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Full Length Research Paper

The sediment characteristic and benthic macro-invertebrate fauna of some fish ponds in Ife north local government area (LGA), Nigeria

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This study investigated the sediment characteristics as well as the taxonomic composition of macrobenthic invertebrate faunae of some ponds in Ife north local government area,(LGA) Nigeria. The sediments were generally sandy, moderately acidic (pH range of 3.8 to 5.8) and well drained. The organic carbon of the sediment were within the usual range of 0.5 to 5% organic carbon while the nutrients (NO_3^-, PO_4^{3-}, SO_4^{2-}) varied from very low to moderate concentration in all the ponds. The failure for a buildup of organic material and nutrients to a very high level indicated that the wastes from the fish and exogenous feed were rapidly and completely broken down and thus does not develop to poor sediment characteristic. Macro-invertebrate fauna recorded were dominated by the molluscs typical of freshwater macrobenthic communities. Orders Architaeniaglossa and opisthobranchia were encountered with *Melanoides (Melanoides) tuberculata* of the order Architaeniaglossa being the most dominant taxon in the ponds. The abundance of pulmonates in these ponds showed that they were mesosaprobic – eutrophic water bodies that are slightly polluted and nutrient rich.

Key words: Poor sediment, organic carbon, acidic pH, nutrients, macrobenthic invertebrate.

INTRODUCTION

Nigeria is greatly endowed with natural and environmental conditions for rapid development of aquaculture in terms availability of suitable aquacultural sites in all the geographical zones of the country (Adikwu, 1999), optimum temperature, optimum annual rainfall and water availability in more than 95% of the land area (FAO, 1994). Nigeria has about 12.5 million hectares of inland water mass plus over 20 million hectares of swamps; lagoons and estuaries which can be used for productive fish farming (Ita, 1980). Though fish farming in Nigeria has a very good investment prospect, it is faced with a lot of problems which make its success unrealizable. Previous studies in Nigeria have shown ineffective management practices coupled with poor supervision skills as the main cause of the poor culture fish production in the country (Egborge, 1999; Anadu et al., 1990; Ajayi et al., 2001). Bad management practices such as excessive exogenous feed input, utilization of wrong feedstuff as well as the application of organic and inorganic fertilizers could lead to increase in the load of nutrients, low dissolved oxygen content, high ammonia concentration and poor bottom sediment conditions. The investigation of this problem of the poor bottom sediment and their biological resources in ponds at Ife North Local Government Area of Osun State is the main concern of this research.

Area of study

Ponds investigated were located on the farm owned by Niger Feeds and Agricultural Operations Limited (NIFAGOL). The company was established in 1984 for

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Abbreviations: NIFAGOL, Niger Feeds and Agricultural Operations Limited; **LGA,** Local Government Area.

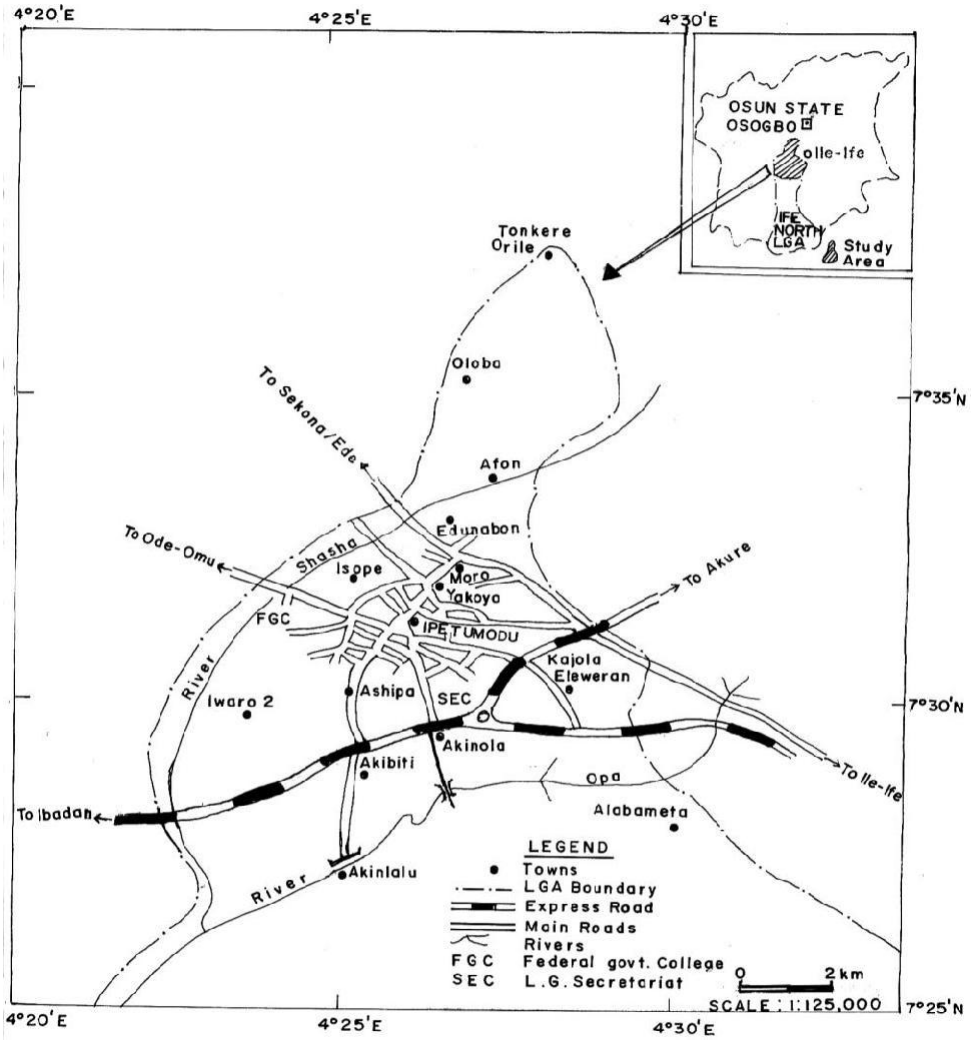

Figure 1. Map of the northern part of Ife north LGA showing the area of study.

the production of fingerlings and table size fish for sale to the public. The ponds are located between latitudes 07° 32.285' N to 07° 32.487' N and longitude 004° 26.699' E and 004° 26.856'E at an altitude between 254to 259 m (Figure 1). The climatic condition of the studied area is governed mainly by two dominant winds, the south-west winds and the North-East winds which blow over most parts of West Africa. The dry season extends from November to March while the wet or rainy season occurs from April to October. There is abundant sunshine almost throughout the year and temperature is more or less equable with very low range of variation. The soil is well drained clayey soil which is being considered as the best soil for pond and fish rearing. The vegetation of the area consists mainly of low-land rainforest and some areas of grassland.

MATERIALS AND METHODS

Sediment samples were taken once in two months between January through July, 2006 using an improvised mad grabber (metallic plates of cross sectional area of 15.2 by 15.2 cm) from four fish ponds located within NIFAGOL farm, Ipetumodu. Half of the grabbed sediment samples were sieved through 0.5 mm mesh sieve using the pond water. The macro-invertebrate benthic organisms found were removed (using a pair of long forceps) and preserved inside an adequately labeled collecting tubes containing 5% buffered formalin solution (APHA, 1995). Identification of the benthic macro invertebrate fauna collected was done using identification keys prepared by IOWATER (2005) and Kohl (2005). Although the identification keys are not specific for tropical freshwater, they satisfy standard international scope for identification of benthic macrobenthic fauna. The other half of the sediment samples were transferred to the laboratory, air dried crushed with a pestle in a porcelain mortar. The sediment was then sieved through a 2 mm mesh sieve before analysis of selected physico-chemical parameters were carried out (Royse, 1970). Colour, particle size analysis, textural composition, pH, organic matter, total nitrogen, pH, sulphate and phosphate levels in the sediment were determined according to Boyd (1995) because natural physicochemical sediment differences were found to be the main determinants in species assemblage patterns among sites (MacFarlane and Booth, 2001).

Table 1. The physiochemical parameters of the pond sediments for the months investigated.

Parameter	February				May				July			
	A	B	C	D	A	B	C	D	A	B	C	D
Value/chroma	3/1	5/6	4/2	2/2	3/3	4/4	2/0	4/2	3/3	4/2	4/2	4/2
Hue	10 year	10 year	7.5 year	5 year	5 year	10 year	2.5 year	5 year	5 year	10 year	2.5 year	2.5 year
Colour	Very dark grey	Yellowish brown	Dark brown	Dark reddish brown	Dark red brown	Dark yellowish brown	Black	Dark reddish grey	Dark reddish brown	Dark greyish brown	Dark greyish brown	Dark greyish brown
Porosity	50	50	48	50	50	48	43	40	44	51	44	41
% Sand	31	83	63	69	77	61	89	87	89	89	89	55
% Silt	38	6	14	24	11	16	4	7	6	4	4	20
% Clay	31	11	23	7	12	23	7	6	5	7	7	25
pH H_2O 1:1	5.4	5.7	6.2	6.4	6.0	5.7	3.8	6.2	6.2	5.8	5.8	6.2
pH $CaCl_2$ 1:2	5.2	5.0	5.4	6.2	5.4	5.2	3.6	5.8	5.4	5.0	5.6	5.2
Redox potential	+105	+90	+50	+60	+80	+90	+200	+60	+75	+80	+40	+70
Org. carbon %	3.74	0.78	1.25	2.38	1.48	1.87	1.21	1.13	0.94	1.01	0.70	0.43
Org. matter %	6.44	1.34	2.15	4.09	2.55	3.22	2.08	2.01	1.61	1.74	1.21	0.74
Phosphate (ppm)	4.98	3.87	18.72	12.48	7.74	7.42	15.08	5.13	3.87	7.19	12.64	11.53
Total nitrogen (ppm)	0.20	0.03	0.06	0.14	0.10	0.09	0.06	0.05	0.03	0.04	0.04	0.05
SO_4^{2-} (ppm)	543.61	171.07	87.43	190.07	167.26	266.10	1334.31	254.7	144.46	247.09	790.70	912.35
Sediment type	Silty mud	Clayey sand	Sandy mud	Silty sand	Silty sand	Sandy mud	Sand	Sand	Sand	Sand	Sand	Silty mud

RESULTS

The sediments were either silty mud or sandy. The colour of silty mud sediment was very dark grey while the sandy ones varied from yellowish brown through dark brown to dark reddish brown to black (Table 1). Sediments of all the four ponds were relatively porous. Their pH was acidic ranging from 3.60 to 6.40. Sulphate concentrations were generally above 50 ppm (1334.31 to 144.46 ppm) while phosphate concentration ranged from 3.87 to 18.7 ppm (< 20 ppm). Total nitrogen concentration was very low ranging from 0.03 to 0.14 ppm. The sediments of all the four ponds were rich in organic carbon (0.43 to 3.74%) which is a factor of the organic matter concentration (0.74 to 6.44%) in the various ponds. The organic carbon and matter decreased from February through July in the ponds except in pond B where there was an increase between February and May (Table 1).

The standard deviation of organ carbon (%), organic matter (%), porosity, sand (%), silt (%), clay (%), redox potential, phosphate, sulphate and total nitrogen were characterized by high scattering around their respective mean values while that of pH is generally low and is characterized by low scattering around its mean value (Table 2). Three gastropod species, one Annelid species and one nymphal form of an insect were recorded. The checklist and outline classification of the fauna is given in Table 3. *Melanoides* (*Melanoides*) *tuberculata* dominated the four ponds and were found in abundance in all the ponds. A few numbers of apple snails (Pomacea) and sinistral snails (Physidae) were found in pond B.

DISCUSSION

The particle size variation recorded in the ponds during the study period revealed that the sediments were generally sandy during the period resulting in porosity of the sediments. The sediment colour is an indicator of the pattern of drainage in the ponds, the sediment with red, yellow and brown coloured sediments showed good drainage except pond A whose sediment was very dark grey in february indicating poor drainage during that period (Aldoufer, 1974). The pH of the sediment was moderately acidic and it was higher in May (early rainy season) and July (mid rainy season) than in February (dry season). This supported the observation of Richard and

Table 2. The mean and standard deviation of the various physiochemical parameters of the pond sediments.

Parameter	Pond A	Pond B	Pond C	Pond D
% Organic carbon	2.05±1.49	1.22±0.58	1.05±0.31	1.33±0.98
% Organic matter	3.53±2.56	2.10±0.99	1.81±0.52	2.28±1.69
Porosity	48.00±3.46	49.67±1.52	45.00±2.65	43.67±5.51
% Sand	65.67±30.61	77.67±14.74	80.33±15.01	70.33±16.04
% Silt	18.33±17.21	8.67±6.43	7.33±5.77	17.00±8.89
% Clay	16.00±13.45	13.67±8.33	12.33±9.23	12.67±10.69
pH $CaCl_2$ 1:2	5.33±0.12	5.07±0.09	4.87±1.10	5.73±0.50
pH H_2O 1:1	5.87±0.42	5.73±0.06	5.26±1.28	6.27±0.12
Redox potential	86.67±16.07	86.67±5.77	96.67±89.62	63.33±5.77
Phosphate (ppm)	5.53±1.99	5.16±1.99	15.48±3.05	9.71±4.00
Total nitrogen (ppm)	0.11±0.09	0.05±0.03	0.05±0.01	0.08±0.05
SO_4^{2-} (ppm)	285.11±224.15	228.09±50.28	889.54±404.51	452.37±399.66

Table 3. Checklist and outline classification of the macrobenthic invertebrates encountered.

	Category	Taxon
1	Phylum	Mollusca
	Class	Gastropoda
	Sub class	Eogastrophoda
	Sub order	*Neritaemorphi*
	Order	*Architaeniaglossa*
a	Sub order	*Discopoda*
	Super family	Cerithiodea
	Family	Thiaridae
	Genus	*Melanoides*
	Species	*Melanoides* (*Melanoides*)
	Sub species	*Melanoides* (*Melanoides*) *tuberculata* (Muller 1774)
b	Order	Architaenioglossa
	Super family	Ampullarioidae
	Family	Ampullarioidae
	Genus	*Pomacea*
	Species	*Pomacea* (*Pomacea*) *columellaris* (Gould 1848)
c	Sub class	Orthogastropoda
	Super order	*Heterobranchia*
	Order	*Opisthobranchia*
	Sub order	*Basommtophora*
	Super family	Physacea
	Family	Physidae
	Sub family	Physinae
	Genus	*Physa*
	Species	*Physa frotinalis*
2	Phylum	*Annelida*
	Class	Hirudinea
	Order	*Rynchobdella*
	Family	Glossiphonidae
	Species	*Glossiphonidae*
	Super phylum	Arthropoda
	Phylum	Insecta
	Order	Plecoptera

Bacon (1994) and Jackson (1997) that in most tropical inland lakes and reservoir, the sediments were acidic. The acidic pH was also observed in Lake Brolus (an Egyptian lake Delta) by Saad, (1980). Platts et al. (1983) suggested that the increase in the pH of the sediments during the wet season was due to the high inflow of flood and this is followed by the re-cycling and re-suspension of benthos material that accompanied it. On the other hand, Davies and Tawari (2010) suggested that the low pH recorded in the dry season was due to high temperature which could lead to high rate of decomposition of matter. This process reduces the amount of oxygen in the sediments thus low pH. The organic carbon of the sediment were within the usual range of 0.5 to 5% organic carbon (Boyd et al., 2002) but changed over time. These changes according to Munsiri et al. (1996) are greatly influenced by pond management inputs. Such as application of organic manure to maintain the ponds and even feeding the fish with dead chicken parts as observed during the period of study.

The very low concentration of total nitrogen in the pond sediments could be attributed to the fact that nitrogen concentration in sediment is controlled by the presence of organic matter as 90% of nitrogen in sediment exists in organic form (Martinova, 1993). Sulphate concentration the in pond sediments were generally low below 0.5% as its concentration in sediment is also known to be dependent on organic matter enrichment. The values of phosphate concentration (< 20 ppm) recorded were generally lower than the optimum range of 30 to 60 ppm (Boyd et al., 1994). This could probably be as a result of the acidic nature of the sediment. According to Boyd et al. (1994), acidic sediment contains primarily iron and aluminum phosphate which are less soluble in dilute acid. Macro-invertebrate fauna recorded were dominated by the molluscs which are very important in the breakdown of plant matter and other detritus that form the basis of many food chains. The rich occurrence of *M. tuberculata* could be attributed to their ability to strive well in the tropics (Derraik, 2008) with habitat preference temperature falling within 21 to 25°C (De Kock and Wolmarans, 2009). They were also known to become invasive on introduction to a new location due to their ability to reproduce parthenogenetically and even bring forth juvenile viviparously (Derraik, 2008).

Their high frequency in the ponds could be attributed to the muddy nature of the sediment, availability of decomposing material and more or less permanence of the water bodies as they are known to have poor ability for aestivation (De Kock and Wolmaran, 2009). Occurrence of *Physa frontinalis* and *Pomacea pomacea columellaris* in Pond 4 shows the level of organic pollution of this water body (Ersan et al., 2009). Moreover the immense abundance of the pulmonates in the water bodies reveals the high trophic state of the water bodies as well as deposits of allochthonous in the water bodies (Yildirim, 2004). In summary, it appears that the sediment at best can be classed as a rich soil. The failure for a buildup of organic material and nutrients to a very high level indicates that the wastes from the exogenous feed and fish are rapidly and completely broken down and thus does not result in poor bottom sediment condition.

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