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TAXONOMY, DISTRIBUTION AND DIVERSITY OF PLANKTONIC ALGAE AT PINDIGA DAM, NIGERIA

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ABSTRACT

Taxonomic identification of algae at both generic and species levels is problematic owing to several reasons including cells' fragility, sensitivity to chemical fixatives and inconspicuous morphological features. The planktonic algae in tropical African dams have been particularly problematic given the paucity of algal taxonomic experts in this region. In this study, we present for the first time the taxonomic and geographic appraisal of planktonic Algae at Pindiga Dam. Further, planktonic algal flora and its monthly variations at the Pindiga Dam were investigated. The study revealed a total of 35 genera. Species in the family Chlorophyceae were the most abundant (42%), followed by those in the families Bacillariophyceae (38%) and Charophyceae (25%). Other taxonomic groups present were Chryophyceae, Cryptophyceae, Cynophyceae and Euglenophyta (7%) each. *Trachelomonas, Tetrahedrom* and *Pleurozester* were the most abundant taxa. The Important Value Index (IVI) and species diversity of algae are dependent on the sampling month. For instance, *Trachelomonas* recorded the highest IVI (23.67) and the lowest was recorded by *Cryptomonas* (8.18) in April, but it was observed that in May; *Tetrahedrom* recorded the highest IVI (22.57) and the lowest was recorded by *Zygnema* (9.38). In June, another set of taxa recorded the highest and the Lowest IVI namely: *Pleurogaster, Crucigenia* (17.63) and *Netrium, Oedogenium* (8.93) each. The composition of planktonic algae families in Pindiga Dam could be said to be Chlorophyceae, Bacillariophyceae, and Cyanophyceae in order of the IVI. The Simpson's index of diversity of planktonic algae at Pindiga Dam was 0.94542, 0.94708 and 0.95364 in April, May and June respectively. The species richness in April was 1.97, in May was 1.92 and in June was 2.10. The values were high indicating a more complex plankton community with a good measure of abundance and diversity. This study has provided baseline information on the taxonomy, distribution and diversity of planktonic algae in Pindiga Dam. This knowledge is useful to groups involved in water utilities; irrigation and drainage districts, industries, private pond owners, fish farmers and aqua culturist.

Keywords: Planktonic algae, Species composition, Diversity, Pindiga Dam

INTRODUCTION

Worldwide, water systems account for a disproportionally high amount of biological diversity (Boulton et al., 2008; Dudgeon, 2010). This habitat of high biodiversity is often supported and possibly enhanced by the exchange of resources between terrestrial and aquatic environments (Wallace et al., 1997). Rivers, streams, pools, puddles, ponds, lakes and dams are the different types of freshwater habitats where algae grow abundantly and are found in diverse forms.

Planktonic algae are a diverse group of plant kingdoms such that the distribution and abundance are affected by seasons (Ezra and Nwanko, 2001), their biomass decline in

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summer but increase through winter (Agawin et al., 2000). Egborge (1974) suggested that in many tropical West African rivers, seasonal variation in rainfall determines the abundance of phytoplankton. It is well known that some phytoplankton species predominate over others at certain times and places in the sea. Thus, In Long Island estuaries receiving effluents from duck farms. Ryther (1956) was able to relate the abundance of green algae as compared with diatoms to the ability of the algae to utilize organic nitrogen. Palmer (1980) reported that algae involved in water pollution may bring about enrichment in water and these may selectively stimulate the growth of a few types, producing massive surface growth (bloom) that in turn reduce the water quality and affect its use. Certain algae are capable to flourish in polluted water with organic waste and play important roles in self-purification of the water body (Somani & Pejaver, 2013). Therefore, phytoplankton has both beneficial and harmful effects, their presence in any type of water body is a sign of pollution (Alhassan et al., 2015).

The planktonic algae in tropical regions and particularly in Nigeria have been particularly understudied and therefore they deserve urgent attention. Our knowledge of their morphology, nomenclature, taxonomy, and geographical distribution is still based largely on traditional light microscopical concepts (Ewebiyi et al., 2015). Again, accurate comparisons with algal taxonomic lists from geographical regions outside the tropical areas may be problematic when electron microscopical information is also involved because such information is almost entirely lacking for the tropical algae (Somani & Pejaver, 2013). As primary producers, planktonic algae are among the most important species of any dam (Mahadik & Jadhav, 2014) but despite their numerous ecological niches and values, baseline information on planktonic algae of Gombe State is not known, hence worthy of scholarly research. Therefore, this study aims to investigate and present for the first time the taxonomy, population structure and diversity of planktonic algae in Pindiga Dam, Gombe State, Nigeria.

MATERIALS AND METHODS

Study Area

Pindiga Dam is located in the eastern part of Pindiga, taking about 1km to Pindiga Metropolis (Figure 1) in Akko Local Government Area of Gombe State. This Dam forms part of the numerous habitat associated with fresh water environment in Gombe State. The Dam lies between latitude 10.13'15^{o}N and longitude 11.11'19^{o}E in the Sudan Savanna grasslands.

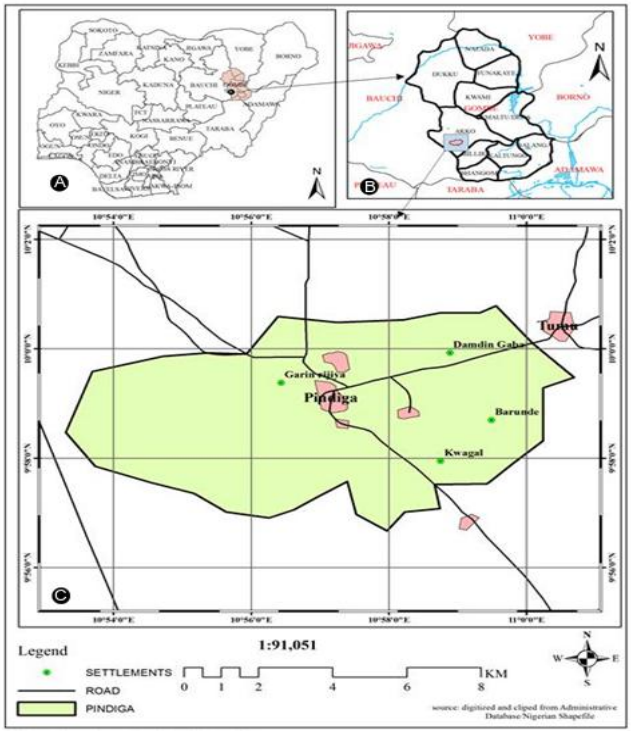

Figure 1: Map of (A) Nigeria (B) Gombe State C) Pindiga Town showing the study area

Collection of Planktonic Algae

Taxon sampling was done between 7 am and 1 pm once a week from April to June 2015. A

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cone-shaped plankton net with a dimension of 20 cm wide was used over 5 m at a rowing speed. The planktonic algae were then collected by filtering water through the planktonic net of mesh size of 50 µm. The filtrate was then transferred into 20 ml sample bottles and preserved in 4% formalin and 2% iodine following Mahadev et al. (2011).

Algal Identification and Cell Count

This involved field mapping work to identify and delineate geologic features and structures with a view to understanding the origin and distribution of black cotton soils with respect to geologic settings within the study area.

Statistical Analyses

The plankton frequency, density and abundance were analyzed using a one-way analysis of variance (ANOVA) of SPSS version 20 on log (x+1) transformed data. The data on diversity of planktonic algae during each month were calculated with the data from plankton abundance by number using the PRIMER software version 6.1.6 (Clarke & Gorley, 2006). Simpson's biodiversity index was carried out to determine the diversity of food items in the breeding habitat of the planktonic samples of Pindiga dam. Simpson's equation is given by:

$$D = \frac{[ni(ni-1)]}{[N(N-1)]}$$

Where: n_i = the number of individuals in i^{th} genera and

N = the total number of individuals

i = Number of genera.

Genera Richness Index (d) was employed according to the method used by Margalef (1958) to examine the community structure. The equation applied was given below:

$$D1 = \frac{(S-1)}{(LogeN)}$$

Where:

D_1= Genera richness index; S = Number of genera in a population; N = Total number of individuals in S genera.

RESULTS

In April, total of 19 genera of planktonic algae were identified at Pindiga Dam (Table 1) and (Figure 2). Planktonic algae genera such as *Trachelomonas, Tetrahedro*, *Denticula, Microora, Navicular, Phacus, Synura* and *Ulothrix* were identified to be the most common with the IVI of 23.67, 18.54, 16.80, 16.48, 14.85 and 14.75 respectively. The family Chlorophyceae had the highest number of genera (9) representing 37%. This was followed by the family Bacillariophyceae with 7 genera representing 29%, Cyanophyceae 4 genera (16%), Euglenophyceae 2 genera (9%), Charysophyceae and Crytophyceae with 1 genus each (8%). It was observed that *Trachelomonas* recorded the highest important value index (23.67), followed by *Tabellaria* (18.54) and *Zygnema* (16.94). The genus *Cryptomonas* recorded the lowest (8.18) IVI, while *Staurastrum, Amphora* and *Anaebena* recorded 12.56 each.

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Table 1: The relative parameters, IVI, Simpson Index of diversity and richness of Planktonic Algae at Pindiga Dam in April

S/N	Genus	Relative frequency	Relative density	Relative abundance	IVI	D
1	*Amphora*	4.88	3.88	3.81	12.56	0.00151
2	*Anabaena*	4.88	3.88	3.81	12.56	0.00151
3	*Ankistrosdesmus*	4.88	4.85	4.76	14.48	0.00236
4	*Aphonocopsa*	4.88	4.85	4.76	14.48	0.00236
5	*Cryptomonas*	2.44	1.94	3.81	8.18	0.00339
6	*Denticula*	6.09	5.82	4.57	16.48	0.00038
7	*Gyrosigma*	3.66	3.88	5.07	12.61	0.00339
8	*Microora*	6.09	5.82	4.57	16.48	0.00339
9	*Nauicula*	3.66	3.88	5.07	12.61	0.00151
10	*Nostoc*	4.88	5.82	5.71	16.41	0.00151
11	*Phacus*	3.66	4.85	6.34	14.85	0.00236
12	*Phormidium*	4.88	4.85	4.76	14.48	0.00236
13	*Quadrigula*	6.09	5.82	4.57	16.48	0.00339
14	*Staurastrum*	4.88	3.88	3.81	12.56	0.00151
15	*Synura*	2.44	4.85	9.51	16.80	0.00236
16	*Tabellaria*	7.31	6.79	4.44	18.54	0.00462
17	*Trachelomonas*	8.53	9.70	5.44	23.67	0.00943
18	*Ulothrix*	2.44	3.88	7.61	13.93	0.00151
19	*Zygnema*	6.09	4.85	3.81	14.75	0.00236
	Total	**92.63**	**94.13**	**96.18**	**282.95**	**0.05119**
	Simpson's I of D	**1 – D =**	**0.94881**			

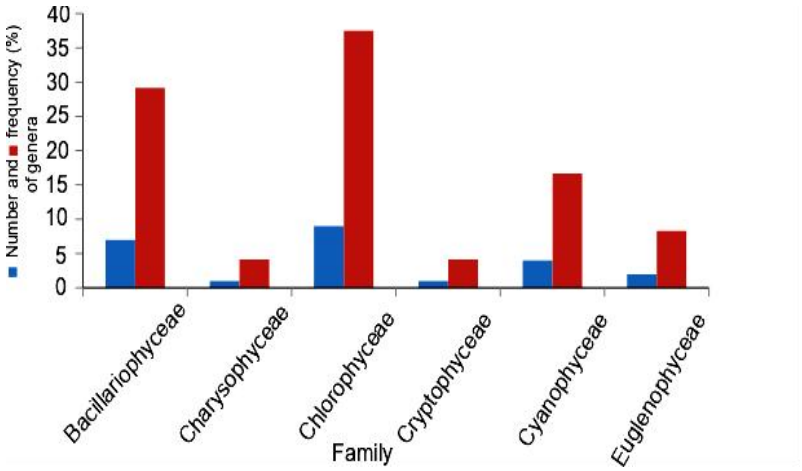

Figure 2: The number of genera and relative frequency in April

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Table 2: The genera relative parameters of planktonic algae and their IVI, diversity and richness in Pindiga Dam in May

S/N	Genus	Relative density	Relative frequency	Relative abundance	IVI	D
1	*Amphora*	5.83	6.81	4.05	16.70	0.00340
2	*Anabaena*	3.33	3.41	4.63	11.37	0.00111
3	*Basicladia*	5.00	4.54	5.21	14.75	0.00250
4	*Denticula*	4.17	4.54	4.34	13.05	0.00174
5	*Diatoma*	5.83	7.95	3.47	17.26	0.00340
6	*Euglena*	6.67	4.54	6.94	18.15	0.00444
7	*Frustulia*	5.00	4.54	5.21	14.75	0.00250
8	*Haematococcus*	5.00	4.54	5.21	14.75	0.00250
9	*Nauicula*	2.50	2.27	5.21	9.98	0.00063
10	*Nitzchia*	5.00	5.68	4.17	14.85	0.00250
11	*Oscillatoria*	5.83	4.54	6.08	16.45	0.00340
12	*Phacus*	4.17	4.54	4.34	13.05	0.00174
13	*Pinnularia*	2.50	3.41	3.47	9.38	0.00063
14	*Pleurogaster*	6.67	4.54	6.94	18.15	0.00444
15	*Polycistis*	5.00	4.54	5.21	14.75	0.00250
16	*Rhoicohenia*	5.00	5.68	4.17	14.85	0.00250
17	*Strichocuccus*	4.17	4.54	4.34	13.05	0.00174
18	*Synedra*	3.33	4.54	3.47	11.35	0.00111
19	*Tetrahedron*	9.17	7.95	5.46	22.57	0.00840
20	*Zygnema*	2.50	3.41	3.47	9.38	0.00063
	Total	**100.00**	**99.94**	**100.02**	**299.96**	**0.05292**
	Simpson's I of D	**1 – D =**	**0.94708**			
	Genera Richness	**=**	**1.92**			

In May, a total number of 20 genera belonging to 4 families were identified (Table 2) and (Figure 3). Planktonic algae genera such as *Euglena, Frustulia, Haematococous, Oscillatoria, Pleurogaster* and *Tetrahedron* were identified to be most common. The family Bacillariophyceae had the highest number of 10 genera (44%). This was followed by the family Chlorophyceae with 8 genera (34%), Cyanophyceae 3 genera (12%), and Euglenophyceae 2 genera (7%). The IVI in May was observed to be highest in the genus *Tetrahedrom* (22.57). This was followed by *Euglena* and *Pleurogater* (18.15) each. The lowest IVI was recorded by *Zygema*, *Pinnularia* and *Nauicula* (9.38) each. Table 3 and Fig. 4 show the occurrence and relative frequency of planktonic algae in June, respectively. A total of 23 genera belonging to 6 families were identified. Genera such as *Basicladia, Clococystis, Cladophora, Euglena, Mongeotioposis* and *Pleurogaster* were identified to be the most common genera. The family Chlorophyceae had the highest number (11) of genera (39%). This was followed by the family Bacillariophyceae with 10 genera (37%), Cyanophyceae with 3 genera (11%), Euglenophyceae, Charysophyceae and

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Crytophyceae with 1 genus (4%) each. The genus *Crucigenia* recorded the highest IVI (17.63) in June, followed by *Pleurogaster* (17.11) and *Cymbella* (15.62). The genera *Netrim* and *Oedogenium* had the lowest IVI (8.93). Other groups of the algal species were found sporadically or with relatively low IVI.

The Simpson's index of the diversity of planktonic algae at Pindiga Dam was 0.94542, 0.94708, and 0.95364 in April, May, and June respectively (Tables 1–3 and Figure 5). The genera richness in April was 1.97, in May was 1.92 and June was 2.10 (Figure 6).

DISCUSSION

The diversity of planktonic algae during these three months at Pindinga Dam was remarkable. The study revealed that Chlorophyceae were the most abundant followed by Bacillariophyceae and Charophyceae (Figs 2–4). This agrees with the results obtained by (Nandan and Mahajan, 2007). The abundance of the genera differs with time as evident from the results in April and June, Chlorophyceae was most abundant but in May the family Bachillariophyceae was most abundant. This shows interesting seasonal variations throughout the period of study and entails that diversity in the Dam is determined by the period of the year. The absence or reduction in density and diversity of some species in a particular month indicates that they could possibly not be adaptable to the environmental changes due to their preference for lotic water bodies. This therefore indicated that season had impact on the density and distribution of these species in the study area.

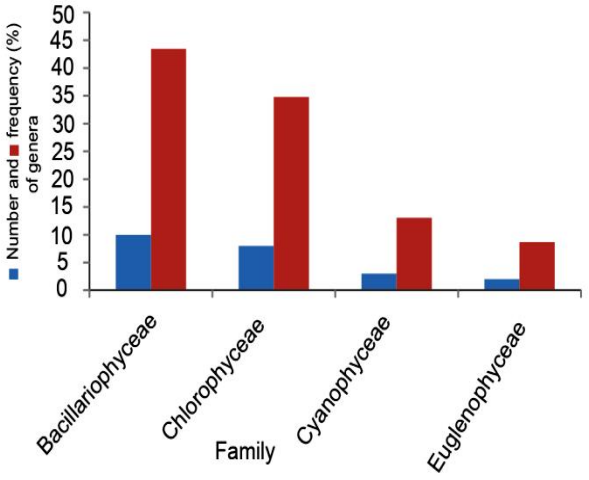

Figure 3: The number of genera and relative frequency in May.

The genera, *Trachelomonas, Tetrahedrom* and *Pleurozester* (Euglenophyceae) were found dominant (Table 1). This has supported the findings of Calijuri (2002) and Chergui et al. (2013) on the distribution of planktonic algae in a typical dam. Though the family Euglenophyceae recorded the lowest occurrence of genera, the genus *Trachelomonas* was observed to be the most abundant. Similar observations were recorded by Dimowo (2013) and Shakila and Natarajan (2012) The Euglenophyta group (7.1%) was recorded to be dominated only by species of the Euglenaceae family. The distribution pattern of phytoplankton in his study showed that all the species, except *Euglena* sp. and *Phacus pyrum* (Euglenophyceae) were homogeneously distributed in four hydrological seasons but the distribution of the present study was heterogeneous during the period under study.

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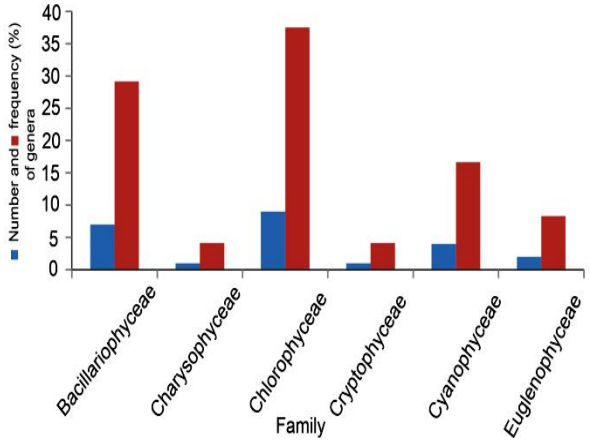

Figure 4: The number of genera and relative frequency in June.

The IVI and species diversity of algae are dependent on the month (Tables 1–3). *Trachelomonas* recorded the highest IVI (23.67) and the lowest was recorded by *Cryptomonas* (8.18) in April. It was observed that in May; *Tetrahedron* recorded the highest IVI (22.57) and the lowest was recorded by *Zygnema* (9.38). In June, other sets of taxa recorded the highest and the Lowest IVI namely – *Pleurogaster, Crucigenia* (17.63) and *Netrium, Oedogenium* (8.93) respectively (Tables 1–3). According to Alhassan (2015), periodic variability in water flow affects phytoplankton abundance. In the same vein, the density of Phytoplankton reaches its maximum during winter because of a reduction in the floods, unless otherwise affected by climatic conditions (Welcomme, 1985) or grazing.

Species diversity in the Pindiga Dam ranged from 0.94881, in April to 0.94708 in May and 0.95364 in June (Tables 1–3 and Figure 5). The genus richness of Pindiga Dam in April is 1.97 in May is 1.92 and June is 2.10. The values were high indicating a more complex community. A community dominated by one or two genera is considered to be less diverse than one in which several different genera. This allows more species interaction, hence greater system stability, and indicates good environmental conditions (Lawrence et al., 2018). The values for species richness were average indicating a more or less complex community.

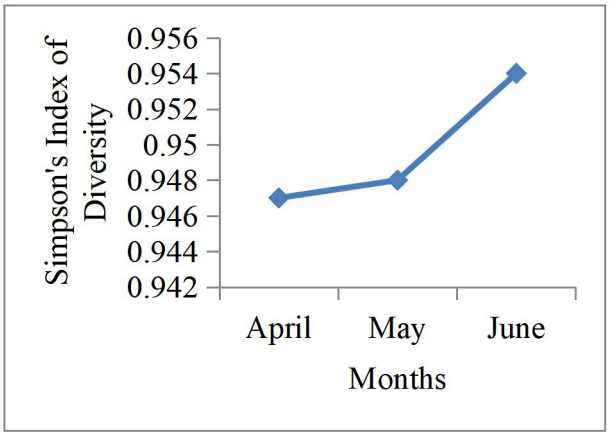

Figure 5: Simpson's index of diversity of Planktonic algae at Pindiga Dam between April and June.

The genera composition of planktonic algae in Pindiga Dam could say to be Chlorophyceae – Bacillariophyceae – Cyanophyceae. This finding agrees with that of most authors who reported that the phytoplankton community in freshwater is mostly Chlorophyta, Cyanophyta, Diatoms, and Dinophyta (Sorayya et al., 2011). Alhassan (2015) discovered 35 species of phytoplankton belonging to four families namely: Chlorophyceae (17 species), Cyanophyceae (12 species), Bacillariophyceae (4 species), and Euglenophyceae (2 species). Similar studies by Adebisi (1981), and Ayodele et al. (1999) showed the same group of algae dominating most tropical African lakes and dams.

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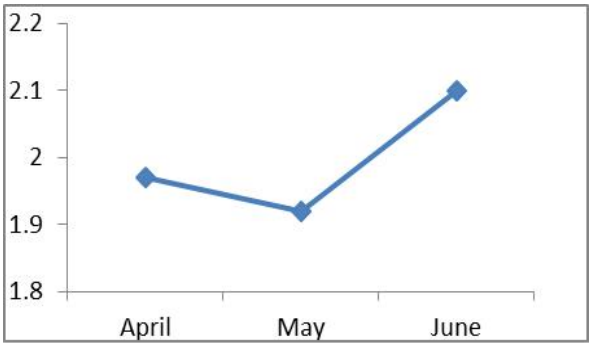

Figure 6: Genus richness of Planktonic Algae in Pindiga Dam between April and June.

CONCLUSION

This study has provided baseline information on the taxonomy, distribution, and diversity of planktonic algae in Pindiga Dam, additional information on Gombe water bodies. This knowledge is useful to groups involved in water utilities; irrigation and drainage districts; industries; private pond owners; fish farmers; aqua-culturists. From this result, it was observed that the water bodies are rich in plankton with a good measure of abundance and diversity. The phytoplankton abundance showed the following order of IVI in general: Chlorophyta > Bacillariophyta > Cyanophyta. It was observed that some plankton species are low in abundance at some months. This may be due to sensitive species disappearing as the water becomes polluted while tolerant ones survive pollution stress. The implementation of relevant laws for the sustainability of the water bodies will be required.

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