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Full Length Research Paper

Impact of urban wastewaters on the diversity and abundance of the fish population of Ogba River in Benin City, Nigeria

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The effects of urban wastewaters on the diversity and abundance of the fish population of Ogba River in Benin City, Nigeria were assessed and monitored at 5 sample stations between November 2007 and October 2008. The physico-chemical properties of the water were also monitored during the period. A total of 486 individual fishes made up of 26 different species were recorded, with *Clarias macromystax* (Clariidae), *Malapterurus electricus* (Malapteruridae), *Xenomystus nigri* (Notopteridae), *Hemichromis fasciatus* and *Oreochromis niloticus* (Cichlidae) being the dominant species. The water chemistry, fish species diversity and abundance at the study stations were different and were negatively impacted upon by urban wastewaters pollution. It was also revealed that the fish communities of the river were under stress and not in good condition. Consequently, a close monitoring of all effluent discharges and other probable stress-inducing factors in Ogba River is recommended.

Key words: Ogba River, Nigeria, municipal wastewaters, fish, impact assessment.

INTRODUCTION

In recent years, inland water bodies have been subjected to ecological degradation (Morris, 1978). Increased agricultural and industrial activities have let to the production of many synthetic and organic wastes, which are introduced into aquatic ecosystems either as direct discharges from industrial plants or as surface run-offs from municipal and agricultural fields. These industrial effluents and municipal wastes cause ecological degradation with the attendant severe adverse consequences on the aquatic biota.

Fish has been used as bio-indicators of water quality by many researchers (Ogbeibu and Victor, 1989; Oguzie, 2003; Yamazaki et al., 1996; Idodo-Umeh, 2002). The justification lies in the fact that, whereas water quality analyses of river samples indicate short-turn conditions, fish communities also respond to episodic events and therefore integrate environmental conditions over time. Several investigations have been carried out on the effects of pollution in aquatic ecosystems. Victor and Tetteh (1988) and Oguzie (2003) reported a reduction in fish species diversity associated with the introduction of municipal wastes and industrial effluents into Ikpoba River, while Idodo-Umeh (2002) attributed similar reduction in fish diversity in Olomoro water bodies to effluents from petroleum refining activities. Other investigators (Fufeyin, 1998; Wangboje and Oronsaye, 2001) reported heavy metal concentrations in some dominant and commercial fishes in Ikpoba reservoir and Ogba Rivers.

The present study focused on the effects of urban wastewaters on the fish population of Ogba River with emphasis on species abundance, diversity, distribution, condition (general well-being), food and feeding habits.

MATERIALS AND METHODS

Study area

The study was conducted in a stretch of the upper reaches of Ogba River in Benin City, Nigeria. The river drains the south-west area of the city in a north-south direction (Figure 1). The study area is bordered on the south by a large Agricultural farm complex and on the north by a Forest reserve, where intensive mixed agricultural

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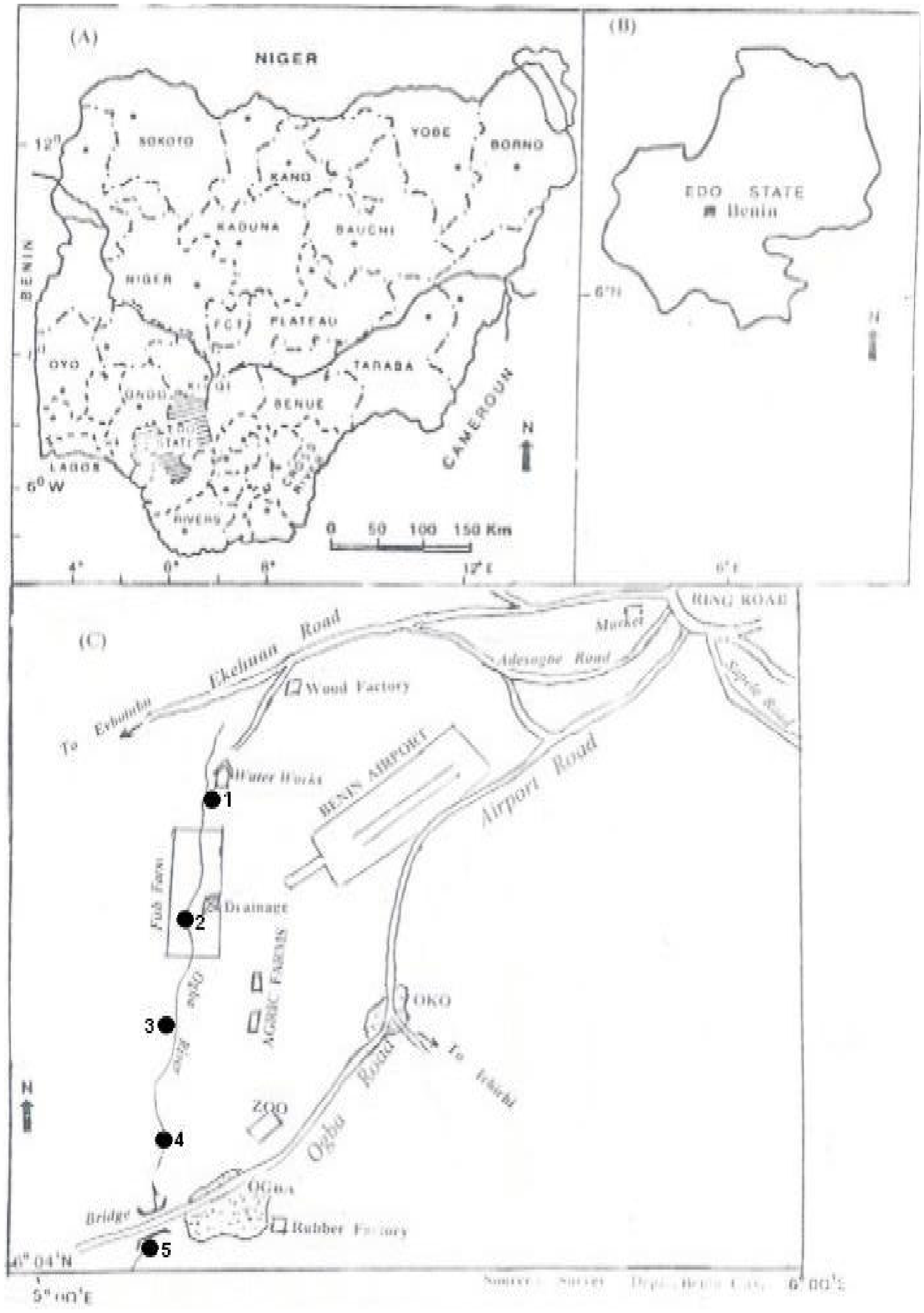

Figure 1. (A) Map of Nigeria showing position of Edo State. (B) Edo State showing position of Benin City. (C) Benin City showing Ogba River and Study Stations.

activities (arable farming, piggery, poultry, fish farming, etc) take place. A large drainage channel fed by Benin City drainage system introduces large volume of urban wastes into the river in the area. This informed the five sampling stations designated Stations 1, 2, 3, 4 and 5 established on the river.

Station 1 was about 500 m from the source of the river. The water at this point has visible unidirectional flow, about 0.3 m deep and 2.0 m wide. It is shaded with fringing vegetation of mainly shrubs like *Commelina* and *Sonchifolia* spp. The sediment is mainly coarse sand and granite. This station served as control as the water at this point is relatively unpolluted. Station 2 was at a kilometer downstream, just after the point, where the drainage channel opened into the river. The water at this point is unshaded, about 4.0 m wide and only 0.2 m deep due to deposition of silt. The sediment is mainly silt and allochthonous matter.

Station 3 was another kilometer further downstream. The river at the station is about 5.0 m wide and 0.45 m deep. The sediment is mainly sand mixed with clay. The fringing vegetation was *Phoenix* palm and grasses. Station 4, at a kilometer downstream of Station 3, has water of about 10 m wide and 1 m deep with no visible directional flow. The sediment is muddy, rich in detritus and decayed organic matter. The vegetation was thick and consisted of Indian Bamboo (*Bambusa* sp.), palm trees (*Elaeis guinensis*), shrubs and grasses. Human activities were mainly bathing and fishing. Station 5 was located close to a bridge, with water of about 10 m wide and 2.0 m deep. The water current at the station is very fast due to the topography of the area. The sediment is mainly sharp sand. Human activities were intense and included sand excavation, bathing, laundering, fishing and idol worshipping.

The climate in the area is tropical with two major seasons: the wet (April - October) and the dry (November - March) seasons. Rainfall is bimodal, peaking usually in July and again in September, with a brief drop in August. Minimal rainfall is in January and February, followed by the onset of heavy rainfall in April. Mean relative humidity in the area is around 70%.

Sample collection and treatment

Fish and water samples were collected monthly between November, 2007 and October, 2008. On each sampling day, water samples were collected in the morning (9 am) from 3 replicate spots in each station (composite sampling) and the mean values recorded. Water samples were collected in the middle of the river at 15 cm depth below water surface in 250 ml capacity plastic bottles with screw caps. The bottles were treated with 10% nitric acid and rinsed with distilled water previously before use (Laxen and Harrison, 1981). Gill nets of various mesh sizes (50 – 78 mm), local traps (Cane, Wire and Bamboo), baited hooks and lines were employed for fishing. The fish samples were ice-packed and transported to the laboratory, where fish were sorted out and identified to species level using keys by Lowe McConnel (1965), Reed et al. (1967), Holden and Reed (1972), Trewavas (1982) and Teugels (1992).

The fish samples were each weighed using a Mettler E200 top loading balance and the body weights were recorded in gram. The standard lengths were recorded in cm using a measuring board. The gut of each specimen was removed and preserved in 10% formalin. Each stomach was cut open and its contents washed into a Petri-dish using 4% formalin (Ogbeibu and Ezeunara, 2002). The food items were identified, counted and analysed using frequency of occurrence, fullness, volumetric, gravimetric and numerical methods (Hynes, 1950). Fulton's condition factor (KF) was calculated using Ricker (1968) formula.

Water quality parameters were determined according to APHA (1989) and Ademoroti (1996). Statistical analysis was carried out using One- way ANOVA repeatedly to determine significant differences in the seasons and between the stations.

RESULTS

Water quality parameters

The results of the water quality parameters are presented in Table 1 and summarized in Table 2. Water temperatures ranged from 25.0 - 29.2°C at the stations. The ranges for the other parameters were: conductivity (22.2 - 174.1 *µscm*); pH (2.1 - 7.0); DO (1.0 - 5.9); BOD (0.13 - 3.3 mg/l); turbidity (2.2 - 137.9 FTU); TDS (15.6 – 239.0 mg/l) and alkalinity (2.4 – 12.6 mg/l). Statistical analyses of the annual mean values showed that all the parameters (except water temperature) were significantly different ($p < 0.05$) among the stations (Table 2).

Fish species diversity and abundance

The species diversity and abundance of the fish community of Ogba River recorded during this study are presented in Table 3. A total of 486 individual fish were caught, and were classified into 14 families and 22 genera and 26 species. Species diversity between the stations was significantly different ($P < 0.05$) and was 18 at Station 1, none at Station 2, 12 at Station 3, 26 at Station 4 and 24 at Station 5.

In terms of abundance, five dominant species, which recorded 31 and above individuals, were selected, for analysis. These were *Clarias macromystax* (Clariidae), which dominated the entire collections with 43 individuals. This fish was recorded at Stations 4 and 5 only. *Malapterurus electricus* (Malapteruridae) which was next recorded 40 individuals with 2, 6, 22 and 10 at Stations 1, 3, 4 and 5, respectively. *Xenomystus nigri* (Notopteridae) followed and recorded 33 individuals, with 6, 10 and 17 at Stations 1, 4 and 5, respectively. *X. nigri* was not recorded at Stations 2 and 3. *Hemichromis fasciatus* recorded 32 with 3, 8, 6, and 15 individuals at Stations 1, 3, 4, and 5 respectively. The least of the dominant species was *Oreochromis niloticus.* The fish recorded 31 individuals, with 9, 13, 7 and 2 at Stations 1, 3, 4 and 5, respectively.

The total number of fish recorded at the respective stations, were varied (Table 3) and significantly different ($P < 0.05$). The highest number of fish (231) was caught at Station 4. Next in descending order were Stations 5, 3 and 1, which recorded 132, 67 and 56 fishes respectively. No fish was caught at Station 2 throughout the duration of this investigation.

Condition factor

The condition factor computed for the dominant fish species varied between 1×10^{-3} and 3.14×10^{-3} (Figure 2). *C. macromystax* was recorded only at Stations 4 and 5. The condition factor for the fish was higher at Station 4, than at Station 5. For *M. electricus,* the condition factor was highest at Station 4, followed in descending order by Stations 5 and 1. The condition factor for X*. nigri, was* highest at Station 4 and least at Station 5. For H. *fasciatus*, the sequence in descending order was Stations 4, 1, 3 and 5, while for O*. niloticus*; the sequence was Stations 4, 3, 5 and 1. Statistical analysis showed significant differences ($p < 0.05$) in the condition of the fishes at the stations as reflected by their condition factors.

Stomach contents analysis

Analysis of the feeding status using the fullness method (Table 4) showed that the stations were not significantly different ($p > 0.05$). The frequency of occurrence indicated that most of the fishes fed on a variety of food items, especially the larvae and pupae of *Chironomus*

Table 1. Monthly variations of water quality (physico-chemical) parameters of Ogba River.

Dry season (November – March)

Parameter	November 2007					December 2007					January 2008					February 2008					March 2008				
	1 WW	2 D	3 Z	4 CW	5 B	1 WW	2 D	3 Z	4 CW	5 B	1 WW	2 D	3 Z	4 CW	5 B	1 WW	2 D	3 Z	4 CW	5 B	1 WW	2 D	3 Z	4 CW	5 B
Temp. (^{0}C)	25.9	26.4	25.9	27.0	26.6	25.0	26.5	26.4	26.3	26.3	25.9	26.7	26.3	26.9	26.9	26.9	25.0	26.9	27.0	27.0	26.1	26.7	26.3	26.9	26.9
Conductivity	29.1	76.5	50.3	81.4	88.1	22.2	80.2	60.1	77.3	66.1	59.9	88.1	67.3	70.2	69.3	50.9	60.4	51.0	70.3	69.5	52.3	102.0	77.7	86.1	90.0
pH	6.9	5.2	6.9	6.9	7.0	6.0	5.0	6.9	6.9	6.8	6.9	4.9	6.0	6.2	6.2	7.0	4.6	6.6	6.9	6.8	6.9	4.5	6.9	6.8	6.9
DO (mg/l)	4.9	1.0	5.2	5.9	5.2	5.2	2.0	4.9	5.6	5.6	4.9	1.2	4.9	5.9	5.4	5.3	3.0	4.9	5.6	5.0	5.0	1.8	4.9	5.5	5.9
BOD (mg/l)	1.6	0.9	1.3	2.0	3.0	1.8	0.6	1.6	2.0	3.1	2.0	0.9	1.4	2.1	3.0	2.3	0.5	2.3	2.6	2.9	1.9	0.4	1.6	2.2	2.6
Turbidity (FTU)	2.4	29.3	4.7	18.3	26.1	2.5	25.5	5.2	18.3	23.9	2.2	21.6	4.9	19.1	23.0	35.3	114.8	64.1	98.2	121.0	26.6	60.3	16.1	20.3	21.1
TDS (mg/l)	26.4	145.5	77.7	111.3	150.3	26.0	153.4	70.3	104.2	112.2	31.1	149.2	71.2	110.2	112.0	15.6	130.2	97.3	104.1	110.9	35.3	150.0	69.4	83.2	91.1
Alkalinity (mg/l)	12.1	9.5	10.2	12.9	12.3	12.3	3.9	8.8	9.0	9.6	11.9	6.2	10.1	9.9	10.9	7.9	2.5	9.0	10.1	10.2	11.8	2.4	8.0	6.7	6.9

Rainy Season (April – October)

Parameter	April 2008					May 2008					June 2008					July 2008					August 2008				
	1 WW	2 D	3 Z	4 CW	5 B	1 WW	2 D	3 Z	4 CW	5 B	1 WW	2 D	3 Z	4 CW	5 B	1 WW	2 D	3 Z	4 CW	5 B	1 WW	2 D	3 Z	4 CW	5 B
Temp. (^{0}C)	26.6	27.9	26.0	26.9	26.9	26.9	27.0	26.0	26.2	27.0	27.0	27.0	29.2	27.1	27.0	26.9	26.8	26.2	26.9	27.0	26.6	27.0	26.0	26.9	26.9
Conductivity	59.9	82.1	60.2	74.7	80.8	59.9	94.1	61.0	77.2	80.0	51.0	173.0	124.1	116.0	98.1	53.1	174.1	152.2	104.6	100.3	48.9	160.6	129.4	86.6	89.3
pH	6.9	5.6	6.8	6.5	6.6	6.2	6.0	6.9	6.8	6.8	6.7	5.9	6.2	6.5	6.9	6.7	4.2	6.0	6.1	6.0	6.9	4.1	6.6	6.8	6.8
DO (mg/l)	4.9	3.0	5.1	5.3	4.9	4.9	3.4	5.0	5.1	5.2	5.0	2.4	4.9	5.3	5.1	4.9	3.1	4.7	5.0	4.9	4.9	1.2	4.9	5.1	5.0
BOD (mg/l)	2.0	0.9	1.2	1.0	1.6	2.3	1.1	1.3	1.2	1.4	1.9	0.9	1.2	2.0	2.0	2.1	1.0	2.0	2.2	2.2	2.0	0.6	1.9	2.0	2.0
Turbidity (FTU)	12.9	107.3	60.2	49.0	119.1	41.3	179.2	91.1	104.0	121.1	31.1	92.1	70.0	80.1	79.2	43.0	101.3	94.1	77.7	89.6	15.5	101.0	93.4	88.9	86.0
TDS (mg/l)	49.2	115.2	66.1	90.4	104.4	61.0	167.0	99.1	102.2	113.0	50.3	99.9	68.2	62.2	60.6	40.4	147.0	88.8	90.0	120.6	29.3	150.2	104.1	92.2	92.0
Alkalinity (mg/l)	9.3	3.2	9.92	9.0	9.1	6.6	2.9	7.3	7.0	8.2	6.7	4.4	6.9	6.9	6.8	6.5	3.9	7.2	7.0	6.4	11.9	7.1	11.1	12.0	11.9

Table 1. cont.

Rainy Season (Cont.)

Parameter	September 2008					October 2008				
	1 WW	2 D	3 Z	4 CW	5 B	1 WW	2 D	3 Z	4 CW	5 B
Temp. (^{0}C)	26.9	27.2	26.9	27.0	27.0	27.0	26.9	26.5	26.2	26.9
Conductivity	60.1	159.3	94.1	103.2	102.9	22.5	81.6	50.7	60.9	63.5
pH	6.7	2.1	6.1	6.4	6.4	6.9	7.0	5.7	6.5	6.4
DO (mg/l)	4.9	2.2	4.9	5.2	5.6	5.1	1.2	4.8	5.0	4.7
BOD (mg/l)	1.3	0.9	1.1	1.7	1.9	2.2	0.13	2.6	2.8	0.3
Turbidity (FTU)	26.4	137.9	40.2	70.5	61.1	31.1	115.1	7.5	12.8	114.1
TDS (mg/l)	90.1	176.0	102.2	109.3	141.1	30.2	179.2	161.0	20.3	239
Alkalinity (mg/l)	6.9	3.4	6.9	6.2	7.1	2.9	9.0	11.9	12.7	12.6

Table 2. Annual mean values of some physical chemical conditions of Ogba River at the study stations.

Parameter	Station 1			Station 2			Station 3			Station 4			Station 5			Probability
	Min	Max	Mean	Min.	Max	Mean	Min	Max	Mean	Min.	Max	Mean	Min.	Max	Mean	
Temp. (^{0}C)	25.0	27.0	26.48 ±0.62	25.0	27.9	26.76 ±0.67	25.9	29.2	26.55 ±0.90	26.2	27.1	26.78 ±0.34	26.3	27.0	26.87 0.21	P>0.05
Conductivity (µs/cm)	22.2	60.1	42.55 ±14.47	60.4	174.1	111.02 ±42.54	50.3	152.2	81.49 ±35.25	70.2	114.6	87.38 ±16.20	63.6	102.9	83.17 ±13.78	P<0.05
pH	6.0	7.0	6.73 ±0.31	2.1	7.0	4.93 ±1.22	5.7	6.9	6.47 ±0.44	6.1	6.9	6.61 ±0.28	6.0	7.0	6.63 0.31	P<0.05
DO (mg/l)	4.9	5.3	4.99 ±0.25	1.0	3.4	2.13 ±0.86	4.7	5.2	4.59 ±0.29	5.0	5.9	5.36 ±0.32	4.7	5.9	5.21 ±0.35	P<0.05
BOD (mg/l)	1.3	2.3	1.95 ±1.09	0.13	1.1	0.73 ±0.29	1.1	2.6	1.63 ±0.48	1.0	2.8	1.98 ±0.51	1.4	3.3	2.41 ±0.83	P<0.05
Turbidity (FTU)	2.2	43.0	20.19 ±14.99	21.6	137.9	85.45 ±48.13	4.9	93.4	51.36 ±37.13	12.8	104.0	54.77 ±35.45	23.0	12.11	73.77 ±43.83	P<0.05
TDS (mg/l)	15.6	90.1	40.41 ±20.06	99.9	179.2	147.08 ±23.20	66.1	161.0	89.68 ±26.78	20.3	111.3	89.97 ±25.97	60.0	239.0	120.14 38.90	P<0.05
Alkalinity (mg/l)	6.5	12.3	9.7 ±3.09	2.4	9.5	4.87 ±2.48	6.9	11.9	8.94 1.71	6.2	12.7	8.95 ±2.44	6.4	12.6	9.33 ± 0.00	P<0.05

Table 3. Fish species abundance and distribution at the study stations.

Fish	Station					
	1	**2**	**3**	**4**	**5**	**Total**
Anabantidae						
Cteropoma kinsleyae (Gunther, 1896)	1	-	-	9	1	11
Bagridae						
Auchenoglanis occidentalis (Cuvier & Valenciennes, 1840)	2	-	-	5	2	9
Chrysichthys nigrodigitatus (Lacepede, 1903)	1	-	-	14	5	20
Channidae						
Parachanna obscura (Gurther, 1861)	-	-	6	16	6	28
Characidae						
Brycinus nurse (Ruppel, 1832).	-	-	-	5	3	8
Alestes longipinnis (Gunther, 1864)	1	-	-	7	-	8
Cichlidae						
Chromidotilapia guentheri (Sauvage, 1882)	-	-	4	2	6	12
Hemichromis fasciatus (Peters, 1857)	3	-	8	6	15	32
Oreochromis niloticus (Trawavas, 1980)	9	-	13	7	2	31
Tilapia mariae (Boulenger,1899)	1	-	6	6	4	17
Tilapia zilli (Genvais, 1848)	4	-	5	4	1	14
Clariidae						
Clarias macromystax (Gunther, 1864)	-	-	-	34	9	43
Clarias anguillaris (Linnaeus, 1758)	-	-	2	6	7	15
Distichodontidae						
Distichodus rostratus (Gunther, 1864)	1	-	-	11	-	12
Hepsetidae						
Hepsetus odoe (Bloch, 1794)	-	-	4	4	2	10
Malapteruridae						
Malapterurus electricus (Gmelin, 1789)	2	-	6	22	10	40
Mochokidae						
Synodontis eupterus (Baulenger, 1789)	5	-	-	8	1	14
Synodontis nigrita (Valenciennes, 1840)	2	-	-	9	5	16
Mormyridae						
Gnathonemus senegalensis (Steidachner, 1879)	4	-	-	8	2	14
Hyperopisis bebe occidentalis (Lacepede, 1803)	4	-	2	4	6	16
Mormyrus rume (Cuvier and Valenciennes, 1846)	3	-	2	2	5	12
Mormyrops engystoma (Boulenger,1866)	-	-	-	8	7	15
Notopteridae						
Papyrocranus afer (Gunther, 1868)	4	-	-	5	4	13
Xenomystus nigri (Gunther, 1868)	6	-	-	10	17	33
Polypteridae						
Erpetoichthys calabaricus (Smith, 1866)	3	-	9	13	5	30
Schilbeidae						
Eutropius niloticus (Ruppel, 1872)	-	-	-	6	7	13
Total No. of Individuals	56	-	67	231	132	486
Total No. of species	18	-	12	26	24	

species (*C. fractilobus* and *C. transvealensis*). Other food items included diatoms, desmids and algal filaments. At Station 3 in particular most fishes fed almost exclusively on *Chironomus* larvae. Plant materials were a major food item in fish at Station 1, but at the other stations downstream of the drainage discharge point, *Chironomus*

Table 4. Stomach contents analysis using fullness method.

Station	Stomach fullness					No. of fish Examined
	Full %	3/4 (%)	½ (%)	¼ (%)	Empty (%)	
1	20	34	27	14	5	56
2	-	-	-	-	-	-
3	10	20	30	30	10	67
4	28	18	26	13	15	231
5	10	20	30	32	6	132

species were the major food item in fish.

DISCUSSION

Water quality is defined in terms of the physical, chemical and biological content of water. The physico-chemical and biotic characteristics of Ogba River have been greatly influenced by the discharge of effluents from the Benin City drainage system, wood processing and rubber factories, solid waste dumps and run-offs from surrounding agricultural fields (Ezemonye and Kadiri, 1998; Kolade, 1998; Eyo, 1999). The range of surface water temperatures (25 - 29.2°C) recorded in this study is high, typical of tropical climates.

Turbidity mean values (20.19 – 85.45 FTU) recorded in this study, were higher than standards set by Canada Drinking Water Standards and Objectives (1968); WHO (1984) and FEPA (2003) indicating the high level of suspended particles. This could be as a result of the heavy influx of silt from drainage effluents. Etienne et al. (1997) attributed similar results in Burkina-Faso reservoirs to polluted urban waste water. Conductivity value was highest at Station 2 and could be attributed to the large quantity of effluents from urban Benin City. High conductivities have been reported under similar conditions in Ikpoba River by (Ohaji, 1983; Fufeyin, 1998; Oguzie, 2003; Ogbeibu and Ezeunara, 2002).

The low DO mean values (2.13 – 5.39 mg/l) recorded, when compared to WHO (1984) standards are indicative of Ogba River pollution. The situation at Station 2, where a minimum DO value of 1.0 mg/l was recorded, showed the serious effect the drainage effluents have on the river at the station. The above could explain why fish was not caught at the station during sampling. Gietema (1992) reported that DO levels of 2 - 4.5 mg/l induced lack of appetite and unfavorable food conversion in fish, while DO levels less than 2 mg/l is harmful, causing gasping, sub-lethal and lethal effects.

The overall number of fish species recorded in this study is low when compared to other freshwater bodies. White (1965) described 10 species in the Niger River. Reed et al. (1967) identified and described 160 species within the northern region of Nigeria, while Ita (1993), reported as many as 239 species in Nigeria's major rivers; 108 within Nigeria's natural lakes, wet lands and their inflowing rivers and 104 species within Nigeria's freshwater reservoirs. The low ichthyo-fauna recorded in Ogba River may have been due to the more variable physical and chemical characteristics caused by drainage effluents and other human activities. This finding agrees with the observation that changes in water quality caused by industrialization and technological development affect fish and other benthic communities (Patil, 1976; Obeng, 1981). The low ichthyofauna could also be due to introduction of some exotic species like *Alestes* and *Oreochromis* spp. from commercial fish farms established on the river. Prolific species like *O. niloticus* and carnivores like *Alestes longipinnis* encourage competition and predation to the detriment of endemic species (Reed et al., 1967). It is conceivable that the absence of *Schilbe mustus* earlier reported in the river by Abuah (1986) could have been due to competition and or predation from introduced exotic species.

Table 3 showed that the fish population at Station 1 was lower in comparison to the fish population at Stations 3, 4 and 5. Station 1 is upstream, shallower with more variable physical and chemical characteristics. According to Hortwitz (1978), among places of the same stream order, the more variable the physical and chemical characteristics, the fewer the species. Station 2 was completely devoid of fish. This situation could be attributed to the effect of the large influx of drainage effluents, which may have completely obliterated any condition favourable for fish habitation. Fish are mobile and they can quickly respond to environmental changes by swimming away from unfavorable areas (Idodo-Umeh and Victor, 1991). Station 3 recorded 67 fishes of 12 species as against the no fish situation at Station 2. The station was affected to a lesser degree by the drainage effluents than Station 2. This could explain the presence of fish at the station.

Station 4 recorded the highest number of fish (231). This station has muddy bottom, rich in detritus and biota and a thick vegetation cover, which probably provided a good shelter for the fish. Muddy soils are known to support larger populations of Catfishes and Cichlids (Reed et al., 1967; Sydenham, 1977; Oguzie, 2003). The favorable conditions at Station 4, could explain the relatively higher fish species population at the station. The lower

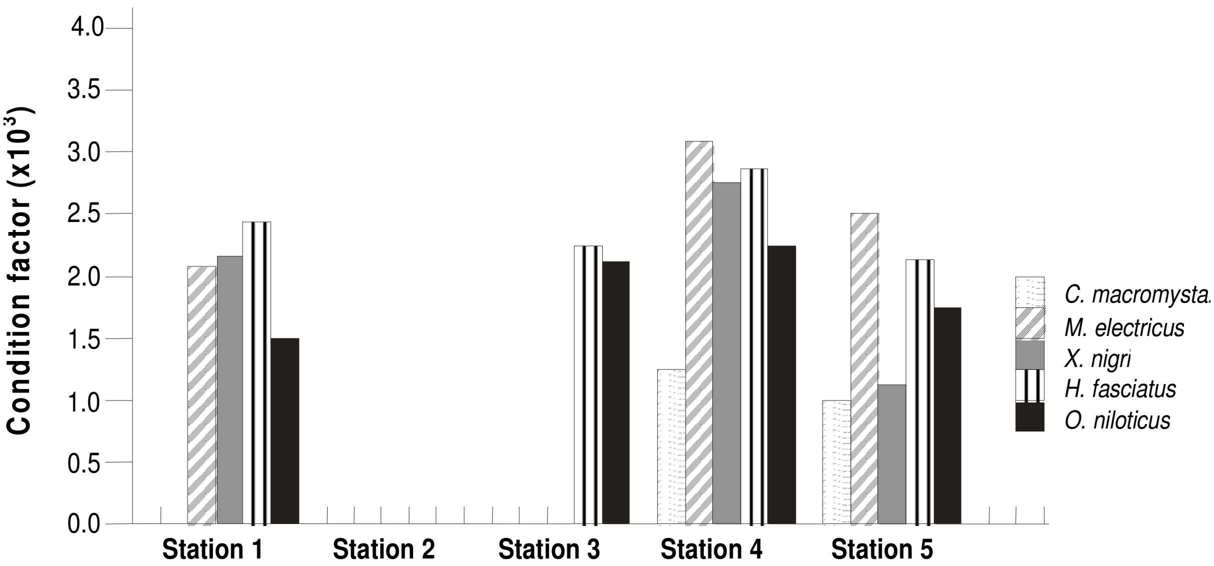

Figure 2. Comparison of the Condition factor of fish species of the study stations.

icthyofauna at Station 5 in comparison to Station 4, even though further downstream, may not be unconnected with the more human activities at the station. However, the improved fish diversity and abundance at Stations 4 and 5, furthest from the drainage discharge point indicated the ability of the river to purify itself after pollution.

Fish diversity indices have been used extensively in impact assessment and as measures of ecosystem stability. Low fish species diversity and abundance are associated with environment under stress (Sanders, 1968; Pearson and Rosenberg, 1978; Ugbomeh, 1987). The differential response of the fish species to the altered environmental conditions at the stations was responsible for the significant differences ($p < 0.05$) in fish population among the stations.

Fish are regarded as highly successful in their feeding habit, because of the ability to utilize varied food items. Their feeding habits vary from predators through plankton to detritus feeders. The physical and chemical characteristics determine the composition of fish food items in a given environment. Certain organisms (*Chironomus* spp. larvae, etc.) which constitute food for fish, are also bio-indicators of pollution and other forms of environmental stress (Ogbeibu and Ezeunara, 2002). Though plankton and aquatic vegetation were found in the stomach of many fishes in this study, it was evident that most of the fishes, especially at Station 3 close to the drainage effluent discharge point, fed principally on *Chironomus* larvae and pupae. It is conceivable that these known bio-indicators of organic pollution were easily available in high density, because of the large volume of effluents discharged into the river at the station.

The condition factor expresses fatness, relative robustness and general well being of a fish. Nikolsky (1963) reported that a heavier fish of a given length is in better condition than a lighter fish of the same length. The condition factor of most of the fishes in Ogba river (Figure 2) were low (< 1.0), suggesting that the fishes were under stress and not in good condition. Similar investigations on the fish species of Ikpoba River in Benin City by Ogbeibu and Ezeunara (2002) recorded relatively higher condition factors (> 1.0), suggesting that the fishes in Ikpoba river were better conditioned than those in Ogba river. The low condition factor of the fishes and the presence of known bio-indicators of organic pollution, recorded in this investigation, indicated the presence of stress-inducing factors, which invariably adversely affected the condition of the fishes in Ogba River.

Conclusion

The influx of drainage effluents into Ogba River has invariably affected the diversity and abundance of the fish community in the river. The comparatively low species diversity, abundance and the poor fish condition, which have emerged from this study, suggested the presence of stress-inducing factors in Ogba River. The ability of the river to purify itself after pollution was amply demonstrated. The reversible and non-residual nature of the contaminants indicated that they were mainly organic in nature.

Previous work carried out in the river (Obasohan, 1997; Wangboje and Oronsaye, 2001) also reported the bioaccumulation of heavy metals by the fishes in the river. There is therefore the need for an assessment of all effluent discharges and other probable stress-inducing factors in the river, with a view to establishing an adequate management strategy for Ogba River and its resources.

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