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Phytoplankton abundance and diversity of River Okpokwu, Benue State

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Abstract
Seasonal abundance and diversity of phytoplankton of River Okpokwu was determined at 3 locations of the River Okpokwu designated as Station A, (Known as Madam Ori side), Station B, (Known as Ogbe side) and Station C (Known as Igede side) all in Ado Local Government Area of Benue State. In dry season, a total of 9118 phytoplankton belonging to five families (Bacillariophyceae, Chlorophyceae, Cyanophyceae, Chrysophyceae and Euglenophyceae) was encountered; while family Bacillariophyceae had the highest percentage (52.92%) phytoplankton abundance, Chrysophyceae had the least (1.57%). While Shannon weinner index of 3.82, 4.37 and 4.34 were recorded for stations A, B and C, Margalef index of 4.04, 4.61 and 4.44 were recorded for stations A, B and C, respectively whereas in rainy season, a total number of 7617 phytoplankton belonging to five families; Bacillariophyceae, Chlorophyceae, Cyanophyceae, Chrysophyceae and family Euglenophyceae were also encountered. Of these families, while Bacillariophyceae (55.32%) had the highest percentage phytoplankton abundance, Chrysophyceae had 0.91% as the least abundance. While Shannon weinner index of 4.38, 4.56 and 4.43 were recorded for stations A, B and C, Margalef index of 4.34, 4.601 and 4.48 were recorded for stations A, B and C, respectively. In dry season, the month of December, 2015 was most abundant (8.63%) in phytoplankton richness while January, 2017 recorded the least phytoplankton abundance (8.15%) whereas in rainy season, the month of October, 2015 was most abundant (8.99%) in phytoplankton richness while January, 2015 recorded the least phytoplankton abundance (7.72%).

Keywords: Seasonal variation, phytoplankton abundance, phytoplankton diversity, River Okpokwu

Introduction
Phytoplankton are the plantlike organisms that are found in aquatic environments, they are the primary producers which serves as food majorly for zooplankton which in turn serves as an important source of food to crustaceans and fish (Thurman, 1997) [15]. They therefore, serve as a major source of organic carbon in rivers and may represent an important source of oxygen in low-gradient aquatic ecosystem. An assessment of phytoplankton community and abundance will enhance the understanding of biological productivity and fish population dynamics as they are known to serve as the food base that supports aquatic life (Abohweyere 1990) [2]
Although phytoplankton distribution and abundance are largely influenced by the light and nutrient, alteration of their natural environment by man can greatly distort this equilibrium. These may explain why plankters are used as bioindicators to monitor aquatic pollution.
Seasonal variations affect the physic-chemical variables thus causing variation in abundance and diversity of phytoplankton. Also, human activities such as agricultural and industrial going on along the Okpokwu River introduce wastes into it, which could affect the physic-chemical variables from season to season. These therefore cause seasonal variation in phytoplankton populations of the river. There is dearth of information on the seasonal abundance and diversity of phytoplankton of River Okpokwu. This work seeks to provide such vital base line information of the river for future references.

Materials and Methods
Study Area and Sample Collection
The study was undertaken at 3 locations of River Okpokwu designated as Station A, (Known as Madam Ori side), Station B, (Known as Ogbe side) and Station C (Known as Igede side) all in Ado Local Government Area of Benue State. These stations were selected considering the riparian nature and activities of the settlements.

Ado Local Government Area of Benue State, Nigeria. River Okpokwu transverses Ogbadibo, Okpokwu, Ado Local Government Areas of Benue State to Cross River State. River Okpokwu occasionally suffers flooding. The water of River Okpokwu is the sole source of drinking water for the inhabitants of Igumale and its environs. Besides, water from the river is also used for irrigation, recreation, sewage disposal, fishing.

The study area is the only portion of the river where there are true riparian communities, with settlements on both banks of the river. The area is located between latitude 6° 48' 0" N and longitude 7° 58' 0" E. The river covers about 76.76km and it is predominantly inhabited by the Idoma speaking group. They live in an area of 13,015 kilometers, covering: Otukpo, Okpokwu, Oju, Ado and Apa Divisions, with Otukpo as their main town. Idoma land is bounded on the north by the Benue River, on the west by the Tiv, on the south by Nsukka and Abakaliki areas, respectively.

The riparian communities of River Okpokwu are all of the Idoma extract at the upstream (Benue State) and Iyala people of Cross River State who reside at the downstream. The people are predominantly farmers who depend largely on the river for their livelihood. Both the people of Ado Local Government Area of Benue State and Iyala in Ogoja Local Government Area of Cross River State speak Idoma and are believed to have descended from one ancestral home. The climate is characterized by two distinct seasons, the dry season (November – April) and Wet season (May – October).

Sample Collection

Phytoplankton sampling of River Okpokwu

Samplings were undertaken fortnightly in the mornings from May, 2015 to April, 2017 by pour through method. Twenty litres of the water sample were collected just beneath the surface and poured through 55µm mesh size plankton net. These were repeated 5 time to add up to 100 litres. The planktons were immediately fixed with 5% formalin solution in 50 ml sampling bottle and transported to the laboratory for analysis and identification. The samples were concentrated to 10mls to enable analysis. One ml of the preserved sample was taken using a pipette. This was place into Sedgwick rafter counting chamber and viewed under different magnifications (x100 and x400) using a light binocular microscope (Nikon 400 binocular microscope). These were done in triplicates. The plankton were identified and sorted into different taxonomical groups with the aid of appropriate identification schemes (Mann 2000, Prasad 2000, Castro and Huber 2005) [11, 14, 5].

Statistical Analyses

All data on the physicochemical parameters and biological studies were analyzed using analysis of variance (ANOVA). Correlation among parameters was done to determine relationship between variables (Gomez and Gomez, 1984) [9]. The effect of significance in ANOVA was tested using Fisher protected LSD to distinguish difference between means.

The estimation of species abundance and diversity of phytoplankton among the stations were done using species Shannon Weiner index and Marglef's index.

Results

Results of the percentage phytoplankton composition and abundance in dry season at the three stations are presented in Table 1 while results of percentage phytoplankton composition and abundance in rainy season at the three stations are presented in Table 2.

In dry season, a total number of 9118 phytoplankton belonging to five families (Bacillariophyceae, Chlorophyceae, Cyanophyceae, Chrysophyceae and Euglenophyceae) was encountered during the study period. Six species of family Bacillariophyceae (*Cyclotella comta, AulacoSeira sp, Fragilaria sp, Nitzschia sp, Coscinodiscus sp* and *Navicula sp*), five species of family Chlorophyceae (*Mougeotia sp, Ulothrix Tenuissima sp, Cladophora Oligoclona sp, Spirogyra sp* and *Oedogonium sp*), three species of family Cyanophyceae (*Chroococcus sp, Merismopedia sp* and *Oscillatoria sp*), two species of family Chrysophyceae (*Asterionella sp* and *Synura sp*) while two species of family Euglenophyceae (*Phacus sp* and *Euglena sp*) were encountered.

At station A, family Bacillariophyceae accounted for 668 out of the 1597 phytoplankton out of which *AulacoSeira sp* was the most abundant (41.62%) while *Navicula sp* the least abundant (3.29%); family Chlorophyceae accounted for 448, out of which *Oedoganium sp* was most abundant (30.58%) while *Ulothrix Tenuissima sp* was least abundant (7.37%); family Cyanophyceae accounted for 329 number of zooplankton of which *Chroococcus sp* was most abundant (48.94%) while *Oscillatoria sp* was least abundant (12.46%); family Chrysophyceae accounted for 56 of which *Synura sp* was most abundant (53.57%) and *Asterionella sp* least abundant (46.43%) while family Euglenphyceae accounted for 96 of which Euglena sp was most abundant (64.58%) and Phacus sp least abundant (35.42%).

At station B, family Bacillariophyceae accounted for 3184 out of the 5173 phytoplankton encountered; while *Coscinodiscus sp* was the most abundant (27.32%), *Nitzchia sp* the least abundant (4.52%); family Chlorophyceae accounted for 1117, out of which *Oedoganium sp* was most abundant (28.29%) and *Mougeotia sp* was least abundant (10.74%); family Cyanophyceae accounted for 753 number of phytoplankton of which *Merismopedia sp* was most abundant (48.61%) while *Oscillatoria sp* was least abundant (13.01%); family Chrysophyceae accounted for 44 of which both *Asterionella sp* and *Synura sp* were (50.00% each), while family Euglenphyceae accounted for 75 of which *Euglena sp* was most abundant (65.33%) and *Phacus sp* least abundant (34.67%).

At station C, family Bacillariophyceae accounted for 973 out of the 2348 phytoplankton encountered; while *Coscinodiscus sp* was the most abundant (27.95%), *Cyclotella comta* was the least abundant (4.93%); family Chlorophyceae accounted for 1022, out of which CladophoraOligoclona sp was most abundant (29.94%) and Mougeotia sp was least abundant (9.49%); family Cyanophyceae accounted for 258 number of phytoplankton of which Merismopedia sp was most abundant (47.67%) and Chroococcus sp was least abundant (25.97%), family Chrysophyceae accounted for 43 of which *Asterionella sp* was most abundant (51.16%) and *Synura sp* was least abundant (48.84%) while, family Euglenphyceae accounted for 52 of which *Euglena sp* was most abundant (63.46%) and *Phacus sp* least abundant (36.54%).

Generally, the decreasing order of abundance phyto[lankton in dry season was family Bacillariophyceae (52.92%), family Chlorophyceae (28.37%), family Cyanophyceae (14.70%), family Euglenophyceae (2.45%), family Chrysophyceae (1.57%) whereas in rainy season, a total number of 7617 phytoplankton belonging to five families; Bacillariophyceae,

Chlorophyceae, Cyanophyceae, Chrysophyceae and family Euglenophyceae were encountered during the study period. Six species of family Bacillariophyceae (*Cyclotella comta, AulacoSeira sp, Fragilaria sp, Nitzchia sp, Coscinodiscus sp* and *Navicula sp),* five species of family Chlorophyceae (*Mougeotia sp, Ulothrix Tenuissima sp, Cladophora Oligoclona sp, Spirogyra sp* and *Oedoganium sp),* family Cyanophyceae (*Chroococcus sp, Merismopedia sp* and *Oscillatoria sp),* two species of family Chrysophyceae (*Asterionella sp* and *Synura sp)* while two species of family Euglenophyceae (*Phacus sp* and *Euglena sp)* were encountered.

At station A, family Bacillariophyceae accounted for 493 out of the 1138 phytoplankton encountered while *AulacoSeira sp* was the most abundant (46.65%), *Navicula sp* was least abundant (2.23%); family Chlorophyceae accounted for 335, out of which *Oedoganium sp* was most abundant (34.33%) while *Ulothrix Tenuissima* sp was least abundant (4.48%); family Cyanophyceae accounted for 129 number of phytoplankton of which *Chroococcus* sp was most abundant (52.23%) while *Oscillatoria sp* was least abundant (8.10s%); family Chrysophyceae accounted for 11 number of phytoplankton of which *Synura sp* was most abundant (52.38%) while *Asterionella s*p was least abundant (47.62%); while, family Euglenophyceae accounted for 26 of which *Euglena sp* was most abundant (61.90%) and *Phacus sp* least abundant (38.10%).

At station B, family Bacillariophyceae accounted for 2916 out of the 4622 phytoplankton encountered while *Coscinodiscus sp* was the most abundant (27.16%), *Nitzchia sp* was the least abundant (3.81%); family Chlorophyceae accounted for 963, out of which *Oedoganium sp* was most abundant (29.70%) and *Mougeotia sp* was least abundant (9.45%); family Cyanophyceae accounted for 350 number of zooplankton of which *Merismopedia sp* was most abundant (51.78%) and *Oscillatoria sp* was least abundant (10.95%); family Chrysophyceae accounted for 27 number of phytoplankton of which *Synura sp* was most abundant (59.26%) while *Asterionella sp* was least abundant (40.74%) whereas, family Euglenophyceae accounted for 40 of which *Euglena sp* was most abundant (77.50%) and *Phacus sp* least abundant (22.50s%);

At station C, family Bacillariophyceae accounted for 805 out of the 1857 zooplankton encountered; while *Coscinodiscus sp* was the most abundant (31.30%), *Cyclotella comta* least abundant (2.73%); family Chlorophyceae accounted for 851, out of which *Oedoganium sp* was most abundant (31.26%) and *Mougeotia sp* was least abundant (7.99%); family Cyanophyceae accounted for 154 number of phytoplankton of which *Merismopedia sp* was most abundant (56.49%) and *Chroococcus sp* was least abundant (19.48%), family Chrysophyceae accounted for 21 number of phytoplankton of which *Synura sp* was most abundant (61.90%) while *Asterionella sp* was least abundant (38.10%) while, family Euglenophyceae accounted for 26 of which *Euglena sp* was most abundant (69.23%) while *Phacus sp* least abundant (30.77%).

Generally, in rainy season the order also was family Bacillariophyceae (55.32%), family Chlorophyceae (28.21%), family Cyanophyceae (14.14%), family Euglenophyceae (1.42%) and family Chrysophyceae (0.91%)

In terms of diversity index, Shannon Weinner diversity index (3.82, 4.37 and 4.34) were recorded for stations A, B and C in dry season but 4.38, 4.56 and 4.43 were recorded for stations A, B and C, respectively. Margalef Index of 4.04, 4.61 and 4.44 were recorded for stations A, B and C in the dry season but 4.34, 4.60 and 4.48 were recorded for stations A, B and C, respectively in rainy season (Tables 1 and 2).

Table 1: Percentage Species Composition and Abundance of Phytoplankton during Dry Season in the Sampling Stations

Phytoplankton Families/Species	Station A		Station B		Station C		% BY family
	No.	%	No.	%	No.	%	
Bacillariophyceae							
Cyclotella comta	135	20.21	162	5.09	48	4.93	52.92
AulacoSeira sp	278	41.62	737	23.15	241	24.77	
Fragillaria sp	61	9.13	705	22.14	186	19.12	
Nitzchia sp	35	5.24	144	4.52	124	12.74	
Coscinodiscus sp	137	20.51	870	27.32	272	27.95	
Navicula sp	22	3.29	566	17.78	102	10.48	
Chlorophyceae							28.37
Mougeotia sp	115	25.67	120	10.74	97	9.49	
UlothrixTenuissima sp	33	7.37	250	22.38	214	20.94	
Cladophora sp	107	23.88	281	25.16	306	29.94	
Spirogyra sp	56	12.50	150	13.43	105	10.27	
Oedoganium sp	137	30.58	316	28.29	300	29.35	
Cyanophyceae							14.70
Chroococcus sp	161	48.94	289	38.38	67	25.97	
Merismopedia sp	127	38.60	366	48.61	123	47.67	
Oscillatoria sp	41	12.46	98	13.01	68	26.36	
Chrysophyceae							1.57
Asterionella sp	26	46.43	22	50.00	22	51.16	
Synura sp	30	53.57	22	50.00	21	48.84	
Euglenophyceae							2.45
Phacus sp	34	35.42	26	34.67	19	36.54	
Euglena sp	62	64.58	49	65.33	33	63.46	
Total Abundance	1597		5173		2348		
Shannon weinner index	3.82		4.37		4.34		
Margalef index	4.04		4.61		4.44		

Table 2: Percentage Species Composition and Abundance of Phytoplankton during Rainy Season in the Sampling Stations

Phytoplankton families/species	Station A		Station B		Station C		% BY Family
Bacillariophyceae	**No**	**%**	**No.**	**%**	**No.**	**%**	
Cyclotella comta	103	20.89	133	4.56	22	2.73	55.32
AulacoSeira sp	230	46.65	693	23.77	210	26.09	
Fragilaria sp	34	6.90	657	22.53	151	18.76	
Nitzchia sp	15	3.04	111	3.81	91	11.30	
Coscinodiscus sp	100	20.28	792	27.16	252	31.30	
Navicula sp	11	2.23	530	18.18	79	9.81	
Chlorophyceae							28.21
Mougeotia sp	91	27.16	91	9.45	68	7.99	
Ulothrix Tenuissima sp	15	4.48	223	23.16	183	21.50	
Cladophora Oligoclona sp	85	25.37	245	25.44	262	30.79	
Spirogyra sp	29	8.66	118	12.25	72	8.46	
Oedoganium sp	115	34.33	286	29.70	266	31.26	
Cyanophyceae							14.14
Chroococcus sp	129	52.23	252	37.28	30	19.48	
Merismopedia sp	98	39.68	350	51.78	87	56.49	
Oscillatoria sp	20	8.10	74	10.95	37	24.03	
Chrysophyceae							0.91
Asterionella sp	10	47.62	11	40.74	8	38.10	
Synura sp	11	52.38	16	59.26	13	61.90	
Euglenophyceae							1.42
Phacus sp	16	38.10	9	22.50	8	30.77	
Euglena sp	26	61.90	31	77.50	18	69.23	
Total Abundance	1138		4622		1857		
Shannon weinner index	4.38		4.56		4.43		
Margalef index	4.34		4.60		4.48		

Results of the monthly percentage phytoplankton abundance in dry season are presented in Table 3 while results of monthly percentage phytoplankton abundance in rainy season are presented in Table 4.

In dry season, 9118 phytoplankton were encountered; November 2015 recorded 757, of which *Coscinodiscus Sp* was most abundant (14.27%) while *Asterionella sp, Synura sp* and *Phacus sp* were least abundant (0.66% each); in December 2015, of 787 phytoplankton, *Coscinodiscus sp* was most abundant (14.10%) while *Asterionella sp* was least abundant (0.64%); in January 2016, of 755 phytoplankton encountered, *Coscinodiscus sp* was most abundant (14.83%) while *Asterionella sp* while least abundant (0.53%); in February 2016, of 760 phytoplankton, *Coscinodiscus sp* was most abundant (14.87%) while *Asterionella sp* least abundant (0.53%); in March 2016, of 757 phytoplankton, *Coscinodiscus sp* was most abundant (14.93%) while *Asterionella sp* least abundant (0.40%); in April 2016, of 769 phytoplankton, *Coscinodiscus sp* was most abundant (14.30%) while *Asterionella sp* least abundant (0.39%); in November 2016, of 760 phytoplankton, *Coscinodiscus sp* was most abundant (13.82%) while *Synura sp* least abundant (0.92%); in December 2016, of 747 phytoplankton, *Coscinodiscus sp* was most abundant (13.92%) while *Asterionella sp* and *Synura sp* were least abundant (0.67%); in January 2017, of 743 phytoplankton, *AulacoSeira sp* was most abundant (14.40%) while *Synura sp* least abundant (0.40%); in February 2017, of 773 phytoplankton, *AulacoSeira sp* was most abundant (13.71%) while *Synura sp* least abundant (0.78%); in March 2017, of 756 phytoplankton, *Coscinodiscus sp* was most abundant (14.42%) while *Synura sp* while *Phacus sp* were least abundant (0.78% each); and in April 2017, of 754 phytoplankton, *Coscinodiscus sp* was most abundant (13.66%) while *Asterionella sp* while *Synura sp* were least abundant (0.80%).

Generally, the month of December, 2015 was most abundant (8.63%) in phytoplankton richness while January, 2017 recorded the least phytoplankton abundance (8.15%).

Whereas, in rainy season, a total of 7617 phytoplankton was encountered of which 643 phytoplankton was recorded in the month of May 2015, wherein, *Coscinodiscus sp* was most abundant (15.55%) while *Phacus sp* least abundant (0.16%); in June 2015, of 588 phytoplankton, *AulacoSeira sp* was most abundant (15.14%) while *Phacus sp* and *Asterionella sp* were least abundant (0.34% each); in July 2015, of 658 phytoplankton encountered, *AulacoSeira sp* was most abundant (15.65%) while *Synura sp* least abundant (0.30%); in August 2015, of 656 phytoplankton, *Coscinodiscus sp* was most abundant (15.09%) while *Phacus sp* least abundant (0.30%); in September 2015, of 650 phytoplankton, *Coscinodiscus sp* was most abundant (15.69%) while *Asterionella sp* least abundant (0.31%); in October 2015, of 685 phytoplankton, *AulacoSeira sp* was most abundant (15.62%) while *Phacus sp* least abundant (0.29%); in May 2016, of 619 phytoplankton, *Coscinodiscus sp* was most abundant (15.51%) while *Phacus sp* and *Synura sp* were least abundant (0.32%); in June 2016, of 589 phytoplankton, *AulacoSeira sp* and *Coscinodiscus sp* were most abundant (15.96% each) while *Asterionella sp* was least abundant (0.17%); in July 2016, of 631 phytoplankton, *AulacoSeira sp* was most abundant (15.06%) while *Asterionella sp* and *Phacus sp* were least abundant (0.32%); in August 2016, of 631 phytoplankton, *AulacoSeira sp* was most abundant (15.21%) while *Phacus sp* least abundant (0.63%); in September 2016, of 613 phytoplankton, *Coscinodiscus sp* was most abundant (14.52%) while *Phacus sp* least abundant (0.16%); and in October 2016, of 654 phytoplankton, *Coscinodiscus sp* was most abundant (15.14%) while *Asterionella sp* least abundant (0.31%).

Generally, the month of October, 2015 was most abundant (8.99%) in phytoplankton richness while January, 2015 recorded the least phytoplankton abundance (7.72%)

Table 3: Monthly % Phytoplankton Abundance in the Dry Season

Species	NOV. 2015	DEC. 2015	JAN. 2016	FEB. 2016	MAR. 2016	APR. 2016	NOV. 2016	DEC. 2016	JAN. 2017	FEB. 2017	MAR. 2017	APR. 2017
Cyclotella comta	3.43	3.43	3.44	3.82	3.83	3.38	3.82	3.75	4.58	3.75	4.23	3.98
AulacoSeira sp	14.00	13.72	13.51	13.55	14.13	13.91	13.68	13.79	14.40	13.71	13.36	13.53
Fragillaria sp	10.30	10.42	10.60	10	9.78	10.53	10.39	11.24	10.63	10.48	10.45	10.48
Nitzchia sp	3.17	3.30	2.91	2.76	3.43	3.51	3.29	3.61	3.10	3.88	3.84	3.05
Coscinodiscus sp	14.27	14.10	14.83	14.87	14.93	14.30	13.82	13.92	11.31	13.84	14.42	13.66
Navicula sp	7.66	7.50	8.08	7.24	7.79	7.02	7.76	7.23	7.81	8.15	7.14	7.43
Mougeotia sp	3.57	3.94	3.05	3.55	3.43	3.51	3.68	3.61	3.90	3.62	3.97	3.85
Ulothrix Tenuissima sp	5.28	5.21	5.30	5.26	5.42	5.20	5.53	5.49	5.92	5.69	5.56	5.57
Cladophora Oligoclona sp	7.93	7.62	7.55	8.29	7.53	8.19	7.24	7.23	7.13	7.63	7.67	7.29
Spirogyra sp	3.43	3.18	3.97	3.29	3.17	3.90	3.16	3.08	3.23	3.62	2.91	3.98
Oedoganium sp	8.32	8.01	7.81	8.29	8.85	7.93	8.42	8.97	8.21	7.37	8.60	8.36
Chroococcus sp	5.55	5.72	5.56	6.45	5.28	5.46	5.53	5.89	5.79	5.05	5.56	6.23
Merismopedia sp	7.13	6.99	7.42	6.71	7.53	6.50	6.58	6.56	6.73	6.21	6.08	6.63
Oscillatoria sp	2.25	2.67	2.38	2.11	1.85	2.60	2.24	2.14	2.56	2.46	2.12	1.86
Asterionella sp	0.66	0.64	0.53	0.53	0.40	0.39	1.05	0.67	1.21	1.16	1.19	0.80
Synura sp	0.66	1.02	0.79	0.66	1.06	1.04	0.92	0.67	0.40	0.78	0.79	0.80
Phacus sp	0.66	1.02	0.66	0.66	0.53	0.91	1.05	0.80	1.21	1.03	0.79	1.06
Euglena sp	1.72	1.52	1.59	1.97	1.06	1.69	1.84	1.34	1.88	1.55	1.32	1.46

Table 4: Monthly %Phytoplankton Abundance in the Rainy Season

	MAY 2015	JUN. 2015	JUL. 2015	AUG. 2015	SEPT. 2015	OCT. 2015	MAY 2016	JUN. 2016	JUL. 2016	AUG. 2016	SEPT. 2016	OCT. 2016
Cyclotella comta	3.11	3.57	3.34	3.51	3.23	2.77	3.39	3.74	3.65	3.17	3.75	3.52
AulacoSeira sp	15.24	15.14	15.65	14.79	13.69	15.62	15.19	15.96	15.06	15.21	12.89	14.07
Fragillaria sp	10.73	10.54	10.64	11.13	10.15	11.10	11.31	11.04	10.14	13.31	11.58	11.01
Nitzchia sp	2.95	3.40	2.74	3.51	2.62	2.19	2.91	2.38	3.17	3.01	2.77	2.60
Coscinodiscus sp	15.55	13.27	14.29	15.09	15.69	15.48	15.51	15.96	14.74	14.90	14.52	15.14
Navicula sp	8.09	9.69	7.90	7.62	9.08	7.30	8.08	9.34	7.61	7.13	7.67	8.41
Mougeotia sp	3.27	3.40	3.34	2.90	3.54	3.36	3.23	3.57	3.33	3.01	3.26	3.21
Ulothrix Tenuissima sp	5.29	5.27	6.08	5.64	5.23	5.40	5.49	5.09	6.02	4.91	5.71	6.12
Cladophora Oligoclona sp	8.09	7.99	8.06	8.23	7.69	7.45	7.59	6.96	8.24	7.45	7.99	7.49
Spirogyra sp	2.96	2.	723.19	2.59	3.39	3.21	2.75	3.06	2.38	2.85	2.61	2.75
Oedoganium sp	8.55	8.50	8.21	7.93	8.77	8.47	9.05	8.49	8.72	9.03	10.77	8.72
Chroococcus sp	5.44	5.10	5.17	5.49	5.85	5.55	5.33	4.75	5.55	5.07	5.87	5.50
Merismopedia sp	7.31	7.31	7.14	7.77	6.62	7.59	6.95	6.45	6.82	6.50	6.53	7.19
Oscillatoria sp	1.56	2.38	1.67	1.37	1.85	2.04	1.29	1.19	2.06	1.59	1.79	1.84
Asterionella sp	0	0.34	0.61	0	0.31	0.44	0.48	0.17	0.32	0.79	0.82	0.31
Synura sp	0.47	0.51	0.30	0.61	0.77	0.58	0.32	0.34	0.79	0.64	0.33	0.61
Phacus sp	0.16	0.34	0.46	0.30	0.77	0.29	0.32	0.85	0.32	0.63	0.16	0.61
Euglena sp	1.24	0.51	1.22	1.52	0.77	1.17	0.81	0.68	1.11	0.79	0.98	0.92
	643	588	658	656	650	685	619	589	631	631	613	654

Discussion

The high Phytoplankton composition observed in river Okpokwu in this study is comparable to that reported by Olaniyan and Akinkuolie (2016) [13] who reported high Phytoplankton composition of Owena River, Ondo State, Nigeria. Similar findings were observed by Arsène *et al*., (2015) [4] who reported high phytoplankton composition in River Ouémé, Benin. Phytoplankton abundance is associated with seasonal differences in flow. Densities of phytoplankton usually reach the peak in the dry season and diminish in the floods. The overwhelming presence of phytoplankton in the dry season during this study could be attributed to increase in transparency, high temperature, type of land, chemical nature of the basin, decrease in water level and nature of input to the river increases plankton biomass during dry season. This agrees with the finding of Elliot (2015) [6]. Additional nutrients may have been derived from the decomposed organic matter remains of plants, animal and sewage, releasing more nutrients whose concentration becomes more pronounced as a result of evaporation. Also, the high number of phytoplankton species recorded in this study could be due to available nutrients and other physical and chemical factors which promote growth of phytoplankton. The family Bacillariophyceae was the most dominant followed by Chlorophyceae, Cyanophyceae, Euglenophyceae and Chrysophyceae. This observation is similar to the observation of Gabriel *et al*., (2013) [7]. The dominance of Bacillariophyceae both in respect to species number and population density in River Okpokwu is in line with the observation of Ja'afaru (2015) [10].

Commonly, in an aquatic system where there is no heavy nutrient inputs possibly from run-off or human inputs, Bacillariophyceae are usually the predominant, but when nutrient levels is high such that eutrophication occurs, then the Chlorophyceae could become more abundant than Bacillariophyceae (Akin-Oriola, 2003) [1]. The high plankton diversity from the study will support fishery in River Okpokwu. Phytoplankton community structure gives a good evaluation of the stability of aquatic ecosystem and provides a veritable tool for the assessment of biological activities. It has been observed that green algae and diatoms dominate the phytoplankton community of many tropical African waters

(Olaniyan and Akinkuolie, 2016) [13]. This was the trend observed in River Okpokwu during the period of study. Dominance of Bacillariophyceae and Chlorophyceae in the river during the dry season could be attributed to the presence of sunshine and extensive catchment area draining of phosphate rich agriculture land. Bacillariophyceae were relatively more abundant in the dry season than rainy season. This observation is in agreement with the findings of Olaniyan and Akinkuolie, (2016) [13]. The relative abundance of bacillariophyceae in the dry season than rainy season could be ascribed to the high photosynthetic activity which probably boosted the growth and subsequent abundance in the dry season. Verma *et al*., (2012) [16] described phytoplankton as rapid detectors of water pollution due to their quick response to changes in environmental variables and produce toxic substances which can accumulate and intoxicate the entire food chain. It was observed in the present study that cyanophyceae were higher in River Okpokwu during dry season than wet season. This observation agrees with the findings of Elliot, (2015) [6] who reported high abundance of cyanophyceae during the dry season from Bui Dam.

Chrysophyceae in the present study is represented by two groups of phytoplankton, which were represented by two genera, *Asterionella sp* and *Synura sp*. The Euglenophyceae identified in River Okpokwu generally had higher relative abundance in dry season than in rainy season. Euglenophyceae in the present study is the least represented group of phytoplankton, which were represented by only two genera, *Euglena spp* and *Phacus spp*. The findings of this study are in agreement with the findings of Altaf and Saltanat, (2014) [3]. Some euglenoids species can tolerate various levels of organically polluted waters and therefore can be used as indicators of organic pollution. Increasing temperature and accumulation of organic loads from surface run-off, autochthonous and allocthonus organic load, sewage and clear sun-shine may be the reasons for the dominance of Euglenophyceae in dry season (George *et al*., 2012) [8]. It was reported that, minimum phytoplankton population can be observed during the Wet season. This may be due to cloudy weather, low transparency, heavy flood which causes decline of phytoplankton density, agrochemical and other discharge that empty into the river. This is in agreement with the work of (Gabriel *et al*., (2013) [7].

The correlation matrices (r) for different phytoplankton species with physiochemical parameters for all Stations in this study is comparable with that reported by Medudhula *et al*., (2012) from Lower Manair Reservoir of Karimnagar district, Andhra Pradesh. In a similar study Altaf and Saltanat (2014) [3] reported correlation matrices in Wular Lake at Lankrishipora, Kashmir. Based on the present study, River Okpokwu is rich in phytoplankton and the available nutrient status is high enough to support the phytoplankton population in the river.

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