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Preliminary Checklist of Phytoplankton and Periphyton in River Okhuo, Nigeria

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Abstract: This study presents the phytoplankton and periphyton diversity of River Okhuo, Edo State, Nigeria from July-December, 2002. Phytoplankton samples were collected using a 55 µm mesh net while periphyton were collected by scrapping wood, stones, leaves and branches and both were preserved separately in 4% formalin. Camera Lucida drawings were taken and a total of 106 species, with more periphyton than phytoplankton were identified using monographs and research publications. The phytoplankton assemblages comprised of Bacillariophyta (43.94%) > Chlorophyta (42.42%) > Cyanophyta (6.06%) ≥ Euglenophyta (6.06%) > Rhodophyta (1.49%) while for the periphyton, distribution of species were: Chlorophyta (57.83 %) > Bacillariophyta (25.30%) > Cyanobacteria (10.84%) > Euglenophyta (4.82%) > Rhodophyta (1.21%). Chlorophyta was dominated by desmids, which were largely represented by species of *Cosmarium* and *Closterium*. The Bacillariophyta was represented by two (2) orders: Centrales and Pennales. Cyanobacteria was grouped into five families: Chroococcaceae, Nostocaceae, Rivulariaceae, Scytonemaceae and Oscillatoriaceae. *Euglena* (5) and *Phacus* (2) of Euglenophyta were recorded while *Batrachospermum vagum* was the only representative of the Rhodophyta.

Keywords: Nigeria, periphyton, phytoplankton, river okhuo, species

INTRODUCTION

In the last two decades, there has been increasing interest in phytoplankton and/or periphyton studies in southern Nigeria. This may be as a result of increased awareness of their importance in assessing the quality of water bodies, utilization of algal biomass for bio-fuels and bioremediation. Phytoplankton can be beneficial and/or harmful to ecosystems and public health. Their beneficial use include: acting as biological indicators, where their presence, absence, diversity, abundance and distribution are used to determine the health (nutrient) status or quality of an aquatic environment (Reynold, 2006). The diversity, abundance and distribution of phytoplankton within any fresh water ecosystem have a direct correlation with the water quality and consequently the whole community structure as phytoplankton form the base of any aquatic food chain and Organic production in the coastal ecosystem (Carol and Timothy, 1993). Phytoplankton are the sources of oxygen in the aquatic systems and are the main primary producers in the food web (Akomeah *et al*., 2010). Therefore, to tap from the potential (benefit) of phytoplankton, it is imperative to study their taxonomy (Atici, 2002).

Among such studies include Kadiri (2010), who documented the phytoplankton of various freshwaters and marine. Opute (1990) compiled the phytoplankton flora of Warri/Forcadoes estuary while (Nwankwo, 1988) presented a checklist of the periphyton and phytoplankton of Lagos lagoons. Akoma (2004) gave a checklist of phytoplankton species in Imo estuary for coastal waters in southern Nigeria. However, many of these studies have been on large rivers and coastal waters while some small rivers remain uncovered, due to difficulty of accessibility encountered.

Presently, no work has been published on the periphyton and phytoplankton flora of River Okhuo, a small river in Edo State, Nigeria. The aim of this study is to investigate the phytoplankton and periphyton diversity of River Okhuo and hence produce a checklist on the biological richness of the river.

MATERIALS AND METHODS

Description of study area: Detailed information on the environmental features of the study area have been previously documented (Edema *et al*., 2002; Alika and Kadiri, 2011). Three sampling stations were chosen between latitudes 6°30′ and 6°33′ N and longitudes 5°37′ and 5°45′ E) and were characterised by slow flowing water.

Sample collection and identification of algae: This study was undertaken fortnightly for a period of six months (July-December, 2002) between 9 and 13 h (GMT + 1 h). Surface water phytoplankton collections

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were carried out by means of a plankton net (55 µm mesh) towed horizontally for about ten minutes. The net samples were transferred into labelled 250 mL plastic bottles with screw caps and immediately preserved with 4% formalin.

Periphyton samples were collected by scrapping the substrata (leaves of aquatic macrophytes, sticks, stones/rocks, submerged grasses) in and around the respective water sampling stations. A little amount of distilled water was added and the mixture preserved with 4% formalin. Both phytoplankton and periphyton were transported to Limnology and Algology laboratory at the University of Benin, Nigeria for further biological investigation.

In the laboratory, two drops at five different times for each sample were mounted on glass slides. These were examined at different magnifications (10, 16 and40 X) and illustrations made using Olympus light microscope (model CX 40)) as well as a Leitz Ortholux Universal side field research microscope equipped with drawing device and calibrated eye-piece graticule. Most taxa within samples were identified to species level by reference to standard works, such as Prescott (1975), Croasdale and Flint(1986), Kadiri (1987), Tomaszewicz (1988) and Opute (1991) and numerous journals.

Table 1: Phytoplankton and periphyton flora of river okhuo

Division	Order	Family	Genera	Species
Chlorophyta	Cladophora	Cladophoraceae	Cladophora Kutzing	+, * *Cladophora oligoclona* Kutz
"	Oedogoniales	Oedogoniaceae	Bulbochaete (Agardh) Hirn	+, * *Bulbochaete nigerica* Gauthier-Lieure
"	"	"	Oedogonium (Link) Hirn	+, * *Oedogonium suecium* Wittr
"	"	"	"	+, * *Oedogonium grande* Kutz
"	Ulothricales	Ulothricaceae	Ulothrix Kutzing	+ *Ulothrix tenuissima* Kutz
"	Volvocales	Volvocaceae	Eudorina Ehrenberg	* *Eudorina elegans* Ehr
"	Zynematales (Conjugales)	Desmidiaceae	Actinotaenium (Naegeli) Teiling	* *Actinotaenium curcurbitum* (Biss) Teil
"	"	"	"	+, * *A.globosum* (Buln.) Forster
"	"	"	"	+, * *Actinotaenium* sp.
"	"	"	Bambusina Kutzing	+, * *Bambusina brebissonii* Kutz
"	"	"	Closterium (Nitzsch) Ralfs	* *Closterium cynthia* de Not
"	"	"	"	* *C. rostratum* Ehr
"	"	"	"	* *C. ehrenbergii* Menegh
"	"	"	"	+, * *C. closteriodes* (Ralfs) Loius and Peters
"	"	"	"	* *C. pseudolunula* Borge
"	"	"	"	* *C. closteriodes*
"	"	"	"	+ *C. diane* Ehr
"	"	"	"	+, * *Closterium* sp
"	"	"	"	+, * *C. incurvum* Breb
"	"	"	Cosmarium (Corda) Ralfs	* *Cosmarium regnelli*
"	"	"	"	+, * *C. askenasyi* Schmidle
"	"	"	"	* *C. spinuliferum* West and West
"	"	"	"	+, * *C. biretum* Breb
"	"	"	"	* *C. salisburii* Fristch and Rich
"	"	"	"	* *C. contratum* Kirch
"	"	"	"	+, * *C. granatum* Breb
"	"	"	"	* *C. abbreviatum* Racib
"	"	"	"	* *C. lavae* Rabenh
"	"	"	"	+, * *C. subauriculatum* W. and G.S. West
"	"	"	"	* *C. javanicum* Nordest
"	"	"	"	+, * *Cosmarium* sp
"	"	"	"	+ *C. porrectum* Nordst
"	"	"	"	+, * *C. quadrum* Lund
"	"	"	Desmogomium Grunow	+, * *Desmogomium rabenhorstianum*
"	"	"	Euastrum (Ehrenberg) Ralfs	* *Euastrum impressulum* Elf
"	"	"	"	* *E. binale* (Turp.) Ehr
"	"	"	"	* *E. ansatum* Ehr
"	"	"	Micrasterias (Agardh) Ralfs	* *Micrasterias aiculata* (Ehr.) Menegh
"	"	"	"	* *M. radiata* Hass
"	"	"	"	+, * *M. thomasiama* Arch.
"	"	"	Penium (de Brebisson) de Brebisson ex Ralfs	* *Penium cylindrus* (Ehr.) ex Breb.
"	"	"	Pleurotaenium Krieger	* *Pleurotaenium ehrenbergii* Krieger
"	"	"	Pleurotaenium Huzel	* *Pleurotaenium ehrenbergii* (Breb.) de Barry
"	"	"	Staurastrum (Meyen) Ralfs	* *Straurastrum hirsutum* (Ehr.) Breb

Table 1: (Continue)

Division	Order	Family	Genera	Species
"	"	"	"	* *S. alternans* de Brebisson
"	"	"	"	* *S. gladosium* Turn
"	"	"	Staurodesmus Teiling	+ *Staurodesmus* sp.
"	"	"	Tetmemorus (Ralfs) Ralfs	* *Tetmemorus brebissonii* (Menegh.) Ralfs
"	"	Zygnemataceae	Mougeotia Agardh	+ *Mougeotia sphaerocarpa* Wolle
"	"	"	Spirogyra Link	+, * *Spirogyra communis* (Hassal) Kutz
"	"	"	"	+, * *S. dubai* Kutz
"	"	"	"	+, * *S. insignis* (Hassal) Kutz
"	"	"	Zynema Agardh	+ *Zynema pectinatum* (Vauch) C. A. Agardh
"	"	Mesotaeniaceae	Netrium (Naegeli) Itz. and Rothe in Rabenhost	+, * *Netrium digitus* (Ehr.) Itz. and Roth
Bacillariophyta	Centrales	Thalassiosiraceae	Aulacoseira Thwaites	+ *Aulacoseira granulata* (Ehr.) Simonsen
"	"	Cosnodiscaceae	Cosnodiscus Ehrenberg	+, * *Cosnodiscus centralis* Ehr
"	Pennales	Achnanthaceae	Achnanthes Bory	+, * *Achnanthes* sp.
"	"	Cymbellaceae	Cymbella C.A. Agardh	+, * *Cymbella* sp.
"	"	Eunotiaceae	Eunotiaceae Ehrenberg	+ *Eunotia pectiales*
"	"	"	"	+, * *Eunotia monodon*
"	"	"	"	+, * *Eunotia* sp.
"	"	"	"	+ *E. papilio* Ehr
"	"	"	"	+, * *E. flesuosa* Kutz
"	"	"	"	* *E. serra* Ehr
"	"	Fragilariaceae	Fragilaria Lyngbye	+, * *Fragilaria javanica* Hust
"	"	"	"	+, * *Fragilaria* sp.
"	"	"	Tabellaria Ehrenberg	+, * *Tabellaria flocculosa* (Roth.) Kutz
"	"	"	"	+ *Tabellaria* sp.
"	"	"	"	+, * *Tabellaria* sp.
"	"	"	"	+, * *T. fenestrata* (Lyngb.) Kutz
"	"	"	Synedra Ehrenberg	+, * *Synedra superba* Kutz
"	"	Naviculaceae	Frustulia Rabenh	+, * *Frustulia rhombodies* (Ehr.) de Toni
"	"	"	Navicula Bory	+, * *Navicula* sp.
"	"	"	Neidium Pfitzer in Hanstein	+ *Neidium irdis* (Ehr.) Cleve
"	"	"	"	* *Neidium taiaensis notata*
"	"	"	Pinnularia Ehrenberg	* *Pinnularia gibba* (Ehr.) Smith
"	"	"	"	+ *P. subcapitata* Greg
"	"	"	"	+, * *P. cardinaliculus* Cleve
"	"	"	"	+ *P. virdis* Ehr.
"	"	"	Stauroneis Ehrenberg	+ *Stauroneis* sp.
"	"	Nitzschiaceae	Nitzschia Hassal	* *Hantzschia amphoxyis*
"	"	"	"	+ *Nitzschia acicularis* W. Smith
"	"	"	"	* *Nitzschia obstusa* Smith
"	"	"	"	+ *Nitzschia* sp.
"	"	Surirellaceae	Surirella Turnips	+ *Surirella angusa* Kutz
"	"	"	"	+ *S. angusta* Kutz
"	"	"	"	+, * *S. elegans* Ehr
Cyanobacteria	Chroococcales	Chroococcaceae	Aphanothece Naegeli	* *Aphanothece* sp.
"	"	"	Merismopedia Meyen in Weigmann	+, * *Merismopedia elegans* A. Br.
"	Nostocales	Nostocaceae	Anabaena (Bory St. Vincent) Bornet and Flahault	* *Anabaena* sp.
"	"	Rivulariaceae	Gleotrichia (J. G. Agardh) Bornet and Flahault	* *Gleotrichia echinulata* (J. E. Smith) Richter
"	"	Scytonemaceae	Scytonema (Agardh) Bornet and Flahault	+, * *Scytonema cincinnatum* Thurex ex Bornet and Flahault
"	Oscillatoriales	Oscillatoriaceae	Oscillatoria (Vaucher) Gomont	* *Oscillatoria ornata*
"	"	"	"	* *O. bornettia* (Kuzal) Forti
"	"	"	"	* *Oscillatoria* sp.
"	"	"	Spirulina (Turpins) Gomont	+, * *Spirulina major* Kutz
"	"	"	"	+ *S. albida* Kolwitzt
Euglenophyta	Euglenales	Euglenaceae	Euglena Ehrenberg	* *Euglena acutissima* Lemm
"	"	"	"	* *E. oxyutris* Schmarda
"	"	"	"	+ *E. rubra* Hardy
"	"	"	"	+ *E. acus* Ehr
"	"	"	"	* *Euglena* sp.
"	"	"	Phacus Dujardin	* *Phacus* sp.
"	"	"	"	+ *Phacus acuminatus* Stokes
Rhodophyta	Nemalionales	Batrachospermaceae	Batrachospermum Roth	+, * *Batrachospermum vagum*

+: Means phytoplankton; *: Means periphyton

Table 2: Summary of phytoplankton community according to divisions, families, orders and genera

Division	Orders	Families	Genera	Species	% taxa composition of the flora
Chlorophyta	4	6	15	28	42.42
Baccilariophyta	2	9	15	29	43.94
Cyanobacteria	3	3	3	4	6.06
Euglenophyta	1	1	2	4	6.06
Rhodophyta	1	1	1	1	1.52
Total	11	20	36	66	100.00

Table 3: Summary of periphyton community according to divisions, families, orders and genera

Division	Orders	Families	Genera	Species	% taxa composition of the flora
Chlorophyta	4	6	18	48	57.83
Bacilariophyta	2	8	13	21	25.30
Cyanobacteria	3	5	7	9	10.84
Euglenophyta	1	1	2	4	4.82
Rhodophyta	1	1	1	1	1.21
Total: 5	11	21	41	83	100.00

RESULTS

For the 6 months survey, a total of 106 species of phytoplankton and periphyton of River Okhuo were recorded as shown in Table 1. Table 2 displayed the summary of the composition of phytoplankton while that of periphyton is seen in Table 3.

Majority of the phytoplankton were the Baccilariophyta or diatoms (43.94%) with the genus *Cosmarium*, having the highest number (7). The Baccilariophyta were composed of the centrales and pennales, with the latter maximised in genera (13 out of 15). The Chlorophyta (42.42%) emerged as second dominant division after Baccilariophyta. Cyanobacteria (6.06%) and Euglenophyta (6.06%) were equal in dominance. The former was represented by three orders namely, Chroococcales, Nostocales, Oscillatoriales and the latter represented by Euglenales only (*Euglena* and *Phacus*). Rhodophyta (1.49%) was the least, with *Batrachospermum vagum* as the only representative.

For the periphyton, Chlorophyta constituted more than half (57.83%) of the assemblage, with the bulk belonging to the order, Zynematales, (89.58%) and these were mainly desmids, *Cosmarium* (13) and *Closterium* (8). Thereafter, followed by Bacillariophyta (25.30%) > Cyanobacteria (10.84%) > Euglenophyta (4.82%) > Rhodophyta (1.21%). Among the Bacillariophyta, the order, Pennales had the highest number of species (15) in comparison to centrales (5). Cyanobacteria was represented by families, Chroococcaceae, Nostocaceae, Rivulariaceae, Scytonemaceae and Oscillatoriaceae. Euglenophyta were of two genera: *Euglena* and *Phacus* and *Batrachospermum vagum* was the only species recorded of Rhodophyta.

Most of the algal species in River Okhuo have occurred in similar freshwater of souther Nigeria. Nevertheless, five of them are new records. The presence of potential toxin-producing (cyanotoxin) harmful alga, *Gleotrichia echinulata* was observed.

DISCUSSION

From the study, there is relatively more periphyton 38 than phytoplankton. The occurrence of an algal species depends on whether it can tolerant the water and flourishes in the system. A good number of the species observed during this study have been documented elsewhere in Nigerian freshwaters (Kadiri, 1987). The observation of more Chlorophyta than Baccilariophyta for the phytoplankton agreed with similar report of Kadiri (1999a, b), who attribute Chlorophyta dorminance over Baccilariophyta as a common trend in wetter parts of West Africa.

The occurrence of more diatoms (and desmids) are attestation of acidic pH, low nutrient status of the water (Kadiri, 2001a; Tevera and Martinez-Almeida, 2004) and is an indication that the water body is relatively clean (Kadiri, 2010). Generally, high incidence of desmids is connected with high rainfall (John, 1986) and water movement (Kadiri, 1987). Therefore, the continuous movement of water in River *Okhuo* allows regular mixing resulting in high diversity of desmids.

Cosmarium and *Closterium* prevalence over other genera is in consonance with the findings of Kadiri (2001b) and Adesalu and Nwankwo (2010). Egborge and Kadiri (2001) claim dominance of pennate diatoms than centric diatoms in many freshwater bodies. This is true of River Okhuo and it can be inferred to be a peculiar phenomenon or characteristic sequence of freshwater habitat. However, (Nwankwo, 1994) recorded pennate dominance in a polluted Lagoon.

The presence of Chlorophyta in addition to Cyanobacteria and Euglenophyta in River *Okhuo* is consistent with similar finding of Opute (1991) in

freshwater zones of Warri/ Forcadoes estuary. The existence of fewer Cyanobacteria at River Okhuo agrees with the report of Paerl (1988) of their intolerance to acidic conditions (with pH 6.0). Members of the Euglenophyta occur in most aquatic habitats, particularly water contaminated with animal faeces and/or decaying organic matter (Palmer, 1980). Since, less human discharge activities were noticed in sampled stations, this accounted for fewer members (genera of E*uglena* and *Phacus* only) of the Euglenophyta.

In the division Rhodophyta, *Batrachospermum vagum* was the only species that was represented probably because the Rhodophyta are predominantly brackish and marine whereas River Okhuo is fresh water. This freshwater red alga has been reported in the plankton of other rivers in Nigeria however it is primarily a periphyton usually attached to submerged and emergent macrophytes (Akoma, 2007; Akomeah *et al*., 2010) The occurrence of Cyanobacteria, *Gleotrichia echinulata* may be by chance; nevertheless, it should not be overlooked as toxic algae have been implicated in death of aquatic flora and fauna (Wessells *et al*., 1995).

Finally, a detailed quantitative investigation of River Okhuo is advocated in the future so that a concrete link can be drawn between frequency of occurrence of algal species at different ecological zones.

CONCLUSION

Result from the present study revealed floristically diverse phytoplankton and periphyton composition in River Okhuo with predominantly more desmids and diatoms at the time of sampling. Diatoms and desmids are indicators of clean water system the section of River Okhuo sampled in this study is pristine, relatively clean or unpolluted. The water quality is adequate and would require low chemical dosage for treatment for potable use.

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