Diversity and Abundance of Zooplanktons, Macroinvertebrates and Fish Larvae from Lake Ribadu, Adamawa State, Nigeria

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Abstract

This study was carried out to look at the diversity and abundance of zooplanktons, macroinvertebrates and fish larvae from Lake Ribadu, Fufore Local Government Area, Adamawa State, Nigeria. The study was carried out for a period of 6 months (July to December 2016). Sampling was carried out by using plankton net of mesh size 55 µm by hauling horizontally for five meters. Frequency counts, percentages were used to analyze the zooplankton species composition and abundance while ComEcolPaC (a Microsoft Excel 2003 based program) was used to analyze the variation in the diversity indices. A total of Twenty one (21) species were observed in the study sites. The study showed copepods with the highest abundance of 38.18% and rotifer with 5.87% as the least abundant. The study recommends that monitoring of the lake by the immediate community and regulation of all anthropogenic activities should be given topmost priority as part of the environmental management policy for sustainability of aquatic resources of the lake.

Keywords: Diversity; Abundance; Zooplanktons; Lake; Ribadu

Introduction

Lakes are very important part of our natural heritage, they are widely been utilized by mankind over the centuries to the extent that very few, if not many are now in a natural condition [1,2]. These lakes have over the years become habitat for primary producers thereby increasing and enhancing the productivity of the lakes hence creating biological hotspots in the ecosystem [3,4]. Recent developments have indicated that lake management and pollution control are becoming threat to water quality and ecosystem heath worldwide, most especially in Nigeria where many lakes are facing the problem of pollution. Hence there’s need for management and maintenance of the lakes. The management and maintenance of these lakes is significantly dependent on the biological diversity and physicochemical properties of the aquatic ecosystems [5]. Research conducted by Adedeji et al. [6], on the Seasonal variations in the physico-chemical parameters of Lake Ribadu, Adamawa state Nigeria; Yohanna et al. [7], on the Physicochemical Parameters and Water Quality for Livestock Consumption from selected Lakes in the Upper Benue Valley Area of Adamawa State, Northeastern Nigeria and Kwaji et al. [8], on catches assessment and biodiversity of fish fauna in Lake Ribadu, Adamawa State, Nigeria all centered on the environmental conditions and fish fauna of the lake. However there are fewer or no research and publication particularly on zooplankton composition, abundance and diversity of Lake Ribadu which actually has an important role in the food chain. Moreover, the knowledge of zooplankton and macro invertebrates distribution with reference to spatial pattern is important to determine the status of the ecosystem structure and functioning of the lake [9]. Zooplankton diversity has relationship with productivity in ecology [10,11]. In addition, the diversity index may be used for habitat characterization [12,13].

According to Ojutiku, Habibu and Kolo [14], zooplanktons are minute drifting organisms found near the surface of the water bodies. They range in size from tiny microbes to jellyfish. Furthermore, Ovie [15] defined zooplanktons as free-floating, aquatic invertebrates, often described as microscopic because of their normal small sizes that range from few to several micrometers and are not often exceeding a millimeter and consists of protozoans, rotifers and crustaceans and others. Furthermore, zooplanktons constitute an important source of natural food resources for aquatic organisms, therefore occupied a strategic trophic level [16]. These planktonic communities are also sensitive to various substances in water such as nutrient enrichment and pollutants. Thus, they have often been used as indicators to assess the condition and change of the freshwater environment [17]. It is thus important to look at the composition, abundance and diversity of the zooplanktons and how environmental conditions impact the trophic level in the lake. According to Ita [18], environmental management of
aquatic ecosystems, particularly the inland water bodies have been of great concern to many scientists, resource managers and environmentalists in recent times. These ecosystems, which are endowed with some unique natural resources, are being increasingly degraded, leading to ecological instability and disappearance of valuable resources, some of which are irreversible. He further stated that the decimation of inland water bodies, especially in Africa, has been attributed to poor management arising from the lack of adequate regulations or their non-implementation where they exist. These concerns and many more are the basis for this study. Hence, the study seeks to look at the diversity and abundance of zooplankton and macro invertebrates from Lake Ribadu and to also provide baseline information on zooplankton diversity of the lake.

Materials and Methods

Study area

Lake Ribadu is located in Ribadu village of Fufore Local Government Area, Adamawa State, Nigeria. As shown in Figure 1, Lake Ribadu is a perennial lake with coordinates 9°01'N, 12°03' E. The study area falls within the southern part of the Sudan Savanna belt of Nigeria characterized by a semi-arid climate of six months wet and six months dry seasons. Annual precipitation values range from 656.70mm to 1113.30mm with peak rains recorded in the months of August and September, while driest months are January, February and March with annual evaporation values ranging from 1675.91mm to 3272.62mm [19]. The lake, being fluviatile by origin receive water inputs mainly from direct rainfall, runoffs and overflow of the Benue River in the wet seasons. The runoffs which are ephemeral in nature originate from hills and uplands in the study area and cut across various land use zones mainly farmlands and build up areas from which they acquire most of the physicochemical parameters drained into the lake. Aquatic vegetation in the lake consist of mass floating weeds such as water lily, water lettuce, water hyacinth, typha grass and wild guinea corn which move on the lake according to the prevailing winds.

Method of data collection

Two sets of water samples were collected once every month from Lake Ribadu during morning hours of 7:00am - 8:00am for a period of six months (July-December, 2016) for chemical and biological analysis. The study area was categorized into three sites: site A, B and C. Station A was located at the shore of the lake where human activities, like bathing, washing and other domestic activities are taking place. Station B was located at the middle of the lake where there is less human activities. Station C was located at the downstream of the lake where irrigation is the major activity. Plankton sampling was carried out by using plankton net of mesh size 55 µm by hauling horizontally for five meters according to the method. Filtered water samples were stored in the sample bottle, and then preserved with Lugol solution of 10%. Identification of the zooplankton species was according to Botes [20]; Emi and Andy [21].

The following physico-chemical parameters were recorded on site: temperature (T) in °C, conductivity and pH using a pocket
tester field conductivity meter, model pH/TDS/salts. Other physicochemical parameters were analysed at the Modibbo Adama University of Technology Yola Zoology Department Laboratory using standard methods [22].

Statistical analysis

Frequency counts, Percentages and ComEcolPaC, a Microsoft Excel 2003 based program was used to calculate: Species richness and species diversity.

Species richness seeks to ascertain the number of species per sample while species diversity seeks to provide more information about community composition than simply species richness (i.e., the number of species present); they also take the relative abundances of different species into account.

\[ H' = \sum_{i=1}^{S} p_i \log_2 p_i \]

\[ S \] - Species richness (number of species), 
\[ p_i \] - proportion of species \( i \)

E-Pielou Evenness Index

\[ E = \frac{H'}{H_{\text{max}}} \]

D - Simpson’s index

\[ D = \sum_{i=1}^{S} p_i^2 \]

\[ S \] - Species richness, \( p_i \) - proportion of species \( i \)

D\(_{\text{Ma}}\) - Margalef Diversity Index

\[ D_{\text{Ma}} = \frac{S - 1}{\ln N} \]

\[ S \] - species richness, 
\[ N \] - Total abundance

D\(_{\text{Me}}\) - Menhinick Diversity Index

\[ D_{\text{Me}} = \frac{S}{\sqrt{N}} \]

\[ S \] - Species richness

Results

Table 1 show the mean and standard error of the physicochemical parameters measured during the study period in Ribadu Lake. The mean water temperature recorded is 24.86. The water pH of the water from the lake were most basic (pH = 7.2). Transparency was 43.40. Dissolved Oxygen levels is 5.64mg/L. Biochemical Oxygen Demand level is 2.66mg/L while Conductivity is 432μmhos/cm and Total Dissolve Solid is 321.56mg/L.

Twenty one (21) species from 6 taxa were observed in the study sites. The study shows that copepoda has the highest abundance 38.18% followed by macro invertebrates with 21.82%, cladocera with 16.37%, protozoa with 10.49%, fish larvae with 7.2% and the least abundant was rotifer with 5.87% were recorded on the study sites as shown in Table 2.

Table 3 and 4 of the study revealed the Shannon-Weiner Diversity Index (H’) and the Spatial Variation in the Diversity indices of the study.

Discussion

Twenty one (21) species were observed in the selected study sites (Table 2). The cluster of species in Lake Ribadu shows lower value of some zooplankton in the first 2 months of raining season. The zooplankton includes; Protozoa 8, Cladoceran 2, Copepods 3, Rotifer 2, Macro invertebrates 6 and fish larvae 1. Zooplankton percentage abundance recorded were Copepods (38.18%), Macroinvertebrates (21.82%), Cladoceran (16.37%), and Protozoa (10.49%) Pisces (7.26%) Rotifera (5.2%). Their distributions might be due to availability of nutrients in water. This agrees with the findings of Kolo et al. [23], Jerling and Wooldridge [24] who reported that the zooplankton was dominated by Copepoda and phytoplankton was dominated by Baccillariophyceae (diatoms) which were more abundant after flood. Macro invertebrates was the second most abundant zooplankton having 21.82% abundance. Furthermore, the study agrees with the findings of Abubakar [25] in Nguru Lake, Nigeria that copepods are the most dominant zooplankton species found in the study. The dominance of copepods among zooplankton in fresh water has also been reported in Lake Victoria [26,27]. The Zooplanktons are globally recognized as pollution indicator organisms in the aquatic environment. A change in the physicochemical aspect of a water body brings about a corresponding change in the relative composition and abundance of the organisms in that water [28,29]. This study showed that the zooplankton species were same throughout the period of study but the number of individual species keeps

| Water Temp (°C) | pH | Transparency (cm) | DO (mg/l) | BOD (mg/l) | Conductivity (μmhos/cm) | TDS (mg/l) |
|-----------------|----|------------------|----------|-----------|-------------------------|========|
| Min             | 22.23 | 6.65 | 32.73 | 4.19 | 5.1 | 37.13 | 321.56 |
| Max             | 29.17 | 8.03 | 54.37 | 6.92 | 6.13 | 450 | 354 |
| Mean ±S.E      | 24.86±0.52 | 7.2±0.06 | 43.4±2.13 | 5.64±0.23 | 2.66±0.15 | 321.3±8.64 | 321.56±1.81 |
changing from the month of July to the month of December. This may be because of the environmental factors [30].

Table 2 and 3 of the study revealed the Shannon-Weiner Diversity Index (H') and the Spatial Variation in the Diversity indices of the study. The Shannon-Weiner Diversity Index (H') ranged between 3.53-3.59 across the three study sites while the spatial variation in diversity indices of fish population across the three study sites are: Pielou Evenness Index (E) ranged between 0.85 - 0.88; Simpson’s Diversity Index (D) ranged between 0.81 - 0.84; Others indices recorded included Margalef Diversity Index (D_M) with the range of 1.50 - 1.57 and Menhinick Diversity Index.
Spatial Variation in Diversity indices of Zooplankton population across the study sites.

<table>
<thead>
<tr>
<th>Site</th>
<th>Richness indices</th>
<th>Diversity indices</th>
<th>Evenness indices</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Margalef (D_M)</td>
<td>Menhinick (D_mn)</td>
<td>Simpson (D)</td>
</tr>
<tr>
<td>A</td>
<td>1.57</td>
<td>0.08</td>
<td>0.11</td>
</tr>
<tr>
<td>B</td>
<td>1.5</td>
<td>0.08</td>
<td>0.1</td>
</tr>
<tr>
<td>C</td>
<td>1.55</td>
<td>0.1</td>
<td>0.11</td>
</tr>
</tbody>
</table>

Index (D_mn) ranged from 0.08 - 0.10. Species richness, diversity and evenness were observed to increase in all sites. This may be attributed to increased living space leading to increased number of microhabitats. The study agrees with the findings of Azma [24] who shows that a Simpson Index value of 0.83 - 0.93 indicates that the communities is mature and stable as the dominance is shared by large number of species. The Pielou index values which are more than 0.5 indicated that the zooplankton community is balance during the study period. According to Azma [31] and Frutos et al. [32], pointed out that if the Pielou Index values are less than 0.5, it could be an indicator of the presence of ecological stress.

**Conclusion**

The study on zooplankton of Lake Ribadu revealed the presence of 21 species from 6 taxa: Protozoa, Cladoceran, Copepods, Rotifer, Macro invertebrates and fish larvae.

Zooplankton density and abundance were majorly influenced by season and by stations and species composition was significantly influenced by season not station. Thus, zooplankton abundance and distribution were closely associated with environmental conditions. Therefore the study recommends that Monitoring of the lake by the immediate community and regulation of anthropogenic activities should be given high priority and should be encouraged as part of environmental management policy for sustainability of aquatic resources.

**References**


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