Ecologia

ISSN 1996-4021

Academic
Journals Inc.

www.academicjournals.com

Ecologia 2 (4): 114-122, 2012
ISSN 1996-4021 / DOI: 10.3923/ecologia.2012.114.122

Survey of Phytoplankton in the Bauchi and Yobe States Segments of the Hadejia-Nguru Wetlands, Northeastern Nigeria

[1]Y. Tanimu, [1]F.A. Tiseer, [2]O.F. Ati and [1]A.U. Ezealor
[1]Department of Biological Sciences, Ahmadu Bello University, Zaria, Nigeria
[2]Department of Geography, Ahmadu Bello University, Zaria, Nigeria

Corresponding Author: Yahuza Tanimu, Department of Biological Sciences Ahmadu Bello University, Zaria, Nigeria

ABSTRACT

A survey of Phytoplankton in the segments of the Hadejia-Nguru wetlands that falls into Bauchi and Yobe states, Nigeria was carried out in November 2010 using standard methods. Samples were collected from four sampling stations on the catchment of the three major rivers (Hadejia, Jama'are and Yobe) in the wetlands. Species of phytoplankton belonging to the Bacillariophyta (diatoms), Chlorophyta (green algae) and Cyanobacteria (blue-green algae) were observed from the samples. The Palmer pollution and Shannon-Wiener diversity indices indicated that the water quality in the wetlands is moderately polluted. Cluster Analysis showed similarities in the abundance and diversity of phytoplankton in the three rivers. The diatoms of the Jama'are River being more similar to those of the Hadejia River than that of the Yobe River while the green algae and cyanobacteria of the Yobe River and Hadejia River were more similar in comparison to those of the Jama'are River.

Key words: Phytoplankton, abundance, diversity, water quality

INTRODUCTION

Mitsch and Gosselink (1986) defined wetlands as lands transitional between terrestrial and aquatic ecosystems where the water table is usually at or near the surface, or the land is covered by shallow water (Prasad *et al.*, 2002). The importance of the world's wetlands is increasingly receiving due attention as they contribute to a healthy environment in many ways. This comprises a vast complexity of direct and indirect uses (Acharya, 1998), which include: (1) water retention during dry periods, thus keeping the water table high and relatively stable; (2) flood mitigation and (3) trapping of suspended solids and attached nutrients, thus, streams flowing into lakes by way of wetland areas will transport fewer suspended solids and nutrients to the lakes than if they flow directly into the lakes (Prasad *et al.*, 2002). The removal of such wetland systems because of urbanization or other factors typically causes lake water quality to worsen (Barbier, 2002). Additionally, wetlands are important feeding and breeding areas for wildlife and provide resting and feeding stop-over places and refuges for migrating and resident waterfowl (Lameed, 2011). As with any natural habitat, wetlands are important in supporting species diversity. Other values include the use of the wetlands for domestic and agro-industrial water supply (Ibrahim and Chiroma, 1988) and the harvesting of wetland bioresources such as fish and plants and the function of wetlands in groundwater recharge and discharge (Yahaya *et al.*, 2010).

Phytoplankton are photosynthetic microscopic organisms which have been reported to be an invaluable tool in biomonitoring of water bodies (Casamatta *et al.*, 1999; Rodriguez *et al.*, 2011;

Abagai *et al.*, 2011; Tanimu *et al.*, 2011), with the advantage of phytoplankton based techniques being inexpensive, fast and reliable (Dokulil, 2003). They are also important in that they do not only show the water quality at the time of sampling but also indicate the impact of pollution over a considerable period of time before the time of sampling (Venkateswarlu and Reddy, 2000). This short study was carried out to further bolster existing information on the phytoplankton of the Hadejia-Nguru wetlands.

MATERIALS AND METHODS

Study area: The Hadejia-Nguru wetlands lies in the northeastern corner of Nigeria, around (12°26´ N and 10°04´E) within Kano, Jigawa, Bauchi, Yobe and Borno States. Near Gashua the area is about 61,120 km^2 and is drained by the Hadejia and Jama'are Rivers, the principal rivers of the basin. These rivers merge in the Hadejia-Nguru wetlands to form the Yobe River which reaches Lake Chad at Yau, draining a total area of 84,138 km^2. The Hadejia River rises from the Kano highlands while the head-waters of the Jama'are River are in the Jos Plateau (Yahaya *et al.*, 2010). Within the Hadejia River system the natural pattern of runoff has been modified by the construction of dams and associated large-scale irrigation schemes, most notably Tiga and Challawa dams and the Kano Irrigation Scheme (KRIP) in the upper basin, and the Hadejia Valley Irrigation Project (HVIP) in the middle of the basin. The Jama'are River is at the moment uncontrolled, but plans to construct a dam at Kafin Zaki have been under discussion for a considerable time. The Wetlands area is famed for its irrigation farming, fishing, water-based transportation, but persistent incidences of flood have prevented the effective utilization of these services (Chiroma *et al.*, 2005).

Samples were taking at four points on Rivers Hadejia, Jama'are and Yobe. On River Jama'are, the first point was at Jama'are town, by the bridge along Kano-Maiduguri road, the second near Kubwa village, the third near Sakkwa village and the fourth by the Azare-Zaki road bridge in Zaki village. On the Hadejia River, the first sampling point was by Fage village, the second 9 km to Hadejia town, the third in Mekintari village while the fourth was by the plague of the Ramsar site on the Hadejia-Nguru road. On the River Yobe, the first two sampling points were at the confluence of the Rivers Hadejia and Jama'are (were the River Yobe is formed), the third about 50 m from the confluence while the fourth in the Dagona Wildlife Sanctuary (Table 1).

Table 1: Description of sampling points on the Jama'are-Nguru wetlands

Location	Sampling point	Coordinate	Elevation(m)	Nearest landmark
River Jama'are	1	N12°52. 381, E 010°26.762	371	Jama'are town
	2	N 11°55.598, E 010°12.759	378	Kubwa village
	3	N 12°00'. 252, E 010°129. 461	366	Sakkwa village
	4	N 12°16' 53.0, E 010°22' 03.3	351	Zaki village
River Hadejia	1	N 12°19' 21.1, E 010°03' 59.0	353	Fage village
	2	N 12°22' 37.5, E 010°03' 05.0	357	9 km to Hadejia town
	3	N 12°27' 00.4, E 010° 02' 12.7	371	Mekintari village
	4	N 12°50' 85.3, E 010°23' 98.6	344	Ramsar site
River Yobe	1	N 12°49' 42.2, E 010°51' 32.3	323	Confluence of Rivers
	2	N 12°49' 42.2, E 010°51' 32.3	323	Jama'are and Hadejia
	3	N 12°49' 42.2, E 010°51' 32.3	323	
	4	N12°13' and 13°00', E 10°00' and 11°00'	323	Dagona wildlife sanctuary

Phytoplankton collection: Phytoplankton samples were collected in one survey in November 2010 with a conical shaped plankton net of 20 cm diameter with a 50 mL collection vial attached to it. Samples were collected at four sampling points along the Rivers Jama'are and Hadejia each, while two samples were collected at confluence of the two rivers (River Yobe) and one in the Dagona Wildlife Sanctuary. Phytoplankton abundance was determined through cell count by the drop count method as described by Verlencar and Desai (2004) and the biota were identified by consulting texts by APHA (1995) and Perry (2003) and Prescott (1977).

Data analysis: Analysis of variance was used to compare the abundance of Phytoplankton in the three rivers and Phytoplankton diversity and similarity was determined using PAST (Paleontological Statistics) ver.1.81.

RESULTS

A total of 19 species of diatoms, 13 green algae and four Cyanobacteria were observed in the wetlands, out of which 11 are among the 20 algal genera used by the Palmer Pollution Index (PPI) for determining levels of organic pollution of a water body (Table 2).

In terms of the number of Genera observed, a higher number of Bacillariophyta was observed in Hadejia (10) in comparison to Jama'are (8) and Yobe (4) catchments of the wetlands. Chlorophyta Taxa abundance showed the following trend Jama'are, 10, Hadejia, eight (8) and Yobe, one (1). Two (2) genera of Cyanobacteria were observed in both the Rivers Jama'are and Hadejia catchments while three (3) were observed in the River Yobe catchment of the wetlands (Fig. 1a).

The number of individuals/L of the Bacillariophyta observed was 1226/L in River Jama'are, 563/L in River Hadejia and 173/L in the River Yobe. The abundance of the Chlorophyta was found to be at 306 individuals/L in the Rivers Jama'are and Hadejia, and 51/L in the River Yobe. Cyanobacteria abundance was 204/L, 119/L and 102/L, for Rivers Jama'are, Hadejia and Yobe respectively (Fig. 1b).

The highest Shannon-Wiener diversity index of 1.5 for the diatoms was recorded in the River Hadejia, followed by 1.28 for River Jama'are, and 1.67 for the River Yobe. For the green algae the highest value of 2.1 was recorded in the River Jama'are catchment followed by 1.48 for River

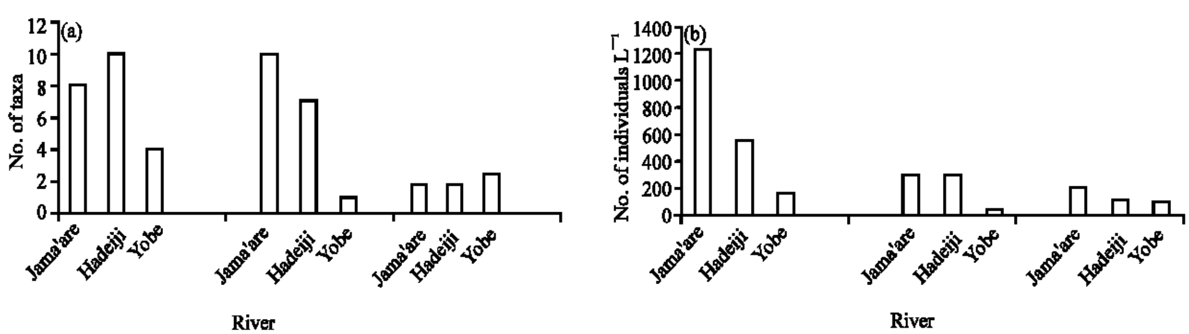

Fig. 1(a-b): Diversity indices (a) No. of taxa and (b) No. of individuals of phytoplankton divisions observed in the Bauchi and Yobe states segment of the Hadejia-Nguru wetlands

Table 2: Phytoplankton diversity, abundance and pollution index of the Hadejia-Nguru wetlands

Phytoplankton	PPI	St1	St 2	St 3	St 4	St 1	St 2	St 3	St 4	St 1	St 2	St 3	St 4
Bacillariophyta													
Asterionella sp.		+	+	+	+		+			+	+	+	+
Caloneis sp.		-	-	-	-	-	-	-	+	-	-	-	-
Coscinodiscus sp.		-	-	+	-	-	-	-	-	-	-	-	-
Cyclotella sp.	1	-	-	-	-	+(1)	-	-	-	-	-	+(1)	+(1)
Cymbella cistula		-	-	+	-	-	+	-	-	-	-	-	-
Frustulia rhomboides	-	-	-	-	-	-	-	-	-	+	-	-	
Gomphonema sp.		-	-	-	-	-	-	-	-	-	-	1	_
Melosira nimuloides	1	-	-	-	-	-	-	-	+(1)	-	-	-	-
Navicula sp.1	3	+(3)	-	+(3)	-	+(3)	+(3)	-	-	+(3)	+(3)	-	+(3)
Navicula sp.2	3	-	-	-	-	-	-	-	-	-	-	+(3)	-
Nitzschia sp.	3	-	-	-	-	-	-	-	-	-	-	+(3)	-
Pinnularia sp.1		+	+	+	-	-	-	-	-	+	-	+	-
Pinnularia sp.2		-	-	-	-	-	-	-	-	-	-	+	-
Pleurosigma sp.		-	-	+	-	-	-	-	-	-	-	-	-
Stephanodiscus sp.		-	-	-	-	+	-	-	-	-	-	-	-
Synedra ulna	2	+(2)	-	+(2)	+(2)	+(2)	-	-	+(2)	+(2)	+(2)	+(2)	+(2)
Terpsinoe americana	-	-	-	-	-	-	-	+	-	-	-	-	
U (I)		-	-	-	-	-	-	-	+	-	-	-	-
U (II)		+	-	-	-	-	-	-	-	-	-	-	-
Chlorophyta													
Ankistrodesmus falcatus	+(2)	-	-	-	-	+(2)	-	-	-	-	-	-	-
Closterium sp.1	-	-	-	-	-	-	+(1)	-	-	-	-	-	-
Cosmarium sp.1		-	-	-	+	-	-	+	-	-	-	-	-
Cosmarium sp.2		-	-	-	+	-	-	-	-	-	-	-	-
Pediastrum simplex		-	-	+	-	-	-	-	-	-	-	-	-
Scenedesmus acuminatus	4	-	4	-	-	-	-	-	-	-	-	-	
Scenedesmus quadricauda		+(4)	-	+(4)	-	-	-	-	-	-	-	-	-
G.M. Smith													
Spirogyra sp.		-	-	-	+	-	-	-	-	-	-	-	-
Spondylosium planum	-	-	-	-	-	-	-	+	-	-	-	-	
Staurastrum sp.1		-	-	-	+	-	-	-	-	-	-	-	-
Staurastrum sp.2		-	-	-	+	-	-	-	-	-	-	-	-
Tetraedron lobatum		-	-	-	+	-	-	-	+	-	-	-	-
G.M. Smith													
Ulothrix sp.		-	-	-	+	+	+	+	-	+	-	-	+
Cyanobacteria													
Merismopedia elegans	-	-	-	-	-	-	-	-	-	-	+	-	
Nostoc sp.		-	-	-	-	-	-	-	-	-	-	+	-
Oscillatoria tenuis C.A. Agardh		4	-	+(4)	+(4)	-	+(4)	-	-	-	+(4)	-	+(4)
Sacconema rupestris	-	+	-	+	-	+	-	+	-	-	-	-	
Total		9	4	13	0	12	3	1	3	9	5	14	10

U: Unidentified, PPI: Palmer Pollution Index, +: Present, -: Absent, No. in parenthesis: Palmer pollution score, St: Station

Hadejia and none in the River Yobe. The blue-green algae showed a higher diversity of 0.87 in River Yobe catchment, while the other two rivers had 0.68 (Fig. 2a).

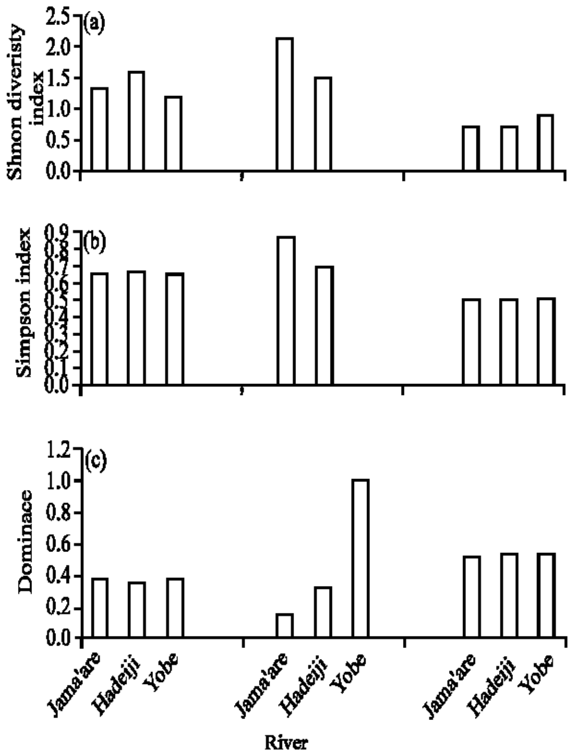

Fig. 2: Diversity indices (a) Shannon diversity index, (b) Simpson index and (c) dominance of phytoplankton divisions observed in the Bauchi and Yobe States segments of the Hadejia-Nguru wetlands

The Simpson index (evenness) for the Bacillariophyta and Cyanobacteria were almost equally distributed around 0.6 and 0.5, respectively in the wetlands. However, Evenness was higher in the Chlorophyta (0.85) in the River Jama'are than in the other rivers (Fig. 2b). Dominance showed a similar pattern with the Simpson index except for a reversed trend observed in the Chlorophyta with River Yobe (1) being the highest followed by River Hadejia (0.3) and then River Jama'are (0.2) (Fig. 2c).

Cluster analysis of phytoplankton species showed similarities in the abundance/L and diversity in the three rivers in the wetlands. For diatom species, diatoms in the Rivers Hadejia and Jama'are were clustered together with a Euclidean similarity value of -35, while the Yobe River had a value of -53 (Fig. 3). In terms of the green algae and blue-green algae, Rivers Hadejia and Yobe rivers were observed to have clustered with Euclidean values of -11 and -27 and the Jama'are River branching away from this two with values of -27 and -43, respectively (Fig. 4 and 5).

DISCUSSION

The variation of phytoplankton diversity and abundance in the Hadejia-Nguru wetlands may be due to differences in water quality at the various sampling locations. The lower diversity and abundance of diatoms and green algae in River Yobe may be attributed to the relatively higher human activities observed, thus leading to poor water quality. Another factor that may be responsible to lower phytoplankton abundance and diversity on the River Yobe could be the reason that the samples were taken only around the confluence i.e., were the river was formed and not on

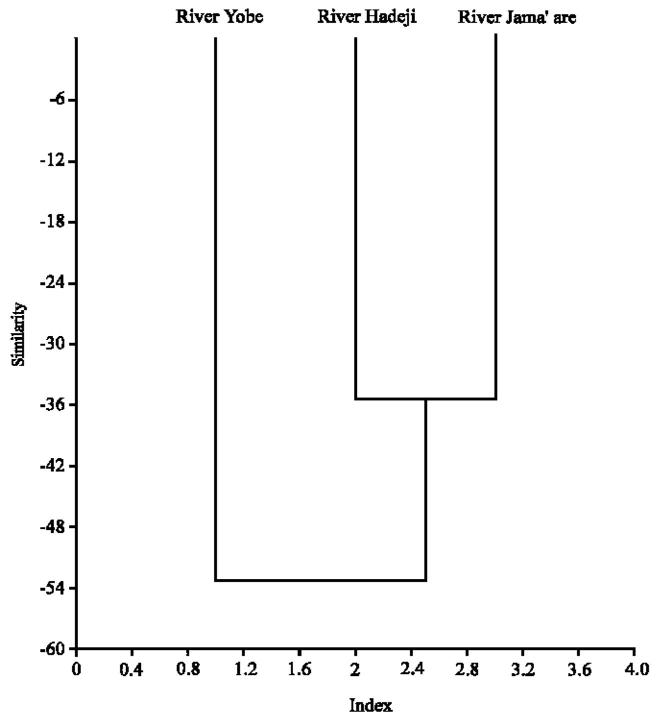

Fig. 3: Euclidean similarity measure of diatom occurrence in the three rivers of the Hadejia-Nguru wetlands

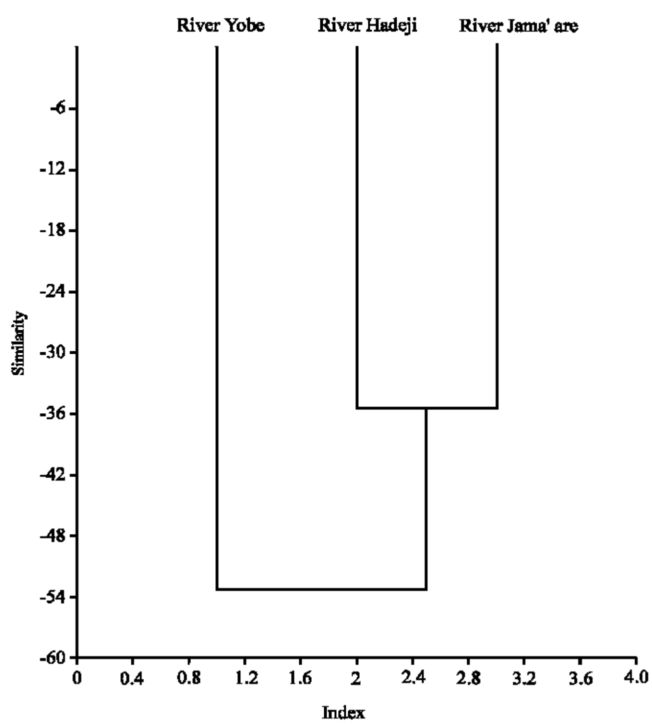

Fig. 4: Euclidean similarity measure of green algal occurrence in the catchment of the three rivers in the Jama'are-Nguru wetlands

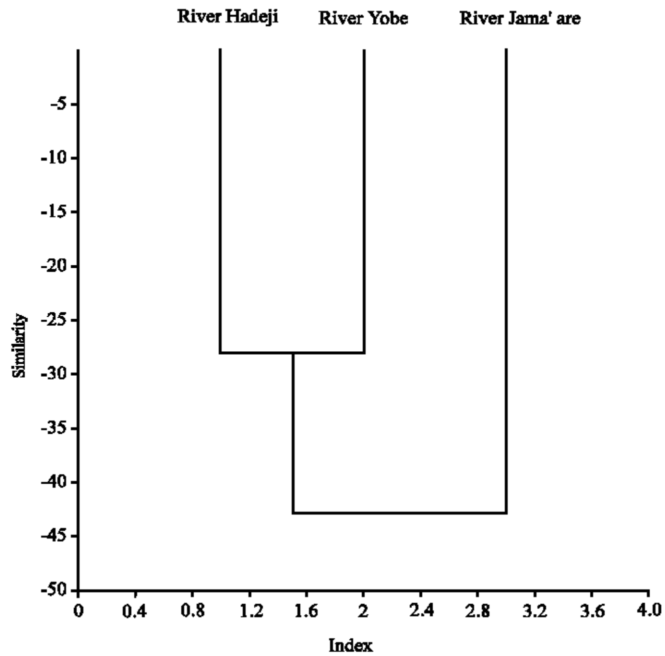

Fig. 5: Euclidean similarity measure of blue-green algal occurrence in the catchment of the three rivers in the Jama'are-Nguru wetlands

a stretch as in the case of the other rivers. Phytoplankton abundance and diversity has been reported to be affected by water quality (Casamatta *et al.*, 1999; Akanta *et al.*, 2011; Zakariya *et al.*, 2011; Abagai *et al.*, 2011; Rodriguez *et al.*, 2011).

All the sampling stations surveyed may be categorized as being mildly organically polluted based on the Palmer Pollution Index. A Palmer Pollution Index of = 14, indicates low organic pollution; 15-19, moderate organic pollution and = 20, high organic pollution (Somani and Pajaver, 2007; Saikia *et al.*, 2010).

Based on the Shannon-Wiener diversity index the three rivers in the wetlands may be classified as being moderately polluted. Water bodies with algal Shannon-Wiener diversity index<1 are classified as being heavily polluted, 1-3, moderately polluted and >3 clean (Wilhm and Dorris, 1966; Islam, 2008; Tanimu *et al.*, 2011).

On the criteria of indicator species, the presence of species of *Stephanodiscus*, an oligotrophic genus and *Pediastrum*, a Mesotrophic genus (Dokulil, 2003), the wetlands may be classified as being oligotrophic to mesotrophic.

The low nutrient and low pollution levels as indicated by the phytoplankton community in the Hadejia-Nguru wetlands may be attributed mainly to the activities of phytoplankton and the relatively high abundance of aquatic macrophytes. These autotrophic components of the aquatic ecosystem have been reported to be vital tools in water purification as thus assimilate nutrients and other substances during metabolic processes (Bako *et al.*, 2005; Tiseer *et al.*, 2008).

CONCLUSION

The three phytoplankton indices (Shannon-Wiener Index, Palmer Pollution Index and algal Indicator Species) used to determine the water quality status of the Hadejia-Nguru wetlands indicated that the waters are both low in nutrient load and pollution level.

REFERENCES

APHA, 1995. Standard Methods for the Analysis of Water and Wastewater. 19th Edn., American Public Health Association, Washington, DC.

Abagai, R.T., F.A. Tiseer, M.L. Balarabe, Y. Tanimu and D. Tanko, 2011. Seasonal survey of phytoplankton as biondicators of water quality in the streams of Kagoro forest, Kaduna, State, Northern Nigeria. Proceedings of the International Symposium on Environmental Science and Technology, June 1-4, 2011, Dongguan, Guangdong Province, China, pp: 37-41.

Acharya, G., 1998. Capturing the hidden values of wetland ecosystems as a mechanism for financing the wise use of wetlands. Proceedings of the Mechanisms for Financing Wise use of Wetlands, November 13, 1998, Dakar, Senegal.

Akanta, A.A., W.E. Amlabu and Y. Tanimu, 2011. A comparative study on phytoplankton abundance and physicochemical characteristics between a concrete and an earthen fish pond in the department of biological sciences, Ahmadu Bello University, Zaria, Kaduna State, Nigeria. Proceedings of the 5th International Conference of Research and Development, November 22-25, 2011, Pan-African Book Company in Association with JIMST, Accra, Ghana, pp: 5-11.

Bako, S.P., I.L. Mordy and S.J. Oniye, 2005. Aquatic macrophytes infestation in relation to water quality status of a small tropical fish farm in the Nigerian savanna ecosystem. Proceedings of the 11th World Lake Conference, October-31-November-4, 2005, Kenyan Ministry of Water and Irrigation and The International Lake Committee, Nairobi Kenya, pp: 137-140.

Barbier, E.B., 2002. Upstream Dams and downstream water allocation: The case of the hadejia'jama'are floodplain, Northern Nigeria. Proceedings of the Environmental Policy Forum, Center for Environmental Science and Policy, Institute for International Studies, November 7, 2002, Stanford University.

Casamatta, D.A., J.R. Beaver and D.J. Fleishman, 1999. A survey of phytoplankton taxa from three types of wetlands in Ohio. Ohio J. Sci., 99: 53-56.

Chiroma, M.J., Y.D. Kazaure, Y.B. Karaye and A.J. Gashua, 2005. Water management issues in the Hadejia-Jama'are-Komadugu-Yobe basin: DFID-JWL and stakeholders experience in information sharing, reaching consensus and physical interventions. http://publications.iwmi.org/pdf/H037511.pdf

Dokulil, M.T., 2003. Algae as Ecological Bio-Indicators. In: Bioindicators and Biomonitors, Markert, B.A., A.M. Breure and H.G. Zechmeister (Eds.). Elsevier Science Ltd., New York, pp: 285-327.

Ibrahim, U.S. and M.J. Chiroma, 1988. Socio-Economic Characteristics of the Wetlands. In: Guidelines for Wise Use of Hadejia-Nguru Wetlands, Okali, D. and H.H. Bdliya (Eds.). Conservation Project Mimeograph, IUCN, Switzerland, pp: 15-25.

Islam, M.S., 2008. Phytoplanktonic diversity index with reference to Mucalinda Serovar, Bodh-Gaya. Proceedings of the Taal'2007: The 12th World Lack Conference, October 28-November 2, 2007, Jaipur, India, pp: 462-463.

Lameed, G.A., 2011. Species diversity and abundance of wild birds in Dagona-Waterfowl Sanctuary, Borno State, Nigeria. Afr. J. Environ. Sci. Technol., 5: 855-866.

Mitsch, W.I. and I.G. Gosselink, 1986. Wetlands. Van Nostrand Reinhold, New York, Pages: 539

Perry, R., 2003. A Guide to the Marine Plankton of Southern California. 3rd Edn., UCLA Ocean GLOBE and Malibu High School .

Prasad, S.N., T.V. Ramachandra, N. Ahalya, T. Sengupta and A. Kumar *et al.*, 2002. Conservation of wetlands of India. A review. Trop. Ecol., 43: 173-186.

Prescott, G.W., 1977. The Fresh Water Algae. 1st Edn., WMC Brown Company Publishers, Dubuque, Iowa, pp: 12-12.

Rodriguez, L.H.R., E.B. Canterle, V. Becker, A. Hamester and D.D.M. Marques, 2011. Dynamics of plankton and fish in a subtropical temporary wetland: Rice fields. Sci. Res. Essays, 6: 2069-2077.

Saikia, M.K., S. Kalita and G.C. Sarma, 2010. Algal indices to predict pulp and paper mill pollution load of elenga beel (Wetland) Assam, India. Asian J. Exp. Biol. Sci., 1: 815-821.

Somani, V. and M. Pajaver, 2007. Evaluation of pollution in the lake Masunda Thane (Maharashtra). J. Ecobiol., 20: 163-166.

Tanimu, Y., S.P. Bako, J.A. Adakole and J. Tanimu, 2011. Phytoplankton as bioindicators of water quality in saminaka reservoir, Northern Nigeria. Proceedings of the International Symposium on Environmental Science and Technology, June 1-4, 2011, Dongguan, Guangdong Province, China, pp: 318-322.

Tiseer, F.A., Y. Tanimu and A.M. Chia, 2008. Survey of macrovegetation and physicochemical parameters of Samaru stream, Zaria Nigeria. Res. J. Environ. Sci., 2: 393-400.

Venkateswarlu, N. and P.M. Reddy, 2000. Plant biodiversity and bioindicators in aquatic environment. http://envfor.nic.in/news/8900/plantbio.html

Verlencar, X.N. and S. Desai, 2004. Phytoplankton Identification Manual. 1st Edn., National Institute of Oceanography, Dona Paula, Goa, India, Pages: 33.

Wilhm, J.L. and T.C. Dorris, 1966. Species diversity of benthic macro-invertebrates in a stream receiving domestic and oil refinery effluents. Am. Midland Nat., 76: 427-449.

Yahaya, S., N. Ahmad and R.F. Abdallah, 2010. Multicriteria analysis for flood vulnerable areas in Hadejia-Jama'are river basin, Nigeria. Eur. J. Sci. Res., 42: 71-83.

Zakariya, A.M., M.A. Adelanwa and Y. Tanimu, 2011. Physico-chemical characteristics and phytoplankton diversity of the lower Niger river in Kogi State, Nigeria. Proceedings of the 5th International Conference of Research and Development, November 22-25, 2011, Pan-African Book Company in Association with JIMST, Accra, Ghana, pp: 10-19.