ISOLATION AND IDENTIFICATION OF MICROORGANISM IN A TROPICAL STREAM IN AKWA IBOM STATE (Country?)

Abstract

An investigation ~~on Isolation and Identification~~ of microorganism in a tropical stream in Akwa Ibom State was carried out at three different stations between April and June, 2019. From the study it is revealed that the zooplankton species were wide spread and abundant in all the studied stations with station 3 recording the highest total abundance of 124 org./l. Eight species of zooplankton were identified during the study which include; *Arcella*sp.,*Askenasiafaurei* and *Difflugia acuminate* for protozoa while *Brachionus*sp., *Lindiatorulose*, ~~*Rotoria*~~ *Rotaria*sp., *Trichotriapocillum*, *Polyyarthra*sp., belong to the family ~~rotifera~~Rotifera. *Rotoria*sp.~~were~~ waspresent in high numerical abundance during the study period with low numerical abundance recorded for Ar*cella*sp. which

was attributed to variation in physicochemical parameters of the study area and duration of the study period. However, the physico-chemical parameters studied were within the standard recommended by WHO for portable water exception of Turbidity which was slightly higher the recommended 5 NTU. Conclusively, this study will provide baseline information as regards the zooplankton community and water quality of Uruk-Uso Stream.

1.0Introduction

Water is essential for life on earth. It is the most naturally occurring mineral compound and its relevance cannot be overemphasized. Increasing human population alongside progressive urbanization has led to a replacement of the world's natural environment with an artificial one. Pollution growth is a global problem that affects water, soil and the atmosphere. Almost every environmental issue today has man at the receiving end of the blame. Man has become the principal driver of change on the earth's surface.

In aquatic ecosystem, the three main benthic faunal components include micro-fauna, meio-fauna and macro-fauna which represent important ecological indicators. Studies on micro-fauna invertebrate diversity in stream ecosystem are crucial in understanding the health status of the environment. Also, understanding the structure of the micro faunal communities with regards to the impacts of pollution is an important part of monitoring changes in stream ecosystems in Nigeria.

Zooplankton density has also been reported to vary depending on the availability of nutrients and the stability of the water. Equally, results of several studies have shown that physical and chemical condition of aquatic ecosystems determine the occurrence, diversity and density of both flora and fauna in any given habitat, which may change with season of the year (Ayodele and Adeniyi, 2005). Zooplankton organisms play an important role in the water quality and entrophic status productivity of water bodies. They form the second step of the food web and as an important food source to many invertebrate and vertebrate animals (Mann, 2000). The composition and density of zooplankton in a particular aquatic ecosystem are relevant to detect the ecological short-term changes in the environment (Atobale*et al.*, 2005).

Zooplankton community structure is influenced by the very current health status of the environment as these organisms are known to swiftly respond to current changes in their habitat (Margalef, 1978).Zooplankton offers several advantages as indicators of environmental quality in rivers and streams, their communities often respond quickly to environmental changes because most species have short generation time. Zooplankton communities respond to a wide variety of disturbances including nutrient loading (Dodson, 1992), acidification (Brett, 1989), contaminants (Cushing, 1992), fish densities (Carpenter and Kitchell, 1993) and sediment inputs (Cuker, 1997). Zooplankton play an important ecological role in rivers and streams, feeding on non-living organic matter, phytoplankton and bacteria, which are in turn being eaten by secondary consumers such as fish (Ayodele and Adeniyi, 2005). Tucker (1992) reported that zooplankton is rich in essential amino and fatty acids, Docosahexacnoic acid (DHA) and Elcosaptaenoic acid (EPA). The freshwater forms of zooplankton are generally smaller in size and in animal phyla than their marine groups and these include; Protozoa, Rotifera, Crustacea, Cladocera, Copepod, Ostracoda and Meroplankton organisms (Parsons, 1980). Zooplankton abundance fluctuates with seasons and phytoplankton density presence. Trivedi *et al. (*2003) added that places of rapidly multiplied phytoplankton usually have low zooplankton population. Studies on zooplankton have being reported by Maruthanayagam*et al.* (2003); Pandey and Verma (2004); Arimoro and Oganah, (2010) and Davies *et al*., (2009).

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~~In aquatic ecosystem, the three main benthic faunal components include micro-fauna, meio-fauna and macro-fauna which represent important ecological indicators. Studies on micro-fauna invertebrate diversity in stream ecosystem are crucial in understanding the health status of the environment. Also, understanding the structure of the micro faunal communities with regards to the impacts of pollution is an important part of monitoring changes in stream ecosystems in Nigeria.~~

Zooplankton communities contribute immensely to the functioning of any aquatic ecosystem. It serves not only as a major source of food for fishes but also helps in the transfer of energy from one trophic level to another. Zooplanktons are better indicators of environmental quality in rivers and streams, their communities often respond quickly to environmental alterations. Their diversity, abundance and composition at a particular time can give a picture of the nature of disturbance in the system. UrukUsoh stream is an important stream in the lives of the inhabitants of the area since the depend on this important stream for domestic purposes and agricultural usage. Human activities associated with this stream are bathing, laundry, etc. This indicates the need for a routine investigation of the pollution status of this stream especially with the nature of anthropogenic activities going on in the study area. Presently, no work has been carried out on the zooplankton community on this stream; hence, the aim of this study is to evaluate the species composition, abundance and distribution of zooplankton as well as the physico-chemical characteristics of Uruk Usoh stream. Knowledge of zooplankton response to alterations in water quality could serve as a very important tool for aquatic environmental managers in the assessment of water quality status in Nigerian streams and other aquatic systems. However, there is a gap in the study of zooplankton in stream ecosystem which this study intends to bridge.

2.0 Materials and Methods

2.1 Study Area

Uruk-~~usoh~~ Usohstream lies within latitude (4^{o}50’ ~~–~~– 4^{o}55’ N) and longitude (7^{o}53’ – 8^{o}.00 E). It is situated mainly within the tropical rainforest belt of Niger Delta, Nigeria. There are two climatic seasons in the area. The rainy season (May ~~–~~–October) is characterized by heavy precipitation, low temperature and a dominant South West trade wind. The dry season (November ~~–~~–April) is characterized with light or no precipitation, high temperature and a dominant North East trade wind. The stream is within the lowland area of Niger Delta with thick tropical rainforest vegetation.

2.2 Sampling stations

Three sampling sites were chosen for the study along the stream channel at approximately 15km apart.

2.3Sample Collection andPhysicochemical analysis

Water samples were collected in each of the sampling stations from February 2022 to April 2022. At all times sampling was carried out between 08.00 hours and 12.00 hours each sampling day. Water samples for ~~Temperature~~temperature, pH, ~~Dissolved~~ dissolved ~~Oxygen~~oxygen, Total Dissolved Solids (TDS), water depth and ~~Turbidity~~ turbidity were measured at *in situ* according to Standard Methods for Examination of Water and Waste water (APHA, 1998) and the Association of Official Analytical Chemists (AOAC, 2002). Water sample for phosphate, nitrate, total suspended solids (TSS), biological oxygen demand (BOD) and alkalinity were collected using 250 ml glass bottle. The sample bottles were filled with water and stoppered under water, ensuring that no air bubble was trap in it. After collection, all samples were stored in ice-packed coolers and transported to the laboratory (Ministry of Science and Technology, Uyo). These samples were further treated by refrigeration in the laboratory at 4 °C to inactivate microbes and preserve the integrity of the samples prior to analysis. In the laboratory samples were analysed using Standard Methods for Examination of Water and Waste water (APHA, 1998).

2.4 Collection of Samples

Water samples was obtained monthly from three sampling stations along the stream channel between February, 2022 and April, 2022. Zooplankton was obtained by passing 25 ~~litre~~liter of water through a 25µm mesh size plankton net with 354 ml glass tube tied to the lower narrow end of the net.

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2.5 Preservation of Samples

The filtered samples were fixed immediately with 3 drop of 4% formaldehyde (Boyd, 1981) and transported to Ministry of science and technology, uyo, for analysis.

2.6 Identification of Samples

In the laboratory, samples were concentrated to 10mls and sub-sampled into plankton sedimentation chambers for microscopy examination using Zeis inverted plankton microscope. Analysis was carried out at 400 and 1000 magnifications (UNESCO, 1978). Identification was achieved with the aid of identification manual provided by Edmondson (1966), Newell and Newell (1963), Shield (1995), Jeje and Fernando (1986).

2.7 Determination of relative abundance (%)

Data obtained from each zooplankton group was empirically analyzed using the formula:

$$\% R_a = {}^{n}/_{N} \times 100$$ (Ali *et al.*, 2003).

Where: $\%_{Ra}$ = relative abundance

n = number of individuals

N = total number of all individuals.

2.8 Statistical analysis

Data obtained was subjected to descriptive statistics for mean, standard deviation and range values of physico-chemical parameters using MS Excel and Statistical package for Social Sciences (SPSS) version 20 was employed to compute Mean, variance and standard error in the data. Two-way analysis of variance (ANOVA) and Least Significant Difference (LSD) test was employed to separate significant differences in mean values computed for stations. The probability level will be set at p = 0.05.

3.0 Results

3.~~1~~ 2 Zooplankton Abundance and Distributionin Uruk-Uso Stream

Spatial occurrence of dominant zooplankton taxa observed in Uruk-Uso stream is shown in table 1a - 1c. A total of 8 taxa of zooplankton were identified consisting of 3 taxa of Protozoa and 5 taxa of Rotifera. Rotifera contributed 72.2% of the total zooplankton density followed by protozoa which had 27.8 %. In station 1, ~~rotifera~~ rotiferswas dominated by ~~*Rotoria*~~*Rotaria*sp. with total of 33 ~~org~~ind./l between February 2022 and April 2022, followed by *Lindiatorulose*with 26 org. / l. Protozoa was dominated by *Askenasiafaurei*. A similar pattern of distribution was observed in station 2 (midstream); Rotifera was the abundance group recording about 73 org. / l of the total zooplankton count followed by protozoa with 23 org. / l stock density. Station 3 (downstream) followed similar trend with Rotifera having 77 0rg. / l and Protozoa 37 org. / l respectively. Cladocera and Copepoda were absent throughout the study duration.

The abundance of protozoans as well as ~~rotifera~~ rotifersincrease markedly during the study (February 2022 to April 2022) throughout the three study stations. A total of 104 org. / l of zooplankton were observed in station 1 (upstream), while 96 and 124 org. / l were recorded for station 2 and 3 respectively during the study period (Table 1a – 1c).

Rotifera was the most abundant zooplankton observed during the study with a numerical abundance of 234 org. / l and a relative percentage abundance of 72.2 % while numerical abundance of 90 org. / l and relative percentage abundance of 27.8 was recorded for protozoa during the study period. It was however, observe that rotifera also had the highest number of taxa with 5 taxa recorded for rotifera and three recorded for protozoa. Throughout, the study duration Cladocera and Copepoda~~was~~ wereabsence (Table 2).

A pie chart showing the relative percentage of zooplankton distribution during the study duration is presented in Fig. 2.

3.~~2~~ 1 Physico-chemical Parameters of Water in Uruk-Uso Stream

Environmental variables were found within the following mean values during the study duration; water depth (1.45 ± 0.47 m), water temperature (26.40 ± 0.43 ^{o}C), TDS (26.0 ± 0.13 mg/l), ~~Nitrate~~ nitrate (3.81 ± 3.68 mg/l), phosphate (0.11 ± 0.77 mg/l), DO (5.87 ± 0.99), BOD (0.95 ± 0.48), pH (6.32 ± 0.96), alkalinity (63.95 ± 20.21), TSS (3.94 ± 1.60) and ~~Turbidity~~ turbidity (5.74 ± 7.30 NTU). Values of water temperature, ~~Nitrate~~nitrate, phosphate, DO, pH and TSS were not significant (p>0.05) during the study period. The lowest depth was recorded

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Table ~~1a~~2a: Distribution and Abundance of Zooplankton Taxa in Sampling Location 1 from (February 2022 to April 2022).

~~Zooplankton~~ Taxa	February	March	April	Total
Protozoa				
Arcella sp.	-	-	-	0
Askenasiafaurei	9	9	6	24
Difflugia acuminate	-	3	3	6
Number of Taxa (s)	3	-	-	-
Total Abundance(N)	**9**	**12**	**9**	**30**
Rotifera				
*Brachionus*sp.	3	2	1	6
Lindiatorulose	12	8	6	26
*Rotoria*sp.	12	11	10	33
Trichotriapocillum	3	4	2	9
Polyarthra sp.	-	-	-	0
Number of Taxa (s)	5	-	-	-
Total Abundance(N)	**30**	**25**	**19**	**74**
Cladocera	-	-	-	0
Total Abundance(N)	**0**	**0**	**0**	**0**
Copepoda	-	-	-	0
Total Abundance(N)	**0**	**0**	**0**	**0**

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Table 1b: Distribution and Abundance of Zooplankton Taxa in Sampling Location 2 from (February 2022 to April 2022).

Zooplankton Taxa	February	March	April	Total
Protozoa				
Arcella sp.	-	-	-	0
Askenasiafaurei	9	8	6	23
Difflugia acuminate	-	-	-	0
Number of Taxa (s)	3	-	-	-
Total Abundance(N)	**9**	**8**	**6**	**23**
Rotifera				
Brachionussp	3	2	1	6
Lindiatorulose	7	8	6	21
Rotoria sp.	12	14	14	40
Trichotriapocillum	-	4	2	6
Polyarthra sp.	-	-	-	0
Number of Taxa (s)	5	-	-	-
Total Abundance(N)	22	28	23	73
Cladocera	-	-	-	0
Total Abundance(N)	0	0	0	0
Copepoda	-	-	-	0
Total Abundance(N)	0	0	0	0

Table 1c: Distribution and Abundance of Zooplankton Taxa in Sampling Location 3 from (February 2022 to April 2022)

Zooplankton Taxa	February	March	April	Total
Protozoa				
Arcella sp.	-	-	1	1
Askenasiafaurei	9	8	7	24
Difflugia acuminate	3	4	5	12
Number of Taxa (s)	3	-	-	-
Total Abundance(N)	12	12	13	37
Rotifera				
Brachionussp	3	2	1	6
Lindiatorulose	5	6	7	18
Rotoria sp.	12	16	14	42
Trichotriapocillum	8	4	6	18
Polyarthra sp.	2	-	1	3
Number of Taxa (s)	5	-	-	-
Total Abundance(N)	30	28	29	87
Cladocera	-	-	-	0
Total Abundance(N)	0	0	0	0
Copepoda	-	-	-	0
Total Abundance(N)	0	0	0	0

Table ~~2~~3: Summary of the Distribution of the Major Zooplankton ~~Families~~ taxonomic groups in Uruk-Uso Stream, Akwa Ibom State during the Study Period (February ~~2022 to~~ – April 2022)

S/N	~~Zooplankton Families~~Taxa	Number of Taxa (S)	~~Numerical~~ Abundance, Ind./l~~(N)~~	Relative ~~Abundance~~ abundance (%)
1	Protozoa	3	90	27.8
2	Rotifera	5	234	72.2
3	~~Cladocera~~		~~0~~	~~0~~
4	~~Copepoda~~		~~0~~	~~0~~
	Total Abundance ~~(N)~~	**8**	**324**	**100.0**

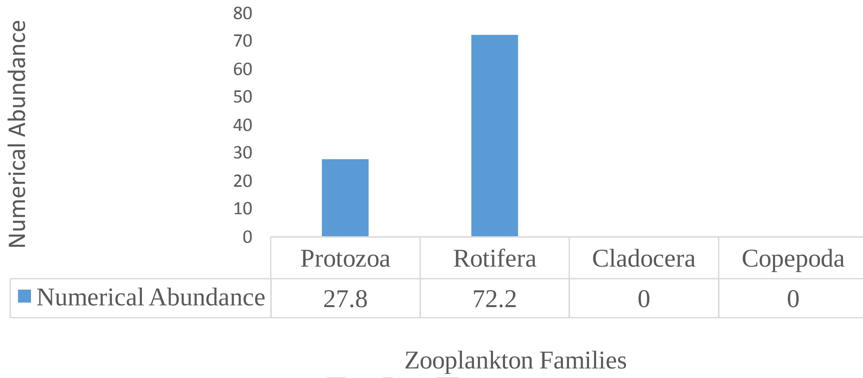

Fig. 1: Variation in Numerical Abundance of the Major Zooplankton Families in Uruk-Uso Stream Akwa Ibom State, during the Study Period **(**February 2022 to April 2022**).**

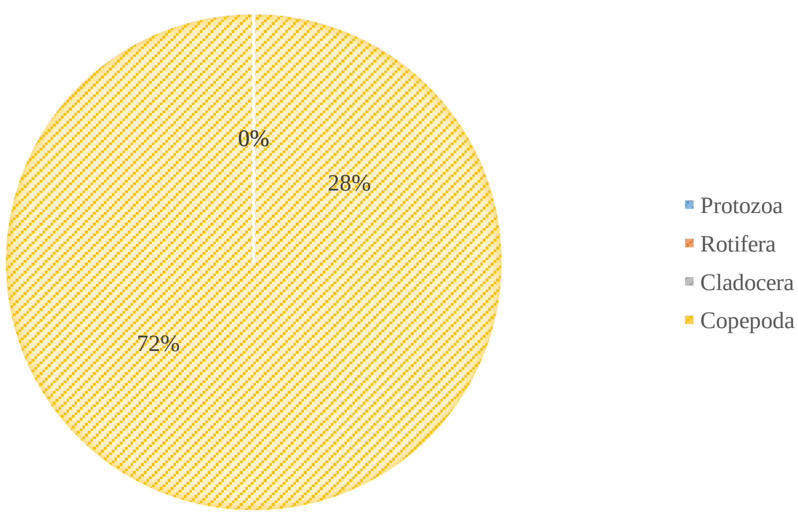

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Fig. 2: Relative Abundance of the Major Zooplankton Families in Uruk-Uso Stream Akwa Ibom State, during the Study Period (February 2022 to April 2022**)**.

Table ~~3~~1: Results of T-test on the seasonal variation of variables measured at Uruk-Uso stream (February 2022 to April 2022).

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Physico-Chemical Parameters	Units	Mean ± S.E	WHO Permissible Limit
Water depth	M	1.45 ± 0.47	-
Water temperature	^oC	26.40 ± 0.43	25 ^oC
Total Dissolved Solids	mg/l	26.00 ± 0.13	1200 mg / L
Nitrate	mg/l	3.81 ± 3.68	50 mg / L
Phosphorus	mg/l	0.11 ± 0.77	250 mg/ L
Dissolved Oxygen	mg/l	5.87 ± 0.99	5.0 mg / L
Biological Oxygen Demand	mg/l	0.95 ± 0.48	50 mg / L
pH		6.32 ± 0.96	6.5 – 9.0
Alkalinity	mg/l	63.95 ± 20.21	500 mg /L
Total Suspended Solids	mg/l	3.94 ± 1.60	> 10
Turbidity	NTU	5.74 ± 7.30	5 NTU

WHO = World Health Organization

4.0 Discussion

Zooplankton density observed during the present study were more of ~~rotifera~~ Rotiferathan ~~protozoa~~ Protozoa with absence of Cladocera and ~~copepoda~~Copepoda. Most of the zooplankton encountered in this study appears to be normal inhabitants of natural lakes, ponds, streams and artificial impoundments in the tropics (Ayodeleand Adeniyi, 2005, Egborge, 1994). Rotifera constituted the largest group of zooplankton recorded in all stations during the present study. Low zooplankton density recorded in station 2 may be attributed to high municipal discharge and heavy sand dredging activities going on within the stream which alter zooplankton stock density. Present results have revealed a dominance of rotifera throughout the 3 study stations. The ability of rotifers to undergo vertical migration, which minimizes composition through niche exploitation and food utilization, could probably be the reason for their high abundance throughout the study duration. This assertion is consistent with reports of Arimoro and Oganah, (2010) in a related study. The dominance of rotifera in Nigeria aquatic ecosystem has been documented by several authors (Ayodele and Adeniyi, 2005; Ogbeibu and Osokpor, 2004). Cladocera and Copepoda were absent throughout this investigation; however, the absence of these species from this stream may not be in connection with pollution because not all types of water are suitable for all kinds of zooplankton groups (Ogbeibu and Osokpor, 2004). However, this study is in deviant with the report of Jonah and George, (2019) which reported high abundance of cladocerans, followed by rotifer.

In this study, high zooplanktons species in station 3 may be attributed to the low degree of human perturbations in this station when compared to other stations with pronounced anthropogenic activities. Low species recorded in station 1 and 2 could be credited to some environmental stress imposed on these stations. These factors probably might have caused disruption of the life cycle, reproductive cycle, food chain and subsequently migrations of zooplankton species in this stations. This assertion agrees with the findings of Jonah and George, (2019) when working on Influence of Water Quality on Zooplankton Community Structure of EtimEkpo River, Akwa Ibom State.

Significant spatial variation observed for water depth in this study may be attributable to the morphometry of the stream bottom at different sampling stations. Temperature values obtained in this study varied within the range mostly observed in tropical freshwater streams (Adeniyi, 1978). Most of the physico-chemical parameters obtained during the study were influenced by rainfall regime and is considered a major factor in seasonal as well as spatial changes in zooplankton community of tropical waters (Arimoro *et al.*, 2008). Values of nitrate concentrations in this study were generally within the limit expected in unpolluted to moderately polluted rivers (Obasi *et al.*, 2004). The distribution of nitrate observed may be attributed to rainfall regimes and runoff from catchment areas. The level of nitrate was higher in station 1 and 2 which is an indication of introduction of organic input from effluent discharge (Arimoro and Oganah 2010). Dissolve oxygen values obtained in this study fell within the range expected in unpolluted to slightly polluted waters (Obasi *et al*., 2004). BOD in this study was observed as having weak positive correlation with DO saturation level; this implies that the decomposition of organic material by micro-organism such as bacteria did not deplete DO concentration significantly. The discharge of municipal effluence directly into station 2 significantly reduced the dissolved oxygen in-spite of high-water velocity. The trends in zooplankton distribution were similar to those obtained by Davies *et al.* (2009) in a related study.

4.1 Conclusions

Studies were conducted on isolation and identification of microorganism in a tropical stream in Akwa Ibom State using water samples obtained from the study sites. The study recorded higher abundance of ~~rotifera~~ rotifersthan protozoa with the absence of Cladocera and ~~copepoda~~ Copepodaduring the period of investigation. A total of 8 taxa was recorded during the study which include, *Arcella*sp., *Askenasiafaurei* and *Difflugia acuminate* for protozoa while *Brachionus*sp., *Lindiatorulose*, *Rotoria*sp.,*Trichotriapocillum*, *Polyyarthra sp*., belong to the family rotifera.However, the physico-chemical parameters studied were within the standard recommended by WHO for portable water exception of Turbidity which was slightly higher than the recommended 5 NTU. The importance of the water quality assessment could not be overlooked as these acted as determinants in the distribution of the zooplankton community in the study areas. The assessment of water quality also showed that Station 2 in the study area was pollution related due to anthropogenic incursions leading to a high deposition of organic matter into the water body which resulted in the low dissolved oxygenconcentration~~s of Dissolved Oxygen~~and abundance of zooplankton species recorded in station 2. Conclusively, this study will provide baseline information as regards the zooplankton community and water quality of Uruk-Uso Stream.

5.0 References

Adeniyi, I. F. (1978). Studies of the physico-chemical factors and the planktonic algae of LakeKainji, Nigeria. Ph.D. Thesis, Department of Biology, University of Ife, Ile-Ife, Nigeria, pp. 2-17.

Ali, M., Salami, A., Jamshaid, S. and Zahra, T., (2003). Studies on Biodiversity in relation to seasonal variation inwater of River Indus at GhazGhatt, Punjab, Pakistan. *Pakistan Journal of Biological Sciences*, 6(21): 1840-1844.

American Public Health Association (APHA) (1998). Standard Methods for the Examination of Water and Waste Water. 20th, New York.

Arimoro, F. O. and Oganah, O. (2010). Zooplankton community responses in a perturbed tropical stream in the Niger Delta, Nigeria.

Arimoro, F. O., Iwegbue, C. M. and Enemudo, B. O. (2008). Effects of cassava effluent on benthic macro-invertebrate assemblages in a tropical stream in southern Nigeria. *Acta Zoological lituanica*, 18 (2):12-14.

Association of Official Analytical Chemist (2000). Official Method of Analysis, 15thEdn. Washington DC, 480 Pp.

Atobatele, O. E., Morenikeji, O. A. and Ugwumba, O. A. (2005). Spatial variation in physical and chemical parameters of benthic macro-invertebrate fauna of River Ogunpa, Ibadan. *The Zoologist*, 3: 58-67.

Ayodele, H. A. and Adeniyi, I. F. (2005). The zooplankton fauna of six impoundments of River Osun, southwest Nigeria, *Zoologist*, 4: 49 – 67.

Boyd, C. E. (1981). Water quality in warm water fish ponds. Agricultural experimental station; Auburn University Craftsmaster publ. Co., Alabama, U.S.A, p. 341.

Brett, M. T. (1989). Zooplankton communities and acidification processes (a review). Water, Air,and Soil Pollution 44: 387 – 414.

Carpenter, S. R and Kitchell, J. F. (1993). *The trophic cascade in lakes*. Cambridge University Press, Cambidge, U. K.

Cuker, B. E. (1997). Field experiment on the influence of suspended clay and Phosphorus on the plankton of a small lake. *Limnology and Oceanography* 32: 840 – 847.

Cushing, C. E. 1992. A plankton sub-sampler. *Limnology and Oceanography* 6: 489 – 490.

Davies, O. A., Abowei, J. F. N. and Otene, B. B. (2009). Seasonal abundance and distribution of plankton of Minichinda stream, Niger Delta, Nigeria. *American Journal of Scientific Research*, 36(2): 20-30.

Dodson, S. (1992). Predicting crustacean zooplankton species richness. *Limnology Oceanography* 37: 848 – 856.

Edmondson, W. T. (1966). Freshwater Biology, 2nd Edition, John Wiley and Sons. Inc. New York and London. 1248pp.

Egborge, A. B. M. (1994). The seasonal variation and distribution of phytoplankton in RiverOshun, Nigeria.*Freshwater Biology*, 4: 177 – 191.

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Jeje, C. Y. and Fernando, C. H. (1986). A Practical Guide to the Identification of Nigerian Zooplankton (Cladocera, Copepoda and Rotifera). Published by KLRI, New Bussa.

Jonah, U. E. and George, U. U. (2019). Influence of Water Quality on Zooplankton Community Structure of EtimEkpo River, Akwa Ibom State, South-South, Nigeria. *World Rural Observations*;11(3):49-57.

Mann, K. H. (2000). Ecology of coastal waters with implication for management, 2nd edition. Blackwell Science Incorporated Massachaseth, U.S.A, 406pp.

Margalef R. Diversity (1978). In: *phytoplankton manual.* (Eds). A. Sournia, Pp 251-260.

Maruthanayagam, C., Sasi, K. M. and Senthikumar, C. (2003). Studies on Zooplanktonpopulation in Thirukkulam pond during summer and rainy seasons. *Nat. Environ Pollut. Technol.* 2(1): 13 – 19.

Newell, G. E. and Newell, R. C. (1963). Marine Plankton: A Practical Guide. Hutchinson Educational Ltd. London, UK. 207pp.

Obasi, R. A, Balogun, O. and Ajayi, O. (2004). The physico-biochemical investigation of riverIreje in Ekiti state South West, Nigeria. *Journal of Applied sciences*; 7(2): 4124 - 4134.

Ogbeibu, A. E. and Osokpor, O.R. (2004). The effect of impoundment on the hydrology and rotifers of the Ikpoba River, Nigeria. *Biosci Res.*, 16(2): 132 – 138.

Pandy, J. and Verma, A. (2004). The influence of catchment of chemical and biological characteristics of two fresh tropical lakes of southern Rajasthan. *Journal of Environ. Biol.*, 25(1): 81-87.

Parsons, I. R. (1980). Zooplankton production. In Barnes R. and Mann, K. H. (eds) Fundamentals plankton of a small lake. *Limnology and Oceanography* 32: 840 – 847.

Shield, R. J. (1995). A Guide to Identification to Rotifers, Cladocerans and Copepods from Australian Inland Water. Albury: Co-operative Research Centre for Fresh-Water Ecology, Murray-Darling Fresh-Water Research Centre, Pp. 1-142.

Trivedi, R. K., Gurung, V., Das, B. K. and Rout, S. K. (2003). Variations of plankton population of two hill streams of the Darjeeling District, West Bengal. *Environmental Ecology*. 21 (SPL): 50 – 53.

Tucker, J. W. (1992). Feeding intensively cultured marine fish larvae p. 129 – 146. In Allen G. I. and Dall, W. (eds). Proceedings of the Aquaculture Nutrition Worship Salamander Bay, 15 – 17th April, 1991. NSW Fisheries, Brackish Water Fish Culture Research Station, Salamander Bay, Australia.

Unesco (1978). Standard for phytoplankton analysis, Geneva. pp. 234-301.

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