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Phytoplankton Dynamics of River Oli in Kainji Lake National Park, Nigeria during Dry Season

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Abstract: In this study, the phytoplankton of River Oli (Borgu sector) of kainji Lake National Park was investigated at the first time. It recorded total of fifty five taxa, belonging to four major divisions; Bacillariophyta, Chlorophyta, Euglenophyta and Cyanophyta. The taxa were dominated qualitative by green algae and quantitatively by euglenoids in particular *Euglena acus*. The paucity of phytoplankton composition in the River Oli could be partly due to the poor light penetration into highly turbid water.

Key words: River Oli, national park, phytoplankton, season, tropical

INTRODUCTION

The Nigerian climate is tropical, characterized by high temperatures and humidity as well as marked wet and dry seasons. The coastal areas have an annual rainfall ranging between 1, 500 and 4,000 mm (Kuruk, 2004). The surface water of the Nigerian coast is basically warm with temperature generally greater than 24°C. Kuruk (2004) reported that the hydrology of Nigeria is dominated by two great river systems, the Niger-Benue and the Chad systems. With the exception of a few rivers that empty directly into the Atlantic Ocean, all other flowing waters ultimately find their way into the Chad basin or down the lower Niger to the sea. The researchers also stated that the two river systems are separated by a primary watershed extending Northeast and North-West from the Bauchi Plateau which is the main source of their principal tributaries. Algological studies on lotic system in Nigeria are few and these include that of Egborge (1973, 1974, 1979), who reported the phytoplankton of Oshun river, Egborge and Sagay (1979) on freshwater ecosystem in Ibadan, Holden and Green (1960) on the River Sokoto, Nwadiaro and Ezefili (1986) and Erondu and Chindah (1991) reported the phytoplankton of new Calabar River, while Kadiri (1999) studied the lower River Niger phytoplankton, Kadiri and Azomani (2000) studied the effect of brewery effluent on the growth of two chlorophytes in Ikpoba River, Kadiri and Omozusi (2002) reported the phytoplankton of River Okhuahe in Benin and most recently Kadiri (2007) reported the phytoplankton of River Ethiope. Of all the mentioned rivers above, River Oli in Kainji Lake National Park and several other water bodies remain without phycological information hence, such study remain important because majority of the riverine inhabitant most of the time depend on their surrounding water (river) apart from rain water for their water needs. This study is a pioneer phycological investigation of River Oli in Nigeria.

MATERIALS AND METHODS

Study area: Kainji Lake National Park located in Niger and Kebbi states of Nigeria, is 560 km North of Lagos, close to the border with the Republic of Benin. It comprises two sectors (Borgu and Zugurma) which are separated by Kainji Lake. Only the Borgu (Western) sector is currently used for tourism; the Zugurma (Eastern) sector lacks infrastructure, including access roads. The Borgu sector is drained mainly by the Oli, Timo and Doro rivers and their tributaries, while the Zugurma sector is drained by the Maingyara and Nuwa Tizururu rivers. It covers an area of about 5.340 km^2 and the most important landmark of the park is Kainji Lake. Adjoining the Western side of the lake is the 3972 km^2 Borgu sector of the park which harbours River Oli, it is perennial as it breaks into pools during the dry season. At this period its surface rate of flow reduces but the pool remains and is often quite large and provides a source of water to the wildlife population while the wet season is characterized by a period of maximum volume. River Oli takes its source from the River Niger which is the third longest river in Africa and the longest river in West Africa with watershed area covers of about 1,250,000 km^2 (John, 1986) and finally crossing Nigeria from North-West to South (Iloeje, 1981). On the Eastern side is the Zugurma sector, both sectors are not connected by land. The larger of the two distinct sectors of the park, Borgu is an ecosystem in Northern Guinea vegetation zone characterized by tall grasses and savannah woodland. The vegetation of the park is typical of the Sudan-Guinea Savanna, although in some areas it appears more Sahelian. Riparian forests occur on the banks of the larger watercourses and some of the vegetation identified around this river are *Cola laurifolia*, *Terminalia aficiodis*, *Xylopia* sp., *Irvingia smithii*, *Bambus vulgaris*, *Burkea Africana*, *Diaspyrus mesfiformis*, *Symchnos spinosa*, *Grewia cubicens*, *Nauclea latifolia*, *Maytanus*

senegalensis and *Mallotus oppositifolis*. There is a distinct raining season from May to October with maximum rains in August and September. The park retains a robust animal population including antelope, lion, hippopotamus, buffalo, roan antelope, jackal, baboon, monkey and crocodile. The park is usually open from December to June, with the best time to visit towards the end of the dry season, when the grass has dried out and the animals move closer to the water for tourists to see. The park retains a robust animal population including antelope, lion, hippopotamus, buffalo, roan antelope, jackal, baboon, monkey and crocodile. The park is usually open from December to June, with the best time to visit towards the end of the dry season, when the grass has dried out and the animals move closer to the water.

Collection of samples: The study was based on a single sampling strategy during reconnaissance field trips in the Kainji Lake National Park, Borgu sector. Samples were collected on 16 April, 2009 from two locations due to accessibility as the river has breaks into pools which harbours animals like hippopotamus and crocodile. Station A (Latitude: 09° 53' 53.6N, Longitude: 003° 59' 07E) was called hippopotamus pool by the workers in the park while, station B (Latitude: 09° 54 43.4, Longitude: 003° 57' 13.5E) was very close to the park hostel. Biological samples were stored in 5 L, concentrated and fixed with 4% unbuffered formalin and analysed with the aid of Olympus XSZ-N107 photomicroscope. Taxanomic keys employed in the identification included Hustedt (1930-1937, 1971), Patrick and Reimer (1966, 1975), Prescott (1961-1973, 1982) and Whitford and Schumacher (1973). Community structure analysis used in this study have been described elsewhere (Adesalu and Nwankwo, 2008).

RESULTS

Surface water temperature recorded 31°C for both stations, the pH values of (7.08 and 7.20), surface water conductivities (70.0 and 70.10 mS cm^{-1}) values and salinity values recorded 0.01 and 0.02 ‰ for stations A and B, respectively.

Phytoplankton composition: A total of 55 taxa classified into 4 major divisions namely, Bacillariophyta, Chlorophyta, Euglenophyta and Cyanophyta were observed in this study. The green algae dominated the phytoplankton spectrum of both stations, it recorded 32.50 and 54.99% of total phytoplankton for stations A and B (Fig. 1) respectively with *Scenedesmus quadricauda* and *Pediastrum boryanum var longicorne* accounted for 7.50 and 6.67% of station A and *P. simplex* (13.78%) with *S. quadricauda* (13.63%) for station B. For station A the diatoms, euglenoids and blue green algae

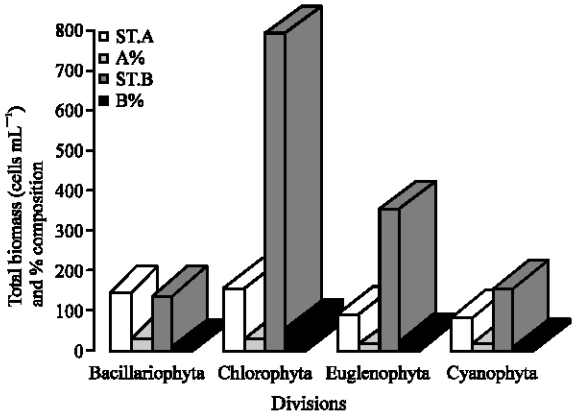

Fig. 1: Percentage composition of different divisions in Oli River

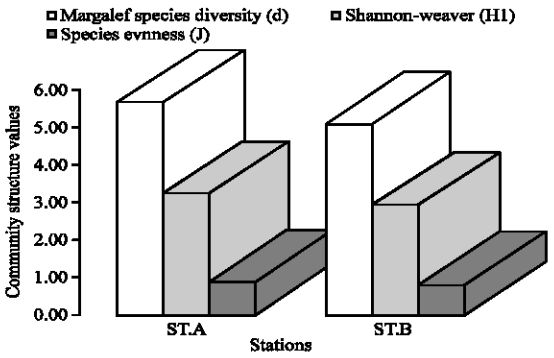

Fig. 2: Variations between community structure analysis in River Oli

recorded 30.42, 19.38 and 17.71% of total phytoplankton in that sequence making the blue-green algae the least represented with only three genera *Oscillatoria*, *Merismopedia* and *Chroococcus*. Interestingly, Station B did not follow that sequence rather the least represented divisions was bacillariophyta (9.50%) with *Navicula decusis* accounted for 2.30% (Table 1). The overall observation showed that the green algae were ably represented by chlorococcales particularly Scenedesmaceae (mostly *Scenedesmus* sp.) and the hydrodictyaceae mainly *Pediastrum* sp. *Euastrum sinuosum* and *Tetraedron* sp. were among the rare species encountered during investigation. Although, the euglenoids recorded lower percentage values for both stations, the taxon had a wide distribution with *Euglena acus* as dominant species. Shannon-Weaver information (H^1) value (3.23) was higher in station A while, low equitability value (0.81) was recorded for station B. Species richness d recorded its highest value (5.67) in station A. Dominance of phytoplankton samples by a few species was reflected by low equitability j value recorded and since, Margalef's d value is influenced by the number

of species and individuals, high d values recorded in station A reflected high species number and relatively low numbers of individuals. Variations between community structure analysis in River Oli are shown in Fig. 2. In River Oli, higher H values observed could be attributed to high j value recorded (Table 1).

Table 1: Phytoplankton abundance and percentage composition (cells mL^{-1}) of Oli River, Kainji Lake National Park (17/4/09)

		Station			
No.	Taxa	A	%A	B	%B
	Division: Bacillariophyta				
	Class: Bacillariophyceae				
	Order 1: Aulacoseirales				
	Family 1: Aulacoseiraceae				
1	*Aulacoseira granulata* (Ehrenb) Ralfs.	14	2.92	4	0.30
2	*Aulacoseira granulata var angustissima* O. Muller	37	7.71	26	1.93
	Order 2: Achnanthales				
	Family: Achnanthaceae				
3	*Achnanthes* sp.	4	0.83		
	Order 3: Fragilariales				
	Family: Fragilariaceae				
4	*Synedra* sp.	4	0.83		
5	*Ulnaria ulna* (Nitzsc) P Compère	18	3.75	2	0.15
	Order 4: Tabellariales				
	Family:Tabellariaceae				
6	*Tabellaria fenestrata* (Lyng.) Kutzing			2	0.15
	Order 5: Bacillariales				
7	*Nitzschia* sp.			2	0.15
	Order 6: Naviculales				
	Family 1: Naviculaceae				
8	*Frustulia rhokmboides var saxonica* (Rabh) de Toni			4	0.30
9	*Gyrosigma scalproides* (Raph.) Cleve			4	0.30
10	*Luticola mutica* Kutzing	20	4.17	15	1.11
11	*Mastogloia* sp.			14	1.04
12	*Navicula cryptocephala* Kutzing	8	1.67	1	0.07
13	*N. decusis* Ostrup	4	0.83	31	2.30
14	*N. exigua* (Greg.) O. Muller	14	2.92		
15	*N. rhyncocephala* Kutzing			12	0.89
16	*Navicula* sp.	4	0.83	12	0.89
17	*Pinnularia biceps* Gregory	6	1.25	4	0.30
18	*Pinnularia* sp.	4	0.83		
	Family 2: Cymbellaceae				
19	*Cymbella ventricosa* Kutzing			2	0.15
20	*Cymbella* sp.	3	0.63		
	Family 3: Gomphonemataceae				
21	*Gomphonema angustatum var producta* Grunow	3	0.63		
22	*G. parvulum* (Kutzing) Kutzing			2	0.15
23	*Gomphonema* sp.	3	0.63		
	Division: Chlorophyta				
	Class: Chlorophyceae				
	Order 1: Chlorococcales				
24	*Euastrum sinuosum Lenor*	3	0.63		
25	*Pediastrum boryanum var longicorne* Raciboski	32	6.67	128	9.48
26	*P. duplex* Meyen			96	7.11
27	*P. simplex* (Meyen) Lemm	17	3.54	186	13.78
28	*P. simplex var echinulatum* (Wittr)	11	2.29		
29	*P. tetras* (Ehr.) Ralfs			16	1.19
30	*Scenedesmus acuminatus* (Lag.) Chodat	8	1.67		
31	*S. armatus*			24	1.78
32	*S. armatus var bicaudatus* (Gugl.-Printz) Chodat	12	2.50		
33	*S. bicaudatus* Dedus			104	7.70
34	*S. denticulatus* Lagerh.	8	1.67		
35	*S. dimorphus* (Turp.) Kutz			16	1.19
36	*S. quadricauda* (Turp) Breb	36	7.50	184	13.63
37	*S. quadricauda var maxima* W and G.S West	4	0.83	20	1.48
38	*Tetraedron* sp.	1	0.21		
	Order 2: Desmidiales				
	Family: Closteriaceae				
39	*Closterium* sp.			4	0.30
	Order 3: Volvocales				
	Family: Volvocaceae				

Table 1: Continued

No.	Taxa	Station A	% A	B	% B
40	*Volvox* sp.	24	5.00	7	0.52
	Division: Euglenophyta				
	Class: Euglenophyceae				
	Order: Euglenales				
41	*Euglena acus* Ehr.	34	7.08	234	17.33
42	*E. deses* Ehr.			4	0.30
43	*Euglena ehrenbergii* Klebs			14	1.04
44	*E. limnophila* Lemm			14	1.04
45	*Euglena viridis*	18	3.75	42	3.11
46	*Euglena* sp.				
47	*Phacus longicauda*	13	2.71		
48	*Phacus orbicularis* Hubner	19	3.96	40	2.96
49	*Phacus* sp.	1	0.21		
50	*Strombbonas ovalis*	4	0.83		
51	*Strombbonas* sp.			8	0.59
52	*Trachelomonas* sp.	4	0.83		
	Division: Cyanophyta				
	Class: Cyanophyceae				
	Order 1: Chroococcales				
	Family 1: Chroococcaceae				
53	*Chroococcus* sp.	21	4.38	80	5.93
	Family 2: Merismopediaceae				
54	*Merismopedia glauca* (Ehr.) Nag	48	10.00	48	3.56
	Order 2: Oscillatoriales				
	Family 1: Oscillatoriaceae				
55	*Oscillatoria formosa* Bory	16	3.33	28	2.07
	Number of species	36		38	
	Total number of individuals	480		1442	
	Margalef species diversity (d)	5.67		5.09	
	Shannon-Weaver (H')	3.23		2.96	
	Species Evenness (j)	0.90		0.81	

% A: Percentage composition of species in station A; % B: Percentage composition of species in station B

DISCUSSION

The paucity of phytoplankton population in the River Oli may be partly due to the poor light penetration into highly turbid water, which reduced photosynthetic depth as a result of natural habitat that the river created for hippopotamus and crocodiles which most often mixes up the water for their own body temperature regulation especially, during dry season when this study was undertaken. In this study, the Euglenophyceae had a wider distribution and two of the organic pollution indicators species observed were *Euglena acus* Ehr. and *Phacus orbicularis* Hubner. The observation of more chlorophyta than diatoms and very few cyanophytes in this study conformed to typical trend in tropical water bodies (Kadiri, 1999; Kadiri and Omozusi, 2002; Couté and Rousselin, 1975; Kebede and Belay, 1994). Wetzel (1983) reported that chlorococcales inhabit water of differing salinity and alkalinity. The low desmids recorded could be a pointer that the river is poor in its ionic composition (Nwankwo, 1996) because, high diversity of desmids is an indication that the water body is largely unpolluted (Egborge and Sagay, 1979) and this is supported with *Euglena acus* recording the highest percentage composition (17.33%) for the overall phytoplankton spectrum. According to Caljon (1987) and Conforti (1991) this group is characteristic of eutrophic or nutrient rich water bodies and there abundant is a pointer that probably, the study area is organically polluted which could be due to animal faecation. So far, no work has been done on the algal flora of River Oli; hence all these forms constitute new records and this study has provided baseline data for the River Oli and more work needs to be done.

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