African Multidisciplinary
Journal of Sciences and Artificial Intelligence

ISSN : 3434-9871

Index: Harvard, Boston, Sydney University, Dimensions, Lens, ResearchGet Scilit, Semantic, Google Scholar, Base etc

https://doi.org/10.58578/AMJSAI.v1i1.3754

Assessment of Aquatic Macroinvetebrate and Physio-Chemical Parameters in River Donga, Donga, Taraba State, Nigeria

Ronald Abhulimen Winifred[1], Igbani Flourizel[2], Iba Nguwasen Rachael[3]
Federal University Wukari, Taraba State, Nigeria
ronaldwinifred@gmail.com

Article Info:

Submitted:	Revised:	Accepted:	Published:
Jun 26, 2024	Jul 12, 2024	Jul 26, 2024	Jul 31, 2024

Abstract

This study assessed the diversity of macroinvertebrates fauna and water quality parameters in river donga. Soil and water samples were randomly collected in the months of September and November, 2022 at three different locations: Headwater (Point A), middle water or Polo (Point B) and tailwater or Spillway (Point C) in the river. The following phylum of macro-invertebrates were reported, Arthropoda and Mollusca. The species present were, *Viviparous viviparous*, *Sadleriana fluminensis*, *Velia caprai*, *Mytilus edulis*. The temperature ranges between 26.67±0.35 to 27.17±0.35 with the middle point and Tail water point having the lowest and highest temperatures respectively. PH values ranges from 6.97±0.01 to 7.04±1.55 with the headwater point and Middle water point having the lowest and highest temperatures respectively. Electrical conductivity (Mg/l) values ranges between 263.33±6.52 to 280.00±8.65 with Tail water and Middle water having the lowest and highest concentrations respectively. Dissolved oxygen concentration ranges between 5.57±0.20 to 5.97±0.53 with headwater and tail water having the lowest and highest dissolved oxygen. There was however no significant difference in the evaluated parameters water parameter ($p \leq 0.05$). All water quality parameters except

AMJSAI Journal is licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License

Electrical conductivity and Dissolved oxygen were slightly above WHO limits of all the evaluated water parameters. Diversity index indicated Head of the sampling locations was more diverse than all other sampling site along river Donga. The present study revealed that Donga River is not polluted as indicated by the abundance of pollution intolerant macro-invertebrate species and the physiochemical parameters of water. The water quality parameters evaluated were favourable and is a clear indication of good water quality. However, findings from the present study revealed the presence of few macro-invertebrates at the study location. This could be attributed to uneven specie distribution in nature. Another factor could be due to duration, season and the sampling locations along the Donga River. It has given us the baseline study of macroinvertebrates present in Donga River and also the water quality of the river

Keywords: Aquatic, Macroinvertebrates, Biodiversity, Physicochemical Parameters

INTRODUCTION

Macro invertebrates are animals that lack a back-bone and are generally visible with the naked eyes. They live in the lower areas of the streams, lakes, and rivers underneath rocks. They include larval forms of many common insects such as Dragon flies, Damsel flies and Crane flies. Macro-invertebrates reveal low mobility, long life-span and high diversity with respect to pollution tolerance that make them useful bio-indicators (Queenilyn, 2017).

Macro-invertebrates are valuable indicators of the health of aquatic environments in part because they are benthic, meaning they are typically found on the bottom of a stream or lake and do not move over large distances. Therefore, they cannot easily or quickly migrate away from pollution or environmental stress.

Macro-invertebrate form an integral part of an aquatic environment and are of ecological and economic importance, as they maintain various levels of interaction between the community and the environment (Adakole, 2011). According to Marques *et al.,* (2013), knowledge of the structure of the benthic macro-invertebrate community provides precise and local information on recent events, which can be seen in their structuring. The use of macro-invertebrates as bio-indicators of water quality has been advocated by several investigators (Adakole, 2011; Ogeibu and Ezeunara 2012).

The use of aquatic macroinvertebrates to monitor changes in the aquatic environment particularly the inland fresh water systems has gained much accolades, as it has been reported, that changes in community structure of aquatic macro-invertebrates, reflects state of the surrounding environment (Arimoro and Ikomi, 2008; Adu and Oyeniyi, 2019).

Water pollution occurs when harmful substances often chemicals or microorganisms contaminate a stream, river, lake, ocean, aquifer, or other body of water quality and rendering it toxic to humans or the environment. This wide spread problem of water is jeopardizing our health. Water pollution affects organisms living in these bodies of water. In almost all cases the effect is damaging not only to individual species and populations, but also to the natural biological communities. Using biological indicators entails measuring the resident biota in the water body and integrating the cumulative impacts of chemical, physical and biological stressors of life of the biota. The human inputs of various toxic substances such as Nitrogen and Phosphorus in aquatic systems are changing the delicate nutrient balance, decreasing available oxygen and affecting the specie richness and diversity among plant and animals.

River Donga which is located in the Northern corner of Taraba State, Nigeria, has been a source of water for domestic, recreational, and agricultural use for the communities located around its banks. Despite the importance of this water body, very few studies exist on the ecological status. Given this premise, this study beamed its focus on the macro-invertebrate fauna and the physicochemical parameters of River. In Nigeria, changes in land-use and other anthropogenic activities which cause harmful effects on water quality, stream habitat and aquatic invertebrate's biodiversity depending on the type, concentration and duration of exposure have threatened the ecological integrity of many river systems

This study was aimed to assess the diversity of the Macro-invertebrates fauna in River Donga by

i. Determining the species diversity of macro invertebrates in River Donga.
ii. Determining the physico-chemical parameters of River Donga.

MATERIALS AND METHODS

Study Area

The study was carried out at River Donga, in Donga Local Government Area of Taraba State. (Fig 1.0). It is located between the Coordinates 7°43'00"N and 10°03'00"E. The Donga River has three forest reserves, Baissa, Amboi and Bissaula River, in the Donga river basin. They lie on the slopes and at the foot of the Mambilla Plateau, south-west of GashakaGumti National Park.

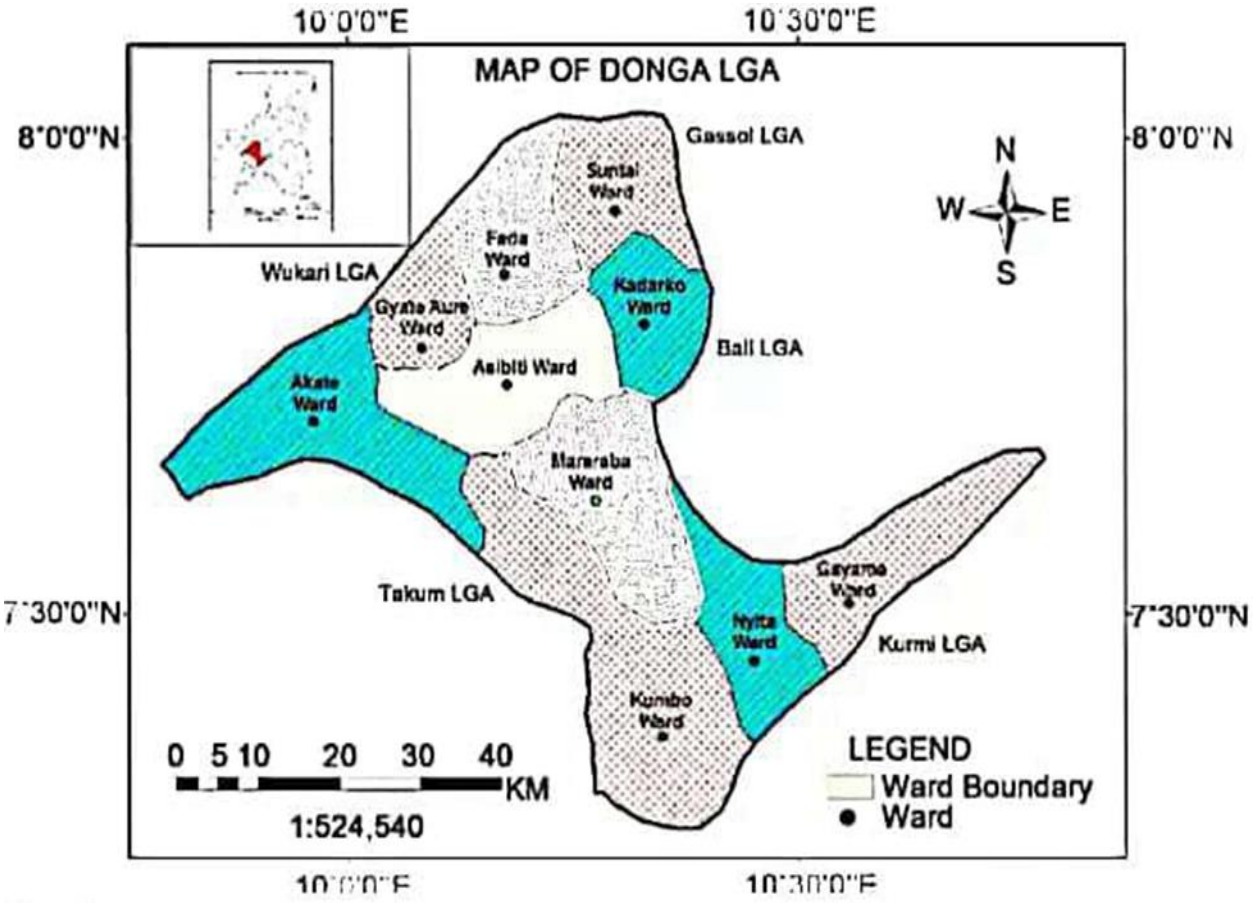


Figure 1: Map showing study area.

Collection of Macro-invertebrates samples

Macro-invertebrates samples were randomly collected in the months of September and November, 2023 at three different locations: Headwater (Point A), middlewater /Polo (Point B) and tailwater /Spillway (Point C) in the river, according to the method described by Andem *et al.* (2012). Samples collected were sieved with a set of Tylersieves of 20 cm diameter and mesh sizes of 2 mm, 1 mm, 150 µm and 100 µm, respectively. The contents retained in the sieves were washed into poly-propylene sampling bottles containing

10%formalin. A dissecting microscope was to sort out the macro-invertebrates organisms in the laboratory. The organisms collected were stored in labeled specimen bottles containing 4% formalin for later examination in Biological Sciences Laboratory of Federal University Wukari, Nigeria.

Identification of Macro-invertebrates

Organisms were identified by reference to appropriate keys and works of Ward and Whipple(1959), Pennak (1953), Mellanby (1963), Hynes (1972), Needham and Needham(1982), Olomukoro (1996) and Brinkhurst (1966). Owing to limited taxonomic knowledge of the benthic fauna of Nigeria, some specimens were assigned to generic level only.

Determination of Macro-invertebrates Diversity

Macro-invertebrates diversity was determined using the formula below:

$$Fsi\ (\%) = \frac{si}{\sum fsi} \times \frac{100}{1}$$

Where:

F = family or number of species families,

si = individual number of macro-invertebrates species family

Statistical Analysis

Taxa richness (Margalef's index), diversity (Shannon index) and evenness indices were calculated using the computer BASIC programme SP DIVERS (Ludwig &Reynolds 1988). The range, mean and standard deviation for each physical and chemical variable was calculated per station. Means variables were compared between stations using one-way analysis of variance (ANOVA). Prior to ANOVA, the assumptions of normality and Means homogeneity of variance were tested using the Shapiro-Wilk and Levene's tests, respectively.

RESULTS

Observable Physical Parameters of Water at the Various Sampling Locations

The observable physical parameters of water at the various sampling locations are presented in Table 1. The observable physical parameters of the water include Colour,

Odour and Taste. Water across the entire evaluated sampling site were colourless while in terms of odour of the water, across the sampling locations, water obtained reportedly had a moderate odour. However, the taste of the water was not examined considering the water sources and fact the water wasn't treated.

Table 1: Observable physical parameters of water at the various sampling locations

Parameters	Point A	Point B	Point C
Colour	Colourless	Colourless	Colourless
Odour	Moderate odour	Moderate odour	Moderate odour
Taste	____	____	____

Abundance of Aquatic Macro invertebrates collected from the study

The result revealed the point A location of the river had the highest number of macro-invertebrates with a total population of 54 while point B of the river recorded the lowest with a population of 47 macro invertebrates. However, fresh water snail was the most dominant specie with a total and percentage abundance of 85 and 56.29% respectively while Bivalves was lowest with a total species and percentage abundance of individual of 14 and 9.27% respectively (Table 2).

Table 2: Total number of aquatic macro-invertebrates across the different part of the river

Phylum	species (Common)	Point A	Point B	Point C	Total	Percentage abundance of individual per class %
Mollusca	Fresh water snail	38	17	30	85	56.29
	Bivalves	2	7	5	14	9.27
Arthropoda	Water crickets	14	23	15	52	34.44
	Total	54	47	50	151	

Result of Aquatic Macro-invertebrate's diversity index

Aquatic macro-invertebrate's diversity indexes across the sampling site are presented in Table 3. Middle part of river Donga reportedly had the highest diversity index followed by point C while point A had the lowest diversity index. For the point A of the river, there is 66% Percent of randomly picking 2 organisms that are from different species while for point B part of the river, there is 91% Percent of randomly picking 2 organisms that are from different species and there is 82% Percent of randomly picking 2 organisms that are from different species for point C.

Table 3: Macro-invertebrates diversity index

Sampling points	diversity index	percentage	Implication
Point A	0.66	66	66% Percent of randomly picking 2 organisms that are from different species
Point B	0.91	91	91% Percent of randomly picking 2 organisms that are from different species
Point C	0.82	82	82% Percent of randomly picking 2 organisms that are from different species

Result of Water Parameters obtained across all sampling locations

Result of water parameters obtained across all sampling location is presented in Table 4. Parameters evaluated include; Temperature, pH, Turbidity, Electrical conductivity, Dissolved oxygen and Total dissolved solid. There was no significant difference ($p \leq 0.5$) in the evaluated parameters across all the sampling locations. Majority of the evaluated parameters were either below or within the range except that of electrical conductivity and dissolved oxygen whose values were slightly above the water quality standard across all sampling locations. The temperature ranges between 26.67 ± 0.35 to 27.17 ± 0.35 with the point B and C having the lowest and highest temperatures respectively. PH values ranges from 6.97 ± 0.01 to 7.04 ± 1.55 with the point A and B having the lowest and highest temperatures respectively. The turbidity values were at 1.01, 1.03and 1.02 for the point A, B and C water. Electrical conductivity (Mg/l) values ranges between 263.33 ± 6.52 to 280.00 ± 8.65 with point C and B water having the lowest and highest concentrations

respectively. Dissolved oxygen concentration ranges between 5.57±0.20 to 5.97±0.53 with point A and point B water having the lowest and highest dissolved oxygen. The Total dissolved solids from the sampling locations ranges between 39.13±3.25 to 39.80±2.36 with the point C and B water having the lowest and highest concentration of total dissolved solids.

Table 4: Comparative result of water parameters obtained across all sampling locations

PARAMETERS	Point A	Point B	Point C	Water quality Standard (WHO;2011)
Temperature	27.00±0.05[a]	26.67±0.35[a]	27.17±0.35[a]	Ambient
pH	6.97±0.01[a]	7.04±1.55[a]	6.99±0.03[a]	6.50 – 8.50
Turbidity	1.01±0.00[a]	1.03±0.01[a]	1.02±0.00[a]	5
Electrical conductivity, Mg/L	266.67±6.53[a]	280.00±8.65[a]	263.33±6.52[a]	250
Dissolved oxygen, Mg/L	5.57±0.20[a]	5.70±0.03[a]	5.97±0.53[a]	5.0
Total dissolved solid, Mg/L	39.43±1.25[a]	39.80±2.36[a]	39.13±3.25[a]	600

Note: Results represent mean ± deviation of triplicate determinations. Results across the rows with same superscript indicate no significant difference ($p \leq 0.05$).

Legend: pH: Potential of hydrogen

DISCUSSION

The study investigated the diversity of macro invertebrate's species and the physiochemical parameters of water in river donga. Water quality is important for species abundance and biological properties in an aquatic system (Ibrahim and Nafi'u, 2017) as well as the food chain. It can be affected by the prevailing environmental conditions due to human activities (Iyiola, 2015). In fisheries and aquaculture, poor water quality reduces growth which ultimately affects fishers' profit. The mean water quality parameters recorded from the river varied across the sampling stations and were within the recommended and the fast flow of water which constantly replenishes the oxygen content in water (Jaji *et al.*, 2007). Taste and odour in water can be caused by foreign matter such as organic materials, inorganic compounds, or dissolved gasses (Tchobanoglous *et al.*, 1985). These materials may come from natural, domestic, or agricultural sources (Tomar, 1999). Findings from this study reveal water from all the sampling locations where colorless and had a moderate odour. The taste was however not evaluated considering the fact the water was not treated. The dissolved oxygen evaluated across the sampling location was slightly above WHO (2011) water quality standard of dissolved oxygen in water. However, there was no significant DO values across sampling site P(0.05) The DO concentration in station A was high and possibly due to the non-decomposition of various organic and inorganic materials which was prevalent in the sampling station which resulted in the abundant availability of oxygen concentration in the water (Idowu and Ugwumba, 2005). pH is a significant factor that impacts many biological and chemical processes. The overall mean pH recorded across the sampling site ranges between 6.97±0.01 to 7.04±1.55. These ranges were with the recommended range of 6.6 – 8.5 as stated by WHO, 2011. Electrical conductivity across the sampling locations ranges between 263.33±6.52 to 280.00±8.65, these values where however above WHO, 2011 water quality standards of electrical conductivity in water bodies. The total dissolved oxygen obtained for this study was far below the acceptable water quality standards of WHO, 2011. This implies safe quality of the water at the individual sampling locations.

The abundance of macro-invertebrates in a water body is related to the water condition, availability of food, and the quality of substrate of the water body (Suleiman and Abdullahi, 2011). Donga River flows through different geographical locations which are open to human activities which can affect the aquatic system. The phylum Mollusca was observed to be dominant (56.29 %) in the river during the period. Findings from the

present studies are similar to findings of Ibrahim and Nafi'u (2017) who reported lamidcae to be the most dominant family with a percentage abundance of 52.95%. The presence of *Velia caprai* and *Viviparus viviparus* are indicator species of less organic pollution in rivers which receives domestic sewage (Ugwumba *et al.* 2011). Ibrahim and Nafi'u (2017), reported similar cases of these species as indicators of no pollution in water. The abundance of and dominance of these species was favored by favourable physiochemical water parameters as majority of the water quality parameters in the present study where within WHO (2011) acceptable limit in water. However, the low species of macro-invertebrates reported in the present study could be due to the season in which the study was conducted. Hynes (1970) and Macan (1974), reported that presence or absence of aquatic fauna is associated with other factors such as predators, behaviour, food, concentration of dissolved salts, hydrogen ion concentrations, oxygen concentration, water current, water level and water temperature. It could also be due to even distribution of even distribution of organisms in nature. Another factor must have been other nature of pollution which was not captured in the study. Yap *et al.* (2013) reported similar results which were attributed to pollution stress having a direct impact on the abundance and diversity of macro-invertebrate species in the river. Middle of the river was more diverse in macro-invertebrate composition because it has the highest H value. This implies that when macro-invertebrate species are selected, they are all represented in the sample. Uguumba *et al.* (2011) reported a similar occurrence of macroinvertebrate composition in Ogunpa and Awba stream in Nigeria.

CONCLUSION

This study evaluated the macro-invertebrates and water quality parameters in river Donga. The following phylum of macro-invertebrates were reported, Gastropoda, Arthropoda, Mollusca. The species present were, *Viviparus viviparous, Sadleriana fluminensis, Velia caprai, Mytilus edulis*. The water quality parameters under consideration in this study were, Temperature, pH, Turbidity, Electrical conductivity (Mg/L), Dissolved oxygen (Mg/L), Total dissolved solid (Mg/L). All water quality parameters except Electrical conductivity and Dissolved oxygen were slightly above WHO limits of all the evaluated water parameters. Diversity index indicated Head of the sampling locations was more diverse than all other sampling site along river Donga. The present study revealed that Donga

River is not polluted as indicated by the abundance of pollution intolerant macro-invertebrate species and the physiochemical parameters of water. The water quality parameters evaluated were favourable and is a clear indication of good water quality. However, findings from the present study revealed the presence of few macro-invertebrates at the study location. This could be attributed to uneven species distribution in nature. Another factor could be due to duration, season and the sampling locations along the Donga River.

Recommendations

It is suggested that further research should be carried out during different seasons in order to determine the variation and the presence of macro-invertebrates at the study site.

REFERENCES

Adakole, J.A., (2011). The effect of domestic agricultural and industrial effluents on the water quality and biota of Bindare Stream, Zaria-Nigeria.PhD thesis, Dept. of Biological Sciences, Ahmadu Bello University, Zaria.*25pp.*

Adu, B. W. and Oyeniyi, E. A. (2019). Water quality parameters and aquatic insect diversity in Aahoo stream, southweatern Nigeria. *Journal of basic and Applied Zoology.* 80, 15.

Andem, B.A., Okorafor, E.K.A. and Ekpo, P.B. (2012). Ecological Impact Assessment and Limnological Characterization in the Intertidal Region of Calabar River Using Benthic Macro-invertebrates as Bioindicator Organisms. *International Journal Fisheries and Aquatic Studies*. 1(2): 8-14.

Arimoro, F. o and Ikomi, R. B (2008) Response of macroinvertebrate communities to abattoir wastes and other anthropogenic activities in a municipal stream in the Niger Delta, Nigeria. *The environmentalist.* 28:85-98.

Arimoro, F. O., and Muller, W. J. (2010): Mayfly (Insect: Ephemeroptera) community structure as an indicator of the ecological status of a stream in Niger Delta. *Environment Monitoring Assessment 165:581-594*.

Brinkhurst, R. O. (1966) Taxonomical studies on the tubiticidae (Annelida, Oligochaeta) Supplement. *Int. revue ges. Hydrobiol.* 51(5):727-742.

Hynes, H. B. N. (1970). The ecology of running waters. University of Toronto Press, Toronto 555 pp

Hynes, H.B.N. (1972). The ecology of stream insects. Annual Review of Entomology15: 25–42.

Ibrahim, S. and Nafi'u, S.A (2017). Macroinvertebrates as Indicators of Water Quality in Thomas Dam, Dambatta, Kano State, Nigeria. *UMYU Journal of Microbiology Research*, 2(1): 1-13.

Idowu, E. O. and Ugwumba, A. A. A. (2005) Physical, Chemical and Benthic Faunal characteristics of a Southern Nigerian Reservoir. *The Zoologist* 3:15-25

Iyiola, A.O. (2015). Human Impact on the Water Quality and Benthic Macro- Invertebrate Compositions in Ogunpa River, Nigeria. *Journal of Agriculture and Ecology Research International.* 2(2): 120-128.

Jaji, M.O., Bamgbose, O. and Arowolo T.A. (2007). Water quality assessment of Ogun River, southwest Nigeria. *Environmental Monitoring and Assessment.* 133: 473–482.

Macan, T. T. (1974). Freshwater Ecology. 2nd edition Longman, London. 343 pp

Marques, M. J., Martinez-Code, E., and Rovira, J. V. (2013). Effect of Zinc and Mining on the benthic macroinvertebrate fauna of fluvial Ecosystem. *Water, Air and Soil pollution. 148: 363-388*

Mellanby, H. (1963). Animal Life in Freshwater.Chapmanand Hall, London

Needham, J.G. and Needham, P.R. (1982). A Guide to the Study of Freshwater Biology.Holden-Day, SanFrancisco

Ogbeibu, A. E. and Ezeunara, P. U. (2002) Ecological impact of brewery effluent on the ikpoba river, using fish communities as bioindicators. *Journal of aquatic sciences*. 17:35-44.

Olomukoro, J. O (1996) Salinity and the macrobenthic community structure in *Eichhornia crassipes* of Warri River, Nigeria. *Journal of biological sciences*. 7(2):309-314.

Olomukoro, J.O. (1996). Macrobenthic fauna of Warri River in Delta State. Nigeria. Ph.D. thesis, University of Benin, Nigeria

Pennak, R.W. (1953). Freshwater Invertebrates of the United States. Ronald Press, New York.

Queenilyn, G. (2017). "The study of macro-zoobenthos community atdownstream waters of Lematang river surrounding in PasarBawah, Lahar Regency,"*Science Research Journal,* 9:12–14.

Suleiman, K and Abdullahi, I. L. (2011). Biological Assessment of Water Quality: A study of Challawa River Water, Kano, Nigeria. *Bayero Journal of Pure and Applied Sciences*, 4(2): 121 – 127.

Tchobanoglous G, Burton FL, Stensel HD. Metcalf & Eddy Wastewater Engineering: Treatment and Reuse 2015

Tomar, M. (1999) Quality Assessment of Water and Waste Water. CRC Press, London.

Ugwumba, A.A.A., Ogidiaka, E. and Esenowo, I.K. (2011). Physico-chemical parameters and Benthic macro-invertebrates of Ogunpa River at Bodija, Ibadan, Oyo state. *European Journal of Scientific Research*, 85(1): 89-97.

Ward, H.B. and Whipple, G.C. (1959). Freshwater Biology (ed.) W.T. Edmondson, 2nd edn. John Wiley and Sons, U.S.A.

World Health Organization (WHO) (2011). Guidelines for drinking-water quality - 4th ed. Gutenberg, Malta. pp. 334-418

Yap, C.K, RahumI.A, Ismail, A. and Tan, S.G. (2003). Species diversity of macrobenthic invertebrates in the Semenyih River Peninsular Malaysia. *Pertaniker Journal of Tropical Agriculture Science*, 26: 139-146.