Observations on the Composition, Physiological Condition and Fisheries in Erinle Lake, Osun State, Nigeria

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Abstract

The level of fish production in Nigeria is far less than the current fish demand. The study, therefore, on fish composition and fishing activities in Erinle Lake is meant to suggest means of bridging the gap between fish supply and demand in the country. Fish samples were obtained from gill-net, cast net and traps. Ten families of fish comprising 19 species were identified, dominated by Cichlid fish (71%) largely made up of *Sarotherodon galilaeus* (42%). The sex-ratio of most fish in the lake tends to unity (1:1), suggesting reproductive stability. Condition factors are high for the fish species – an indication that they thrive well in the habitat. Key water quality parameters such as *p*H, DO, etc. were found to be favourable for survival and thriving of food for some fish species. Fishermen on the lake used 2.54 cm mesh size net contrary to 7.62 cm mesh size recommended in Sea Fishing Regulations of 1971, which is a supplement of Nigerian Sea Fisheries Decree (ACT) of 1971. As a result the lake had been exploited of fish resulting in a low and small size catches. It is recommended that the fisheries be closed during the peak spawning period to allow possible recovery. Also, strict monitoring control and surveillance of the lake is highly recommended, most especially in the use of unapproved fishing nets and methods.

Introduction

Erinle Lake is the largest of all water bodies in Osun State, Nigeria. It has many tributaries of which the major inflow rivers, Awon and Erinle, are the main sources of water. The lake basin which is about 342 km^2 extends in width from longitude 4° 24' E to 4° 35' E and in length from latitude 7° 45' N to 7° 58' N. The lake itself is located at longitude 4° 27' E and 7° 46' N (Fig. 1). The surrounding vegetation has a mixture of savanna, light and thick forest, with scattered cultivations due to various human activities (Akinbuwa, 1999). The substratum of the lake is mud and sand granules with scattered logs of wood. The surface area is about 1.25 km^2 (Akinbuwa, 1999); the highest depth of 7.1 m was recorded in October 2007 at the peak of the floods with a calibrated measuring line, while a mean of 3.6 m was recorded for the lake.

Fishes contribute as much as 17% of the worlds animal protein, and inland fisheries play important role in the provision of adequate protein to numerous Nigerians. Arawomo (2004) reported that the annual demand for fish in Nigeria was 1.56 m tons while fish production was 0.3 m tons. This large deficit is filled through fish importation. Nigeria, with more than 1 million tons of imported fish annually, was reported by Inside Nigeria Fish Report (2006) as the largest market in West African sub-region. Nigeria needs more fish for its teeming population of about 140 millions. However, imported fish have become very expensive (Komolafe & Arawomo, 2008).

Poor management practices and over exploitation of inland waters might be attributed to downward trend of fish intake. An understanding of the factors governing fish production is necessary so as to improve

TABLE 1

A checklist of fish species in Erinle lake between November 2006 and May 2008

Family	*Genus/Species*	*Common name*
Alestidae	*Alestes longipinnis* Gunther	African tetra
	Alestes macrolepidotus Guvier & Valenciennes	African tetra
Bagridae	*Bagrus bayad macropterus* Daget	Bagrid
Channidae	*Parachanna obscura* Gunther	Snake head
Characidae	*Chrysichthys auratus* Pfaff	Characines
Cichlidae	*Hemichromis faciatus* Peter	Banded jewel fish
	Oreochromis niloticus Linnaeus	Nile *Tilapia*
	Pelmatochromis guntheri Sauvage	-
	Sarotherodon galilaeus Trewavas	Mango *Tilapia*
	Tilapia mariae Boulenger	-
	Tilapia melanopleura	-
	Tilapia zillii Gervais	Red belly *Tilapia*
Clariidae	*Clarias gariepinus* Burchell	African cat fish
Cyprinidae	*Labeo coubie* Ruppell	African cap
Hepsetidae	*Hepsetus odoe* Bloch	African pike
Mormyridae	*Mormyrus rume* Cuvier & Valenciennes	Elephant nose fish
	Gnathonemus cyprinoides Linne	-
	Gnathonemus senegalensis Steindachner	-
Schilbeidae	*Schilbe mystus* Linnaeus	African butter fish

TABLE 2

Relative abundance and size distribution of fish species in Erinle Lake between November 2006 and May 2008

Fish species	*Number caught*	*Percentage*	*Standard length range (cm)*	*Mean standard length ± S.D (cm)*	*Weight range (g)*	*Mean fish weight ± S.D (g)*
Alestes longipinnis	25	0.9	6.0-9.5	6.9 ± 0.497	12-20	15.4 ± 3.249
Alestes macrolepidotus	11	0.4	10.3-15.1	12.8 ± 1.605	46-71	70.3 ± 19.293
Bagrus Bayad macropterus	5	0.2	10.9-13.2	12.04 ± 0.816	26-37	31.6 ± 2.728
Parachanna obscura	27	1.0	9.9-35.4	24.1 ± 0.997	12-640	242.6 ± 8.491
Chrysichthys auratus	71	2.6	8.0-18.6	12.6 ± 2.432	90-102	37.2 ± 11.626
Hemichromis faciatus	383	13.9	4.9-11.2	7.3 ± 1.633	3-73	21.8 ± 2.104
Oreochromis niloticus	115	4.2	7.6-20.5	16.3 ± 3.067	32-296	177 ± 5.905
Pelmatochromis guntheri	15	0.5	6.6-9.9	7.7 ± 1.290	10-20	13.3 ± 3.961
Sarotherodon galilaeus	1173	66.4	8.3-24.9	16.8 ± 2.318	18-520	196.3 ± 4.303
Tilapia mariae	46	1.7	8.8-11.0	9.6 ± 0.856	28-58	42.9 ± 4.319
Tilapia melanopleura	18	0.6	8.4-10.1	9.3 ± 0.627	31-38	35.1 ± 2.472
Tilapia zillii	312	11.4	7.4-15.0	11.3 ± 2.046	25-121	57.9 ± 3.568
Clarias gariepinus	161	5.8	19.7-30.5	23.2 ± 3.007	74-344	135.4 ± 7.240
Labeo coubie	8	0.3	11.4-16.5	11.54 ± 3.782	51-68	51.12 ± 11.963
Hepsetus odoe	78	2.8	10.2-32.1	21.4 ± 4.196	12-418	100.8 ± 6.243
Mormyrus rume	190	6.9	16.2-47.5	26.4 ± 3.543	44-796	242.2 ± 22.570
Gnathonemus cyprinoides	50	1.8	13.6-19.1	15.2 ± 1.585	42-95	55.8 ± 14.815
Gnathonemus senegalensis	4	0.2	14.7-18.3	16.3 ± 2.470	47-88	79.25 ± 41.154
Schilbe mystus	57	2.1	10.1-21.2	14.5 ± 2.030	12-140	49.1 ± 4.720

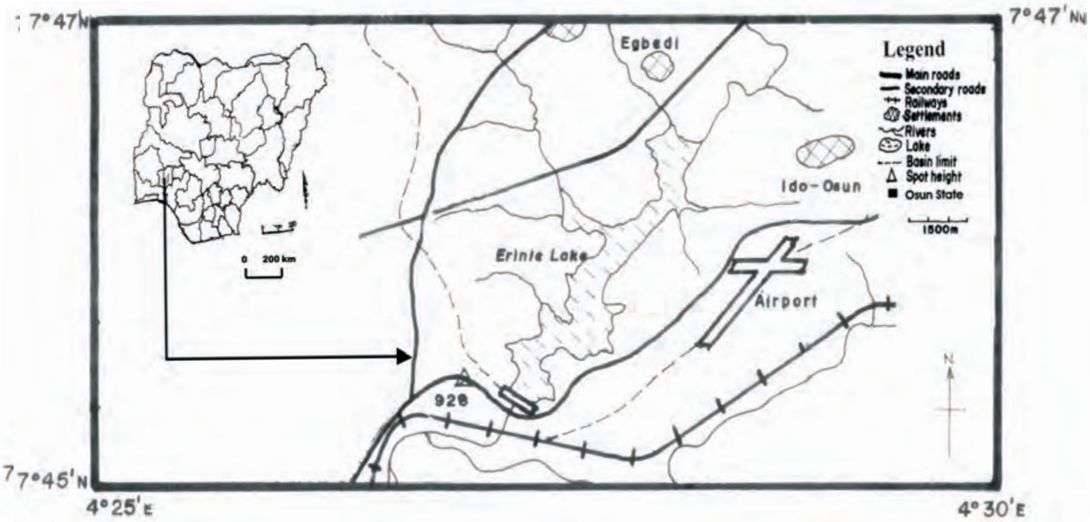

Fig. 1. Erinle Lake and catchment area showing Nigeria (inset)

production. The need for achieving self sufficiency in fish production was recommended by Arawomo (2004). He suggested the exploitation of the fishes in the rivers, streams, ponds, natural and man-made lakes in Nigeria, hence, the need for the study to call the attention of authorities to the situation. It aims, therefore, at getting information on the diversity of fish species, fishing gears used, sex-ratio and condition factor, water quality and the activities of fishermen on the lake for the development of management strategy for the lake fisheries.

Materials and methods

Study area

Fish sampling on monthly basis started in November 2006 and extended to May 2008. By courtesy of Fisheries Department, fishing gears used included cast-net and gill-net of 2.54 cm mesh size and traps. The gill-net, which measured 100 m long and 4 m deep, was set overnight and removed the following morning. The traps were made from plant *Eremospatha* sp. in the form of funnel with entrances of non-return valves. Traps baited with ripe palm-fruits were set under vegetation cover along the shoreline for fish samples. The lake water transparency was determined with a Sechi-disc measuring 15 cm (Quayle, 1988). All fish samples were put in ice-chest, covered with ice and brought to the laboratory where standard morphometric parameters of each fish were measured. Fish specimens were identified using the keys by Reed *et al.,* 1967; Holden & Reed, 1978 and Adesulu & Sydenham, 2007.

Each fish specimen was slit open venterally from the anus to the pectoral fin to determine the sex and stage of gonad maturity by visual inspection (Kesteven, 1960; Roberts, 1989). Water samples were collected between 7.00 and 7.30 a.m. using BOD water bottles rinsed with distilled water. The bottles were immersed inside the lake water to allow air out of the bottle and corked inside the water when filled up. Total alkalinity of the water was determined by titrating water samples with sulphuric acid standard solution, using a drop of phenolphthalein solution and one sachet of Bromocresol green-methyl red as indicator until the sample changed from blue green to pink. Total alkalinity which is expressed in mg/l^{-1} is the total number of drops of sulphuric acid solution used multiplied by 17.1 (Fish Farmers' Water Quality Testing Kit Manual, 1990). The *p*H of water was measured using a colour comparator to get a colour match in a water sample treated with wide range *p*H indicator. Mercury-in-glass thermometer was used to take surface water temperature. Dissolved oxygen content was determined by a modified version of the Winklers' titrametric method between 8.00 and 9.00 a.m.

The condition factor (K) or Ponderal index (Weatherley, 1972) primarily expresses the condition of a fish such as the degree of well-being and relative robustness or fatness in numerical terms.

$$K = \frac{100{,}000}{L^3} \text{ (Williams, 2000)}$$

where W = weight of fish (mg), and L = length of fish (mm).

Fishermen were interviewed orally and their fishing gears were observed at various sites on the lake.

Results

Fish species composition and relative abundance

A total number of 2881 fish individuals made up of 10 families and 19 fish species were caught. The Cichlidae with seven species constituted the largest family while Mormyridae and Alestidae had three and two species, respectively. Other families of fish in the lake had one species each (Table 1).

The family Cichlidae constituted 73.69% of all fish specimens. Other fish families in order of abundance included Mormyridae, Clariidae and Characidae, with 8.81%, 5.59% and 4.55% of the population, respectively. Other prominent fish families included Hepsetidae 2.71%, Schilbeidae 1.98%, and Alestidae 1.25%. Channidae, Cyprinidae and Bagridae completed the population with 0.9%, 0.28% and 0.17%, respectively.

S. galilaeus constituted 43% of the total population. This was followed by *H. faciatus* and *T. zillii* with 13.29% and 10.83%, respectively. Other species with appreciable relative abundance were *M. rume* 6.59%, *C. gariepinus* 5.59% and *C. auratus* 4.58%. It is of interest to note that three fish species, *viz. B. bayad macropterus, L. coubie* and *G. senegalensis* were caught once while *P. guntheri, A. longipinnis* and *A. macrolepidotus* were each caught twice at different months during the study period.

Sex-ratio and condition factor of fish species

The mean standard length and weight distribution of the various fish species is shown in Table 2. The sex-ratios of nine fish species ranged between 1:05–1:08 (male to female). Three other fish species showed sex-ratios of between 1:03–1:04 (male to female) while the lowest sex-ratio of 1:0.2 (male to female) was recorded for *T. mariae* and *A. longipinnis*. Two fish species, *S. mystus* and *G. cyprinoides,* had more females than the males with sex-ratios of 1:2 and 1:1.4 (male to female) (Table 3). The condition factor (*K*) of fish species varied according to species.

TABLE 3

Sex-ratio and condition factor of fish species in Erinle Lake between November 2006 and May 2008

Fish species	Number of fish	Sex-ratio Male	Female	Sex-ratio	X^2 value	P (0.05)	Condition factor (K) Range	Mean X± S.D of X
Alestes longipinnis	25	21	4	1:0.2	0.29	NS	1.412-2.641	2.268±0.494
Alestes macrolepidotus	11	7	4	1:0.6	0.82	NS	0.899-1.157	1.044± 0.108
Bagrus Bayad macropterus	5	3	2	1:0.7	0.20	NS	0.784-0.918	0.816±0.050
Parachanna obscura	27	18	9	1:0.5	7.71	NS	0.781-0.986	0.874±0.072
Chrysichthys auratus	71	43	28	1:0.7	13.47	NS	0.436-1.012	0.751±0.093
Hemichromis factatus	383	197	186	1:0.9	44.62	NS	1.131-2.292	1.627±0.274
Oreochromis niloticus	115	64	51	1:0.8	45.73	NS	1.717-2.056	1.848±0.143
Pelmatochromis guntheri	15	11	4	1:0.4	15.0	NS	1.412-1.628	1.548±0.066
Sarotherodon galilaeus	1173	619	554	1:0.9	22.16	NS	1.522-2.210	1.973±0.117
Tilapia mariae	46	40	6	1:0.2	8.73	NS	1.932-2.700	2.267±0.219
Tilapia melanopleura	18	13	5	1:0.4	0.27	NS	2.295-2.500	2.392±0.062
Tilapia zillii	312	194	118	1:0.6	10.74	NS	1.544-2.367	1.765±0.226
Clarias gariepinus	161	107	54	1:0.5	34.13	NS	0.560-0.859	0.679±0.085
Labeo coubie	8	5	3	1:0.6	0.50	NS	1.082-1.621	1.364±0.181
Hepsetus odoe	78	55	23	1:04	26.13	NS	0.492-0.931	0.745±0.041
Mormyrus rume	190	131	59	1:0.5	46.55	NS	0.513-0.775	0.602±0.060
Gnathonemus cyprinoides	50	21	29	1:1.4	36.71	NS	0.641-1.085	1.015±0.118
Gnathonemus senegalensis	4	3	1	1:0.3	0.21	NS	0.812-0.930	0.821±0.215
Schilbe mystus	57	19	38	1:2	52.82	NS	0.500-0.809	0.691±0.105

S = Significant

N = Not significant

TABLE 4

Summary of water quality in Erinle Lake between November 2006 and May 2008

Parameters	*Rainy season April-October (mean)*	*Dry season November-March (mean)*
Transparency (cm)	87	93
*p*H	7.5	7.6
Temperature (°C)	28.7	29.8
Dissolved oxygen content mg/l	3.6	3.8
Total alkalinity mg/l	68.3	82.6

The mean condition factor ranged from 0.602 in *M. rume* to 2.350 in *T. melanopleura.*

Water quality of Erinle Lake

The water quality parameters of the lake (Table 4) showed that transparency values ranged between 86 cm and 101 cm through the study period. The mean *p*H of the lake was 7.5 during the rainy season and 7.6 in the dry season. The surface water temperature values ranged between 26.4 °C and 31 °C while the mean for rainy and dry season were 28.7 °C and 29.8 °C, respectively. Dissolved oxygen content of the lake had a minimum of 3.5 mg/l and a maximum of 3.9 mg/l while the mean was 3.6 mg/l and 3.8 mg/l for rainy and dry seasons. The values of total alkalinity during the study period were between 67.8 mg/l and 85.3 mg/l.

Fishing activities in Erinle Lake

Fishing gears used by the 25 registered fishermen, apart from poachers, included gill-nets, cast-nets, bamboo traps, cages, raffia traps, hooks and lines. The gill nets used varied in length between 200–500 m, and each of the fishermen had a minimum of two gill-nets. The mesh size of the gill nets, 2.54 cm, was short of 7.62 cm-mesh size approved by the Federal Fisheries Department. In order to maintain their families, all the fishermen worked round the clock to achieve their objectives. There was no limit to type and number of fish species to be caught resulting in over fishing. Every section of the fish population was exploited and some of the young recruits were discarded for not being marketable. On two occasions hazardous chemicals were used, resulting in numerous floating dead fishes on the lake. Since these fishermen were not checked or penalized many unregistered fishermen and poachers were found on the lake. These led to a decline in productivity of the lake, which was also confirmed by registered fishermen.

Discussion

The diversity of fish in Erinle Lake is high, considering 19 species made up of 10 families, compared to Osinmo reservoir with four families and seven species and Opa reservoir with five families and 11 species (Komolafe & Arawomo, 2007, 2008). These water bodies with their vast catchment area are in the same geographically located axis flowing into Osun river which empties into the Lagos lagoon. The Cichlid family, made up the largest part of the population, constituted about 71%. This was also experienced in Opa and Osinmo reservoirs by Komolafe & Arawomo (2003, 2008). The concen-tration of many species of Cichlids in these water bodies also support the view of Holden & Reed (1978), who reported over 200 species of cichlids in West African water bodies. *Tilapia zillii,* which is about 11% of the present population, was about 29% and 27% in Osinmo & Opa reservoirs. Also, *H. faciatus,* which constituted 13.9% of the present population, was 8.6% in Osinmo reservoir and 0.1% in Opa reservoir (Komolafe & Arawomo, 2003).

Apart from food and high reproductive efficiency, reported by Komolafe & Arawomo (2007), abundance of the Cichlids might also be attributed to low concentration of predators. Presently, carnivores constituted about 26% of the population in Erinle lake compared to 1% in Opa reservoir where the Cichlids population was 98%. In Osinmo reservoir, the carnivores have a population of approximately 35.9%

(Komolafe & Arawomo, 2008), which may have a bearing on the lower percentage of Cichlids in this waterbody when compared to Erinle. *H. faciatus*, with 4.9 cm standard length and weight of 3.0 g, was the smallest fish in Erinle reservoir, while the biggest fish was *Parachanna obscura*, with a standard length of 35.4 cm and a weight of 640 g. The length-weight relationship of the various fish species in the lake agreed with the observations on fish in other water bodies (Abayomi, 1995; Fawole, 1995; Komolafe & Arawomo, 2008).

The study showed seasonal variations in the sex-ratio of the species. *S. galilaeus* and *H. faciatus* had sex-ratios of 1:0.9 (male to female) which tended to unity. This is an indication of reproductive efficiency towards optimum. Other species sex-ratio gave an indication of a growing population. *G. cyprinoides* and *S. mystus* had a sex-ratio of 1:1.4 and 1:2 (male to female). The preponderance of the female over the male in the study was also recorded by Obodai & Waltia (2003) in the Tono dam, where *S. mystus s*ex-ratio was 1:1.2 (male to female). The non-significance of the sex-ratio of some fishes *viz*. *S. senegalensis, L. coubie* and *S. bayad macropterus* might probably be attributed to low sample number. The three species were each caught once during the study period. Also, *A. longipinnis, A. macrolepidotus* and *P. guntheri*, each caught twice in the study along with other fish, showed non-significant sex-ratios.

The condition factors of both male and female fish species as a group varied significantly throughout the study period. These high condition factors were a reflection of the availability of adequate food and other essential materials for fish species in the habitat. All the species thrived well in the habitat as was also reported by Komolafe & Arawomo (2008) for fishes of Osinmo reservoir. The lake which had a limited wind fetch and surface temperature, coupled with water transparency, showed little variation during the study period. The highest surface temperature of 30.1 °C was recorded in December at the peak of the dry season while the lowest temperature of 26.7 °C, observed in August, was within the peak of the rainy season.

High discharge of water from rivers, especially in the rainy season and occasionally when water from upstream reservoir was released into it during the dry season contributed to the stability of the lake. Dissolved oxygen of the lake was low with very little variation. The mean dissolved oxygen was 3.6 mg/l during the rainy season and 3.8 mg/l in the dry season. The mean *p*H of 7.5 during the rainy season and 7.6 in the dry season were an indication that the lake was moderately alkaline and was within the range of *p*H known for most lakes and streams of the world (Welch, 1952).

Little variation in dissolved oxygen observed in the present study was also observed by Akinbuwa (1988) and Komolafe & Aawomo (2008) in Opa and Osinmo reservoirs, respectively. This may be due to low level production of oxygen as a result of turbidity brought by suspended particulate matters carried into the lake by flood. The lakes' total alkalinity, along with other parameters, indicated that the habitat was stable to support its various fish species. High water quality observed presently was also reported by Akinbuwa (1999), Obodai & Waltia (2003) and Komolafe & Arawomo (2008) in Erinle, Tono and Osinmo reservoirs. According to them, this high water stability resulted in better reproductive activities and subsequent development of the fishery resource of the environment.

Conclusion

It is recommended that proper security check on the lake is made available throughout the season to check the activities of unregistered fishermen so as to put a stop to the use of toxicants. The lake should be closed for fishing for one spawning season to allow renewal of fishery resources and to educate potential fishermen on the sustainability of the fish resources in the lake. Fishermen should be advised to use approved gillnet and cast net mesh sizes of 7.62 cm to fish, while other fishing gears should be banned.

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