International Journal of Scientific Engineering and Applied Science (IJSEAS) - Volume-1, Issue-4, July 2015
ISSN: 2395-3470
www.ijseas.com

EFFECT OF PHYSICO-CHEMICAL FACTORS OF WATER ON THE DISTRIBUTION OF MACROBENTHIC INVERTEBRATE FAUNA IN THE HADEJIA-NGURU WETLANDS

Mohammad Mustapha Abubakar and [2]Saminu Murtala Yakasai
Department of Biological Sciences,
Federal University Dutse, Nigeria
[2]Department of Chemistry,
Federal University Dutse

ABSTRACT
Assessment of the physico-chemical properties of water in the Hadejia-Nguru wetlands was carried out with the view to assessing it's suitability to serving as habitat to diverse groups of organisms. Standard methods were used to determine the physical and chemical properties of water in the laboratory. Benthic fauna was sampled using Paterson bottom grab. Physical parameters like temperature, transparency, pH and conductivity were higher than the average for other water bodies in the Sudano-sahelian region of Nigeria. Total nitrogen and phosphorus were also above average. Cations were dominated by calcium. Thirteen species of benthos, belonging to four major taxa were identified. The benthos was dominated by the Arthropoda and Mollusca. The altered physico-chemical characteristics of the water together with growing occurrence of the pollution indicator species, like *Cryptochironomus deribae* allows us to conclude that the wetland is tending towards eutrophication.

Key Words: benthos, fauna, Hadejia-Nguru, Wetland

INTRODUCTION
Wetlands have been shown to provide several ecological, biological and hydrologic functions that provide economic, aesthetic, recreational, educational and other values to the society [1]. The value of the world's wetlands are increasingly receiving due attention as they contribute to a healthy environment in many ways [2]. However, the conversion of wetlands to agricultural lands has greatly impacted fish and wildlife habitats throughout the world [3]. Due to unplanned management, tremendous development of industry and agriculture and disposal of untreated public sewage water, agricultural run-off and other human and animal wastes in to rivers, lakes, reservoirs and other water bodies are continuously deteriorating in their quality and biotic resources [4],[5].

Water quality monitoring is of immense importance in the conservation of water resources for fisheries, water supply and other activities; it involves the assessment of physico-chemical parameters of water bodies. Impacted changes in the quality of water are reflected in the biotic community structure, with the vulnerable dying, while the most sensitive species act as indicators of water quality [6].Several studies on aquatic ecosystem impairment have been reported in Nigerian water bodies. These include the works of [7],[8] and[9].

On the other hand, the benthic invertebrates in aquatic ecosystems play an important role in the transformation of the organic matter sediment on the bottom to its base elements

and subsequently contribute to the basic nutrition of fish. The composition of the benthic fauna has largely been considered as a good indicator of water quality because, unlike planktonic species, they form relatively stable communities in the sediments which do not change over long time intervals and reflect characteristics of both sediments and upper water layer[10].
Macrobenthic invertebrates in Lakes are frequently used to evaluate the overall ecosystem "health" because these communities are important to material cycling and secondary production, and are sensitive to environmental contaminants [11]. Their composition, abundance and distribution pattern acts as an ecosystem index, thereby indicating trophic structure, water quality and eutrophication level of the ecosystem [12].
Macrobenthic invertebrates apart from being efficient energy converters, constitute an important link in the aquatic food web [13].
This work aims to study the physico-chemical properties of water in the Hadejia-Nguru wetlands with a view to assessing it's suitability to serving as habitat to diverse groups of organisms.

MATERIALS AND METHODS

Study Area

The Hadejia – Nguru wetlands lies between latitudes 12^{o}10N and 13^{o}N and longitudes 10^o 15E and 11^o 30E. The NHW lie within the semi-arid region of Nigeria. The wetland has an area of about 3,500km^2. The topography of the area is mostly low laying flat surfaces on the north-eastern side and limited local relief in the southern and western parts. Rainfall pattern in the NHW has not been stable over the years, but in most cases starts from June and falls through September. Vegetation is mainly Sudan Savanna, with transitional northern Guinea Savanna and Sahel Savanna in the Southern and Northern limits respectively. Since this is a preliminary survey, seven (7) permanent water bodies were selected for collection of samples. Details of geographical locations and activities of the site are provided in Table 1.

Sampling Procedure

Water samples were collected from the seven samples points designated after a reconnaissance survey of the wetland (Table 1). Water samples were collected using a Van Dorn water sampler. Ambient and water temperature were determined in the field using mercury in glass thermometer, depth was measured using graduated rope attached to a weight, transparency was measured using *Secchi* disc and colour by visual estimation.

Analysis of Physico-chemical properties

Other physico-chemical parameters were determined in the laboratory using the techniques described in [14]. pH was measured with pH meter, Jenway model 7020, electrical conductivity was measured with a Conductivity meter, dissolved oxygen was determined using the iodometric method of Winkler. Total alkalinity was determined by titration method using sulphuric acid with methyl orange and phenolphthalein indicators. Other parameters were determined using Hach 2010 spectrophotometer under laboratory conditions.

Sampling for Macrobenthic invertebrates

Macrobenthic invertebrates were sampled with a Peterson bottom grab that samples 0.076 m^2 of the sediment. The samples were treated as described by [15]. Benthic fauna were separated from silty sediments by the modified sugar floatation technique of [16].

The animals were later identified to the lowest taxa possible using keys in [17].

RESULTS AND DISCUSSION

Physico – Chemical properties of water

Mean values of physico – chemical characteristics of water recorded from the seven sampling stations in the wetland were presented in Table 2. The water temperature ranged between 35^{0}C and 38^{0}C in the wetland. The water temperature is on the high side which is a typical characteristic of tropical wetlands. The same pattern of water temperature was recorded by [18] in Bardawil Lagoon in Egypt. Except for Hadejia barrage where there was excessive anthropogenic input as a result of washing and other domestic activities transparency in the wetland is directly proportional to depth of the water bodies. The highest transparency was observed at Nguru Lake, which is the deepest water body. The high transparency may be attributed to stability of the lake and decreased wind speed during the time of sampling. The same explanation was given by [19]. The pH at Hadejia – Nguru wetland is slightly alkaline (7.4 – 8.4). The high pH values may be attributed to increased photosynthetic activity during the rainy season, which reduced the amount of CO_2 in the water [20].

The dissolved oxygen (DO) range of 5.1 – 7.4 mg/l was lower than the average for water bodies. This according to [13] may be attributed to higher temperatures. However the faster rate of organic matter decomposition also leads to consumption of DO.

The composition of cations in the wetland was dominated by calcium (Ca^{++}), which is followed by magnesium (Mg^{++}), and potassium (K^+) respectively. Though the level of calcium and other cations in the wetland is lower than the values recorded by [13] in Shallabugh wetland in India. Total hardness was higher in the floods than in the lakes of the wetland. The increase in hardness may be attributed to the addition of Ca – Mg salts from the catchment area and also to evaporation of the surface water [21]. The values of nitrate ranged from 262µg/l to 292µg/l, while that of nitrite ranges from 12µg/l to 23µg/l these values are higher than those observed by [13] but considerably lower than the values recorded by [20]. The reduction of these nutrients is a result of photosynthetic activities of aquatic macrophyte and phytoplankton.

Diversity of Macrozoobenthos

The benthos collected from the wetland during the study period consists of 13 species belonging to four major taxa. The benthos are jointly dominated by the Arthropoda and the Mollusca each consisting of five species each. While the Annelida has two species and the Nematoda has a species.

The diversity of macrozoobenthose was higher than the 10 species observed at Nguru Lake by [22]. Even though the benthic Fauna is still lower than the over 55 taxa recorded by [23] in a Ugandan stream. According to [24] the benthic fauna of hard strong or muddy bedrock is richer than that of the silty reaches. The presence of Nematodes among the benthic fauna in the wetland is an indication of siltation [25].

Of the 13 species recorded in the wetland during the study only 6 namely *Cryptochironomus deribae, Caenis sp., Tanypus sp., Tubifex sp., Pila werni and Rhabdolainus sp.,* appeared in all the sampling stations, while the others only appeared in some of the stations. The deepest and permanent water bodies sowed the highest diversity of benthos, while the floods that are liable to drying up at some time during the year had test diversity of benthos. The richness of benthic fauna in water bodies is related to primary production dissolved oxygen content composition to cations and anions and other factors [26]. The Chironomid *Cryptochironomus deribae* is the most dominant individual organism, having the highest density and occurring in all stations. This organism is known to be pollution tolerant and can withstand low oxygen content and high organic nutrients [27].

Acknowledgements
This research was funded by the Tertiary Education Trust Fund (TETFUND) research intervention of the Federal University Dutse 2013/2014. We are therefore grateful to the management of the University for facilitating and processing the grant.

CONCLUSION

The altered physico-chemical characteristics of the water together with growing occurrence of the pollution indicator species, like *Cryptochironomus deribae* allows us to conclude that the wetland has evolved over the years as a eutrophic ecosystem and merits urgent attention for ecorestoration and sustainable management.

REFERENCES

[1] Rewa, C. A. Fish and Wildlife benefits associated with wetland establishment practices. The Wildlife Society, technical review 07-1. USDA, NRCS, Resource inventory and assessment division. Maryland USA. 71-82, 2007

[2] Dixon AB and Wood AP. Wetland cultivation and hydrological management in eastern Africa: Matching community and hydrological needs through sustainable wetland use. Natural Resources Forum 27(2): 117-129,2003

[3] Lemly, A. D., R. T. Kingsford, and J. R. Thompson. Irrigated agriculture and wildlife conservation: conflict on a global scale. Environmental Management 25:485-512, 2000

[4] Venkatesan,J. Protecting Wetlands. Current Science, 93, 842-854, 2007

[5] Elmaci, A., Topac, F. O., Ozengin, N., Teksoy, A. Kurtoglu, S. and Baskaya, H. S. Evaluation of physical, chemical and microbiological properties of lake Ulubat, Turkey. Journal of Environmental Biology, 29, 205-210, 2008

[6] Barbour, M. T., J. Gerristen, B.D. Synder, and J.B. Stribbling, Rapid Bioassessment protocols for use in streams and wadeable rivers. Periphyton, Benthic Macroinvertebrates and Fish, Second edition EPA 842-B-99-002 USEPA,office of water, Washington D.C. 1999.

[7] Ogbogu,S.S., and A.T. Hassan, Effects of sewage on physico-chemical variables and Ephemeroptera (Mayfly) larvae of a stream reservoir. Journal of Aquatic Sciences. 11 pp 43-55, 1996

[8] Oben, B. O., Limnological assessment of the impact of agricultural and domestic effluents of three man-made lakes in Ibadan, Nigeria. (unpublished) Ph.D. thesis, university of Ibadan, 2000.

[9] Ogbogu, S.S., Fundamentals of Ecology, W.B. Saunders Ltd. Philadelphia, USA 610,2001

[10] El-Shabrawy, G.M ., Khalil, M. T. Macrobenthos of La ke Bardawil and Zaranik Lagoon. A report presented to Nature Conservation Sector, EEAA.

MedWetCoast Project, Conservation of Wetland and Coastal Ecosystems in the Mediterranean Region, Ecologica l Survey of Zaran ik Nature Protectorate, 2003

[11] Reynoldson, T. B., Bailey, R. C., Day, K. E., Norris, R. H. Biological guide lines for freshwater sediment based on benthic assessment of sediment (beast) using a multivariate approach for predicting biological state. Aust. J. Ecol., 20 (1):198–220, 1995.

[12] Mehdi MD, Bhat FA, Yousuf AR . Ecology of macrozoobenthos in Rambiara Stream, Kashmir J. Res. Dev. 5: 95-100. 2005

[13] Siraj S., A. R. Yousuf, F. A. Bhat and M. Parveen 2010. The ecology of macrozoobenthos in Shallabugh wetland of Kashmir Himalaya, India. Journal of Ecology and the Natural Environment 2*(5)*, pp. 84-91, May 2010

[14] APHA. Standard methods for examination of waters and wastewaters.21st edition American public health authority Washington DC, 2112-2115,2005

[15] Wetzel RG, Likens GE. Limnological analysis. W.B. Saunders Philadelphia. 357,1979

[16] Anderson RO. A modified floatation technique for sorting bottom Fauna samples. Limnology and Oceanography 4, 223-255,1959

[17] Jeje CY, Fernando CK. A practical guide to the identification of Nigeria Zooplankton. Kainji Lake Research Institute, 25-54, 1986

[18] Ali, M. H. H., Sayed, M. F., Goher, M. E. Studies of water quality and some heavy metals in hypersaline Mediterranean Lagoon (Bardawil Lagoon, Egypt*). Egypt Journal of Aquatic Biology and Fisheries,* ***10*** *(4):* 45-64, 2006

[19] Siliem,T.A.A. The chemical conditions in Bardawil Lagoon. III-Some limnological studies. Bull. Nat. Inst. Oceanogr. &Fish. ARE., 15: 21-33, 1989

[20] Khalil, M.T., Saad, A.A., Fishar, M. R., and Bedir, T.Z. Ecological Studies on Macrobenthic Invertebrates of Bardawil Wetland, Egypt. World Environment 3(1): 1-8, 2013

[21] Khan, M. A., Shah, M.A., Mir, S.S. and Suzana, B. The Environmental status of a Kashmir Himalayan wetland game reserve. Aquatic plant communities and eco-restoration measures. Lakes and Reservoirs : Research and Management (Blackwell, Australia) 9 (2): 125-132, 2004

[22] Abubakar, M. M., Balarabe, M. L. and Auta, J. The Association between benthic invertebrates and aquatic macrophytes in a tropical lake, Nguru Lake: a preliminary survey. Journal of Biodiversity and Environmental Sciences 3(5):36-40, 2013

[23] Matagi SV. The effects of pollution on benthic macro invertebrates in a Ugandan stream. Hydrobiologia 137 (4), 549-554, 1996

[24] Boulton AJ. Parallels and contrasts in the effects of drought on stream macro invertebrates assemblages. Freshwater Biology 48, 1173 – 1185,
GEF, 30 pp., 2003

[25] Ogbeibu AE, and B.J. Oribhahor . The ecological impact of stream regulation using benthic macroinvertebrates as indicators. Journal of Aquatic Sciences 16(2), 132-138,2001

[26] Sharma, S. and D. K. Belsare . Faunastic study of shore birds, fish and benthic communities of shoreline areas of Sirpur Lake. Him. J. Env. Zool. 11:125-128, 1997

[27] Pandit, A.K. Ecology of insect community in some typical wetlands of Kashmir Himalayas. Pp 271-286 In Current trends in Fish and Fishery Biology and Aquatic Ecology (A.R. Yousuf, M.K. Raina and M.Y. Qadri eds) P.G. Dept of Zoology, Univ. of Kash. Srinagar, 1992

Table 1. Specific locations of sampling sites used in the survey

Site	Geographical co-ordinates	Elevation
Baturiya (BTR)	12^{O} 27.889'N, 10^{O} 17.958E	362m
Hadejia Barrage (HDB)	12^{O} 26.343'N, 10^{O} 01.905'E	358m
Maikintari Flood (MKF)	12^{O} 38.959'N, 10^{O} 13.750E	349m
Kirikasamma flood (KKF)	12^{O} 40.631'N, 10^{O} 15.099E	347m
Tukwikwi Flood (TKF)	12^{O} 49.258'N, 10^{O} 20.939E	344m
Nguru Lake (NGL)	12^{O} 50.448'N, 10^{O} 24.037E	345m
Dagona (DGN)	12^{O} 50.640'N, 10^{O} 45.152E	348m

Table 2. Results of physics – chemical properties of Hadejia – Nguru wetlands

	SAMPLING STATIONS						
Parameter	BTR	HDB	MKF	KKF	TKF	NGL	DGN
Air temperature (^{0}C)	35	36	37	37	38	38	38
Water temperature (^{0}C)	23	23	25	26	29	22	27
Depth (m)	2.5	2.9	2.2	1.8	2.1	8.2	4.8
DO (mg/l)	5.8	6.2	4.8	4.9	5.1	7.4	5.2
BOD (mg/l)	17	19	18	20	22	33	26
COD (mg/l)	47	47	38	44	49	51	32
Transparently (m)	1.3	0.6	1.0	0.9	0.8	1.4	1.1
Alkalinity	108	132	129	127	132	148	142
PH	7.8	7.6	7.6	7.4	8.1	8.4	8.1
Conductivity (µs/l)	292	344	361	372	389	332	365
Total Hardness (mg/l)	104	172	192	201	208	171	184
Ca (mg/l)	71	52	49	68	98	32	48
Magnesium (mg/l)	32	34	35	31	31	48	22

Potassium (mg/l)	3	4	5	6	6	4	3
Bicarbonate (mg/l)	109	127	143	142	148	133	141
Chloride (mg/l)	21	16	12	12	22	28	24
Sulphate (mg/l)	2	6	3	2	2	3	4
Nitrite (µg/l)	12	14	14	14	13	23	22
Nitrate (µg/l)	172	291	262	268	166	292	286
Silicate (mg/l)	1	Tr	Tr	Tr	Tr	2	2
Total phosphorus (µg/l)	171	178	192	202	173	109	122

Table 3. Diversity of macrozoobenthos in Hadejia – Nguru wetlands

	SAMPLING STATIONS						
Arthropoda	BTR	HDB	MKF	KKF	TKF	NGL	DGN
1. *Cryptochironomus deribae*	+	+	+	+	+	+	+
2. *Caenis Sp.*	+	+	+	+	+	+	+
3. *Tanypus Sp.*	+	+	+	+	+	+	+
4. *Neumania Sp.*	+	+	-	-	-	-	-
5. *Chaoborus Sp.*	-	-	+	+	+	-	-
Annelida							
1. *Tubifex Sp.*	+	+	+	+	+	+	+
2. *Lumbricilus Sp.*	+	-	-	-	-	+	+
Mollusca							
1. *Pila werni*	+	+	+	+	+	+	+
2. *Bulinus sp.*	+	+	-	-	-	+	+
3. *Cleopatra bulinoides*	+	+	-	-	-	-	-
4. *Mutela dubia*	-	-	+	+	+	+	+
5. *Corbicula Africana*	-	-	+	+	+	-	-
Nematode							
1. *Rhabdolainus Sp.*	+	+	+	+	+	+	+