International Journal of Science and Research Archive
eISSN: 2582-8185
Cross Ref DOI: 10.30574/ijsra
Journal homepage: https://ijsra.net/

(RESEARCH ARTICLE)

Check for updates

Biodiversity of aquatic insects flourished in the rain water collected from Kosti and Rabak cities, White Nile State, Sudan

Abdalaal A. Hamad Ali [1,*], Mutaman A. A. Kehail [2] and Bakri Yousif Nour Eldaem [3]

[1] *Ph.D. Student, Blue Nile National Institute for Communicable Diseases, University of Gezira, Sudan.*
[2] *Associate Professor, Faculty of Science, University of Gezira, Sudan.*
[3] *Associate Professor, Blue Nile National Institute for Communicable Diseases, University of Gezira.*

International Journal of Science and Research Archive, 2024, 11(02), 1798–1803

Publication history: Received on 13 March 2024; revised on 19 April 2024; accepted on 22 April 2024

Article DOI: https://doi.org/10.30574/ijsra.2024.11.2.0684

Abstract

Biodiversity including description of status of ecosystems and populations to the best to our knowledge and major threats for better biodiversity conservation. The aim of this study was to evaluate the biodiversity of aquatic insect population in the rain water collected from White Nile State. The samples of the rain water were collected during (March and October 2022) from Kosti and Rabak Cities, White Nile State, Sudan, in clean disposable plastic bottles from random sites. *Anopheles, Culex* and *Aedes* mosquito's larvae were identified and counted, in addition to their aquatic predators (mayfly, dragon fly and water beetles), while algae and snails were just checked for their presence within this sites. The results at Kosti city during March 2022, showed the dominance of *Anopheles* (37 larvae) over *Culex* (14 larvae), while mayfly were the more abundant predators (16 naiads), followed by water beetle (6 beetles). In Rabak city, *Culex* (44 larvae) was the most dominant in addition to water beetles (12 beetles). During October 2022, *Anopheles* (78 larvae), *Culex* (34 larvae) and mayfly were the dominant organisms. In Rabak city, *Culex* (50 larvae) was the most dominant genus, while *Aedes* larvae were not noticed throughout this study. Mayfly and dragon fly naiads, and water beetles were not noticed in all Rabak sites.

Keywords: Biodiversity; Aquatic Insects; Rain Water; Kosti; Rabak; White Nile State; Sudan

1. Introduction

Waterborne disease means adverse effects on human health, such as death, disability, illness or disorders caused by pathogenic micro-organisms that are transmitted directly by water or indirectly by vectors. These diseases can be spread while bathing, washing, drinking water, or by eating food exposed to contaminated water [1]. While diarrhea and vomiting are the most commonly reported symptoms of waterborne illness, other symptoms can include skin, ear, respiratory, or eye problems [2]. Lack of clean water supply, therefore, reliable access to clean drinking water and sanitation is the main method to prevent waterborne diseases [3].

Other important classes of waterborne diseases are caused by metazoan parasites, e.g., certain Nematoda (Dracunculiasis). Another class of waterborne metazoan pathogens are certain members of the Schistosomatidae, a family of blood flukes. They usually infect people that make skin contact with the water [*4*]. Blood flukes are pathogens that cause Schistosomiasis of various forms, more or less seriously affecting hundreds of millions of people worldwide [5].

Aquatic insects or water insects live some portion of their life cycle in the water. Some diving insects, such as predatory diving beetles, can hunt for food underwater. The naiads of mayflies and dragonflies, possess gills, which

* Corresponding author: Abdalaal A. Hamad Ali

are outgrowths of the body wall containing a dense network of tracheae covered by a thin cuticle through which oxygen in the water can diffuse [*6]*.

Some insects have densely packed hairs around the spiracles that allow air to remain near, while keeping water away from, the body. Other types of insects have gills [*7]*. Mosquitoes are approximately 3,600 species of small flies comprising the family Culicidae. The life cycle consists of egg, larva, pupa, and adult stages. Eggs are laid on the water surface; they hatch into motile larvae that feed on aquatic algae and organic material. These larvae are important food sources for many freshwater animals, such as dragonfly naiads and other aquatic predators [8].

The mosquito's saliva is transferred to the host during the bite, can cause an itchy rash, and can transmit some pathogens. In this way, mosquitoes are important vectors of parasitic diseases such as malaria and filariasis, and arboviral diseases such as yellow fever, Chikungunya, West Nile, dengue fever, and Zika. By transmitting diseases, mosquitoes cause the deaths of more people than any other animal taxon: over 700,000 each year [*9]*. It has been claimed that almost half of the people who have ever lived have died of mosquito-vectored disease, but this claim is disputed, with more conservative estimates placing the death toll closer to 5% of all humans [8].

2. Materials and Methods

2.1. Study area

Kosti and Rabak cities, White Nile State, Sudan, were selected to conduct this study lies south of Khartoum, the capital of Sudan, and stands on the western and east banks of the White Nile River, the capital of the White Nile state is Kosti. These areas has a mean temperature ranged between 31 to "42 ℃"., average rain fall of 0 to 119 mm, RH of 26 and 71%, mean monthly sunshine 217 – 317 hours (55 -89%). The rain season extended from April – November but the rain water may stagnant in these cities till the next rain season [10].

2.2. Water samples

The stagnant water samples were collected in clean disposable plastic bottles (500 ml) from random sites of each of the study area. The water samples were collected using standard dipping bottle. Water sample was taken after autumn (October) and winter (March) seasons of 2022.

2.3. The study deign

A series of repeated sampling (cross section) were carried out to collect mosquito larvae and their aquatic predators from across the study area over a period of two years, to account for seasonal data. A total of five sites were selected across Kosti and another from Rabak cities to account for different environment.

2.4. Biodiversity of the aquatic organisms

The aquatic predators (tadpole, mayfly and dragonfly naiad, and aquatic beetle adults and larvae) collected among the samples were immediately counted and discarded from the collecting bottles, while mosquito's larvae were identified to as main genus, whereas, pupae were just counted and never classified. The presence ($\surd$) or absence (0) of algae and snails were also reported within the collected samples.

2.5. Identification of mosquito's larvae

Mosquito larvae (and not the adults) were transferred to the Principle Science Laboratory, University of Gezira, so as to be classified as *Anopheles, Culex* or *Aedes*, using their morphological characteristics according to [11]. Several samples of mosquito larvae were preserved in ethanol (70%).

3. Results

3.1. The diversity of aquatic organisms during March 2022

The diversity of aquatic organisms flourished within rain water at some sites of Kosti city during March 2022 (Table 1), showed the presence of *Anopheles* (total of 37 larvae from 4 out of 5 sites) and *Culex* (total of 14 larvae from 3 out of 5 sites), while no *Aedes* larvae were noticed, but a total of 7 mosquito's pupae were found in 3 sites out of 5. It was also noticed that, mayfly naiads were the more abundant predators (total of 16 naiads from 4 sites out of 5), followed by

water beetles (total of 6 beetles from 3 sites out of 5), but dragon fly naiads were the least (total 2 naiads from one site out of 5). Algae and snails were also noticed in almost all sites.

Table 1 Number of counted aquatic organisms at some sites of Kosti city during March 2022

Site	*Anopheles* larvae	*Culex* larvae	*Aedes* larvae	Mosq. Pupae	Dragon fly naiad	Mayfly naiad	Water beetle	Algae	Snails
1	12	7	0	2	0	3	2	√	√
2	8	3	0	2	2	7	0	√	√
3	13	0	0	0	0	5	1	√	√
4	0	0	0	0	0	0	0	√	√
5	4	4	0	3	0	1	3	√	√
Total	37	14	0	7	2	16	6	*All*	*All*

The diversity of aquatic organisms within rain water of at some sites of Rabak city during March 2022, showed the presence of *Anopheles* (total of 2 larvae from only one site) and *Culex* (total of 44 larvae from all sites), while no *Aedes* larvae were noticed, but a total of 10 mosquito's pupae were found in all sites. It was also noticed that, water beetles were the more abundant predators (total of 12 beetles from all sites), followed by mayfly naiads (total of 2 naiads from 2 sites out of 5), but dragon fly naiads were not noticed. Algae were also noticed in all sites unlike snails which were not noticed (Table 2).

Table 2 Number of counted aquatic organisms at some sites of Rabak city during March 2022

Site	*Anopheles* larvae	*Culex* larvae	*Aedes* larvae	Mosq. Pupae	Dragon fly naiad	Mayfly naiad	Water beetle	Algae	Snails
1	0	17	0	2	0	0	2	√	0
2	0	3	0	2	0	1	2	√	0
3	2	9	0	1	0	0	1	√	0
4	0	11	0	3	0	0	4	√	0
5	0	4	0	2	0	1	3	√	0
Total	2	44	0	10	0	2	12	*All*	0

3.2. The diversity of aquatic organisms during October 2022

Table 3 Number of counted aquatic organisms at some sites of Kosti city during October 2022

Site	*Anopheles* larvae	*Culex* larvae	*Aedes* larvae	Mosq. Pupae	Dragon fly naiad	Mayfly naiad	Water beetle	Algae	Snails
1	0	7	0	1	0	3	0	√	0
2	13	3	0	2	0	7	0	√	0
3	39	0	0	0	0	8	0	√	0
4	2	0	0	2	0	0	0	√	√
5	24	24	0	1	0	3	0	√	√
Total	78	34	0	6	0	21	0	*All*	40%

Anopheles (total of 78 larvae) and *Culex* (total of 34 larvae) were the most abundant insects in Kosti, while no *Aedes* larvae were noticed, but a total of 6 mosquito's pupae were recorded. It was also noticed that, mayfly naiads were the

only abundant predators (total of 21 naiads), whereas water beetle and dragon fly naiads were not noticed at any site. Algae (in all sites) and snails (from 2 out of 5 sites) were also noticed (Table 3).

The diversity of aquatic organisms within rain water at some sites of Rabak city during October 2022 (Table 4), showed the presence of *Anopheles* (6 larvae) and *Culex* (50 larvae), while no *Aedes* larvae were noticed, but a total of 3 mosquito's pupae were found. Mayfly and dragon fly naiads, water beetles and snails were not noticed in all sites. Algae were also noticed in all sites.

Table 4 Number of counted aquatic organisms at some sites of Rabak city during October 2022

Site	*Anopheles* larvae	*Culex* larvae	*Aedes* larvae	Mosq. Pupae	Dragon fly naiad	Mayfly naiad	Water beetle	Algae	Snails
1	0	7	0	0	0	0	0	√	0
2	2	23	0	1	0	0	0	√	0
3	0	15	0	1	0	0	0	√	0
4	0	11	0	1	0	0	0	√	0
5	4	4	0	0	0	0	0	√	0
Total	6	50	0	3	0	0	0	*All*	*All*

4. Discussion

The diversity of aquatic organisms flourished within rain water at some sites of Kosti city during March 2022 (after autumn), showed the presence of *Anopheles* (37 larvae) and *Culex* (14 larvae), but 7 mosquito's pupae were found. It was also noticed that, mayfly were the more abundant predators (16 naiads), followed by water beetle (6 beetles), but dragon fly were the least (2 naiads). Algae and snails were also noticed in all sites. In Rabak city, *Anopheles* (only 2 larvae) and *Culex* (44 larvae) were found. Also, water beetle were the more abundant predators (12 beetles), mayfly (2 naiads), but dragon fly naiads were not noticed. Algae were also noticed in almost all sites unlike snails which were not noticed.

Concerning October 2022, *Anopheles* (78 larvae) and *Culex* (34 larvae) were found in Kosti rain water sites. Also, mayfly were the only abundant predators (21 naiads), whereas water beetle and dragon fly naiads were not noticed. Algae and snails were also noticed. That of Rabak city showed the presence of *Anopheles* (6 larvae) and *Culex* (50 larvae), while no *Aedes* larvae were noticed throughout this study, but a total of 3 mosquito's pupae were found. Mayfly and dragon fly naiads, and water beetles were not noticed in all sites. Algae were also noticed in all sites, while snails were not recorded.

These results reflected the biodiversity of some vectors and their aquatic predators in the rain water of Kosti and Rabak cities during March and October 2022.

Humanity depends on biodiversity for health, well-being, and a stable environment. As biodiversity change accelerates, we are still discovering the full range of consequences for human health and well-being [12].

Inland aquatic ecosystems, such as streams, rivers, ponds and lakes, play an important role in maintaining global aquatic biodiversity and ecosystem services. They have been increasingly influenced by environmental change such as global warming, dam construction, habitat fragmentation, eutrophication and urbanization. However, our understanding of the impact of global change on aquatic biodiversity and ecosystem functions remains elusive [13].

Aquatic ecosystems support a substantial source of the earth's biological diversity. Both aquatic resources and its biodiversity are interrelated to each other and they perform a myriad of functions and are valuable and essential for the sustainability of biotic communities. Aquatic biodiversity in both freshwater and marine environments are under continuous decline because of over exploitation of species, introduced exotic plant or animal, pollution sources from cities, industries and agricultural zones, loss and changes in ecological niche [14].

The biodiversity of Sudan including description of status of ecosystems and populations to the best to our knowledge, importance of some plants and animals in livelihoods, major threats and some conservation efforts,

and crucial future directions needed for better biodiversity conservation. The ecosystems in Sudan is divided into two major types; namely aquatic and terrestrial habitats. There are many opportunities for mainstreaming and endorsement such as the National Constitution, policies, strategies, and legislations. Sudan can be ecologically divided into five vegetation zones according to rainfall patterns [15].

Habitats in the freshwater, and on land differ dramatically in species composition and diversity. Of the roughly 1.5 million known species of macroscopic organisms on earth, the modern ocean supports only about 15% of species, whereas terrestrial environments account for about 80% of species, and freshwater for the remaining 5%. Even when taking into account previously undetected biodiversity [16].

5. Conclusions

During March and October 2022, *Anopheles* larvae and mayfly naiads were more abundant aquatic insects, in Kosti, unlike Rabak in which *Culex* larvae and water beetles were more abundant aquatic insects, also algae were abundant in all sites, while *Aedes* larvae and dragon fly naiads were not noticed in all sites. During October 2022, mayfly naiads, water beetles and snails were not noticed in Rabak city.

Compliance with ethical standards

Acknowledgments

Thanks are extended to Blue Nile National Institute for Communicable Disease and Principle Science Laboratory, University of Gezira, for hosting the Laboratory work.

Disclosure of conflict of interest

No conflict of interest to be disclose.

References

[1] Von Sperling, M. (2015). Wastewater Characteristics, Treatment and Disposal. Water Intelligence Online. 6: 9781780402086. doi:10.2166/9781780402086.

[2] WHO (2017). Guidelines for drinking-water quality. World Health Organization (Fourth edition incorporating the first addendum ed.). Geneva. 2017. ISBN 9789241549950.

[3] WHO (2014). Burden of disease and cost-effectiveness estimates. World Health Organization, February 13, 2014.

[4] Janovy J, Schmidt GD, Roberts LS (1996). Gerald D. Schmidt & Larry S. Roberts' Foundations of parasitology. Dubuque, Iowa: Wm. C. Brown. ISBN 978-0-697-26071-0.

[5] CDC, Centers for Disease Control and Prevention (2012). Chapter 3. In Brunette GW (ed.). CDC Health Information for International Travel 2012. The Yellow Book. Oxford University Press. ISBN 978-0-19-976901-8.

[6] Will, K. (2020). Field Guide to California Insects: Second Edition. University of California Press. ISBN 978-0-520-96357-3.

[7] Thorpe, W. H. (2008). Plastron respiration in aquatic insects. Biological Reviews, 25 (3): 344–390. doi:10.1111/j.1469-185X.1950.tb01590.x.

[8] Winegard, T. C. (2019). The Mosquito: A Human History of Our Deadliest Predator. Text Publishing. p. 2. ISBN 9781925774702.

[9] Davidson EW (1981). Pathogenesis of invertebrate microbial diseases. Montclair, N. J.: Allanheld, Osmun. ISBN 978-0-86598-014-3.

[10] Kramer, R.; Lobban, R. and Fluehr-Lobban, C. (2013). Historical Dictionary of the Sudan (4th ed.). Lanham/Toronto/Plymouth (UK): The Scarecrow Press. pp. 191–192. ISBN 978-0-8108-6180-0.

[11] Service, M. (2012). Medical Entomology for Students (5th ed.). Cambridge University Press. ISBN 978-1-107-66818-8.

[12] Bernhardt, J. R. and O'Connor, M. I. (2021). Aquatic biodiversity enhances multiple nutritional benefits to humans. PNAS, 118 (15). e1917487118. https://doi.org/10.1073/pnas.1917487118.

[13] Wang, J.; Soininen, J. and Jani Heino, J. (2021). Ecological indicators for aquatic biodiversity, ecosystem functions, human activities and climate change. Ecological Indicators. Volume 132, https://doi.org/10.1016/j.ecolind.2021.108250.

[14] Irfan, S. and Alatawi, A. M. M. (2019). Aquatic Ecosystem and Biodiversity: A Review. Open Journal of Ecology, 9(1), DOI: 10.4236/oje.2019.91001.

[15] Siddig, A. A. H.; Magid, T. D. A.; EL-Nasry, H. M.; Hano, A. I. and Mohammed, A. A. (2018). Biodiversity in Sudan. 1st ed., Apple Academic Press, pp. 22. ISBN 9780429469800.

[16] Grosberg, R. K.; Vermeij, G. J. and Wainwright, P. C. (2012). Biodiversity in water and on land. Current Biology, 22(21): 900-903. https://doi.org/10.1016/j.cub.2012.09.050.