African Journal of Environment and Natural Science Research
ISSN: 2689-9434
Volume 3, Issue 6, 2020 (pp. 67-74) www.abjournals.org

ABUNDANCE AND DISTRIBUTION OF PERIPHYTON SPECIES IN THE NEW CALABAR RIVER, NIGERIA

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ABSTRACT: *Studies on the periphyton speciesin the New Calabar River were conducted in the months of March and April, 2014. The aim was to ascertain the abundance and distribution of periphyton species. The experimental approach includes: the use of the ARC GIS tool to select six geo-reference stations; a horiba water checker to investigate the physicochemical characteristics of the river, the collection of scrapings from the substrates from an area of 6cm x 2cm and a light microscope to determine the periphyton. The results for physico chemical parameters ranged from 24˚C to 31˚C; 3.7 mg/L and 7.08 mg/L; 4.98 and 7.05; 2.2 mg/L – 4.14 mg/L; 10.34ppm to 2446.5ppmand 17.2µs and 2693µsfor Temperature, Dissolved Oxygen, pH, Biological Oxygen Demand, Conductivity and Total Dissolved Solids respectively in the six stations. Analysis of Variance show some level of variability between the physicochemical parameters tested in all stations. The Periphyton recovered was a total of five phyla, representing thirteen genera. Bacillariophyta had the highest number of genera (8) while Chlorophyta had (2), Cyanophyta (1), Dinoflagellata (1) and the cysts of zooplankton and invertebrates (1). Shannon-Wiener's and Margalef indices revealed that station 1 had maximum diversity.Pielou's index of evenness revealed that the species were more evenly distributed in station 5 while Station 2 recorded the lowest species evenness. This study therefore, provided information on the distribution and the abundance of periphyton communities in the Study area. However, the variation in some water quality variables and possibly substrate type may have influenced the distribution and abundance of periphyton species.*

KEYWORDS: Periphyton, New Calabar River, Physico-chemical parameters, Shannon-Wiener, Abundance

INTRODUCTION

Periphytons encompassall unicellular and filamentous algae, attached protozoa, bryozoa and rotifers, which are attached to a substrate but do not penetrate into it (Horner and Welch, 1978). They occur on different kinds of substrates, usually mangroves, floating logs, rocks on river beds etc. and as such, are rarely found in large bodies of water, but are more common in rivers, lakes and streams where the water current is not so high that the organisms get washed off their substrates.

Periphyton in streams and rivers constitute an important component of the aquatic ecosystem through its provision of ecosystem services such as food and habitat (for cysts and eggs) for aquatic invertebrates and fishes in local and downstream ecosystems (Finlay *et al.*, 2002).

In addition to the ecosystem services mentioned above, the aquatic ecosystem also contributes to the following; production of oxygen, carbon sequestration, aesthetic, spiritual

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ISSN: 2689-9434
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and cultural benefits. These services are needed for the continued support of human life on earth. They are provided not solely by the water itself but also by the diverse organisms that call this ecosystem, home. These organisms range from the "unseen" microorganisms to the very conspicuous life forms of both the animal and the plant kingdom e.g. the macroalgae.

As opposed to other aquatic organisms like the phytoplankton with well-established benefits, little is known of the periphyton benefits due to under study. Also, the distribution of these lifeforms are based on different factors such as current velocity, nutrients etc. thus, it is necessary that studies be done on the abundance and distribution of the various biotic components of this ecosystem like the Periphyton, for an effective management process.

MATERIALS AND METHODS

Study Area

Description of study area

The New Calabar River flows along a course from 5˚0'3.899" N 6˚44'15.2982" E to 4˚25'00" N 7˚02'00" E, with its source at Elele-Alimini. It is located in the Tropical rain forest region of the Lower Niger Delta and has a gradual transition from fresh water to salt water (Udoh, 2015). This river is a black water type with a length of 98km; it empties into the Atlantic Ocean. The source of this river is fresh, acidic and not tidal. The climate of the study area, located in the New Calabar River, is tropical and marked by two distinct seasons, the dry season (November – March) and the wet season (April – October).The sampling stations as shown in Fig. 1 shows a total of six stations that were sited along the river.

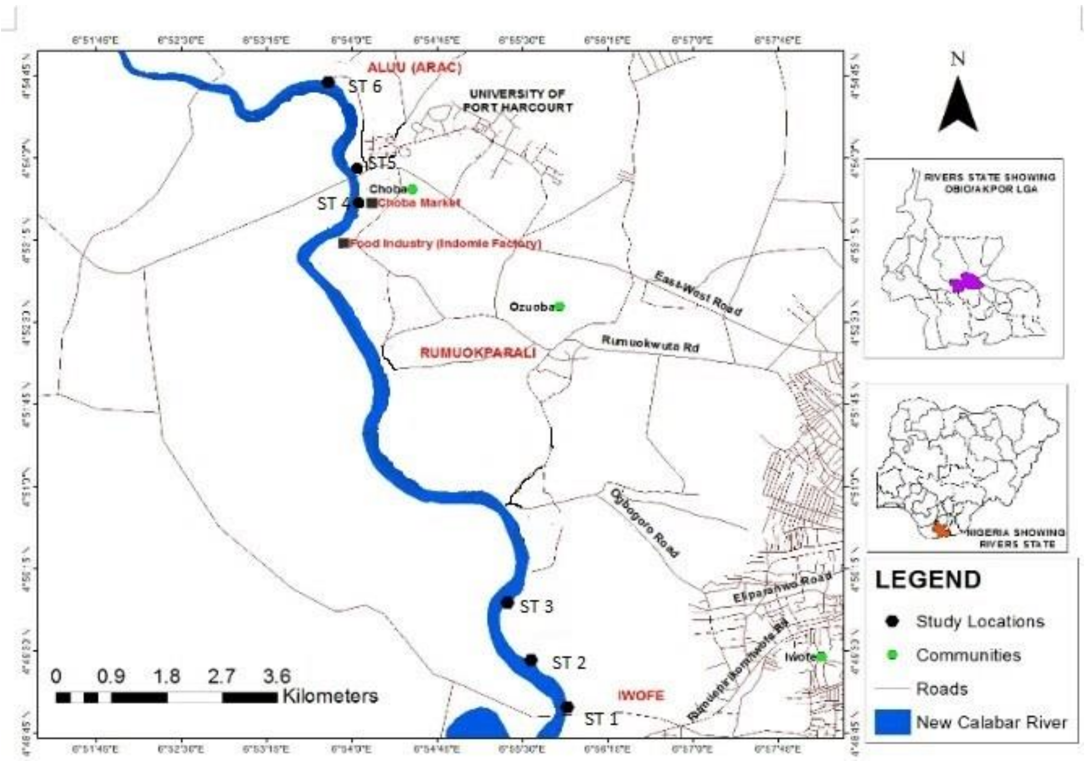

Figure 1: Map of the Study Area Showing the Sampling Stations

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ISSN: 2689-9434
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Sample Collection, Preparation and Analyses

Samples were collected from six geo-reference stations using the ARC GIS tool.Scrapings were collected from the substrates at each sample station using a knife and a 15cm meter rule (Chindah, 2004) and stored in sample containers with formalin added. Also, water samples were collected in clear plastic and amber bottles for ex-situ analyses. Physicochemical parameters such as: Temperature, pH, Dissolved Oxygen, Total Dissolved Solids and Conductivity were measured in-situ using a water checker while Transparency was measured using a Secchi disk and a meter rule at each sampling location. Allcollected samples were then transported to the laboratory for preparation and analyses.

During the laboratory analysis, micrographs of identified periphyton were taken by using a camera fixed at the top of the microscope, while the ROPME Phytoplankton Guide was employed to identify the organismsseen.

RESULTS

Table 1: Physicochemical Parameters of the New Calabar River

	MARCH						APRIL					
Parameter	1	2	3	4	5	6	1	2	3	4	5	6
DO (mg/L)	5.45± 0.03^{abc}	5.95± 0.58^{ab}	6.30± 0.20^{a}	6.25± 0.17^{a}	5.08± 0.21^{bc}	4.40± 0.48^{c}	5.55± 0.10^{b}	5.97± 0.07^{ab}	6.25± 0.19^{a}	6.35± 0.17^{a}	5.05± 0.20^{c}	4.55± 0.11^{d}
Tran (cm)	33.50± 1.80^{d}	42.00± 2.30^{c}	42.00± 0.81^{c}	65.50± 1.30^{b}	74.50± 1.80^{a}	72.00± 1.52^{a}	23.50± 0.87^{bc}	19.50± 0.83^{de}	18.25± 0.69^{e}	27.23± 0.84^{a}	21.00± 0.76^{cd}	25.50± 0.11^{ab}
Temp (˚c)	27.30± 2.03^{a}	27.00± 1.38^{a}	27.35± 0.28^{a}	27.10± 0.24^{a}	26.90± 0.61^{a}	26.00± 0.58^{a}	27.90± 1.67^{a}	26.43± 0.73^{a}	28.23± 0.54^{a}	26.85± 0.84^{a}	26.90± 0.66^{a}	27.00± 1.04^{a}
Cond (µs)	1374.66± 135.06^{c}	1857.50± 146.76^{b}	2616.33± 74.68^{b}	30.40± 0.42^{b}	25.35± 0.83^{d}	22.13± 0.84^{d}	1897.50± 60.12^{a}	1742.00± 87.93^{b}	667.33± 39.18^{c}	317.40± 27.26^{d}	20.32± 1.00^{c}	17.62± 0.23^{e}
TDS (ppm)	1002.98± 119.60^{b}	1283.50± 29.35^{b}	1889.50± 295.87^{a}	19.65± 0.41^{c}	16.57± 0.32^{c}	13.22± 0.42^{c}	1377.50± 108.19^{a}	1237.33± 90.12^{a}	952.45± 21.97^{b}	25.32± 0.76^{c}	12.62± 0.27^{c}	10.97± 0.31^{c}
pH	5.78± 0.45^{b}	5.94± 0.33^{ab}	6.08± 0.32^{ab}	6.83± 0.12^{a}	6.80± 0.10^{a}	6.10± 0.03^{ab}	5.94± 0.15^{ab}	6.19± 0.18^{ab}	6.15± 0.22^{ab}	6.44± 0.22^{a}	5.62± 0.20^{bc}	5.26± 0.18^{c}
BOD (mg/L)	2.50± 0.15^{a}	2.80± 0.15^{a}	2.60± 0.26^{a}	2.60± 0.10^{a}	3.00± 0.06^{a}	2.90± 0.23^{a}	2.60± 0.25^{b}	3.90± 0.13^{a}	2.60± 0.15^{b}	3.30± 0.19^{ab}	2.50± 0.17^{b}	2.90± 0.40^{b}
Nitr (mg/L)	2.96± 0.29^{b}	3.63± 0.33^{a}	1.30± 0.02^{d}	0.23± 0.01^{e}	1.48± 0.06^{d}	2.09± 0.10^{c}	1.82± 0.07^{a}	0.87± 0.05^{b}	0.22± 0.13^{c}	1.09± 0.22^{b}	1.38± 0.36^{ab}	0.84± 0.05^{b}
Sulp (mg/L)	4.31± 0.65^{c}	6.43± 0.18^{b}	7.07± 0.19^{a}	8.08± 0.65^{a}	1.17± 0.06^{d}	4.50± 0.38^{c}	4.04± 0.14^{a}	2.04± 0.04^{b}	0.93± 0.04^{c}	1.98± 0.10^{b}	1.07± 0.10^{c}	0.20± 0.00^{d}
Phos (mg/L)	3.07± 0.60^{c}	4.47± 0.26^{ab}	4.36± 0.12^{ab}	3.62± 0.06^{bc}	4.08± 0.30^{b}	5.27± 0.08^{a}	0.14± $\mathbf{0.01^{b}}$	0.17± $\mathbf{0.01^{b}}$	0.13± $\mathbf{0.01^{b}}$	0.19± $\mathbf{0.01^{b}}$	3.98± $\mathbf{0.07^{a}}$	0.22± $\mathbf{0.01^{b}}$
Flow rate (cm/s)	18.50± 2.09^{c}	10.80± 0.17^{e}	15.59± 0.12^{d}	13.50± 0.36^{de}	23.70± 0.26^{b}	36.30± 0.26^{a}	18.72± 0.64^{b}	18.71± 0.63^{b}	24.00± 1.68^{a}	17.84± 0.11^{b}	7.35± 0.20^{c}	6.26± 0.13^{c}

**Superscripts of the same alphabet are not significantly different (P<0.05)*

***Superscripts of different alphabets are significantly different (P<0.05)*

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The physicochemical parameters above showed that the mean values for temperature in the stations rangedfrom 26.00±0.58˚C in Station 6 to 28.23±0.54˚Cin Station 3;Dissolved Oxygen range was between 4.40±0.48mg/l at Station 6 to 6.35±0.17mg/l at Station 4; while Biochemical Oxygen Demand levels were between 2.50±0.17mg/l at station 5 and 3.90±0.13mg/l at station 2.The lowest pH value of 5.26±0.18 was recorded at Station 6 while the highest value of 6.83±0.12was recorded at Station 4.Total Dissolved Solid values ranged from 10.97±0.31ppm at Station 6 to 1889.50±295.87ppm at Station 3, Conductivity levels were between 17.62±0.23µs at Station 6 to 2616.33±74.68µs at Station 3.Transparency levels in the study area ranged between 18.25±0.69cm at Station 3 to74.50±1.80cm at Station 5 and The flow rate was between 6.26±0.13cm/s and 36.30±0.26cm/s both in station 6, the flow rate was highest in March,while April had the lowest flow rate. Nitrate levels ranged between 0.22±0.13mg/l at station 3 to 3.63±0.33mg/l at station 1, Sulphate ranged from 0.20±0.00mg/l at station 6 to 8.08±0.65mg/l at station 4 while Phosphate range was from 0.13±0.01mg/l at station 3 to 5.27±0.08mg/l at station 6.

In all six stations sampled 13 genera from 11 families were identified and counted. Taxonomic listing of the species found and their spatial distribution and abundance along the New Calabar River is shown in Table 2 below. The classes ofperiphyton groups represented in the studyare Dinophyceae,Bacillariophyceae, Cosnodiscophyceae, Trebouxiophyceae, Cladophoralesand Cyanophyceae which represents twelve genera, and cysts of aquatic invertebrates.Bacillariophyceae had the highest number of genera (8) while Trebouxiophyceae, Cladophoralesand Cyanophyceae recorded one (1) genera each.

Station 4 recorded the highest number of individuals with 11,044 where *Chlorella sp*. contributed the most with 2,103 individuals, while Station 6 had the lowest number of individuals with 6,244;*Nitzschia sp*. contributing the most in this station with 1,067 individuals. Bacillariophyta is the taxa with the highest number of individuals with 27,713, followed by Chlorophyta with 9,505 individuals, then Cyanophyta with 7,020 individuals, Cysts of aquatic invertebrates had 3,359 individuals and Dinoflagellata had the lowest with a total of 2,908 individual organisms. Thus, a grand total of 50,923 individuals were found. As a result, the abundance gradient of the periphyton was Station 6 < Station 1 < Station 3 < Station 2 < Station 5 < Station 4.

Table 2: Periphytontaxa in the New Calabar River

Phylum	Class	Family	Species/taxa
Dinoflagellata	Dinophyceae	Prorocentraceae	*Prorocentrum sp.*
Bacilliarophyta	Bacillariophyceae	Naviculaceae	*Navicula sp.*
	‘’	Cymbellaceae	*Cymbella sp.*
	‘’	Pleurosigmataceae	*Pleurosigma sp.*
	‘’	‘’	*Gyrosigma sp.*
	‘’	Baccilariaceae	*Nitzschia sp.*
	‘’	Surirellaceae	*Petrodictyon sp.*
	Cosnodiscophyceae	Aulacoseiraceae	*Aulacoseira sp.*
	‘’	Leptocylindraceae	*Leptocylindricus sp.*

Cyanobacteria	Cyanophyceae	Microcoleaceae	*Trichodesmium sp.*
Chlorophyta	Trebouxiophyceae	Chlorellaceae	*Chlorella sp.*
	Cladophorales	Cladophoraceae	*Cladophora sp.*
			Cyst

DISCUSSION

From the results of this study, it was observed that the temperature ranges of 24˚C to 31˚C was in agreement with findings earlier reported in the Niger Delta waters; Chindah (1998) reported temperature range of 26 ºC and 30.5 ºC, Sikoki and Zabbey (2006) 26 ºC and 27.8 ºC, Hart and Zabbey (2005) 25.8 ºC and 30.4 ºC, Dibia (2006) 25 ºC to 27 ºC and Jamabo (2008) reported a temperature range between 27 ºC and 30 ºC in the upper Bonny River in the Niger Delta.The pH range of 4.98 and 7.05 made the study area slightly acidic, this conforms with Chindah (2004), who reported a pH range of 5.5 to 7.0 in the wet season.Dissolved Oxygen in the water body had a mean range of 3.7mg/L and 7.08mg/L and the values are within the USEPA (1998)standard classification range of 7 to 3 for dissolved oxygen, the lowest DO was observed in station 6 which was a non-activity area; this could be attributed to the action of microbes in degrading waste material from the vegetation around the area.Station 2 had the highest BOD value and that is indicative of the effects of the industrial activities (dredging, illegal oil refining etc.) being carried out in the station (http://polyseed.com, 2017).

The flow rate was between 6.26cm/s and 36.8cm/s both in station 6, the flow rate was highest in March,while April had the lowest flow rate, and station 6 in April had the least number of organisms, this agrees with the findings of Ahn *et al*., (2013).From the results of the Transparency test, the ranges of values were from 18.3cm to 74cm and it was observed that the level of transparency increased from station 1 to 6.Conductivity ranged from 17.2µs to 2693µs which does not conform with the recommended optimum range of 150µs-1500µs for fresh water bodies (Behar, 1997). The TDS levels of the sampled stations were between 10.34ppm to 2446.5ppm which is within the optimum range for Natural water bodies (WHO, 2003).

The nutrients level in the studied area ranged from 0.22mg/L to 3.63mg/L (Nitrate), 0.20mg/L to 8.08mg/L (Sulphate) and 0.13 mg/L to 5.27 mg/L (Phosphate). The lowest Nitrate level was in Station 3 and this may be attributed to the lack of anthropological activities in the area. The highest Sulphate level was in Station 4; this could be because of the industrial activities that take place in this station. Phosphate levels was highest at Station 5 in April, and can be caused by the dredging activities that were occurring at the same time samples were being collected.

The percentage abundance of the taxa among the stations is dominated by the Bacillariophyta (54.8%) and this is in agreement with the findings of Chindah (2004), which stated that 'Quantitatively, the Bacillariophyta dominated and constituted over 50% of the community for the stations irrespective of season'.

The highest number of individuals occurred in Station 4 which had very low nitrate levels (0.23±0.01mg/l) and this level of Nitrate concentration can be attributed to its being used up by the periphyton community present; as supported by Goldman*et al.*, (1968). The sulphate level at this station is also above the minimum level for algal growth, and this can be seen in the dominance of *Chlorella sp.* which isgreen algae. The DO level of this station is the highest and this may be credited to the photosynthetic activities being carried out by green algae in the station.

The lowest number of individuals recorded was in Station 6, and this station had a phosphate level much higher than the acceptable limit of 0.01mg/l, decomposition of organic matter from the leaves of the vegetation and influx of detergents and soaps from the residences around the study area may be the contributors to the high phosphate level, and this might be a limiting factor to the abundance of periphyton in the station. Also, the sulphate level in this station was 0.20mg/l which is lower than the minimum sulphate level for algal growth (0.50mg/l). The low nitrate level in this station could be attributed to the photosynthetic plants in the station which use up this nutrient during photosynthesis. Additionally, the low DO levels may be credited to the microbial activities going on in the station due to the breakdown of leaf litter.

Pielou's index of evenness revealed that the species were more evenly distributed in station 5 while the lowest species evenness occurred in Station 2. Shannon-Wiener's and Margalef indices calculated for all species per stations indicated that diversity was maximum in Station 1 for the two indices respectively.

CONCLUSION

The study revealed the abundance of certain species of attached aquatic microorganisms and their distribution in the New Calabar River, over a period of two months. The key findings of the study corroborate the fact that the variation in some water quality parameters may have influenced the periphyton species abundance and distribution in the study area. Thus,it is recommended that further studies on the effects of certain physicochemical parameters on Periphyton should be carried out in order to better understand this component of the aquatic ecosystem.

Periphyton in the new Calabar River

PLATE: I

Class: Bacillariophyceae

Family: Cymbellaceae

Genera*: Cymbella sp.*

PLATE: II

Class: Cyanophyceae

Family: Microcoleaceae

Genera: *Trichodesmium sp.*

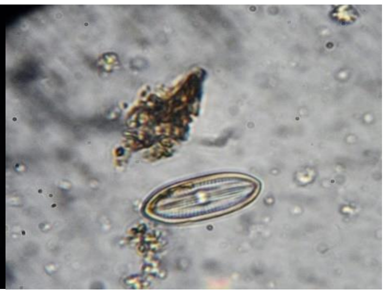

PLATE: III

Class:Bacillariophyceae

Family:Surirellaceae

Genera: *Petrodictyon sp.*

PLATE: IV

Class: Bacillariophyceae

Family:Naviculaceae

Genera*: Naviculasp.*

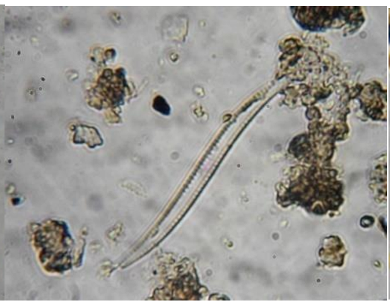

PLATE: V

Class: Bacillariophyceae

Family: Bacillariaceae

Genera: *Nitzschia sp.*

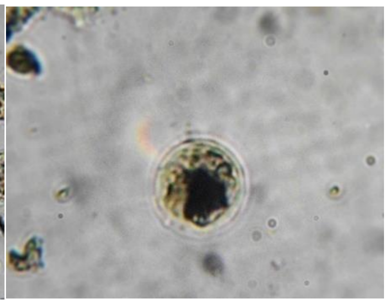

PLATE: VI

Class:Dinophyceae

Family:Prorocentraceae

Genera: *Prorocentrum sp.*

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