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The Association between benthic invertebrates and aquatic macrophytes in a tropical lake, Nguru Lake: a preliminary survey

M. M. Abubakar[1*], M. L. Balarabe[2], J. Auta[2]

[1]*Department of Biological Sciences, Federal University Dutse, Jigawa State, Nigeria*

[2]*Department of Biological Sciences, Ahmadu Bello University, Zaria, Nigeria*

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Abstract

This study was carried out with the purpose of determining which benthic invertebrate fauna are associated with aquatic macrophytes in Nguru Lake. Water and sediment samples were collected over a twelve month period between May 2006 and April 2007.The samples were analysed using standard methods. Seven species of benthic macroinvertebrates belonging to classes Mollusca, Insecta, Annelida and Nematoda were recorded. Distribution of the various physico-chemical parameters was also determined. The density of benthic community recorded from stations infested by aquatic macrophytes particularly Typha sp. are significantly less than those recorded from stations with no or sparse aquatic macrophytes ($p<0.01$). This benthic macroinvertebrate community observed in the present study was different from that found in Nguru Lake in 1997. And the diversity of taxa was also generally low.

***Corresponding Author:** Abubakar MM ✉ mmabubakar2005@yahoo.com

Introduction

In African water bodies the benthic invertebrate fauna associated with aquatic macrophytes has not been studied extensively although data have been reported from lake Volta (Petr 1974), lake Chilwa (Mclachlan 1975), lake Chad (Dejoux 1983), lake Kariba (Machena and Kautsky 1989), Nguru Lake (Abdullahi 1997), the Ethiopian rift lakes (Tudorancea 2003) and lake Kariba (Mhlanga and Siziba 2006),

In Nguru Lake the development and dynamics of the benthic fauna was investigated along with the general biodiversity of the lake by Abdullahi (1997). During the study Abdullahi (1997) recorded 13 species of benthic fauna. Four group's taxa of organisms were observed then, i.e Nematoda, Annelida, Mollusca and Insecta.

The aquatic macrophytes recorded in the lake by Abdullahi (1997) were dominated by *Echinochloa stagnina*, *E. obtisflora*. *Panicum subalbidum* (Poaceac) and *Cyperus exaltatus*, *C. haspen* (Cyperaceac). By 2006 these macrophytes are no longer important species because the lake had been taken over by *Typha latifolia T. australis, Ceratophyllum demersum* and *Nymphaea lotus*. (Balarabe and Abubakar (2007).

The purpose of this investigation is to determine which invertebrates were associated with *Typha* and other macrophytes and to asses how they might differ from those that were previously found in association with *Echinochloa*.

Materials and methods

Study Area

Nguru Lake is located in northeastern Nigeria. The lake is located in a semi-arid zone between latitude 12°40`N to 13°60`N and longitude 10°20`E to 15°00`E. It has an area of 58,100ha and an elevation of 340-345m. Nguru Lake has a maximum depth of 8m. Temperature range in the area is 19 -45°C and average rainfall is 550mm. the lake, is a wetland of international importance, it is a Ramsar site.

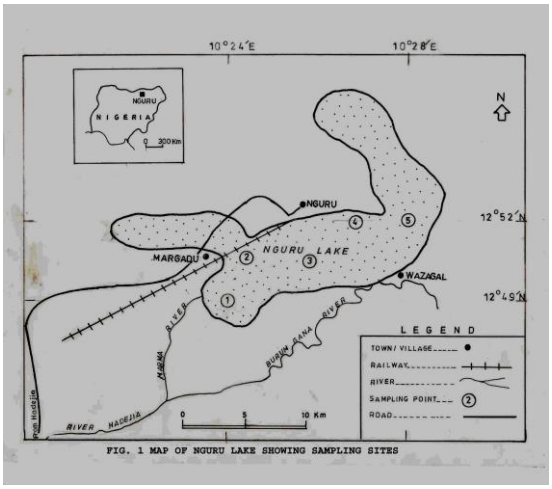

Fig. 1. Study area.

Sampling

Samples were collected for a period of twelve months. Water and benthic samples were collected from five sampling stations selected after a preliminary study. Two of the stations (l and 2) were devoid of floating and emergent macrophytes. While the other three stations (3, 4 and 5) are infested with floating and/or emergent macrophytes. Benthic invertebrates were sampled with a Peterson bottom grab that samples 0.076 m^2 of the sediment. The samples were treated as described by Wetzel and Likens (1979). Benthic fauna were separated from silty sediments by the modified sugar floatation technique of Anderson (1959). The animals were later identified to the lowest taxa possible using keys in Jeje and Fernando (1986).

The water samples were analysed for physico-chemical factors by the methods described in APHA (1998).

Data Analysis

Data collected were subjected to analysis of variance (ANOVA) to ascertain variation between the sampling stations, Shannon- Weaver and equitability indices were used to measure the species diversity between the stations.

Results

The results obtained for the physico-chemical parameters (table 1) indicate that pH, transparency, depth and dissolved oxygen were highest in the two stations which were devoid of macrophytes. On the other hand, total dissolved solids, suspended solids, turbidity and conductivity were lowest in the stations devoid of macrophytes. All of the physico-chemical parameters showed highly significant spatial variation ($p<0.001$).

The number and type of benthic macroinvertebrate fauna observed during the study is presented in table 2. Seven species of benthic invertebrates were recorded during the study period. The Mollusca dominated the benthos with 3 species *Bulinus sp*, *Pila werni* and *Mutela dubia*. However the Insecta with only one species the *Cryptochironomus deribe* were recorded. The two other groups Annelida and Nematode had two and one species respectively. The number of benthic invertebrates collected when subjected to analysis of variation showed highly significant spatial variation ($p<0.001$). Result of the Shannon-weaver index showed that stations 1 and 2 which are devoid of emergent or floating macrophytes had a higher diversity index than the three other sites. The population of benthic invertebrates was greater at the stations with no macrophytes, a difference that was highly significant ($p<0.001$).

Table 1. Mean spatial distribution of physico-chemical parameters.

Parameter	Station 1	Station 2	Station 3	Station 4	Station 5
Temperature	16.25b	20.29a	17.63b	21.71a	20.92a
PH	8.77a	8.59b	8.16c	7.87d	8.29a
Transparency	91.46b	137.67a	42.55c	17.67d	19.83d
Depht	178.8a	188.08a	54.29b	52.16b	49.87b
TDS	74.17c	61.75d	90.08b	97.21a	92.25ba
Suspended solids	2.04d	3.38c	3.25c	6.00a	5.00b
Turbidity	2.50d	4.17c	6.75b	12.63a	6.46b
Conductivity	171.25b	122.77c	180.68b	203.38a	182.76b
Alkalinity	30.54b	35,67a	25.75b	203.38a	182.76b
Dissolved Oxygen	7.64a	7.09b	6.39c	6.25c	6.37c
BOD	2.26d	1.98d	9.40a	4.09c	5.44b
COD	6.42dc	5.73d	7.73c	11.48b	15.24a
Total Phosphate	5.93b	5.12b	5.74b	5.93b	11.56a
Total Nitrogen	5.37c	6.03a	5.45a	6.23a	6.32a
Sulphate	3.29c	5.01b	4.79b	6.04a	5.84a

Table 2. Mean distribution of benthos of Nguru Lake.

Annelida	Station 1	Station 2	Station 3	Station 4	Station 5
Lumbricilus sp.	-	8	-	14	10
Hirudo medicinalis Lin	-	-	-	21	18
Mollusca					
Bulinus jousseaumei Lin	46	51	-	31	12
Pila werni Kutz	52	63	7	-	-
Mutela dubia Lin.	27	41	6	-	-
Insecta					
Cryptochironomus deribae Sars	79	110	28	108	121
Nematoda					
Rhabdolimus sp.	7	19	-	-	-
Mean No. of individuals(N)	211	292	41	174	161
No. of species(S)	5	6	3	4	4
Shannon-Weaver index(D)	4.8241	4.3121	3.0313	2.8225	2.7154
Evenness index(E)	0.8912	0.8231	0.6872	0.5618	0.5128

Discussion

There was a striking contrast between the macrobenthic invertebrate populations in the stations with dense macrophyte growth and those with sparse macrophyte growth. This is similar to the findings of Mhlanga and Siziba (2006) who observed same phenomena with benthic invertebrates growing on *Eichhornia* in lake Kariba. It is evident from the study that stations 1 and 2 which had little or no macrophytes are also the deepest (depth> 2m) parts of the lake, perhaps this may be the reason why rooted macrophytes like Typha are not present there. The macro-benthic invertebrate fauna of Nguru Lake is low in diversity. In terms of density the *Mollusca* and *Dipterans* dominated. With only seven taxa the benthic invertebrate of Nguru Lake is in total contrast to the over 55 taxa reported by Kizito (1980) in Kimimba rice farm, Victor and Ogbeibu, (1985) in a Nigerian stream, and Matagi, (1996) in a Ugandan stream. The poorness of benthic taxa in Nguru Lake can be explained partly by the nature of the substratum on which the fauna lives. According to Boulton (2003) the benthic fauna of hard, strong or muddy bedrock is richer than that of the silty reaches both in numbers of species and in total biomass. The silty bottom of Nguru Lake is a good reason for the poor diversity of benthos. Water quality, nature of substratum and food availability are important factors governing the abundance and distribution of benthic macroinvertebrates (Victor and Ogbeibu, 1985). According to Ogbeibu and Oribhabor (2001), siltation increases the amount of suspended solids in water, which in turn reduces light penetration and water transparency. The presence of Nematodes according to Ogbeibu and Oribhabor (2001) is an indication of siltation. And *Oligochaeta* are present when there is organic pollution and growth of aquatic macrophytes. Therefore, the presence of both taxa in this study is a clear indication of siltation and growth of aquatic macrophytes in Nguru Lake.

The aquatic macrophytes in Nguru Lake are dominated by *Typha sp, Ceratophyllum* sp and *Nymphaea* sp. According to Woo and Zedler (2002) where wetlands receive urban run-off, *Typha* sp and other invasive plants often displace the natural vegetation. This is clearly evident in Nguru Lake. As the lake is receiving run-off from Nguru town and agricultural run-off from cultivated lands near the lake.

Macrophytes concentrate great amount of various substances (e.g. metals) and are consequently useful indicators of local pollution (Kumar *et al*; 2006).

This study had clearly shown that there was variation in the distribution of benthic fauna in Nguru Lake. However it is not clear whether the variation is due to presence or absence of macrophytes, nature of substratum, depth of water or quality of water. This highlights the need for further investigation into the ecology of macrophytes and their associated fauna in Nguru Lake, as well as their role in ecosystem functioning.

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