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Aquatic Macrophytes Diversity and Physico-Chemistry of Asu River, Southeastern Nigeria: Implication for Aquatic Ecosystem Management

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The species diversity of the aquatic macrophytes present in Asu River located in Akpoha community of Afikpo North Local Government Area of Ebonyi State, South-Eastern part of Nigeria and the physico-chemistry of the river's water quality was studied. The physico-chemical parameters are major factors when considering the quality of water sample in relation to the presence of macrophytes in the aquatic ecosystem. The mean value of water temperature was 28.95°C. Total Dissolved Solids had a mean value of 35.25 mg/L. Conductivity, the mean value was 80.50µS/cm. The pH value was also recorded; the mean was 7.57. The dissolved oxygen had a mean value of 5.75mg/L. The family with highest species is the Poaceae which had a number of 15 species followed by the seedlings of aquatic weeds with 7 species and then the Cyperaceae with 6 species. The Onagraceae family with a total number of 2 species, and the rest of the families (Amarathaceae, Eraceaa, Azollaceae, Convolulaceae, Nymphaeaceae, Leguminosae, Pontederiaceae and Titiaceae) had 1species each. It was observed that the physico-chemical parameters of Asu River fall under normal range that shows a good water quality supporting the growth of the aquatic macrophytes.

Introduction

Macrophytes are an important component of the aquatic ecosystem and broad changes in the abundance of individual species and community composition provide valuable information on how and why an ecosystem might be changing. Macrophytes are also becoming increasingly valued as a means of indirectly monitoring water quality as, for instance, eutrophication can produce a progressive change in species composition and a loss of species diversity [1]. The emphasis of the freshwater monitoring programme is on the aquatic environment, the macrophyte survey covers plants growing in the water body but not the adjacent bank sides. "Bank species" occurring above the level of the river or lake are not recorded because the influences of the river or lake substrate and water chemistry are likely to be less important than local edaphic and climatic influences. The river channel is defined as those parts of the substrata which are likely to be submerged for 85% of the time, whilst 'Bank' is that part of the side of the river (or islands) which is submerged for more than 50% but less than 85% of the time. Macrophytes include any plant observable by the naked eye and nearly always identifiable when observed [2]. This includes all aquatic vascular plants and bryophytes, together with groups of algae which can be seen to be composed predominantly of a single species. It will, however, rarely be possible to survey whole rivers and lakes and in most cases macrophyte surveys will be undertaken at selected sampling points [3]. The main requirement is that the methods employed should be consistent so that information can be used to compare change both within and between sampling points at different sites and times. Common procedures have been recommended for lakes and rivers wherever possible. Wherever possible the recommended methods are close adaptations of existing, widely practiced methods in order to ensure continuity with historic data and to reduce the need for training. Although a number of techniques have been developed for survey and monitoring of aquatic macrophytes in rivers and for characterizing waterside habitats particularly in relation to its need for detailed data for detecting change at individual sites [4-8]. This study takes into account the rationale and methods adopted in the analysis. AsuRiver is one of the most important rivers (aquatic resource) in Ebonyi State and Nigeria at large. However, much of its biotic information (macrophyte and physico-chemical variables) is still unknown. Therefore, this study is aimed at providing baseline information on the species richness of aquatic macrophytes and physico-chemical variables of Asu River, southeastern Nigeria.

Materials and Methods

Study Area

The study area lies between longitudes $7^{0}51^{l}$E and $8^{0}00^{l}$E and latitudes $5^{0}55^{l}$N and $6^{0}00^{l}$N within the Afikpo syncline of the Cross River basin of the Benue Trough. The Benue Trough of Nigeria formed as a result of series of tectonism and repetitive sedimentation in the Cretaceous time when South America separated from Africa. Afikpo is located in the southern Benue Trough, between the Abakiliki anticlinorium running northeast and the Cameroon Line in the southeast.

Sample Collection

Samples in Asu River were collected from the month of September, 2014 to December 2014 (4 months study period). Aquatic macrophytes were collected along river bank of Asu River and on the surface water for the floating macrophytes each time a trip was made to the site for the period of four months; both creeping and standing macrophytes were collected. The macrophytes collected were arranged and preserved in white paper and covered with brown paper envelop to avoid drying up. It was quickly transported to Applied Biology Laboratory for identification. Water samples from the river were collected. During the collection, some water quality parameters were determined *in situ*.

Aquatic Macrophytes Identification

Macrophytes were identified to species level according to [4].

Physico-Chemical Parameters

Water Temperature: Digital thermometer was used to determine the water temperature *in situ*. Each time a trip was made to the site by dipping thermometer into the water until a steady value was observed then recorded as the water temperature in.

Hydrogen Ion Concentration (pH): This was determined *in situ* using Hanna pH meter model HI96107. The meter was calibrated using pH buffer at 8.9 then dipped in the water sample until steady value was read, then recorded as pH values.

Dissolved Oxygen (DO): The amount of dissolved oxygen was determined *in situ* by Winkler's methods;

a. A 300ml glass stopper BOD (Biological Oxygen Demand) bottle was filled with the water sample ensuring that there were no air bubbles.

b. 2ml of Manganese (ii) sulphate was added to the collection bottle by inserting a calibrated pipette just below the surface of the liquid and the pipette squeezed out slowly to ensure that bubbles are not introduced into the sample through the pipette.

c. 2ml of alkaline potassium iodide solution was added into the sample in the same manner as in b.

d. The bottle was carefully covered with a stop cock ensuring that air was not introduced and the sample mixed by inverting the bottle severally. The sample was checked for air bubbles and if found, the sample was discarded. The presence of oxygen in the sample was noticed by the appearance of a brownish-orange cloud of precipitate.

e. 2ml of concentrated Hydrogen-tetra-oxosulphate (vi) acid was added to the sample. The bottle was carefully covered and inverted severally dissolving the precipitate. Thus, the sample was 'fixed'.

f. 201ml of the sample in a glass was titrated with sodium thiosulphate until a pale straw colour was obtained. This was done by slowly dropping the sodium thiosulphate solution (1 ml) from a calibrated pipette and swirling the sample.

g. 2ml of freshly prepared starch solution was added to the sample which gave a dark- blue colour.

h. Addition of sodium thiosulphathe (B ml) continued slowly until the sample turned clear which marks the end point of the experiment.

The concentration of the Dissolved Oxygen in the sample was equivalent to the milliliters equal of sodium thiosulphate used during the titration as 1ml equal 1mg/l dissolved oxygen. That is, the concentration of Dissolved Oxygen = A ml + B ml (knowing that 1ml of sodium thiosulphate is equal to 1mg/ of Dissolved Oxygen).

Conductivity: This was determined using Hanna conductivity meter (model H198801). The meter was inserted in the water *in situ* and allowed to attain a steady value and then recorded in (µS/cm).

Total Dissolved Solids (TDS): This was measured using Hanna TDS metre (model H198801). The meter was inserted into the water and allowed to attain a steady value; the value was recorded at TDS (mg/L) [9].

Results

The family with highest species is the Poaceae which had a number of 15 species followed by the seedlings of aquatic weeds with 7 species and then the Cyperaceae with 6 species. The Onagraceae family with a total number of 2 species, then the rest of the family (Amarathaceae, Eraceaa, Azollaceae, Convolulaceae, Nymphaeaceae, Leguminosae, Pontederiaceae and Titiaceae) had 1each (Table 1).

Table 1. *Species diversity and abundance of aquatic macrophytes in Asu River.*

FAMILY	SPECIES PRESENT	ABUNDANCE
AMARANTHACEAE	*Alternanthera sessilis*	+
TOTAL	*1*	
ARACEAE	*Pistia stratiotes*	+
TOTAL	*1*	
AZOLLACEAE	*Azolla pinnnata*	+
TOTAL	*1*	
CONVOLVULACEAE	*Ipomoea aquatic*	+
TOTAL	*1*	
POACEAE	*Acroceras zizanioides; Echinochloa obtusiflora; Echinochloa stagnina; Leersia hexandra; Leptochloa caerulescens; Oryza barthii; Panicum laxum; Panicum subalbidum; Paspalum scrobiculatum; Paspalum vaginatum*	++++
TOTAL	*10*	
CYPERACEAE	*Cyperus difformis; Cyperus haspan; Cyperus iria; Fimbristylis littoralis; Kyllinga erecta; Mariscus longibracteatus*	+++
TOTAL	*6*	
ONAGRACEAE	*Ludwigia abyssinica; Ludwigia hyssopifolia*	++
TOTAL	*2*	
NYMPHAEACEAE	*Nymphaea llotus*	+
TOTAL	*1*	
SEEDLINGS OF SELECTED AQUATIC WEEDS	*Kyllinga erecta; Fimbristylis littoralis; Heteranthera callifolia; Pentodon pentandrus; Cyperus difformis; Ludwigia abyssinica; Paspalum scrobiculatum*	+++
TOTAL	*7*	
LEGUMINOSAE: PAPILIONOIDEAE	*Aeschynomena indica*	+
TOTAL	*1*	
PONTEDERIACEAE	*Eichhornia natans*	+
TOTAL	*1*	
TITIACEAE	*Clappertonia ficifolia*	+
TOTAL	*1*	

Keys
+ Present
++ Abundant
+++ More abundant

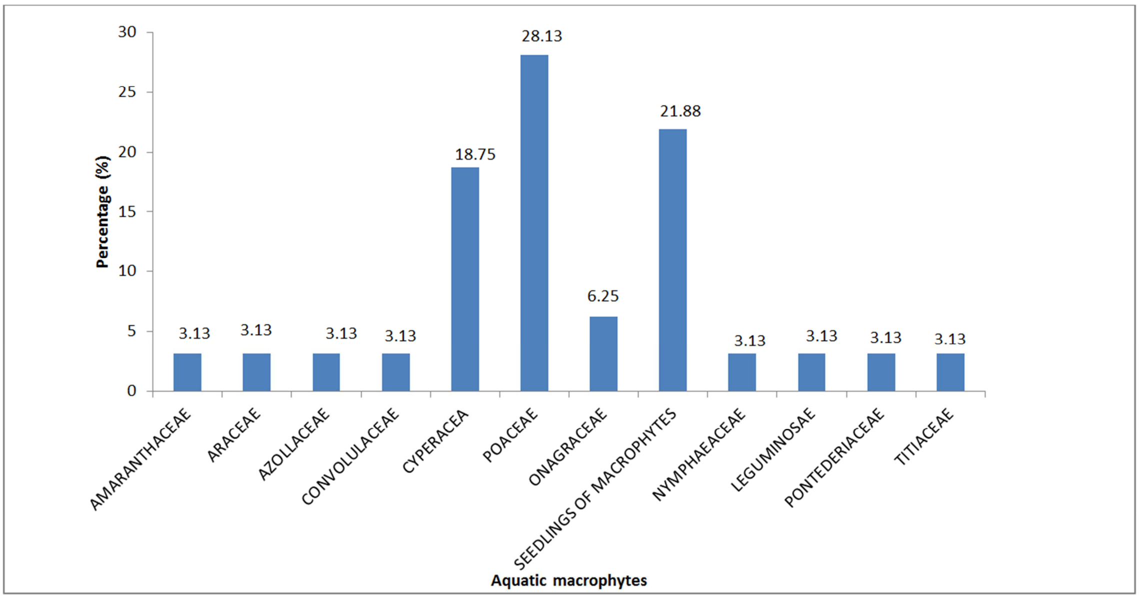

Figure 1. *The aquatic macrophytes by family collected in Asu River.*

The results of the physico-chemical parameter of Asu River were recorded in Table 2 having values obtained for different parameters during the study period. The mean value of water temperature was 28.95, with minimum value recorded in October as 27.20 and maximum value of 31.3 December. Total Dissolved Solids had a mean value of 35.25 with minimum value of 20.00 and maximum of 52.00 in the month of September and December. Conductivity, the mean value was 80.50 with the minimum and maximum values of 43.00 and 102.00 in the month of September and December respectively. The pH value was also recorded; the mean was 7.57 with minimum value of 6.60 in the month September and maximum value of 8.40 in October. The Dissolved Oxygen had a mean value of 5.75, minimum value of 4.60 in and maximum value of 6.70 in September.

Table 2. *Mean and standard deviation of physico-chemical variable of Asu River.*

Water parameter	Mean value ± standard deviation	Minimum value	Maximum value
Water temperature (°C)	28.95± 1.95	27.20	31.30
Total Dissolved Solids(mg/L)	35.25±13.84	20.00	52.00
Conductivity(µS/cm)	80.50±28.28	43.00	102.00
pH-value	7.57±0.83	6.60	8.40
Dissolved Oxygen(mg/L)	5.75±0.89	4.60	6.70

Discussion

A total of 12 families and 33 different species of macrophytes were identified each family having different numbers of species. The family Poacease has the highest species in Asu-river with 10 different species. Next is the family of seedlings aquatic weeds with 7 species followed by the Aceacyperse family with 6 numbers of species. Onagraceae has 2 species. Every other family has only one species each. The highest number of species in the Poaceae family may be associated with the availability of the water nutrients that support the growth of Poaceae. Different species of macrophytes have been characterized by dissimilar physiology and chemical composition, which would result in the release of different types of substrate. The presence of these different substrates may affect the availability of ecological niches for different associated communities. The chemical composition of macrophytes depends on the availability of main resource, light, carbon dioxide and mineral nutrient and, is closely related to the structure of the aquatic environment. As stated by water fluctuation of up to three metres increase the aquatic macrophytes species riches but higher fluctuation causes decrease, this might affect the survival rate of those species [10-13]. *Ipomoea aquatic*, belongs to the family Convolvulaceae**,** with a common name of water spinach. The plant is a hairless, aquatic perennial with milky latex and hollow, creeping stem that roots at the nodes, trails on mud or floats on water. It reproduces mainly from vegetative stems and stolons and rarely from seeds. It is a common aquatic weed of poorly drained soils, often found in rice paddies throughout West Africa. *Fimbristylis littoralis* is erect, tufted annual sedge 20-60 cm high that reproduces from seeds. It has weak, slender stems that are flattened at the base and are strongly angled at the top; it is a weed of wet, swampy areas, common in rice fields. *Pentodon pentandrus* is a semi-fleshy, climbing perennial herb that grows in muddy, swampy soil and reproduces from seeds. The stem is weak, more or less erect, but often trailing. The plant is a weed of wet and muddy areas commonly found in rice paddies. *Alternanthera sessilis*, belongs to the family of Amaranthaceae. It is a semi-prostrate annual herb with erect shoots up to 50cm high that reproduces from seeds. It's a weed of shady, damp soils in cultivated and waste areas. *Leptochloa caerulescens* (Poacea) an aquatic, annual grass with erect, sometimes climbing stems up to 1.5m high, rooting at the lower nodes that reproduces from seeds and vegetatively from stolons. The plant is an aquatic weed commonly found in lowland rice, marshes and drainage canals. It is widely spread across West Africa. The family Cyperaceae has large, tufted sedge that can grow to about 1m high and reproduces from seeds. It is an aquatic weed of lowland rice and open wet grounds in the forest zone. *Ludwigia abyssinica*of the family Onagraceae has a common name of water primrose. It is an erect, annual or perennial shrub about 1-2m high that reproduces from seeds. It is commonly found in lowland area. *Oryza barthii* of the family Poaceae is an erect, tufted, annual grass about 1.5m high that roots at the lower nodes and reproduces from seeds. It occurs in swamps and shallow waters. *Leersia hexandra* belonging to the family Poaceae is a lax, climbing aquatic perennial grass with long rhizomes that root at the nodes and sends up erect shoots up to 1m high and can reproduce from seeds as well as from rhizomes. The species *Panicum subalbidum* of the family Poaceae is a tufted swamp grass up to 2 m high that reproduces from seeds. It occurs in deep water rice and swamps. *Panicum laxum*is of the family Poaceae; a lax, tufted annual grass 30-60 cm high that reproduces from seeds and commonly found in shallow streams and marshes usually in the forest zone. *Paspalum Scrobiculatum*is also of the family Poaceae; a glabrous, tufted, perennial grass about 60-100 cm high that reproduces from seeds, commonly found in both savanna and forest zones [4].

Conclusion

Asu River supports the growth of Poaceae which is a family of grass weeds and has higher important plants like the common rice. This family of aquatic macrophytes serves as food to both lower and higher animals. The leguminous type of macrophytes are also present in the study area which provides nutrient to other plants and as well supports microscopic animals which are of economic benefit in both positive and negative effect [14 and 15]. It is observed that the physico-chemical parameters of the water quality of Asu River falls under normal range that shows a good water quality. The pH value proved that the river is a fresh water river which supported the growth of the aquatic macrophytes that were identified and also the total dissolved solids indicated the presence of dissolved nutrients that are used by both aquatic plants and the aquatic animals both micro and macro organisms present in the location. ■

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