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

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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 Cashua the area is about 61,120 km² 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 km². 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 (KRIS) 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 and 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>
<thead>
<tr>
<th>Location</th>
<th>Sampling point</th>
<th>Coordinate</th>
<th>Elevation(m)</th>
<th>Nearest landmark</th>
</tr>
</thead>
<tbody>
<tr>
<td>River Jama’are</td>
<td>1</td>
<td>N12°52’38.1E,010°36.762</td>
<td>371</td>
<td>Jama’are town</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>N11°55’58.8E,010°12.759</td>
<td>378</td>
<td>Kubwa village</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>N12°00’25.2E,010°12.461</td>
<td>366</td>
<td>Sakkwa village</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>N12°16’53.0E,010°22’03.3</td>
<td>351</td>
<td>Zaki village</td>
</tr>
<tr>
<td>River Hadejia</td>
<td>1</td>
<td>N12°19’21.1E,010°3’59.0</td>
<td>353</td>
<td>Fage village</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>N12°22’37.5E,010°3’05.0</td>
<td>357</td>
<td>9 km to Hadejia town</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>N12°27’00.4E,010°0’12.7</td>
<td>371</td>
<td>Mekintari village</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>N12°50’35.3E,010°23’58.6</td>
<td>344</td>
<td>Ramsar site</td>
</tr>
<tr>
<td>River Yobe</td>
<td>1</td>
<td>N12°49’42.2E,010°51’32.3</td>
<td>323</td>
<td>Confluence of Rivers</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>N12°49’42.2E,010°51’32.3</td>
<td>323</td>
<td>Jama’are and Hadejia</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>N12°49’42.2E,010°51’32.3</td>
<td>323</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>N12°13’13’ and 15’00’,E10°00’ and 11°00’</td>
<td>323</td>
<td>Dagona wildlife sanctuary</td>
</tr>
</tbody>
</table>

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**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 Yobe.

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![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](image)
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 they 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


