 4**
FBI	4.51	4.68	4.31	5.71
BMWPs	123	123	81	128
%EPT	28.1	34.8	23.3	27.2
ASPT	7.69	7.24	6.23	7.11

4. Discussion

The physical and chemical condition of the water at the study stations were significantly different ($P<0.05$) except for pH and Total dissolved solids, the similarities in these parameters could be attributed to natural inherent qualities which appears not to be influenced by anthropogenic input into the water body (Rotimi and Iloba, 2002b). these similarities have been reported by earlier workers on different regions of Ikpoba river concluding that this is typical of study streams (Victor and Dickson, 1985; Victor and Onomivori, 1996).

The composition and abundance of aquatic fauna is determined by factors such as physical and chemical disturbance, seasonal water flow, temperature, ion concentration, food base of the stream, interaction of stream and substrate (Bishop, 1973; Ward and Stanford, 1979; Dance and Hynes, 1980). In addition, human activities such as recreational and agricultural activities are associated with reduction in species diversity of aquatic insect community (Wahizatul et al., 2011). The abundance of Ephemeroptera, Plecoptera, Trichoptera and Chironomidae in a water community indicates the balance of the community. Since Ephemeroptera, Plecoptera and Trichoptera are particulatly sensitive to water quality and Chironomidae are less sensitive to environmental stress (El-Husseiny et al., 2015). Hence an evenly distributed community of these four families indicates a good biotic condition of water (Lenart and Penrose, 1996).

The high proportion of Odonata in the study stations could be attributed to the abundance of aquatic macrophytes which provides breeding sites and shelter for them (Rotimi and Iloba, 2002a). Dipterans especially Chironomids, Ephemeroptera were also among the dominant taxa present in the water body, this could be attributed to the sandy bottom of the water (Bishop, 1973). Coleopteran, Trichopterans and Hemiptera were sparsely distributed and did not show habitat restriction (Rotimi and Iloba 2002a). This distribution enables them exploit food, habitat area and other factors that influence aquatic organisms such as predator avoidance and food availability. Studies of other tropical water bodies have shown that the number of aquatic insects and other macrobenthic invertebrates varies depending on the prevailing condition of the water bodies (Reuda et al., 2002; Rosenberg and Resh, 1993; Arimoro and Ikomi, 2008). The presence or absence of organism from a community indicates its ability or inability to find a suitable niche and not that it is unable to reach a location. Hence the absence of Plecoptera in stations 1 and 3 shows there was no suitable niche for them compared to the other sites were they were available.

Applying diversity indices to the aquatic fauna data, the result of the Shannon Weiner diversity were greater than 1 which is indicative of good water quality, as also depicted by the Margalef's index which gave values higher than 3, the least value was found in station 3. The fauna composition revealed that stations 2 and 4 had similar taxa number and 3 had the least. The biotic indices showed that the different stations had good water quality indicating low pollutant into the water. The Biological Monitoring Working Party score and Average Score per Taxa as well as the % EPT showed that pollution sensitive taxa were in high abundance denoting very good water quality (Wahizatul et al., 2011; Barma and Gupta, 2015). In general, the aquatic insect communities had high diversity in River Eruvbi, these indices showed that the water had good quality. Further research could be conducted to determine the interaction between physical habitat quality characteristics, biological and ecological components in the tropical freshwater ecosystem.

5. Conclusion

The abundance of indicator species as well as the biotic index values in the stations is an indication that the study stations are relatively free from gross pollution. This baseline study therefore addresses the need for more intensive study on the entire length of the river to fully comprehend the general fauna assemblage of the river.

Competing Interest

The authors declare no competing interest

Author Contributions

OL- Conceptualization, Investigation, Writing- original draft and review; **RJ**- Supervision and Methodology. All Authors read and approved the final draft.

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