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DIVERSITY OF BENTHIC BIOTA OF SOME FRESHWATER HABITATS IN KABBA/BUNU LOCAL GOVERNMENT, KOGI STATE, NORTH-CENTRAL, NIGERIA

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Abstract
The composition and diversity of different water bodies in Kaaba/Bunu Local Government, Kogi State were investigated for both micro and macrobiota. The study covered Oinyi, Odogo and Odonkolo Rivers. Salinity values ranged between 0.03‰ and 0.07‰ indicating the freshwater status of these water bodies, pH was between 6.50 and 7.61. Conductivity values were between 88.1µS/cm and 131.7µS/cm while dissolved oxygen highest value (5.12mg/L) was recorded at Odonkolo River. For the phytobenthos, eighty-five taxa recorded were distributed among five divisions, Bacillariophyta, Chlorophyta, Charophyta, Euglenophyta and Cyanobacteria. Bacillariophyta (Diatoms) accounted for 78.28% of the identified species, followed by the Charophytes, (6.99%), Chlorophytes (5.61%), Euglenophytes (7.43%) and Cyanobacteria (1.69%). Macrobenthic invertebrates recorded three group; gastropoda (37.71%), insecta (28.57%) and oligochaeta (35.71%).

Key Words: *Phytobenthos, macrobenthic, Water, River, Diversity, Kogi State*

Introduction

Water bodies like rivers, are important by being involved in maintaining a balance in the ecosystem by supporting diverse plankton and other organisms in the food chain. Algae are important primary producers, since phytoplankton communities produce approximately half of the global net primary production (Field *et al*., 1998) as cited by Marinković *et al*. (2016). According to the European Water framework Directive (WFD 2000), phytoplankton and phytobenthos are used in the determination of water quality. They help to improve water quality and serve as nursery grounds for fish and crabs. Benthic algae, according to Makovinsca and Hlubikova (2015) are the most successful primary producers in aquatic habitats. They are important chemical modulators, transforming inorganic chemicals into organic forms, (Molholland, 1996) functions as stabilizers of substrata and serve as important habitat for many organisms (Makovinsca and Hlubikova, 2015). Biggs *et al*. (1998) were of the opinion that benthic algal community structure is driven by light and nutrients availability and disturbances which is hydrological stress. According to George *et al.* (2009)

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cited by Esenowo and Ugwumba (2010), macrobenthos play an important role in aquatic community which includes mineralization, mixing of sediments and flux of oxygen into sediment, cycling of organic matter and assessing the quality of inland water. The ecological problems in Kogi State include leaching, erosion and general impoverishment of the soil. These problems are compounded by the annual bush burning of the savanna that further exposed the top soil to more erosion. (Adeoye, 2012). This study was undertaken in order to have the baseline biota of these rivers since no phycological work has been done in these waters.

Materials and Methods

Description of Study Sites

The study site is located at the northern part of Kabba town, Alape road along Kabba-Ilorin road, Kabba, Kogi state (Fig 1.), Nigeria. Kogi state is characterized as a sub humid zone with derived savannah vegetation, patches of rainforest and harsh tolerance plant species alongside with economic trees and agricultural crops. Kabba/Bunu Local government part of the study site is described as Southern Guinea Savanna zone of secondary forest with dominant type being savanna woodland consisting of trees of varying species and scanty grass cover with a number of small sized farms growing a mix of cassava, yams, maize and cowpeas. Riparian vegetation along the study sites consist of *Raphia hookeri* G. Mann and H.Wendl, *Pterocarpus erinaceus* Poir, *Anchomanes difformis* (Blume) Engl, *Anogeissus leiocarpus* (DC.) Guill. And Perr., *Detarium macrocarpum* Harms, *Eriosema psoralioides* (Lam) G. Don, *Sporobolus pyramidalis* P. Beauv.,*Tephrosia linearis* (Willd.) Pers., *Urena lobata* L., *Vitex doniana* Sw., *Holarrhena floribunda* (G.Don.) Dur. & Schinz, *Mimosa pudica* L., *Margaritaria discoidea* (Baill.) Webster, *Hyptissua veolens* (L.) Poit, *Byrsocarpus coccineus* Schum. And Thonn., *Canavalia ensiformis* (L.) DC.),*Waltheria indica* L. The rivers are seasonal and partly dry up during the dry season but are very deep and wide during the wet season. These rivers serve as the main source of water for the inhabitants of the environment especially during wet season. During the wet season, the inhabitants carry out fishing activities in the river. Farming and Lumbering is the major activity at the study sites.

Oinyi River: Is a protected area, is in Oinyi Forestry Reserve and after Okpa area. The River is said to reach a depth of about 34m if traced further down. However, this particular location was more of a stream measuring 0.23m depth. The stream was covered by high forest vegetation (Plate 1 (A and B)). It was difficult to navigate further down because of the roughness of the terrain. The vegetation around this water body is dominated by *Tectona grandis, Gmelina arborea* and *Mimosa pudica* was seen growing abundantly at this site. Seven stations with GPS readings of N08^{O} 00.322' E006^{O} 17.231' (Station 1); N07^{O} 58.005' E006^{O} 15.811' (Station 2); N08^{O} 00. 213' E006^{O} 16.989' (Station3); N08^{O} 00. 253' E006^{O} 17.419' (Station 4); N08^{O} 00. 262' E006^{O} 16.911' (Station 5); N08^{O} 00. 538' E006^{O}16.690' (Station 6) and N07^{O} 57. 296' E006^{O} 14. 419' (Station 7) were created. The sediment is sandy.

Other Rivers: Some of the location shows evidence of erosion. The water was cloudy as a result of leaching of clay soil into the stream. The sediment was sandy with lot of stones for most of the water bodies around the study area. The vegetation around this area is similar to that describe above. Most rivers at the study site especially Odogu and Orioyo water are gravel bed river (Plate 1 (C and D)). Odonkolo River bank is densely populated with high forest plant species, the water looks clear; the depth and transparency measurements were the same (0.27m). Three stations with GPS readings of N07^{O} 57. 260' E006^{O} 14.593' (Station 8); (N07^{O} 57. 454' E006^{O} 15.250' (Station9); N07^{O} 56. 578' E006^{O} 14. 966' (Station 10) for Odogu and Orioyo River while Odonkolo has one station N07^{O} 58. 956' E006^{O} 20. 769' (Station 11).

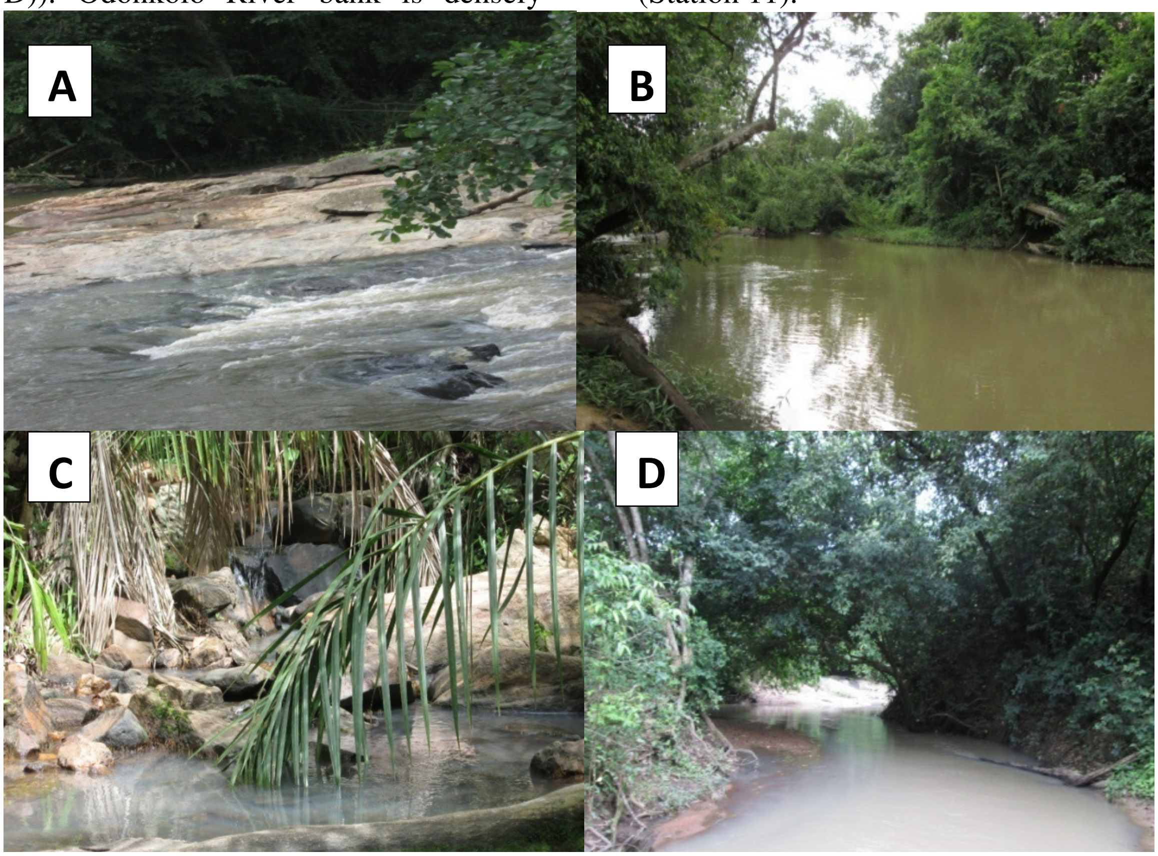

Plate 1: Some of the sampling sites at the location

Collection of Samples
Phytobenthos Sampling

Three replicate water samples were collected twice (March and June) to denotes the season (Dry and Wet). Due to the shallowness of the study site, water sampler was used directly to collect the water samples which were transferred into well labeled 500ml plastic containers with screw caps and preserved with 4% unbuffered formalin (Adesalu *et al*., 2015). Surface water samples for physico-chemical analysis were collected in 2litre container. Some analyses were done *in-situ* before taken the water samples for further analysis (Adesalu *et* *al*., 2015) Biological samples were analysed using relevant texts (Hustedt (1930–1937; 1954) Whitford and Schumacher (1973); Hendey (1964); Patrick and Reimer (1966, 1975), Krammer and Large-Bertalot (1986). Bukhtiyarova and Pomazkina, 2013.

Macrobenthos Sampling

As explained in Adesalu *et al*. (2016), at each station, soil samples were scooped directly at the sampling points due to shallowness of these sites. The sediments were sieved through a 0.5mm mesh size stainless sieve. The sieve and its contents were immersed in the native water and gently agitated until organisms debris matrix removed and sieve contents transferred into properly labeled, wide mounted glass jars containing 4% unbufferred formalin solution for preservation. The macrobenthos was observed under the Olympus microscope at different magnifications and biological species documented. Identifications were made using appropriate keys (Needham and Needham, 1962; Quigley, 1977; Atobatele, *et al*., 2005; Ibemenuga and Inyang, 2006).

Scanning Electron Microscopy

Phytobenthos collections were prepared for light and scanning electron microscope observations. A portion of the cleaned sample was added to distilled water. This slurry was filtered onto a 0.45 µm Millipore type HA filter. The filters were allowed to dry. A portion of the filter was cut and mounted to an aluminum stub using adhesive carbon tape. The aluminum stub was sputter coated with 20nm of gold or gold-palladium. All scanning electron microscope observations were performed with a JOEL JSM 6060LV using a 10 kV accelerating voltage at St. Cloud State University, U.S.A.

Physico-chemical Analysis

Measurement of the surface water temperature was made *in-situ* with the aid of mercury-in-glass thermometer while water depth was measured using a pole and measuring tape. Surface water salinity was determined by using handheld refractometer; conductivity was determined by the use of Philips PW9505 Conductivity Meter (Range: 3-100,000µS/cm and Automatic Temperature Compensation Unit) and the hydrogen ion concentration (pH) was analyzed using the Cole Parmer Tester3 (an electronic pH meter). Total suspended solid and total dissolved solids were determined using the Gravimetric method (2540D APHA, 1998). Dissolved oxygen was determined using Titrimetric (Iodometric) method (Azide modification procedure (APHA, 1988).

Community Structure Analysis

To obtain the estimate of species diversity, three community structure indices were used: Margalef's diversity index (d), Shannon-Weaner Index (H^1) (Shannon and Weaner 1963) and Species Equitability (j) or Evenness (Pielou, 1975).

Results

Physico-chemical Analysis

Surface water samples recorded an average of 28^{o}C and 32^{o}C for both season (wet and dry) while the salinity (0.03‰ - 0.07‰) of the water showed a freshwater environment the pH ranged between 6.50 and 7.61 for both season Table 1.

Table 1: Physico-chemical parameters results obtained at the different stations (Average)

	Stations										
	Parts of Oinyi River							Parts of Odogo River			Odonkolo River
	1	2	3	4	5	6	7	8	9	10	11
Air temperature (^{O}c)	32	30.5	34.5	30	31	33	34.8	30.5	35	33	32.8
Water temperature (^{O}c)	32	32	33	28.5	31.8	34	31	27.5	30.8	32	32.2
pH	7.53	7.12	7.46	7.24	7.33	7.61	7.49	6.50	7.26	6.52	7.56
Salinity (‰)	0.05	0.04	0.05	0.06	0.05	0.05	0.07	0.03	0.06	0.04	0.06
Depth (m)	0.76	0.67	0.67	0.43	0.34	0.46	0.53	0.41	0.52	0.46	0.40
Conductivity (µS/cm)	102.4	131.7	101.8	113.4	103	96.9	127.8	61.8	110	88.1	113
Total Dissolved Solids (mg/L)	75.7	53.9	74.8	84.8	76.3	69.1	98.1	45.2	80.6	65.7	83.7
Dissolved Oxygen (mg/L)	4.5	4.08	3.83	3.15	4.42	4.78	1.94	0.08	3.92	3.4	5.12

Phytobenthos

The phytobenthos community of the Kaaba/Bunu locations of the sampling sites recorded 85 taxa distributed among five divisions Bacillariophyta, Chlorophyta, Charophyta, Euglenophyta and Cyanobacteria (Table 2). The composition of different groups among the eleven stations sampled is shown in Figure 1. Most species belong to the division, Bacillariophyta which is a diverse group with 78.28% of the identified species, followed by Euglenophytes (7.43%) and Charophyta (6.99.0%) and The Chlorophytes and Cyanobacteria recorded 5.61% and 1.69% respectively, (Figure2). Among the diatoms, *Pinnularia* (10 species), *Nitzschia* (9 species), *Navicula* (7 species), *Amphora* (6 species) and *Gomphonema* (5 species) were the dominant genera. The Chlorophytes and Euglenophytes recorded 8 species each with six and three genera respectively. The blue green (Cyanobacteria) had three species with two genera, *Chroococcus* and *Oscillatoria*. Community structure analysis as shown in Figure 3 revealed the relationship between the Shannon Weaner index and Margalef (diversity) following almost same pattern. Scanning electron microscopy images of some species especially diatoms are presented on Plate 2.

Table 2: Phytobenthos composition at the different locations in Kogi during dry and wet seasons at (cells/ml)

		Parts of Oinyi River						Parts of Odogu River				Odonkolo River
		1	2	3	4	5	6	7	8	9	10	11
		(N08^{O} 00. 322' E006^{O} 17. 231')	(N07^{O} 58. 005' E006^{O} 15. 811')	(N08^{O} 00. 213' E006^{O} 16. 989')	(N08^{O} 00. 253' E006^{O} 17. 419')	(N08^{O} 00. 262' E006^{O} 16. 911')	(N08^{O} 00. 538' E006^{O} 16. 690')	(N07^{O} 57. 296' E006^{O} 14. 419')	(N07^{O} 57. 260' E006^{O} 14. 593')	(N07^{O} 57. 454' E006^{O} 15. 250')	(N07^{O} 56. 578' E006^{O} 14. 966')	(N07^{O} 58. 956' E006^{O} 20. 769')
	Division: Bacillariophyta											
	Class:Bacillariophyceae											
	Order: Aulacoseirales											
	Family: Aulacoseiraceae											
1	*Aulacoseira. granulata* var. *angustissima* (O.Müll.) Simonsen	_	30	_	_	_	_	_	_	_	_	_
	Order: Bacillariales											
	Family Bacillariaceae											
2	*Nitzschia fasciculate* (Grunow) Grunow	40	_	_	40	_	_	10	_	_	_	_
3	*N. flexoides* Geitler	30	_	20	_	_	10	_	_	_	_	10
4	*Nitzschia filiformis* var. *ignorata* (Krasske) Cleve	40	_	10	20	_	_	_	_	_	_	_
5	*N. flexoides* Geitler	_	40	_	_	20	_	_	_	_	_	_
6	*N. ignorata* Krasske	_	10	_	30	10	_	_	_	_	_	_
7	*N. linearis* W. Smith	10	_	_	_	_	_	_	_	_	_	_
8	*N. palea* (Kutz) W.Sm	10	_	20	_	_	30	_	_	_	_	30
9	*N. sigmoidea* (Nitzsch) W.Smith	_	_	_	_	_	_	_	_	_	_	10
10	*N. sublinearis* Hustedt	30	_	_	_	_	_	_	_	_	_	_
11	*Nitzschia* sp.	10	_	10	40	_	_	_	_	_	_	_
	Order: Cocconeidales											
	Family: Cocconeidaceae											
12	*Cocconeis disculus* (Schumann) Cleve	20	_	_	_	_	_	_	_	_	_	_
13	*Cocconeis placentula*Ehrenberg	_	_	10	_	10	20	_	_	_	_	80
	Family: Achnanthidiaceae											
14	*Achnanthidium* sp.	60	_	_	_	_	_	_	_	_	_	_
15	*Planothidium lanceolatum* (Brébisson ex Kützing) Lange-Bertalot	10	_	_	_	_	_	_	_	_	_	_
	Order: Coscinodiscales											
	Family: Coscinodiscaceae											
16	*Coscinodiscus* sp.	_	_	_	_	_	_	_	_	100	_	_
	Order: Cymbellales											
	Family: Cymbellaceae											
17	*Cymbella silesiaca* Bleisch	_	10	_	_	_	_	_	_	_	_	_
18	*Cymbella* sp.	_	_	20	_	10	20	_	_	_	_	10
	Family: Gomphonemataceae											

19	*Gomphonema angustatum* Agardh	_	10	_	_	_	_	_	_	_	_	_
20	*G. clavatum* Ehrenberg	10	10	_	_	10	_	_	_	_	_	_
21	*G. subclavatum* (Grunow) Grunow	_	_	10	_	_	10	_	_	_	_	_
22	*G. minutum* C. Agardh) C. Agardh	10	_	_	_	_	_	_	_	_	_	_
23	*G. parvulum* (Kützing) Kützing	10	_	_	_	_	_	_	_	_	_	_
	Order: Eunotiales											
	Family: Eunotiaceae											
24	*Eunotia subarcuatoides* Alles, Nörpel & Lange-Bertalot	_	_	10	_	_	_	_	_	_	10	_
	Order: Fragilariales											
	Family: Fragilariaceae											
25	*Fragilaria* sp.	70	20	_	_	10	_	_	_	_	10	_
26	*Synedra* sp.	50	50	_	10	_	70	_	_	_	_	10
	Order: Licmophorales											
	Family: Ulnariaceae											
27	*Ulnaria ulna* (Nitzsch) Compère	_	_	30	10	30	60	_	_	_	_	10
28	*U. ulna* var. *contracta* (Østrup) Morales	60	_	_	_	_	_	_	_	_	_	_
29	*Ulnaria danica (Kützing) Compère & Bukhtiyarova*	_	10	_	10	_	_	_	_	_	_	_
30	*U. ulna* var. *oxyrynchus* (Kützing) Aboal	10	10	_	30	10	_	_	_	_	_	10
31	*Ulnaria* sp.	_	20	10	_	10	10	_	_	_	_	20
	Order: Naviculales											
	Family: Amphipleuraceae											
32	*Frustulia rhomboids* (Ehr.) de Toni	_	10	_	_	_	_	_	_	_	_	_
33	*F. rhomboids* var. *crassinervia* ((Brébisson ex W.Smith)) Ross	_	10	_	_	_	_	_	_	_	_	_
34	*F. vulgaris* (Thwaites) De Toni	_	10	_	_	_	_	_	_	_	_	_
	Family: Naviculaceae											
35	*Gyrosigma scalproides* (Rabenhorst) Cleve	_	30	_	_	_	_	_	_	_	_	10
36	*Navigeia decussis* (Østrup) Bukhtiyarova	20	10	_	_	_	_	_	_	_	_	_
37	*Navicula exigua* (Greg.) O. Muller	30	70	30	_	20	20	_	_	_	_	30
38	*N. mutica* Kutzing	20	180	110	60	40	20	_	_	_	_	10
39	*N. placenta* Ehr.	_	10	30	_	10	_	_	_	_	_	_
40	*N. pupila* Kutz.	40	390	190	120	30	20	10	10	_	_	100
41	*N. radiosa* (Kutz.)	110	_	50	10	10	_	_	10	_	_	10
	Family: Neidiaceae											
42	*Neidium*sp.	_	_	10	_	_	_	_	_	_	_	_
	Family: Pinnulariaceae											
43	*Pinnularia abaujensis* (Plant.) Ross	_	_	_	10	_	_	_	_	_	_	_
44	*P. acrosphaeria* Smith	_	_	_	_	20	_	10	_	_	_	_
45	*P. legumen* Ehr.	_	_	_	_	_	_	_	10	_	_	_
46	*P. lundii* Hustedt	70	_	_	_	_	_	_	_	_	_	_

47	*P. macilenta* Ehr.	160	460	130	270	130	30	10	_	10	30	110
48	*P. maior* (Kutzing) Rabenhorst	_	_	10	10	_	_	_	_	_	_	_
49	*P. microstauron* (Ehrenberg) Cleve	20	_	_	_	_	_	_	_	_	_	_
50	*P. subcapitata* Gregory	10	_	30	_	40	_	_	_	_	_	10
51	*P. viridis* (Nitz.) Ehrenberg	_	_	10	_	_	_	_	_	_	_	
52	*Pinnularia* sp.	30	40	_	_	_	_	_	_	_	_	20
	Family: Pleurosigmataceae											
53	*Pleurosigma* sp.	90	80	40	40	20	_	_	10	_	_	10
	Family: Stauroneidaceae											
54	*Stauroneis phoenicenteron* (Nitzsch) Ehrenberg	_	10	80	_	_	_	10	_	_	_	_
55	*Stauroneis* sp.	_	20	_	_	_	_	_	_	_	_	10
	Order: Rhopalodiales											
	Family: Rhopalodiaceae											
56	*Rhopalodia gibba*(Ehr.) Muller	40	20	310	10	10	40	_	_	_	_	100
57	*Rhopalodia* sp.	_	40	170	_	_	20	_	_	_	_	130
	Order: Stephanodiscales											
	Family: Stephanodisceae											
58	*Cyclotella* sp.	10	20	_	_	_	_	10	_	_	_	_
	Order: Surirellales											
	Family: Surirellaceae											
59	*Cymatopleura solea* (Breb) W. Sm	30	270	10	120	50	_	_	_	_	_	10
60	*Surirella elegans* Ehrenberg	10	_	_	_	10	_	_	_	_	_	_
	Order: Thalassiophysales											
	Family: Catenulaceae											
61	*Amphora coffeaeformis* (Agardh) Kützing	_	_	30	_	10	_	_	_	_	_	20
62	*A. commutate* Grunow	_	10	_	_	20	_	_	_	_	_	_
63	*A. delicatissima* Krasske	_	_	10	_	_	_	_	10	_	_	_
64	*A. holsatica* Hustedt	10	_	_	_	_	_	_	_	_	_	_
65	*A. ovalis* (Kutzing) Kutzing	10	_	_	_	_	_	_	_	_	_	_
66	*Amphora* sp.	_	30	10	_	10	20	_	_	_	_	20
	Division: Charophyta											
	Class: Zygnematophyceae											
	Order: Desmidiales											
	Family: Closteriaceae											
67	*Closterium acerosum* Ehrenberg ex Ralfs	_	_	_	_	_	_	_	_	_	_	20
68	*C. closterioides* (Ralfs) A. Louis & Peters	_	_	_	10	_	_	_	_	10	_	_
	Family: Desmidiaceae											
69	*Cosmarium* sp.	_	_	20	_	20	_	_	_	_	_	10
	Family: Gonatozygaceae											
70	*Gonatozygon* sp.	_	_	20	20	_	_	_	_	_	_	30
	Order: Zygnematales											

	Family: Zygnemataceae											
71	*Spirogyra* sp.	_	_	_	_	_	500	_	_	_	_	_
	Division: Chlorophyta											
	Class: Chlorophyceae											
	Order: Sphaeropleales											
	Family: Scenedesmaceae											
72	*Desmodesmus quadricauda* (Turp.) Breb.	10	_	_	_	_	_	10	_	_	_	_
73	*D. quaricauda*var. *westii*G.M. Smith	_	10	_	_	_	_	_	_	_	_	_
	Family: Microsporaceae											
74	*Microspora* sp.	_	_	_	_	_	_	500	_	_	_	_
	Division: Euglenophyta											
	Class: Euglenophyceae											
	Order: Euglenales											
	Family: Euglenaceae											
75	*Euglena acus* var. *rigida* Huebner	_	_	_	_	_	_	_	_	10	_	_
76	*E. intermedia* (Klebs) Schmitz	_	_	_	_	_	_	_	_	10	_	_
77	*E. proxima* Dangeard	_	10	_	_	_	_	_	_	_	_	_
78	*Euglena* sp.	_	10	_	_	20	20	_	20	430	10	10
82	*Trachelomonas* sp.	10	_	_	_	_	_	_	_	_	_	_
	Family: Phacaceae											
79	*Phacus curvicauda* Svirenko	_	_	_	_	_	_	10	_	10	_	_
80	*P. longicauda* (Ehrenb.) Dujardin	_	_	_	_	_	_	_	_	30	_	_
81	*Phacus* sp.	_	_	_	10	40	_	1	_	40	_	_
	Division: Cyanobacteria											
	Class: Cyanophyceae											
	Order: Chroococcales											
	Family: Chroococcaceae											
83	*Chroococcus* sp.	_	10	_	_	_	_	_	_	_	_	_
	Order: Oscillatoriales											
	Family: Oscillatoriaceae											
84	*Oscillatoria agardii* Gomont	60	_	_	_	_	_	_	_	_	_	_
85	*Oscillatoria* sp.	_	_	_	10	_	_	80	_	_	_	_
	Total number of species	37	35	30	21	27	17	11	6	9	4	28
	Total number of individuals	1270	1980	1450	890	630	920	661	70	650	60	860
	Margalef (d)	5.04	4.48	3.98	2.94	4.03	2.34	1.54	1.18	1.24	0.73	4.00
	Shannon-Weiner (H1)	3.25	2.58	2.74	2.36	2.96	2.60	1.41	1.75	1.20	1.24	2.84
	Species evenness (j)	0.90	0.73	0.09	0.78	0.90	0.92	0.59	0.98	0.55	0.89	0.85

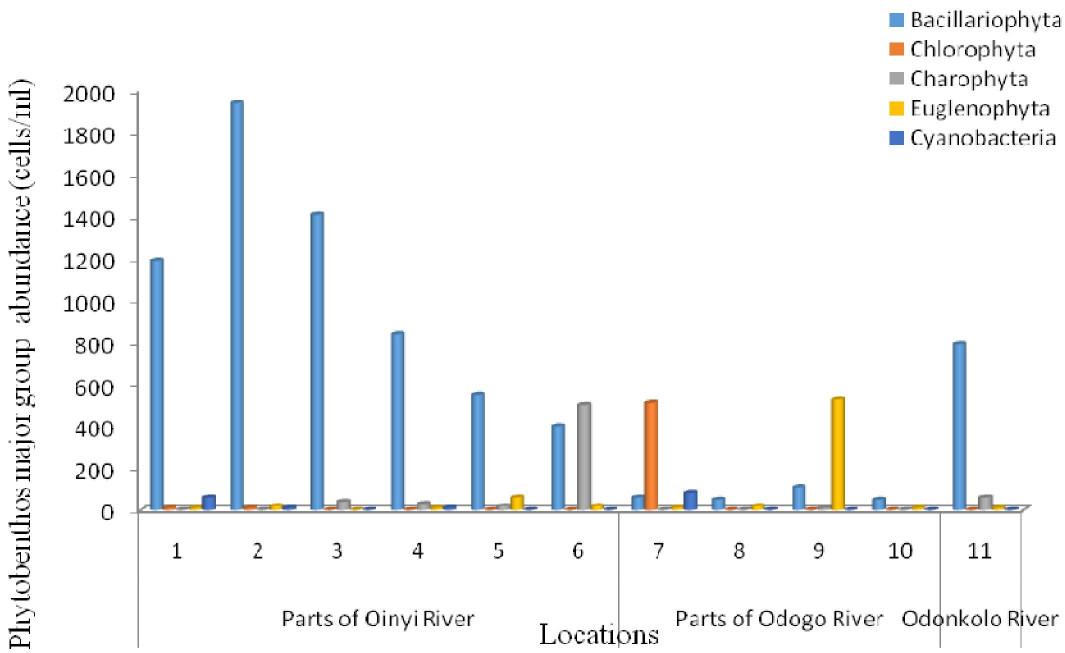

Figure 1: Comparison of different phytobenthos group abundance at different locations in Kaaba/Bunu Kogi

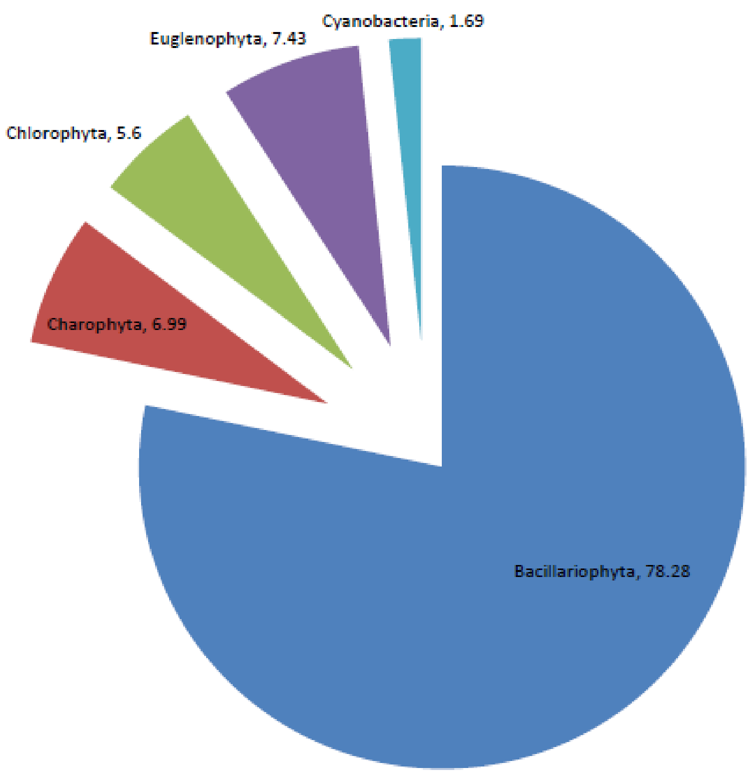

Figure 2: Percentage composition of major groups of phytobenthos

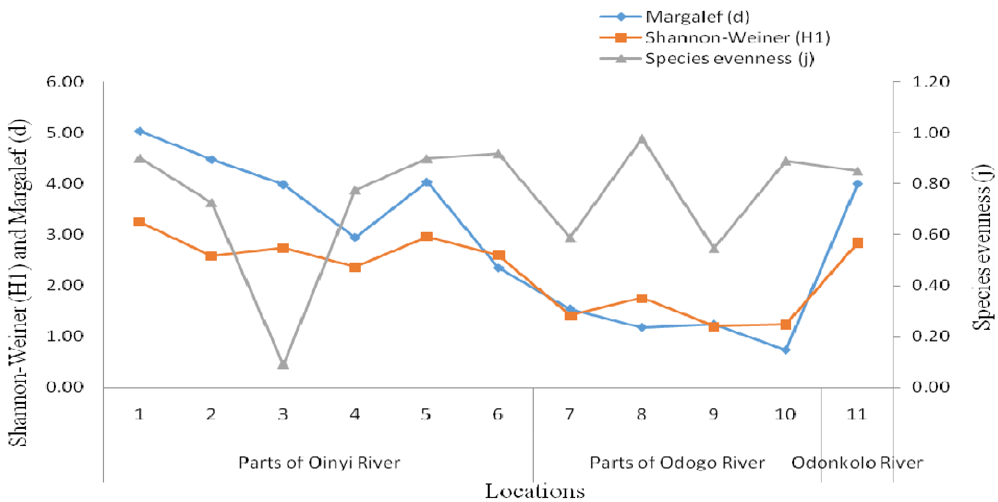

Figure 3: Community structure analysis at Kaaba/Bunu, Kogi locations

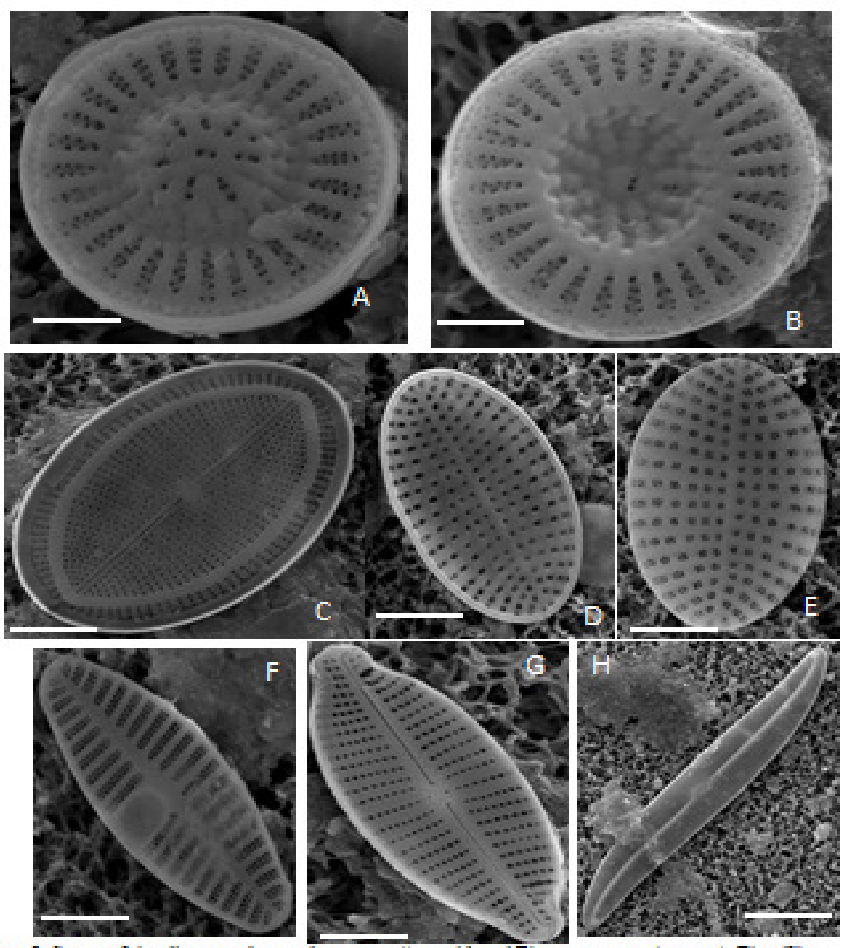

Plate 2: Some of the diatoms observed , *Discotella* sp. (A and B); *Cocconeis placentula* Ehr. (C); *Cocconeis disculus* (Schumann) Cleve (D); *Cocconeis* sp. (E); *Achnanthes lanceolata* (Brébisson ex Kützing) Grunow (F); *Achnanthidium* sp. (G) and *Gyrosigma scalproides* (Rabenhorst) Cleve (H). Bar =10μm

Macrobenthos

The analysis for the benthic samples was presented on Table 3 .The macro benthic invertebrates were represented by 14 taxa, belonging to 3 groups (Table 3).The dominant groups were the Gastropoda and Oligochaeta with each accounting for 35.71% while the Insecta group accounted for 28.57% of the total individuals respectively (Figures 4 and 5). The dominant taxa were *Potamopyrgus* and *Lumbriculus* species accounting for 35.71% each of the total individuals recorded while *Aeschna* and *Chironomus* species were least represented with 14.29% each of the total individuals recorded (Figure 6).The Shannon-Wiener Index (Hs)**,** Margalef Index (d) and Equitability Index (j) were highest at some stations (Table 3).

Table 3.The distribution, occurrence and diversity indices of macro-benthic invertebrate community at the study stations

	Stations										
	Parts of Oinyi River					Parts of Odogo River					Odonkolo River
	1	2	3	4	5	6	7	8	9	10	11
GASTROPODA											
Potamopyrgus spp.	1	-			1	3	-		-	-	-
INSECTA											
Aeschna spp.	-	-	-	-		1	-	1	-		
Chironomus spp.	-	-	-	-	1		-		-		1
OLIGOCHAETA											
Lumbriculus spp.	1	-	-	-	1	1	-		-	1	1
Total species diversity (S)	2	-	-	-	3	3	-	1	-	1	2
Total abundance (N)	2	-	-	-	3	5	-	1	-	1	2
Log of Species diversity (Log S)	0.30	-	-	-	0.45	0.45	-	0.00	-	0.00	0.30
Log of abundance (Log N)	0.30	-	-	-	0.45	0.7	-	0.00	-	0.00	0.30
Shannon-Wiener Index (Hs)	0.30	-	-	-	0.48	0.41	-	0.00	-	0.00	0.30
Margalef Index (d)	1.45	-	-	-	1.82	1.24	-	0.00	-	0.00	1.45
Equitability Index (j)	1.00	-	-	-	1.07	0.91	-	0.00	-	0.00	1.00

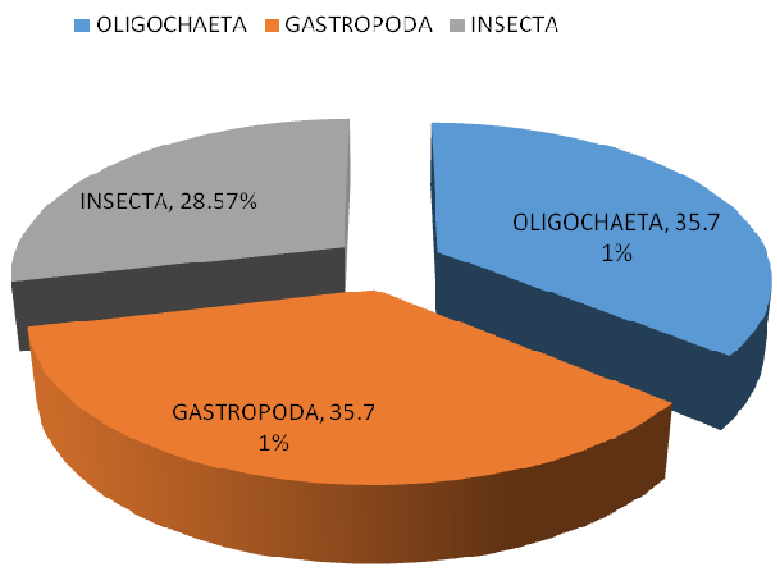

Figure 4: Percentage contribution of the major macro-benthic invertebrate groups at the study stations

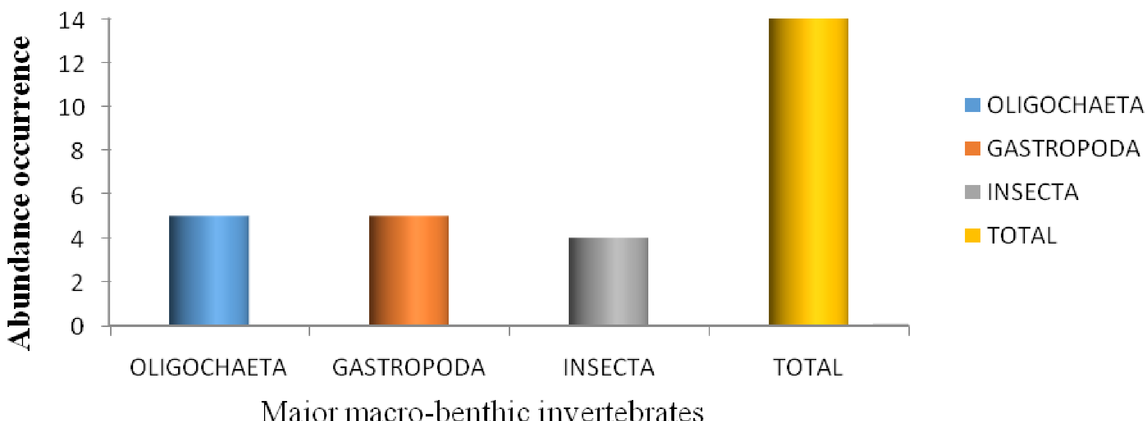

Figure 5: Summary of the abundance (Number of individuals/m^2) of macro-benthic invertebrate groups at the study stations

Discussion

The relative abundance of diatoms in these rivers may be as a result of the shallowness which paved way for deep light penetration which supports the rate of photosynthesis. The dominance of diatoms over other group confirms earlier reports made by Chindah and Pudo (1991) in Bonny River; Erondu and Chindah (1991) in the newCalabar River, Niger Delta; Adesalu (2008) in Lekki lagoon; Adesalu and Nwankwo (2005, 2008) in Olero and Abule Eledu creek respectively; Adesalu and Kunrunmi (2012) in the Lagoons of South-Western Nigeria, Adesalu and Kunrunmi (2016) for Majidun creek; Adesalu *et al.* (2008, 2014, 2015) in Ogbe and Ipa-Itako creeks and Majidun. However, the low number in the population of macro-benthic invertebrates recorded at the study stations could be due to the developmental rate of small macro-invertebrates, since most aquatic invertebrates are benthic only at larval stages while their adult lives are spent outside aquatic environments (Ibemenuga and Inyang, 2006).The total number of 14 taxa reported in this present study is far less than those reported for rivers elsewhere (Edema *et al*., 2002; Adakole and Anunne, 2003, Adesalu*et al*., 2016a and b) and these may be as a result of different environmental conditions such as water quality and movement, substrate instability and food availability (Esenowo and Ugwumba (2010).The water body as described previously, especially the Oinyi river is seasonal and this was observed in dry season as most of the river course was dry while in wet season, the water was not evenly distributed. Parts of the river were also dried while some parts were flooded in the wet season but no fish was caught.

Conclusion

The dominant of diatoms species in this study supported other reports from similar water bodies in Nigeria while the absence of *Eunotia* species conformed to the fact that they thrive very well in acidic water in this case the water is essentially neutral. However, the euglenoids, an indicator of organically polluted area which was observed in some of the stations especially Station 10 is probably due to the closeness of this station to settlements where domestic wastes get into the water body unabated. The paucity of benthic fauna in these rivers might be due to the nature of the river bed.The observation of desmids, an indicator of nutrient poor water (oligotrophic) also implies that the rivers still support life as depicted by high dissolved oxygen value..

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