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Plankton assemblages in Alape river, Igbokoda in Ilaje local government area of Ondo state, Nigeria

[1]Igejongbo, T.F., [2]Komolafe, S. and [3]Amadu, N.O.
Department of Fisheries and Aquaculture Technology, Federal University of Technology, Akure.

Corresponding Author: *tfigejongbo@futa.edu.ng.* ***Phone Number:*** *+2348065693483.*

Abstract
The knowledge of plankton species composition and distribution to time and space are of great importance as reduction in plankton populations could lead to food unavailability for higher trophic levels (fish) in aquatic ecosystems. Phytoplankton are the most important primary producers and biological indicators in aquatic ecosystems. This study assessed plankton composition in Alape River, Ondo State. Water samples were collected from January to June 2022 from station I and II, were transported to the laboratory for qualitative and quantitative analysis of the monthly occurrence, distribution and abundance of phytoplanktons species. The results showed that annual mean percentage composition of different groups of phytoplankton contributed nearly 29.39% of chlorophyceae, 12.68% of bacillariophyceae, 46.4% of myxophyceae and 11.53% of euglennineae in Station I and 23.20% of chlorophyceae, 21.60% of bacillariophyceae, 33.60% of myxophyceae and 21.60% of euglennineae in Station II. The annual mean percentage composition of different groups of zooplankton showed that rotifera contributed 25.56%, cladocera 22.22%, copepoda 27.41% and protozoa 24.81% in Station I while rotifera contributed 25.56%, cladocera 22.22%, copepoda 27.41% and protozoa 24.81% in Station II. Thus, the study concluded that the dominance of plankton species such as phytoplankton (chlorophyceae, bacillariophyceae, myxophyceae and euglinae) and Zooplankton (cladocera, rotifera, copepoda and protozoa) as strongly showed that the river is eutropic. The study provides important baseline data on the composition and distribution of zooplankton in the Alape River, which can be used for future comparative studies and to monitor changes in the zooplankton community over time. There is a need for increased public awareness of the importance of plankton in aquatic ecosystems.

Keywords: *Phytoplankton, Zooplankton, Ecology, Nigeria.*

Introduction

Planktons are large numbers of tiny, living organisms that floats, drift freely or feebly swim in the waterbody thereby making some of them an ecosystem that is productive on earth and biodiversity hotspots (Amah-Jerry *et al*., 2017). In aquatic ecosystems, plankton can be divided into phytoplanktons and zooplanktons. They are one of the important biological communities found in fresh water ecosystem (Sharma, 2016). Phytoplankton play an important role in CO_2 sequestration and it is the major microbial biomass of aquatic ecosystems (Jia *et al*., 2022). They are the basis of food webs in waters that provide food for higher trophic levels in the food web or for larger organisms higher up in the food web, such as zooplankton, fish and mammals. Phytoplankton contribute to roughly half of global primary production that occurs in the aquatic ecosystem (Cermeño *et al*., 2016). They play a major role in aquatic ecosystems because their biological activity affects the biogeochemical cycles of several macro and micronutrients (carbon, silicon, sulphur,

nitrogen, iron). Phytoplanktons depends primarily on light energy and nutrients. However, too many nutrients often accelerate the growth of phytoplankton, and an overpopulation of phytoplankton may cause algal blooms (Scholz-Starke *et al.,* 2018), which ultimately change the dissolved oxygen (DO) conditions, eventually leading to the death of many aquatic animals and seriously damaging the health of the aquatic ecosystem (O'Boyle *et al*., 2016).

Zooplankton play an important role in supporting the life of various marine organisms by transfering the organic matters from surface waters to deeper waters through daily vertical migration activities (Huliselan *et al*., 2021). The zooplankton consist of holo and meroplankton, which have differences due to their life cycle, they have a high abundance in different type of waters. Most of holoplanktonic are present from coastal to the oceanic waters, while meroplanktonic mostly occur closed to coastal waters. The presence of meroplanktonic is a linked to the reproduction patterns of the adults and usually present throughout the year. The zooplankton, have wide distribution across environmental determinant, but others are restricted to hydrological parameters fluctuation, therefore, they can used as biological indicators of waters-mass types they populate. Copepods can be characterized by specific water masses as they are usually sufficiently abundant in the marine water (Huliselan *et al*., 2021). The water quality parameters of the aquatic are influenced by biological, chemical and physical factors (Yao and Somero, 2014; Hemraj *et al.,* 2017).

Plankton richness within waterbodies appears to be largely controlled by factors related to productivity, water quality and fish predation levels. Regular monitoring of this planktons is an easy and cheapest method of assessing the biodiversity and productivity of any water body as they are the major primary and secondary producers in the ecosystem (Dauda *et al*., 2021). Additionally, the abundance of planktons in water bodies depends on the percentage of activities carried out on the waterbodies, rivers are the sites of the greatest biological diversity and human activity (Odulate *et al*., 2017).

Ilaje is fast-growing and developing into a big city, this brings along human anthropogenic activities and unrestricted dumping of pollutants into the river (Idowu and Alebiosu, 2020). Thus, there is a dire need to have a comprehensive update and baseline documentation of the plankton assemblage of this important river. The study was carried out in Alape River, Igbokoda in Ilaje Local Government Area of Ondo State, Nigeria. The upstream of Igbokoda River is known to be the Alape River which is one of the major and important rivers in Ondo State, Nigeria. The river lies on latitude 4◦ 40'-5◦ 00' N and 6◦ 00'-6◦ 20'E. Alape River is a natural habitat of freshwater fishes. The river serves as means of transportation to other states like Lagos, Ogun and Delta States among others.

Materials and methods

Study Area

The study was carried out in Alape River, Igbokoda in Ilaje Local Government Area of Ondo State, Nigeria. The upstream of Igbokoda River is known to be the Alape River which is one of the major and important rivers in Ondo State, Nigeria. The river lies on latitude 4◦ 40'-5◦ 00' N and 6◦ 00'-6◦ 20'E. Alape River is a natural habitat of freshwater fishes. The river serves as means of transportation to other states like Lagos, Ogun and Delta States among others.

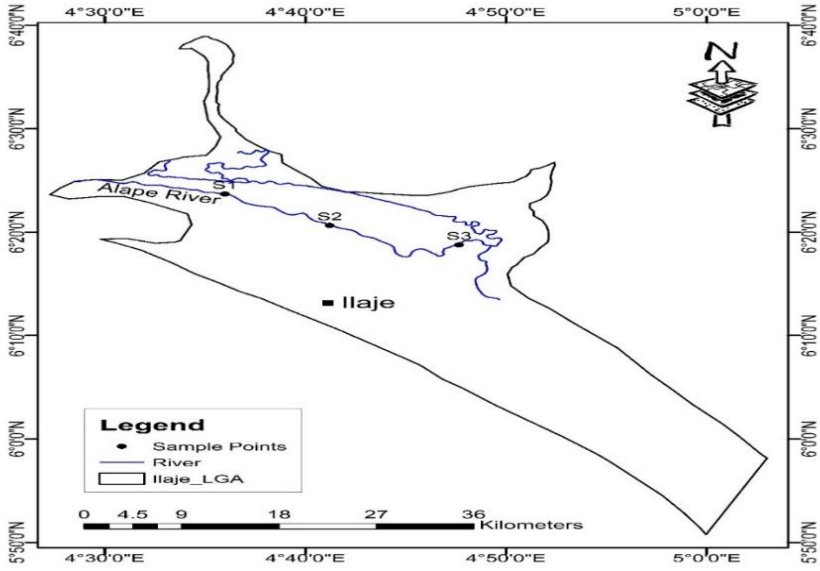

Fig 1. Map of Alape River

Sample collection and analysis

The collection of water samples was carried out on monthly basis for a total duration of six (6) months between January and June, 2022. During each sampling time, six (6) samples of water were collected for the two sampling stations**.**

Plankton sampling and analysis

The plankton samples were collected on monthly basis, from Alape river at sub-surface level, using 75 ml sampling bottles and transported to the laboratory in Department of Fisheries and Aquaculture Technology, Federal University of Technology, Akure for analysis. In the laboratory, the samples were observed under Olympus Research Microscope (mag X60) Model No: XSZ-107BN. The content was emptied into plastic container and fixed immediately with 4% formalin in the field (Onyema, 2007). After 48hours, the preserved plankton samples were concentrated to 10 ml (Nwankwo, 1984). The plankton sample was then agitated and 1 ml subsample was withdrawn into a petri dish using a bulb pipette and observed under the microscope at different magnifications (X100 and X400). Appropriate texts were used to aid identification (Jeje and Fernando, 1986; Needham and Needham, 1969). The drop count method described by NIO (2004) was used for plankton calculation.

Results

Phytoplankton (Station I)

The qualitative and quantitative monthly occurrence of phytoplankton species at Station I are presented in Table 1 and Fig. 2. The mean number of species of phytoplankton encountered from station 1 of which, 17 species belonged to chlorophyceae, 7 species to bacillariophyceae, 27 species to myxophyceae and 7 species to euglinae. Total phytoplankton population density ranged from 37 in January to 80 in June. A gradual increase in the total density of phytoplankton population was observed from January to May 2022. The annual mean

percentage composition of different groups of phytoplankton contribute nearly 29.39% of chlorophyceae, 12.68% of bacillariophyceae, 46.4% of myxophyceae and 11.53% of euglennineae.

Station II

A mean total number of 42 species of phytoplankton belonging to chlorophyceae, bacillariophyceae, myxophyceae and euglenineae were identified and are presented in Table 2 and Fig. 3. The changes in the total population density of different phytoplankton groups and their month wise percentage composition were also depicted. The maximum density of 66 cells/ml was observed during June, 2022 whereas the minimum of 26 cells/ml was observed during January, 2022. The mean percentage composition of different groups of phytoplanktons contribute nearly 23.20% of chlorophyceae, 21.60% of bacillariophyceae, 33.60% of myxophyceae and 21.60% of euglennineae.

Table 1: Monthly distribution of Phytoplankton in Alape river (Station I)

Month	Chlorophyceae	Bacillariophyceae	Euglinae	Myxophyceae	Total phytoplankton
January	11	7	7	12	37
February	14	8	6	15	43
March	16	9	6	22	53
April	17	6	8	29	60
May	21	4	8	41	74
June	23	10	5	42	80
Mean	**17**	**7.33**	**6.66**	**26.83**	**57.83**

Table 2: Monthly distribution of Phytoplankton in Alape river (Station II)

Month	Chlorophyceae	Bacillariophyceae	Euglinae	Myxophyceae	Total phytoplankton
January	5	5	7	9	26
February	6	7	9	8	30
March	7	11	8	16	42
April	10	10	11	5	36
May	13	9	8	20	50
June	17	12	11	26	66
Mean	**9.66**	**9**	**9**	**14**	**41.67**

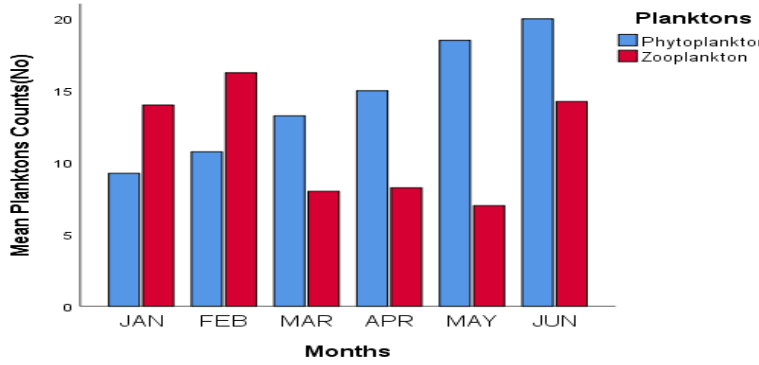

Fig 2: Monthly distribution of Phytoplankton and Zooplankton in Alape River (Station I)

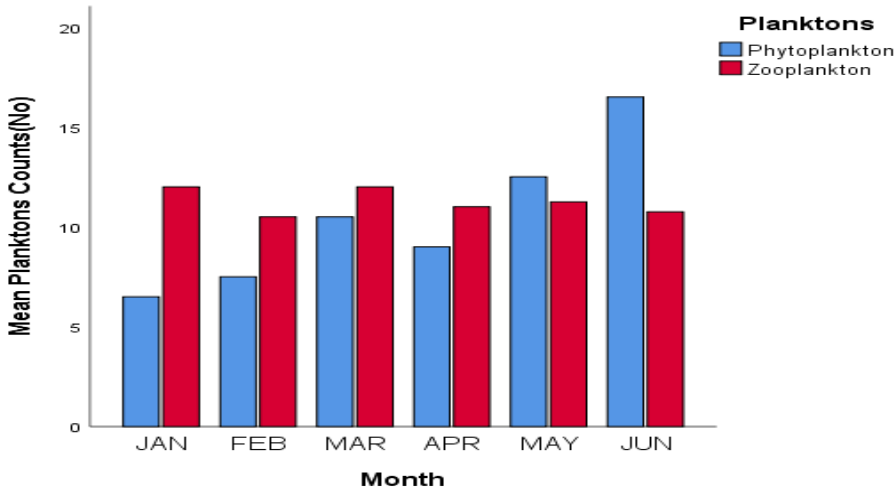

Fig 3: Monthly distribution of Phytoplankton and Zooplankton in Alape River (Station II)

Zooplankton

Station I

The zooplankton species encountered at Station I and their month wise distribution are presented in Table 3 and Fig. 4. A total of 45 species were recorded from this station, of which, 12 species belonged to cladocera, 9 species to rotifera, 12 species to copepoda and 12 species to protozoa. The maximum population density (65) was observed in February and minimum (28) in May. The annual mean percentage composition of different groups of zooplankton showed that rotifera contributed 25.56%, cladocera 22.22%, copepoda 27.41% and protozoa 24.81%.

Station II

A total of 45 species of zooplankton were identified from this station of which, 10 species belonged to cladocera, 12 to rotifera, 12 to copepoda and 11 to protoza. The monthly occurrence of various zooplankton species during the present study are shown in Table 4 and Fig. 5. The total zooplankton population density varied from 42, during February to 48, in January and March. The annual mean percentage composition of zooplankton groups showed that rotifera contributed 25.56%, cladocera 22.22%, copepoda 27.41% and protozoa 24.81%.

Table 3: Monthly distribution of Zooplankton in Alape river (Station I)

Month	Cladocera	Copepoda	Rotifera	Protozoa	Total zooplankton
January	17	13	9	17	56
February	19	23	13	10	65
March	8	9	6	9	32
April	7	10	10	6	32
May	6	7	7	8	28
June	13	9	14	21	57
Mean	**11.67**	**11.83**	**9.3**	**11.83**	**45**

Table 4: Monthly distribution of Zooplankton in Alape river (Station II)

Month	Cladocera	Copepoda	Rotifera	Protozoa	Total zooplankton
January	11	14	10	13	48
February	9	11	12	10	42
March	12	12	14	10	48
April	10	13	10	11	44
May	9	11	13	12	45
June	9	13	10	11	43
Mean	**10**	**12.33**	**11.50**	**11.17**	**45**

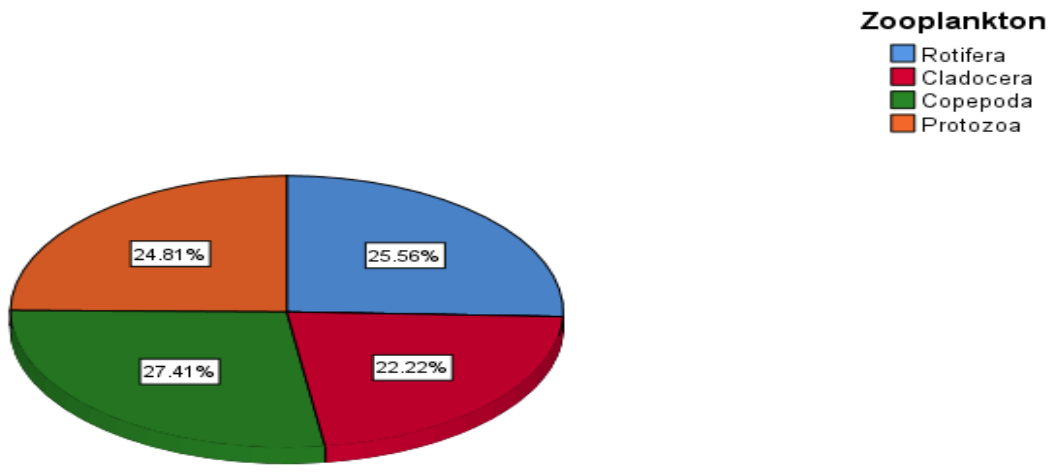

Fig 4: Zooplankton abundance in (Station I)

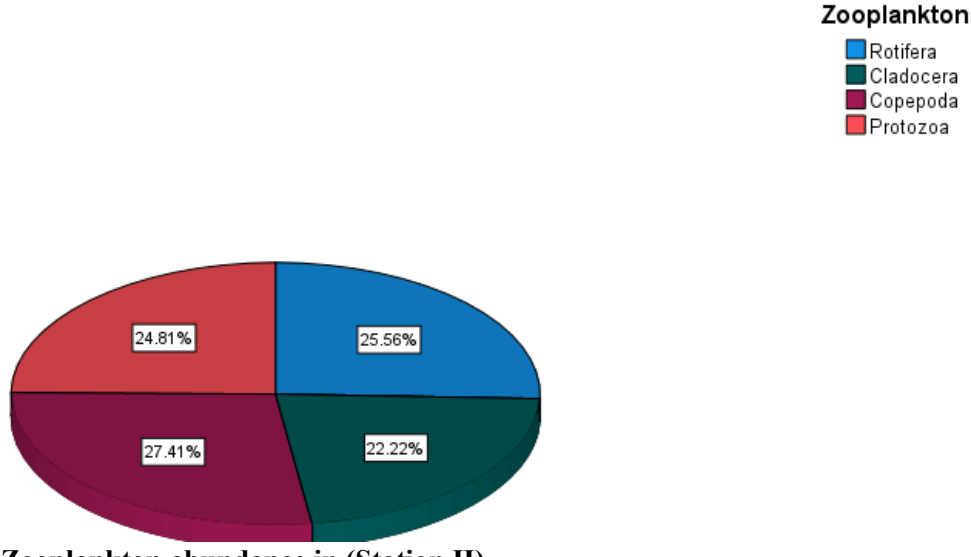

Fig 5. Zooplankton abundance in (Station II)

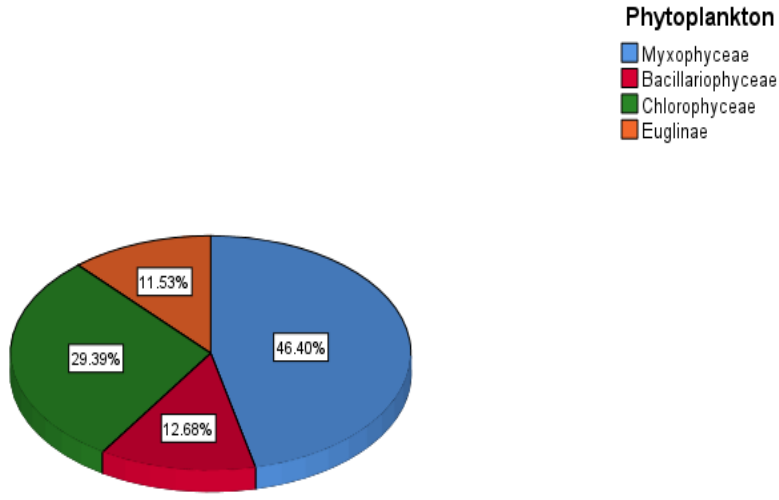

Fig 6: Phytoplankton abundance in (Station I)

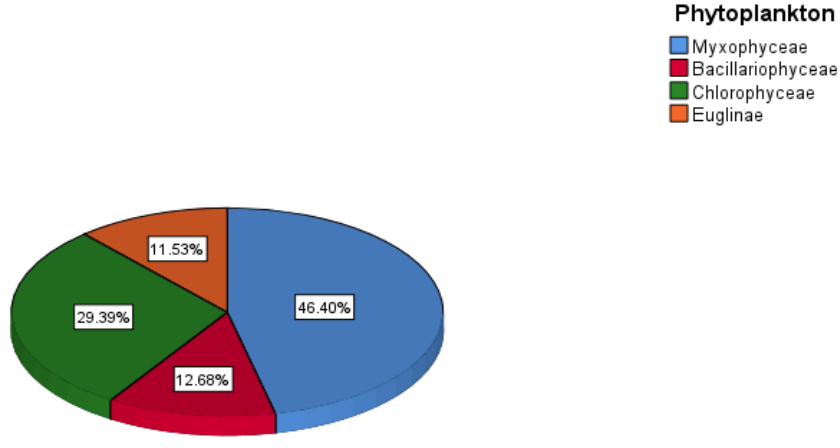

Fig 7: Phytoplankton abundance in (Station I)

Discussion

The knowledge of plankton species composition and distribution to time and space are of great value especially in aquatic ecosystems. A noticeable difference in abundance and composition of phytoplankton were found among the Station I and II with abundances more than double in the month of June as compared to January. The results presented in this study shows that myxophyceae is the most dominant group of phytoplankton in both Station I and II. A study by Adeniyi-Martins and Adesalu, (2023) conducted in Ikere Gorge Dam, Oyo State, reported the dominance of chlorophyceae and myxophyceae. These findings suggested that the dominance of particular groups of phytoplankton is a common occurrence in different aquatic ecosystems.

The reason for the abundance of Myxophyceae class in Alape river is due to their ability to adapt to a wide range of environmental conditions, including low light and nutrient availability.
compared to the other phytoplankton groups (Indrayani *et al*., 2023).

Generally there is an increase in total number of taxa encountered in this study compared to previous studies: 14 taxa, Akin-Oriola (2003); 43 taxa, Olagbemide (2011) and 49 taxa, Anago *et al*. (2013). This could be due to difference in methods of collection and sampling stations and also this suggests gradual eutrophication of the Awba reservoir according to Lepistö and Rosenström (1998). Phytoplankton diversity in eutrophic waters is the highest compared to other types of trophic waters.

The abundance is followed by chlorophyceae and Bacillariophyceae which is in line with the study of (Yuliana, 2015; Rahmatullah *et al*., 2016; Hossain *et al*., 2020) who reported the abundance of chlorophyceae and Bacillariophyceae in Atrai river, Bangladesh. The difference in the number of species according to the theory of intermediate disturbances Reynolds *et al*. (1993) was probably due to the slight changes in the ecosystem.

This result shows that chlorophyceae and Bacillariophyceae contribute to the major portion of the total plankton community in a lotic water body. Chlorophyceae were highly represented in Alape river and it agrees with studies on Lake Skadar and Thomas dam (Ibrahim and Nafi'u, 2017). This is contrary to the report of Akin-Oriola (2003) that blue-green algae dominated the phytoplankton community. Under conditions of nutrient enrichment or eutrophication, the blue-greens are known to proliferate and form noxious blooms in freshwater environments (Stoyneva, 2003).The development of phytoplankton blooms in coastal water bodies is attributed to their ability to accommodate reduced nitrogen to phosphorus ratios due to their large colony sizes (Barica, 1994)

Differences in the composition of phytoplanktons in various locations are caused by differences in environmental conditions including physical and chemical parameters. This is in accordance with the report of (Wiltshire *et al.*, 2015) who stated that the structure of the phytoplankton community is very dynamic which changes rapidly in response to environmental changes. The blue-green algae in the Alape river are capable of rapid uptake of phosphate and nitrogen and hence producing large surface blooms and out competing other phytoplankton as asserted by Xie *et al.* (2003). Thermal stratification of the water of Alape river in the dry season may be responsible for the array of planktons found. (Akin-Oriola, 2003), and once stratification is stabilized, the non-motile greens begin to sink and decline in the water column, and sedimentation increases. Non-motile greens appear to be restricted to a relatively short growth period defined by a narrow range of environmental conditions. The variation in the phytoplankton species richness and diversity with sampling points agreed with the findings of Sekandende *et al*. (2004) in Lake Victoria basin (Tanzania side) and Eyo *et al.* (2013) on the great Kwa River. Species composition and abundance of zooplankton communities can be influenced by a number of physical, chemical and biological factors as demonstrated by Sampajo *et al*.,(2002) especially temperature, quality and availability of food, competition and predation.

Zooplankton are excellent pollution indicators and may exhibit the effects of even low levels of chemical pollution in a water body (Adadu *et al*., 2019). The results of this showed that there are four groups of

zooplanktons obtained. The zooplankton found in station I and II were cladocera, rotifera, copepoda, protozoa. This is in line with the report of (Majeed *et al*., 2022) who reported the occurrence of cladocera, rotifera, copepoda, protozoa in some selected rivers (Agba, Oyun and Asa Dam) within Ilorin, Kwara state.

Cladocera was the most dominant in the zooplankton group and this is in contrast with the report of (Adedeji *et al.,* 2019) who stated that rotifera have been identified as the most dominant zooplankton group in Nigeria Aquatic ecosystems because of their opportunistic nature and their ability to reproduce throughout a wide temperature range. The dominance of cladocerans in the zooplankton community of Alape river during period of study could result from selective feeding by the invertebrate predators including fish on small-sized zooplankton like rotifers. Cladocerans were dominant in Alape river and also dominant in Nigeen lake and Keenjhar lake (Jan *et al*., 2015; Rao and Azmi 2019), and it was attributed to temperature enhancing rapid hatching of eggs, high nutrient conditions and food availability. This is not in agreement with Chukwuka and Uka (2007) who reported rotifers as the dominant group and Anago *et al*. (2013) encountered the copepod Thermocyclops as the most abundant.

Cladocerans have been claimed to be good indicators of trophic state in lentic ecosystems and can also be used as water quality indicators. Temporal variation and succession in zooplankton species were observed in the Alape river. The quality and quantity of food can alter species composition as well as the abundance of the species, since particular organisms are highly selective about the size and the type of phytoplankton they eat. Protozoans were frequently encountered during the study in Alape river. Protozoans exhibit rapid and exponential reproductive strategies which have allowed parasitic protozoans to colonize aquatic environments globally. It accounts for significant economic losses in aquaculture, the ornamental fish trade and epidemics in wild fish populations, resulting in mass mortalities (Matthews. 2005).

Conclusion

This study provided baseline information on the ecological status of Alape River. The dominance of plankton species such as phytoplankton (chlorophyceae, bacillariophyceae, myxophyceae and euglinae) and Zooplankton (cladocera, rotifera, copepoda and protozoa) has strongly showed that the river is eutropic. There is a need for increased public awareness of the importance of plankton in aquatic ecosystems and the need to conserve these ecosystems.

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