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Ecological Studies on Phytoplankton Community of Upper Reaches of Orashi River, Niger Delta, Nigeria

Davies* O. A. and Nwose F. A.

Department of Fisheries and Aquatic Environment, Rivers State University, Nkpolu-Oroworukwu, Port Harcourt, Rivers State, Nigeria

***Corresponding Author:** Davies O. A, Department of Fisheries and Aquatic Environment, Rivers State University, Nkpolu-Oroworukwu, Port Harcourt, Rivers State, Nigeria Email:daviesonome@yahoo.com*

ABSTRACT

Fisheries resources are fast reducing in Nigeria due to over exploitation and inadequate management of her coastal waters. Composition, Length-weight relationship and condition factor of schilbeidae from Agbura landing site was investigated bi-weekly for three months (May-July 2018). A total of 431 Schilbeidae were collected. Results showed that Agbura landing site consist of 5 species viz; Pareutropius buffei, Schilbe intermedius, Schilbe uranoscopus, Parailia pellucida and Siluranodon auritus from four (4) genus. P. pellucida and S.auritus were observed only once (May) during the three months sampling period. The b-value and Pearson's correlation coefficient, r (in bracket, 2 decimal places) of the pooled data (May-June) were P. buffei 2.89 (0.99), S. intermedius 2.94 (0.88) and P. pellucida 2.56 (0.98) reveals negative allometric growth pattern, while S. urano scopus 3.24 (0.99) showed positive allometry. The condition factor (Fulton's K) was >0.5 for P. buffei and <1 P. pellucida for the sampling period. Condition factor decreased significantly in June (0.45±0.07) and July (0.34±0.07) for S. intermedius. S. uranoscopus showed significant poor condition factor in May (0.25±0.02) and July (0.22±0.03). There is need to conduct in depth study physiochemical parameter of Ekole Creek and further study on fish species from the Creek for the period of 12 months so as encompass the hydrology of the water body.

Keywords: *Phytoplankton, assemblage, Orashi River, Niger Delta*

INTRODUCTION

Phytoplanktons are photoautotrophic organisms of aquatic ecosystems. They are the plant plankton that is graded according to size, commonly used in aquaculture as food for larval fish and invertebrates (Frank and Snell, 2008). Their growth and distribution depend on the carrying capacity of the environment and on the nutrients concentrations (Odiete, 1993). Phytoplankton uses precursors such as light and carbon dioxide to manufacture their food viathe process of photosynthesis. Phytoplankton community composition enhances the functioning of aquatic ecosystems.

In the aquatic ecosystem, the phytoplankton constitute the foundation of the food webs and chains, in providing a nutritional base for zooplankton and subsequently to other invertebrates, shell fish and finfish (Emmanuel and Onyema, 2007). Phytoplankton communities are major producers of organic carbon in large rivers, a food source for planktonic consumers and may represent the primary oxygen source in low-gradient Rivers. They are widely used in biomonitoring of pollution (Davies *et al*., 2009). Their distributions, abundance and species diversity, species composition are used to assess the biological integrity of the water body (Townsend *et al*., 2000). Phytoplankton also reflects the nutrient status of the environment. They lack control over their movements thus they cannot escape pollution in the environment. Barnes (1980) reported that pollution affects the distribution, standing crop and chlorophyll concentration of phytoplankton.

The study of plankton is of important to fisheries due to the followings. Plankton constitute the major food source in any aquatic environment on which fish and some other aquatic organisms depend on as food source (Horsely and Witton, 2000). Zooplankton grazing plays a key role in the recycling of all biogenic elements, and the community structure of the pelagic food web which determines the export of elements from the upper water column. Zooplankton are food for commercially important fish, such as, copepods in the genus *Calanus*. Also, they are the primary food source for larval and juvenile cod, one of the most important commercial species in the North Atlantic, and even in tropical environments where they form an important link to forage fish and thus to larger commercial species (Kane, 1984).

However, a handful of research has been made on the phytoplankton of Niger Delta Creeks. Some of these among others include: Davies *et al.*, 2006; Davies *et al.*, 2008; Ebigwai, 2014;

MATERIALS AND METHOD

The Study Area

The study was carried out on the Upper Reaches of Orashi River Basin System, Niger Delta, Nigeria. The river basin starts from Ndoni-Onelga and stretches to the sea via Abonnema-Asalga (Fig. 3.1). The region lies in the southern fringe of the tropical rainforest belt. It is located between latitudes 4°32' and 5°23'N, and longitudes 6°24' and 6°59'E. It shares boundary with the following local governments areas: Ahoada East and Ogba/Egbema/Ndoni in the North; Akuku-Toru in the South; Degema and Asari-Toru at the South-South East; Ahoada East and Emohua in the Eastern flank; Yenagoa at the North-West, Brass and Ogbia (Kolo Creek Communities) Local Government Areas of Bayelsa State at its South-South West and West respectively. It is a low lying region between 0 to 55 meters above sea level. Its hydro-geologic profile is characterized by alluvial sedimentary strata composed chiefly by poorly leached loosed porous sandy to fertile loamy soils.

Sampling Stations

Water samples were collected from three sampling stations within the upper reaches of Orashi River and the Stations were located lengthwise along the River namely: Station 1 (Obiafu /Obrikom (OB/0B) Gas Plant Jetty), Station 2 (Onukpor water side at Omoku), and Station 3 (G.R.A water side at Omoku).

Duration of Study

Surface water samples collection for physico-chemical parameters and plankton were done once a month for three months from (April to June 2016) at the three stations within the River.

Field Collection of Phytoplankton

Phytoplankton samples were collected from sampling stations (Station 1, Station 2 and Station 3) in day light hours from (11.000 to 14.00 hours) using a 55 µm mesh size standard plankton net. The phytoplankton net was hauled horizontally against the water current for about 5 minutes and samples collected by the hauled net were transferred each time to one litre well labeled plastic containers with screw caps. Samples were preserved with 4% formaldehyde for microscopic analysis.

Laboratory Analysis of Phytoplankton

Five hundred (500) ml of each sample were allowed to stand for a minimum of 24 hours before decanting the supernatant. The supernatant was removed carefully until a 100 ml concentrated sample is taken. One (1) ml of sub-sample was collected from it and transferred into a Sedgwick–Rafter counting chamber using a stampel pipette**.** Five grids of the Sedgwick rafter were employed for identification and enumeration. Identification and enumeration were done under a binocular compound microscope with magnification 40 x 400. Three replicates of the sub-samples were analysed.

Phytoplankton Identification

Identification and characteristics of planktonic species was done by the descriptive keys by Needham and Needham (1962), Newell and Newell (1963), Patrick and Reimer (1966), Williams (1968), Han (1978), Durans and Leveque (1980), Prescott (1982) and Kadiri (1988) amongst others. Results were expressed in number of organisms per ml.

Calculation of Plankton Community Indices

The following formulae were used for the calculation of phytoplankton parameters:

Density of phytoplankton (Number of plankters per ml) =

$$(T)\,\frac{1000}{AN} \times \frac{\text{Volume of concentrate (ml)}}{\text{Volume of sample (ml)}}$$ (Boyd, 1981)

Where: T = Total number of plankters counted

A = area of grid in mm^2

N = number of grids employed

1,000 = area of counting chamber in mm^2 (Boyd, 1981)

Margalef Species diversity

$$H = \frac{S - 1}{\text{InN}}$$ Margalef (1958) in Boyd (1981)

Where S = the number of species (or other taxonomic group)

N = total number of phytoplankters

Shannon's index of general diversity (H)'

H'= log N-1

N Σ ni, log ni Cox (1996)

Where: ni = total number number of individuals in each species

N = total number of individuals of all species

Furthermore, data obtained were analyzed for analysis of variance (ANOVA) and descriptive statistics using Statistical Packages for Social Sciences (SPSS 206).

RESULTS

Phytoplankton Composition, Abundance and Distribution

A total of 24 species of phytoplankton from 3 taxonomic groups, Bacillariophyta (12 species), Chlorophyta (7 species) and Cyanophyta (5 species) were recorded from the upper reaches of Orashi River. A total of 795 cell counts were recorded from the three families. Bacillariophyceae dominated with a total population of 467 representing 58.74% individuals followed by Chlorophyceae with a total population of 276 individual representing 34.72%. The class Cyanolphyceae with the total population of 52 representing 6.54% was the least group of the taxonomic groups recorded. These are presented in (Table 4.1).

Spatially, the highest number of phytoplankton (312 cell counts) representing 39.10%) were observed in Station 1 while the lowest number 227 representing 28.45% were observed in Station 3 (Table 4.2). Spatially, the order of occurrence in increasing order is Station 1> Station 2 > Station 3. In all, the highest number of phytoplankton per individuals were observed in the month of June (267 cell counts) while the least (262 cell counts) were observed in May (Table 4.2). Bacillariophyceae had the highest value (169 cell counts) in the month of April while the lowest value (143 cell counts) was observed in May. The highest values of the class Chlorophyleae and Cyanophyceae (98 and 21 cell counts) were observed in May.

Table 4:1. *Spatial Variations of Phytoplankton in the Upper Reaches Orashi River*

	Taxa/Species	**Stations**			
S/N	**BACILLARIOPHYTA**	**1**	**2**	**3**	**Total**
1	*Cyclotella Kutzingiana*	30	19	12	61
2	*Cyclotella glomerata*	24	10	4	38
3	*Melosira Varians*	22	30	11	63
4	*Coscinodiscus Lacustris*	12	14	4	30
5	*Tabellaria Fenestrata*	2	1	4	7
6	*Diatoma vulgare*	6	5	4	15
7	*Meridion Circulare*	23	29	19	71
8	*Gyrosigma sp.*	32	17	25	74
9	*Cymbella sp.*	9	4	3	16
10	*Synedra nana*	15	18	10	43
11	*Synedra pulchella*	9	16	14	39
12	*Bacillaria Paradoxa*	5	3	4	12
	Total	**189**	**166**	**124**	**469**
	CHLOROPHYTA				
1	*Volvox globator*	40	22	15	77
2	*Volvox aureus*	7	16	18	41
3	*Netrium digitus*	13	8	4	25
4	*Desmidium Optogonium*	15	18	11	44
5	*Spirogyra sp.*	14	19	20	53
6	*Ulothrix sp.*	6	4	2	12
7	*Closterium dianae*	8	4	13	25
	Total	**103**	**91**	**87**	**277**
	CYANOPHYTA				
1	*Oscillatoria Limosa*	3	2	3	8
2	*Oscillatoria Lacustris*	3	3	7	13
3	*Rivularia planctonica*	8	7	2	17
4	*Microcystis Puulvenea*	3	3	3	9
5	*Anacystis aeruginosa*	3	1	1	5
	Total	**20**	**16**	**16**	**52**
	Total No of Individuals	**312**	**273**	**227**	**812**

	Percentage Occurrence	39.10	34.21	28.45	100.00
	Total No of Species 24				

Table 4.2. *Monthly Variations of Phytoplankton in the Upper Reaches of Orashi River*

	Taxa/Species				
S/N	**BACILLARIOPHYTA**	**April**	**May**	**June**	**Total**
1	*Cyclotella Kutzingiana*	22	14	25	61
2	*Cyclotella glomerata*	15	7	16	38
3	*Melosira varians*	24	16	20	60
4	*Coscinodiscus lacustris*	10	9	12	31
5	*Tabellaria fenestrata*	3	1	3	7
6	*Diatoma vulgare*	5	3	7	15
7	*Meridion circulare*	27	22	22	71
8	*Gyrosigma sp.*	32	24	18	74
9	*Cymbella sp.*	3	7	6	16
10	*Synedra nana*	15	14	14	43
11	*Synedra pulchella*	12	16	11	39
12	*Bacillaria paradoxa*	0	10	2	12
	Total	**169**	**143**	**156**	**467**
	CHLOROPHYTA				
1	*Volvox globator*	27	26	24	77
2	*Volvox aureus*	14	14	13	41
3	*Netrium digitus*	8	10	7	25
4	*Desmidium optogonium*	17	12	15	44
5	*Spirogyra sp.*	18	14	21	53
6	*Ulothrix sp.*	3	7	1	11
7	*Closterium dianae*	0	15	10	25
	Total	**86**	**98**	**91**	**276**
	CYANOPHYTA				
1	*Oscillatoria limosa*	3	2	3	8
2	*Oscillatoria lacustris*	4	5	4	13
3	*Rivularia planctonica*	4	5	8	17
4	*Microcystis Puulvenea*	0	4	5	9
5	*Anacystis aeruginosa*	0	5	0	5
	Total	**11**	**21**	**20**	**52**
	Total No of Individuals	**266**	**262**	**267**	**795**
	Percentage Occurrence	33.46	32.96	33.58	100.00
	Total No. of Species 24				

The results of the study revealed that station 1 had the highest number of phytoplankton. Among the three taxonomic groups of phytoplankton were found in the research. These are: Bacilloriophycea, Chlorophyceae, Cyanophyceae The Bacillariophyceae species with the highest frequency of occurrence were *Cyclotella kutzingiana* (61 cell counts) and *Gyrosigma sp.* (74 cell counts) while the least was *Tabellaria fenestrate* (7 cell counts).

Also, the Chlorophyceae species with the highest frequency of occurrence were *Spirogyra sp.* (53 cell counts) and *Volvox globator* (77 cell counts), while the least was the *Ulothrix sp.* with (11 cell counts).

For the Cyanophyceae species with the highest frequency of occurrence were *Oscillatoria lacustris* (13 cell counts) and *Rivularia planctonica* (17 cell counts), while the least was *Anacystis aeruginosa* having just (5 cell counts).

Fig 4.1 shows the spatial and temporal mean density of phytoplankton in the study area. The mean density of Bacillariophyceae was consistently higher in all the stations and months than any other taxonomic group followed by Chlorophyceae while the least was Cyanophyceae. There was no significant difference ($p>0.05$) between and within taxonomic groups spatially and temporally. Bacillariophyceae had the highest density (1.82 org/ml) in April (Station 1), while in the month of May and June the values were uniform (1.79 org/ml). In the month of May and June chlorophyceae had uniform highest density value of (1.30 org/ml) both in (Station 1), while in April Chlorophyceae had the highest density of (0.80 org/ml) in Station 1. Cyanophyceae had the highest density (0.30 org/ml) in May station 1, while in the month of April and June the values were uniform (0.20 org/ml).

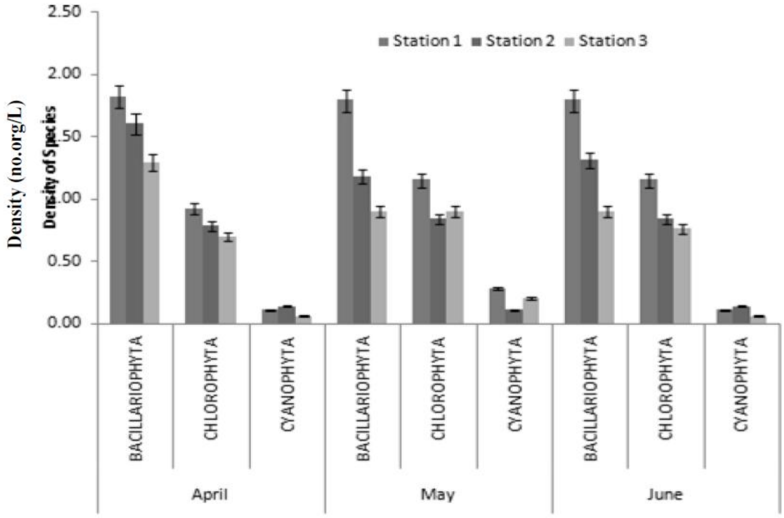

Figure 4.1. *Spatial and temporal density of phytoplankton in Upper reaches of Orashi River.*

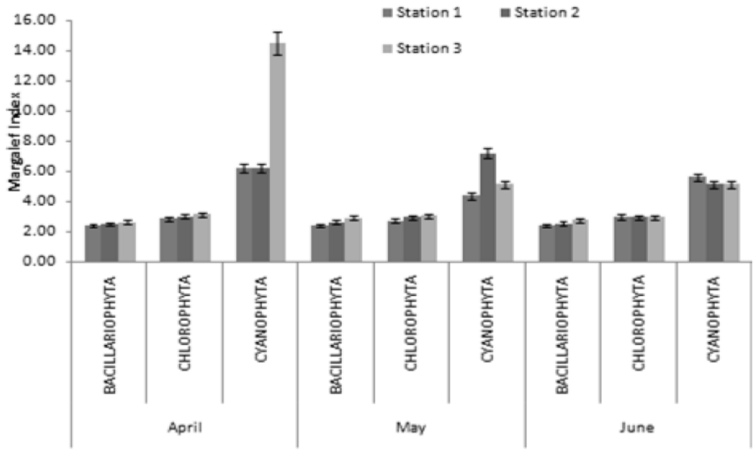

Figure4.2. *Spatial and temporal Margalef index of phytoplankton in Upper Reaches of Orashi River*

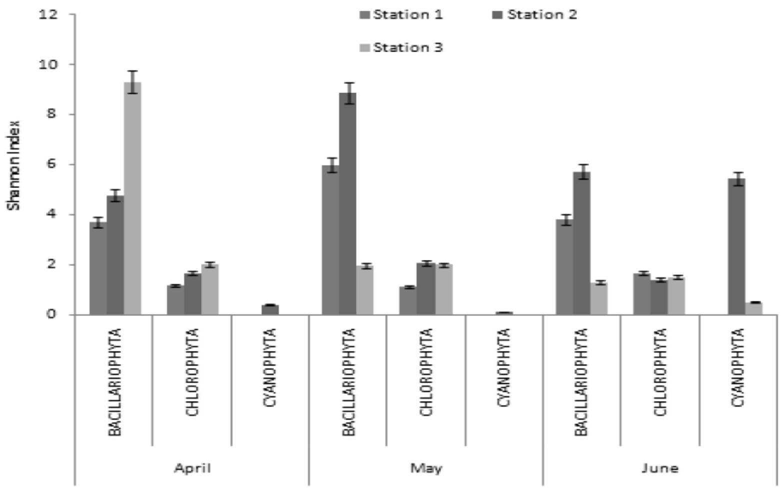

Figure 4.3. *Spatial and temporal Shannon index of phytoplankton in Upper Reaches of Orashi River*

Species Indices

Figs. 4.2 and 4.3 show the Margalef and Shannon indices studied. Margalef index ranged from Stations 1 to 3 in all the phytoplankton taxonomic groups (Bacillariophyceae, Chlorophyceae and Cyanophyceae). Bacillarioplyceae ranged from 2.40 (Station 1) to 2.61 (Station 2) in April, Chlorophyceae ranged from 2.86 (Station 1) to 3.11 (Station 3), while Cyanophyceae ranged between 6.19 (Station 1) and 14.50 (Station 3). The overall mean values of (Margalef index) for the month of April were 7.49 = 0.105 (Bacillariophyceae) 8.97 = 0.125 (Chlorophyceae) and 26.60 = 4.792 (Cyanophyceae). The values increased from Bacilleriophyceae to Cyanophyceae. Shannon index increased from Station 1 to 3 and decreased from Bacillarophyceae to Cyanophyceae in April. Bacillanophyceae ranged from 3.72 (Station 1) to 9.33 (Station 3)) Chlorophyceae ranged from 1.19 (Station 1) to 2.05 (Station 3) while Cyanophyceae ranged from 0.06 (Station 3) to 0.03 (Station 1) in the month of April (Fig 4.3) temporally. Overall mean values ranged from Cyanophyceae 0.15 = 0.25 to Bacillariophyceae (5.94 = 2.98) in April. Others are as in (Fig. 4.3).

Discussion

The obtained number of species of phytoplankton from the three taxonomic groups with Bacillariophyceae dominating and was comparable with the 34 species of phytoplankton reported by Yakubu *et al* (2000) in Nkisa River but incomparable with the 305 species reported by Adeniyi (1978) in Kainji Dam which would be attributed to difference in environmental factors. This result also differed from other studies in the Niger Delta and Nigeria such as Chindah and Pudo (1991) of 148 species in Oginigba Creek. According to Guy (1992), the major factors influencing phytoplankton abundance are temperature, turbidity, light, nutrient availability, water current and chlorophyll ‘a’ grazing by zooplankton etc. The dominant Bacillariophyceae is a common phenomenon and feature of the open eutrophic water systems according to Townsend (1990). The predominance of Bacillariophceae in Niger Delta waters observed was not only phytoplankton communities but also in periphyton communities (Chindah and Nduaguibe, 2008; Nwankwo, 2004 and Chindah, 2004). Therefore the dominance of diatoms Bacillariphyceae in this study confirms the statement that diatoms predominate unpolluted natural lotic water bodies in the tropics (John and Lawson, 1990, Herlihy and Collin, 1996). Dominance of Bacillariophyceae could be due to their ability to compete favourably with others for nutrients (John and Lawson, 1990). It could also be an indication that the upper reaches of Orashi River is organically polluted according Ruivo (1972) study that stated that organisms are used for monitoring pollution based on the belief that natural unpolluted environments are known by balanced biological conditions and contain a great diverse of plants and animals life with no one dominating.

The high abundance of phytoplankton in Station 1 above other stations could be attributed to difference in environmental factors such as nutrient values and low rate of grazing by zooplankton. The two indices of species diversity (Margalef’s species richness and Shannon’s diversity index) used in this study showed variation minimally throughout the period of study.

The ranges of Margalef’s index observed for the various phytoplankton classes, Bacillariophycere, Cholorophyceae and Cyanophyceae are typical of eutrophic water as reported by Roberto *et al*. (1998). The observed *Melosira varians*, *Oscillatria limosa* and *O. lacustris* denotes nutrient enrichment of the upper reaches of Orashi River according to (Zargarad and Ghosh, 2006; Ganai and Parveed, 2014).

Those studies stated that excessive growth of certain algal genera namely *Scenedesonus*, *Anabaena*, *Oscillaria* and *Melosira* indicate nutrient enrichment of aquatic bodies.

Conclusion

The presence of dominant Bacillariophyceae and Copepoda indicates that this River is perturbed and organically polluted. Also, the recorded *Melosira varians* (Bacillariophyceae), *Oscillatoria limosa* and *O. lacustris* (Cyanophyceae) denotes nutrient enrichment of this River and the the level of vulnerability of this river to environmental factors or hazards.

Recommendation

Based on the results, the following are recommended:

- There should be proper monitoring of the activities of people living at the bank of the River to ensure that they comply with environmental laws.
- Companies, sited close to the bank of the River not complying with the environmental rules and regulations should be sanctioned.

- There should be surveillance on regular bases to ensure that the issues of threat could be averted.

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