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Plankton abundance in relation to physicochemical factors in the Bui reservoir of Ghana's Black Volta River

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Abstract

The relationship between physicochemical factors and plankton abundance in the newly created Bui reservoir was studied during 2011 and 2012. The objective was to assess the influence of physicochemical factors on plankton abundance and provide data for monitoring the hydrobiology of the newly created Bui reservoir. Two sampling stations were selected on the Black Volta upstream (Bui) and downstream (Bamboi) of the dam, with samples taken pre- and postimpoundment during the study period. Canonical Correspondence Analysis (CCA) was used to trace temporal plankton community changes and to examine the relationships between species composition and physicochemical variables. The relative abundance of some phytoplankton species such as *Anabaena sp.*, *Planktothrix* sp. and *Scenedesmus* sp. was directly correlated to nitrates. CCA indicated that physicochemical variables explained 41–64% of zooplankton and 8–12% of phytoplankton variation. Hence, there were correlations between environmental variables and the structure of plankton assemblages. This feature should therefore be used for bio-monitoring of environmental variables of the river by the Bui Power Authority to ensure protection of the aquatic biota downstream of the Bui dam.

Key words: ecology, limnology, nutrient dynamics, phytoplankton, relationship, zooplankton

Résumé

Nous avons étudié en 2011 et 2012 la relation entre certains facteurs physico-chimiques et l'abondance du plancton dans le nouveau réservoir de Bui. Notre objectif était d'évaluer l'influence de facteurs physico-chimiques sur l'abondance du plancton et de récolter des données pour le suivi de l'hydrobiologie dans ce nouveau réservoir. Nous avons sélectionné deux stations d'échantillonnage sur le cours de la Volta noire, en amont (Bui) et en aval (Bamboi) du barrage, et prélevé des échantillons avant et après sa mise en eau. Une Analyse canonique des correspondances (ACC) fut utilisée pour suivre les changements de la communauté de plancton dans le temps et pour examiner la relation entre certaines espèces de phytoplancton et des variables physico-chimiques. L'abondance relative de certaines espèces de phytoplancton, tels *Anabaena sp.*, *Planktothrix* sp. et *Scenedesmus* sp., fut directement liée aux nitrates. L'ACC indiquait que des variables physico-chimiques expliquaient de 41 à 64% des variations du zooplancton et de 8 à 12% de celles du phytoplancton. Il y avait donc des corrélations entre des variables environnementales et la structure des assemblages de plancton. Cette caractéristique devrait donc être prise en compte pour le biomonitoring des variables environnementales de la rivière par les autorités hydro-électriques de Bui pour garantir la protection des biotes aquatiques en aval du barrage de Bui.

Introduction

The ecological impacts of impounding a river have been dramatic and extensive. Dams can affect the geomorphology of streams that have a large sediment load, as the reservoir traps sediments and release clear water. The resulting downstream geomorphic effects of clear water releases from dams include channel instability and alteration of habitat (FAO, 2001). The biotic community then responds by reducing species diversity and becoming gradually simpler, a response evident during the first few years after impoundment. Paller & Gladden (1992)

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observed that these responses are aggravated by catalysts such as unsuitable water temperature, low dissolved oxygen, inadequate spawning sites and the absence of shelter for prey.

In Ghana, most dams such as Vea, Akosombo, Weija, Barekese, Kpong and Tono have been constructed either for irrigation, hydroelectric power supply, water supply, flood control or fisheries by damming the White Volta and Black Volta, Densu, Owabi and Tono, respectively. The Bui reservoir created by damming the Black Volta is subjected to considerable climatic and temperature fluctuations. Filling and operation of the Bui dam will create 440 km^2 of new lacustrine habitat with a maximum depth of 29 m, replacing approximately 40 km of riverine habitat along the Black Volta River. Prior to filing, the main part of the reach will retain its current riverine characteristics, with the exception of the temporary diversion channel. During this period, the biological communities in the reservoir will begin to be exposed to lacustrine characteristics (ERM, 2007).

The contribution made by phytoplankton to primary production within rivers is generally regarded to be low when compared to other types of aquatic ecosystems. However, phytoplankton is present in rivers and contributes to the nutrient balance and the trophic requirements of some of the fish species. In tropical rivers, temperature plays a less important role in phytoplankton abundance and the greatest densities of phytoplankton coincide with low water temperature (Welcomme, 1985). Phytoplankton is sensitive to velocity and turbulence of flow in rivers as the rapid currents and mechanical stresses of rapids and waterfalls inhibit the development of new plankton and rapidly suppress any existing organisms discharged from any associated lentic waters. In the Nile River at the Gebel Aulia dam in Sudan, the dam slowed the Nile current and produces a rapid increase in phytoplankton concentration. When the dam was opened, the flow was faster and the plankton concentration dropped and hence demonstrated a strong correlation between phytoplankton and current velocity in the river (Prowse & Talling, 1958).

Nutrient availability also plays an important role in the determination of the abundance of phytoplankton in rivers. In clear white waters of neutral pH, diatoms and green algae were more abundant (Welcomme, 1985). In the Nile River in north-eastern Africa, there was a negative correlation between phytoplankton abundance and nitrate concentration (Talling, 1957).

Zooplankton abundance in rivers on the other hand has been attributed to differences in flow, turbidity, dissolved oxygen concentration, conductivity and seasons (Welcomme, 1985). Zooplankton species succession and spatial distribution result from differences in ecological tolerance to abiotic and biotic factors (Marneffe, Comblin & Thomé, 1998); yet, bio-indicator approaches, using the responses of organisms to evaluate trophic state, have often been neglected in favour of chemical and physical techniques.

Despite the considerable potential of zooplankton as effective indicators of environmental change, zooplanktonic communities have not been widely used as ecosystem indicators (Stemberger & Lazorchak, 1994). There have been little comprehensive phytoplankton and zooplankton studies of most Ghanaian freshwater bodies. At the shallow parts of the Volta Lake, bacillariophyceae, cyanophyceae and chlorophyceae were dominant (Viner, 1969). According to Biswas (1966), there were seasonal variations in phytoplankton abundance in the Volta Lake. The dominant genera of phytoplankton were *Synedra* and *Melosira* in the main channel while *Oscillatoria* dominated the shallow arms (Obeng-Asamoah, 1984). Rotifers were the dominant zooplankton (Biswas, 1966) while cladocerans, copepods and protozoans were recorded in smaller numbers (Obeng-Asamoah, 1984). The paucity of information on the plankton–environment relations in Ghanaian freshwater bodies and the Black Volta River in particular prompted this study. The purpose of this study was to investigate how physicochemical factors influence the taxonomic composition of freshwater phytoplankton and zooplankton assemblage in a newly impounded river in Ghana.

Materials and methods

Study site

The study was conducted on the Bui dam section of the Black Volta. The study area stretched from the Bui reservoir (upstream) to Bamboi (downstream) within latitudes 8°09′–8°16′°N and longitudes 2°01′–2°15′W and a distance of about 37.5 km. This formed part of the Black Volta basin primarily located in north-western Ghana approximately 150 km upstream of Lake Volta. The basin covers portions of the Upper, Northern and Brong Ahafo Regions of Ghana. The basin has a total catchment area of 142,056 km^2 including areas outside Ghana.

There is considerable variation in local relief of the Black Volta basin. The northern areas ranged between 300 and 600 m above sea level (masl). The Basin is gently undulating from the north to the south. Most parts of the Black Volta fall under the savannah zone which is undulating with gentle slopes that promotes overland flow. The low relief is also a cause for the poor surface drainage with a consequent flooding which characterize the desertification-prone areas during the wet season (Agorsah, 2004).

The Bui Power Authority Act (Act 740) was enacted by the parliament of Ghana and assented to by the President of the Republic of Ghana in July 2007 to establish an Authority known as the Bui Power Authority (BPA) which was to plan, execute and manage the Bui Hydroelectric Project (BHP). The impoundment of the Black Volta River was started in June 2011 and got completed in December 2012. The BHP which is currently being implemented was designed primarily for hydropower generation. It, however, also includes the development of an irrigation scheme for agriculture development and presents an opportunity for enhanced ecotourism and fisheries. The morphometric characteristics of the Bui reservoir are full supply level (FSL) of 183.0 m; reservoir area at FSL of 444 km^2; storage volume at FSL of 12.57×10^9 m^3; minimum operating level of 168.0 m; and active storage of 7.72×10^9 m^3.

Measurement of physicochemical parameters

Monthly readings of temperature, pH, dissolved oxygen, conductivity, colour and Total Dissolved Solids (TDS) were taken in the field using the WQC-24 Water Quality Checker or probe (Fresenius, Quentin & Schneider, 1988) for 22 months (March 2011–December 2012). The 2011 sampling year was a period of pre-impoundment (March–June 2011) and immediate postimpoundment (July–December 2011). The 2012 sampling period on the other hand was a period of late postimpoundment (January–December 2012). Three readings, 30 cm below the water surface, were taken at each sampling station for each of the above parameters and the average calculated. Water samples were also taken from the same depth at each station with a 2.0-l Hydro-Bios Kiel TP water sampler and stored in ice chest and carried to the Council for Scientific and Industrial Research – Water Research Institute laboratory in Tamale for nutrient content analysis.

Nutrient content analysis

Phosphates, nitrates and sulphates were analysed using a Hach DR2010 direct-reading spectrophotometer and prepackage reagents within 24 h after sampling. For phosphates analysis, about 25 ml of the water taken to the laboratory was measured into a reaction bottle and Phos Ver 3 reagent added and swirled. The sample was then allowed to stand for 2 min. Blue colour indicated the presence of phosphates in the sample. The concentration of phosphate was recorded in mg l^{-1} on a spectrophotometer at 890 nm to two decimal places following the methods described in APHA (American Public Health Association) (1998).

For nitrates analysis, another 25 ml of water was measured into a reaction bottle and Nitra Ver 5 reagent added and shaken for 1 min. The sample was then allowed to stand for 5 min. Brown colour indicated the presence of nitrates in the sample. The concentration of nitrates was recorded in mg l^{-1} to two decimal places on the spectrophotometer at 400 nm following the methods described in APHA (1998).

For sulphates analysis, about 10 ml of water sample was measured into a 25-ml erlenmeyer flask. Exactly 0.5 ml conditioning reagent was added and mixed by stirring. A spoonful of barium chloride crystals was then added while still stirring and timing immediately for 60 s at a constant speed. After stirring, the absorbance rate was measured at 420 nm on the spectrophotometer within 5 min. The concentration of sulphate was read directly from the calibration curve, and the results expressed in mg l^{-1} to two decimal places.

Collection of phytoplankton and zooplankton samples

The phytoplankton samples were collected monthly for 22 months (March–December 2011 and January–December 2012) between 0600 and 0700 GMT. Phytoplankton samples were obtained by towing a 0.5-m-diameter phytoplankton net (35 μm mesh size and 0.25 m^2 mouth surface area) from a nonmotorized canoe through a distance of 100 m against the current from downstream to upstream at a speed of 0.60 ms^{-1}. The phytoplankton samples were preserved with Lugol's solution in 50 ml sampling bottles.

Zooplankton samples were also collected monthly using a zooplankton net of 55 μm mesh size and 0.25 m^2 mouth surface area for 22 months (March–December 2011 and January–December 2012) between 6 h and 7 h GMT from a nonmotorized canoe through a distance of 100 m against the current from downstream to upstream. Collected zooplankton samples were preserved in 4% buffered formaldehyde solution in 50 ml sampling bottles.

Enumeration of phytoplankton and zooplankton samples

For enumeration of algal taxa, the technique of Lund, Kipling & Le Cren (1958)was adopted using a Carl Zeiss inverted microscope (Carl Zeiss, Inc, Thornwood, NY, USA). Species identification was carried out following Needham & Needham (1962). The water samples were well shaken, and aliquots of 15 ml were transferred into counting chambers for microscopic study. Sedimentation was carried out in counting chambers with a settling time of 4 h for every 1 cm of water column of the sample described by Wetzel & Likens (1990). The densities of phytoplankton were expressed as number m^{-3} from the average count of three aliquots of 5 ml each.

For enumeration of zooplankton, a 5-ml subsample was taken from the water sample. Zooplankton counts were carried out in Sedgwick–Rafter counting chambers under an inverted microscope (Nikon Eclipse TE-200; Nikon Instrument Inc, Melville, NY, USA) as recommended by Downing & Rigler (1984). The zooplankton densities were expressed as number-m^{-3} from the average count of three aliquots of 5 ml each. Zooplankton species identification was guided by descriptions from Edmondson (1969), Jeje & Fernando (1986), and Fernando (2002).

Statistical analysis

Plankton–physicochemical relationships were evaluated by Canonical Correspondence Analysis (CCA) using CANOCO software version 4.5A (Microcomputer Power, Ithaca, NY, USA) (Smilauer, 2003). Before using CCA, variables that covaried with other variables (Pearson's correlation $r > 0.8$, $P < 0.05$) were removed. Rare species (< 2% per season) were not included in the CCA. In addition, data were subjected to log $(x + 1)$ transformation before the CCA analysis to prevent extreme values (outliers) from unduly influencing the ordination. Species–physicochemical correlation coefficients provided a measure of how well variation in community composition could be explained by individual physicochemical factors. A Monte Carlo permutation test with 499 permutations (Jockel, 1986) was used to assess the significance of the canonical axes extracted.

Results

Phytoplankton abundance

Table 1 below shows the abundance of phytoplankton species and classes recorded in 2011 and 2012. In 2011, 35 species were recorded belonging to the following classes: Bacillariophyceae (four species); Chlorophyceae (seventeen species); Cyanophyceae (twelve species) and Euglenophyceae (two species). In 2012, however, only fifteen species were recorded and belonged to the following classes: Bacillariophyceae (two species); Chlorophyceae (seven species); and Cyanophyceae (eight species). In 2011, *Ulothrix* sp. (15.3%) dominated while *Microcystis wesenbergii* (19.7%) dominated the phytoplankton samples in 2012.

Phytoplankton–physicochemical relationship

The relationship between phytoplankton species abundance and measured physicochemical factors in 2011 and 2012 sampling years is shown in Figs 1 and 2. In 2011, 8% of variations in phytoplankton species abundance was accounted for by the physicochemical factors measured. The strongest explanatory factors were nitrates, phosphates and temperature. The length of the environmental arrows in the CCA ordination plots indicates their relative importance to each axis. Environmental arrows represent a gradient, where the mean value is located at the origin, and the arrow points in the direction of its increase. It was observed from the ordination plot that *Pseudanabaena* sp. was more sensitive to nitrates. *Lyngbya circumcreta,* on the other hand, seemed to prefer phosphates or more likely low DO while *Synedra ulna* was associated with moderate temperature. *Chlorella* sp. and *Scenedesmus* sp. were extremely positioned (not influenced much by any of the measured physicochemical parameters). TDS, conductivity, pH and sulphates had little influence on the variations on phytoplankton species abundance.

In 2012, 12% of variations in the phytoplankton species abundance was accounted for by the physicochemical factors measured. The most important physicochemical variables were conductivity, TDS and

Table 1 Phytoplankton abundance in 2011 and 2012

Class/species	2011 (cells m^{-3})	2011 (% no.)	2012 (cells m^{-3})	2012 (% no.)
Bacillariophyceae				
Gyrosigma sp.	57	1.1	0	0
Navicula sp.	145	2.9	15	1
Surirella sp.	10	0.2	0	0
Synedra ulna	169	3.4	18	1.2
Subtotal	380	7.6	33	2.2
Chlorophyceae				
Ankistrodesmus sp.	387	7.8	45	3.1
Carteria sp.	20	0.4	0	0
Chlamydomonas sp.	145	2.9	3	0.2
Chlorella sp.	56	1.1	39	2.6
Chlorogonium sp.	10	0.2	0	0
Closterium sp.	174	3.5	0	0
Coelastrum sp.	72	1.4	0	0
Cosmarium sp.	10	0.2	0	0
Dictyosphaerium sp.	100	2	0	0
Micrasterias sp.	10	0.2	9	0.6
Pediastrum sp.	237	4.8	46	3.1
Scenedesmus sp.	40	0.8	79	5.4
Schroederia sp.	15	0.3	0	0
Staurastrum sp.	14	0.3	6	0.4
Stigeoclonium sp.	20	0.4	0	0
Ulothrix sp.	760	15.3	157	10.7
Volvox sp.	69	1.4	0	0
Subtotal	2139	43	383	26.1
Cyanophyceae				
Anabaena sp.	372	7.5	85	5.8
Chroococcus sp.	178	3.6	0	0
Coelosphaerium sp.	112	2.2	0	0
Lyngbya circumcreta	74	1.5	30	2
Merismopedia punctata	87	1.7	174	11.8
Microcystis aeruginosa	536	10.8	247	16.8
Microcystis wesenbergii	320	6.4	290	19.7
Oscillatoria sp.	61	1.2	10	0.7
Planktothrix sp.	256	5.1	94	6.4
Pseudanabaena sp.	405	8.1	127	8.6
Rivularia sp.	15	0.3	0	0
Spirulina sp.	1	0	0	0
Subtotal	2416	48.6	1055	71.7
Euglenophyceae				
Euglena sp.	20	0.4	0	0
Phacus pyrum	20	0.4	0	0
Subtotal	40	0.8	0	0
Grand total	4974	100	1471	100

nitrates. It was observed that *Pseudanabaena* sp. and *Microcystis wesenbergii* were associated with moderate conductivity but low levels of nitrates. *Planktothrix* sp., *Scenedesmus* sp. and *Anabaena* sp. were more sensitive to high nitrate levels but low TDS. *Merismopedia punctata* and *Pediastrum* sp. preferred high TDS or more likely, a

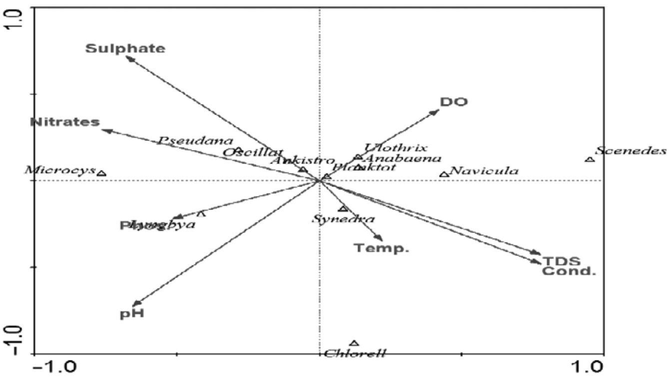

Fig 1 Canonical Correspondence Analysis (CCA) ordination diagram showing the relationship between physicochemical variables and phytoplankton. The arrows represent each of the physicochemical variables plotted pointing in the direction of maximum change of explanatory variables in 2011

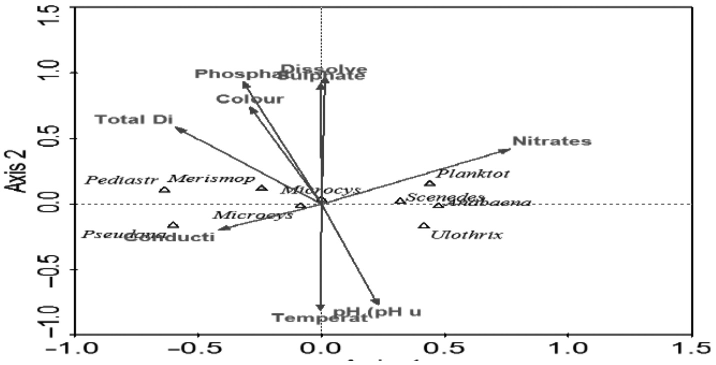

Fig 2 Canonical Correspondence Analysis (CCA) ordination diagram showing the relationship between physicochemical variables and phytoplankton. The arrows represent each of the physicochemical variables plotted pointing in the direction of maximum change of explanatory variables in 2012

lower temperature and pH. There was little or no influence of pH, temperature, phosphates, sulphates and DO on the species abundance during the 2012 sampling period.

Zooplankton abundance

Table 2 shows the relative abundance of zooplankton species in 2011 and 2012. In both 2011 and 2012, sixteen species of zooplankton were recorded belonging to the following: Anostraca (one species); Cladocera (ten species); Copepoda (four species); and Podocopida (one species). *Leptodora* sp. dominated the Cladocerans in both 2011 (25%) and 2012 (14.4%) while *Cyclops* sp. dominated the Copepods in both 2011 (30.5%) and 2012 (31.2%). The dominance of *Leptodora* sp. and *Polyphemus* sp. which are large predatory cladocerans than their prey such as *Bosmina* sp. and *Daphnia* sp. in the Bui dam area of the Black Volta was not clearly known in this study. It could, however, be a function of surface water sampling and therefore requires further investigation by limnologists.

Zooplankton–physicochemical relationship

The relationship between zooplankton species abundance and measured environmental variables in 2011 and 2012 is shown in Figs 3 and 4. In 2011, the strongest explanatory factors were conductivity, TDS, pH, DO and phosphates. About 64% of variations in the species abundance data were accounted for by the physicochemical factors measured. *Daphnia* sp. and *Diaphanosoma* sp. were more sensitive to moderate to high levels of conductivity and TDS but to low levels of sulphate and DO. *Ceriodaphnia* sp. and *Polyphemus* sp. preferred moderate DO levels or more likely low temperature and phosphate. *Cyclops* sp. on the other hand preferred moderate pho sp hate levels but lower sulphate and nitrate levels, while *Cypridopsis* sp. preferred high pH levels. *Diaptomus* sp. and *Leptodora* sp. were extremely positioned.

In 2012, the strongest explanatory factors were conductivity, pH, temperature, phosphates, sulphates and nitrates. About 41% variations in the species abundance data were accounted for by measured physicochemical parameters. It was observed that the frequency of *Leptodora* sp., *Polyphemus* sp. and *Ceriodaphnia* sp. was associated

Table 2 Zooplankton abundance during 2011 and 2012

Taxa/species	2011 (no. m^{-3})	2011 (% no.)	2012 (no. m^{-3})	2012 (% no.)
Anostraca				
Eubranchipus sp.	3	0.1	5	0.9
Cladocera				
Alonella sp.	2.5	0.1	3	0.6
Bosmina sp.	0.8	0	4	0.8
Ceriodaphnia sp.	212	6.1	16	3.2
Daphnia sp.	127	3.7	38	7.5
Diaphanosoma sp.	87	2.5	33	6.5
Leptodora sp.	865	25	73	14.4
Macrothrix sp.	0.5	0	3	0.6
Moina sp.	5	0.1	29	5.7
Polyphemus sp.	783	22.6	44	8.7
Sida sp.	4	0.1	4	0.8
Subtotal	2086	60.3	247	49.7
Copepoda				
Canthocamptus sp.	2	0.1	3	0.6
Cyclops sp.	1058	30.5	158	31.2
Diaptomus sp.	10	0.3	18	3.5
Limnocalanus sp.	185	5.3	60	11.9
Subtotal	1255	36.2	239	47.1
Podocopida				
Cypridopsis sp.	120	3.5	16	3.2
Grand total	3464	100	507	100

with low levels of conductivity, phosphates and sulphates. *Diaphanosoma* sp. was, however, associated with pH and temperature. *Moina* sp., *Ceriodaphnia* sp., *Limnocalanus* sp. and *Daphnia* sp. were extremely positioned.

Discussion

Construction of the Bui dam will permanently alter the fundamental hydrology and aquatic ecology of the impounded reach, with a highly significant impact (Environmental Resources Management (ERM), 2007). This is because phytoplankton abundance in rivers is also associated with seasonal differences in flow. Densities usually reach a peak in the dry season and diminish in the floods unless otherwise influenced by temperature (Welcomme, 1985). In the Bui dam area of the Black Volta in Ghana, there was a significant variation in the mean values of phytoplankton abundance between 2011 and 2012. This may be due to the impoundment (or blocking of the normal flow) of the Black Volta in June 2011. This is because there was no continuous flow of water in 2012 which might prevent the near uniform distribution of phytoplankton species (Zabbey, Sikoki & Edoghotu, 2008).

Apart from the seasonal differences in flow, the CCA ordination in this study also showed that many phytoplankton species had affinity for higher nutrient concentrations, for example *Anabaena* sp., *Pseudoanabaena* sp., *Planktothrix* sp. and *Scenedesmus* sp. were clustered more specifically with nitrates. Nitrates and/or phosphates are considered the limiting nutrients in many aquatic environments (Sakka *et al.*, 1999). The source of these nutrients was probably the quick turnover that increased primary productivity of the reservoir as a result of breakdown of organic load from submerged vegetation as a result of the impoundment. This may increase the potential fish yield of the Bui reservoir in subsequent years as a result of increased primary productivity.

In general, the CCA ordination plots showed a pattern where nitrates, phosphates, temperature, DO, conductivity and TDS and many phytoplankton species were correlated. The study therefore infers that in addition to hydrobiological factors (e.g. chlorophyll *a* concentration),

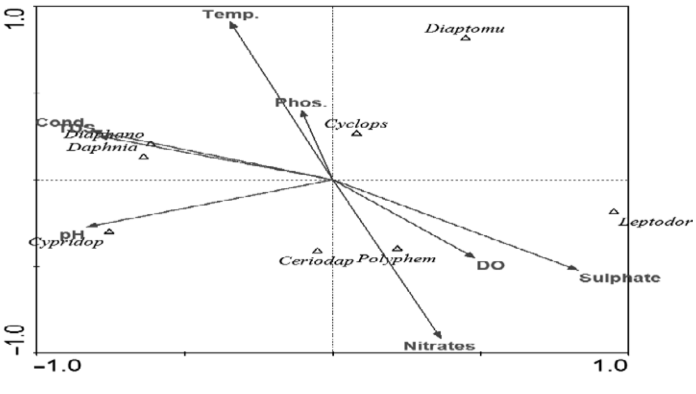

Fig 3 Canonical Correspondence Analysis (CCA) ordination diagram showing the relationship between physicochemical variables and zooplankton. The arrows represent each of the physicochemical variables plotted pointing in the direction of maximum change of explanatory variables in 2011

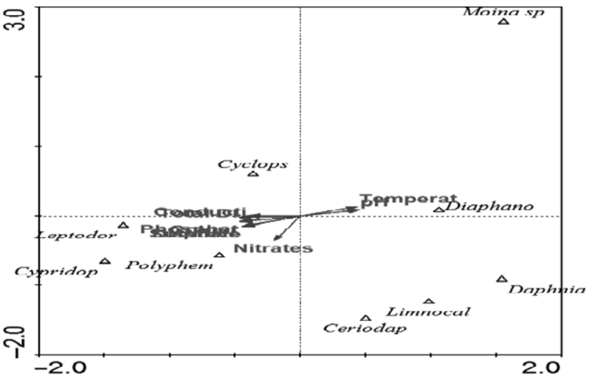

Fig 4 Canonical Correspondence Analysis (CCA) ordination diagram showing the relationship between physicochemical variables and zooplankton. The arrows represent each of the physicochemical variables plotted pointing in the direction of maximum change of explanatory variables in 2012

changes in physicochemical variables affected the composition of the phytoplankton community. The study revealed that TDS, conductivity, pH and sulphates had little influence on the variations on phytoplankton species abundance in 2011. In 2012, however, there was little or no influence of pH, temperature, phosphates, sulphates and DO on the species abundance of phytoplankton in the study area. The CCA ordination indicated that zooplankton organisms responded to a number of physicochemical variables, and 41–64% of the variations in zooplankton densities were accounted for by the measured physicochemical variables. The correlation coefficient indicated that several physicochemical factors exert a considerable influence on the zooplankton abundance, especially DO, pH, TDS, conductivity, temperature, phosphates and sulphates. Consistent with the findings of this study, Sarkar & Choudhury (1999) reported significant multiple correlations between zooplankton abundance and several physicochemical variables. The correlations of the zooplankton with phosphates and sulphates may not necessarily be a direct relationship of the zooplankton utilizing the nutrients, but could be attributed to the dependence of the phytoplankton (which serves as food for the zooplankton) on these nutrients (Mustapha, 2009).

DO, conductivity, pH, TDS and phosphates have been found to be important to zooplankton in other tropical studies (Ogbeibu, 1998; Arora & Mehra, 2003; Pandey & Verma, 2004; Okogwu & Ugwumba, 2006). Size, structure and biomass of plankton population are closely related to physicochemical conditions of the water body (Mitchell-Innes & Pitcher, 1992). Environmental factors such as dissolved oxygen, temperature, pH, nitrates and phosphates are reported to marshal the activities and composition of organisms (Collins, 1983), and their abundance and diversity reflect the physicochemical conditions of aquatic ecosystem in general and its nutrient status in particular (Anene, 2003). Due to the strong interaction between the zooplankton abundance and physicochemical variables, factors such as climatic changes and/or dam construction that will modify the flooding pattern of the river will inadvertently alter the zooplankton community structure in the newly created Bui reservoir and may have serious implications for fish production of the entire Black Volta ecosystem (Okogwu, Nwant & Ugwumba, 2009). The study revealed that temperature and nitrates had little influence on the abundance of zooplankton species in 2011 while the abundance of the following zooplankton species; *Moina* sp., *Daphnia* sp., *Limnocalanus* sp. and *Ceriodaphnia* sp. were not influenced by any of the measured environmental variables in the study area.

The CCA ordination indicated that physicochemical variables explained 41–64% of the variations in zooplankton densities. Hence, the zooplankton variations during the study were accounted for by the measured physicochemical factors and not possibly the impoundment of the Black Volta River. The physicochemical parameters explained only 8–12% variations in phytoplankton densities. This therefore suggests that the absence of the 20 phytoplankton species in 2012 was probably due to the impoundment and not necessarily the measured physicochemical parameters. The study therefore infers that in addition to other factors, changes in physicochemical variables influenced the composition and abundance of zooplankton community.

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