World Journal of Fish and Marine Sciences 2 (6): 524-531, 2010
ISSN 2078-4589

Fish Diversity in Three Tributaries of River Ore, South West, Nigeria

Lawson O. Emmanuel and Olusanya O. Modupe

Department of Fisheries, Faculty of Science, Lagos State University, Ojo,
P.O. Box 001, LASU Post Office, Lagos, Nigeria

Abstract: Fisheries resources are on the decline in Nigeria due to over exploitation and inadequate management of her inland waters. For sustainability of these resources, an adequate knowledge of species composition, diversity and relative abundance of her water bodies must be understood and vigorously pursued. A study was conducted to determine fish species diversity in Igbesa, Itele and Iba tributaries of River Ore in South west, Nigeria, between June 2007 and May 2008. Specimens were collected with baited non return valve traps, cast and gill nets. Simpson index was used to determine the species richness, while dominance and evenness by Shannon-Weiner index of diversity. The fish composition comprised 11 species from 10 families and 10 genera. A total of 103, 111 and 96 individuals were caught from Igbesa, Itele and Iba stations, respectively. The fish diversity ranged from typically freshwater fishes such as *Tilapia* and *Clarias* to brackish species such as *Chrysichthys nigrodigitatus*. The most abundant group of fish was the Clariids. The dominant species, *Clarias gariepinus* consisted 32.26% of the population, *Heterotis niloticus*, a rare and least abundant species was 0.32%. Fingerlings, juveniles and sub-adults were among the catch, smallest being *Tilapia mariae*, while the largest was *H. niloticus*. Populations of several groups of shrimps, prawns, bivalves and gastropod mollusks were either threatened, critically endangered, vulnerable or nearly extinct and could not be recorded at all. The indices of diversity included (d) =0.155, 0.257 and 0.196; H=2.015, 1.899 and 1.896; and E=0.740, 0.659 and 0.600 respectively for tributaries at Igbesa, Itele and Iba. Estimates from these indices were indication of low fish species composition and richness and unevenness in the population of fish in R. Ore. The discharges from industries (industrialization) that surrounded the adjacent Ologe lagoon and the domestic wastes from boundaries settlements (urbanization) and the farming activities along the tributaries might have contributed to low species diversity. Therefore there is need for the conservation and management of the fisheries resources of this water body by relevant agencies. Data obtained from this study could be used as baseline for this purpose.

Key words: Conservation % Ecosystem % Index % Population % Taxa

INTRODUCTION

Biodiversity is often ambiguously misused or overused to describe population dynamics of a location or community. It a measure of the numbers of species that make up a biologic community and is considered to be one of the most important aspects of community organisation and structure. Species richness and relative species abundance describe key elements of biodiversity. Former is the number of different species in a given area and is the fundamental unit in which to assess the homogeneity of an environment and commonly used in conservation studies to determine the sensitivity of ecosystems and their resident species, while the latter describes how common or rare a species is relative to other species in a given community and are usually described for a single trophic level.

The biodiversity and conservation of fish in the aquatic ecosystem have attracted the attentions of various workers [1- 8]. Watters [9] reviewed the fish diversity of freshwater fishes relative to habitat. Myers [10-12] identified important areas for freshwater high diversity termed “hotspots”. Kottelat and Whitten [13] have reviewed many aspects of freshwater biodiversity in Asia, including discussion of taxonomy, hotspots and policy. A clear manifestation of the most well known global diversity gradient, namely species diversity increases with decreasing latitude [14].

Corresponding Author: Lawson O. Emmanuel, Department of Fisheries, Faculty of Science, Lagos State University, Ojo, P.O. Box 001, LASU Post Office, Lagos, Nigeria, E-mail: ollulawson@yahoo.com.

Distribution maps from Berra [15] for the 142 families recognized by him with representation in freshwater have been digitized. Teugels and Guegan [16] reviewed fishes in Congo Basin, the region known for very high richness, second to the Amazon basin in species richness, 25 families and 686 species were reliably reported. 40 groups of fish species in Madagascar from brackish and freshwaters were reported by Stiassny and Raminosoa [17]. Teugels and Powell [18] reviewed group of fishes in Niger basin, a region of high richness, 36 families and 243 species primarily of freshwater were reported. Boulenger [19] listed 976 species of African freshwater fishes comprising 185 genera and 43 families. Ita [20] reported 268 different fish species in 34 well known Nigeria freshwater rivers, lakes and reservoirs, which constitute about 12% of Nigeria's total surface area of about 98, 185, 000 hectares. However, according to Jamu and Ayinla [21] the yields of most of these inland waters are generally on decline due to environmental degradation (such as water pollution) and improper or poor management of fisheries resources. Environmental protection agency (EPA) recommended species richness and relative abundance as ecological risk assessment in aquatic ecosystem [22]. Welma [23] produced a list of 181 species of fish that could be found in Nigeria Inland waters. Ita [20] reported an estimated 230 species of fish in Nigeria rivers. Odo *et al.* [24] reported estimated 52 fish species belonging to 17 families from Anambra River, Nigeria. Soyinka *et al.* [25] gave a report on seasonal distribution and richness of fish species in the Badagry Lagoon, South west Nigeria, 37 species distributed among 21 families of fish were reportedly caught from the lagoon. There is no available record on the fish diversity and composition in R. Ore which drains directly into Ologe lagoon and empties into Atlantic Ocean via Badagry creek in Lagos.

Therefore, our objective in this study was to provide accounts of the fish diversity and species composition in R. Ore with particular references to its three tributaries. The information from this investigation will serve as a baseline data for carrying out further study on ecology, conservation, sustainability and management of fisheries resources of this water body.

MATERIALS AND METHODS

Description of River Ore: River Ore (Fig. 1) lies between 3°0 and 6°30'E and 3°07'N 6°45'E. It is a major source of water to downstream Ologe lagoon. It is characterized by three (3) major tributaries, passing through Igbesa (T1), Itele (T2) and Iba (T3) towns. T1 and T2 are tributaries located in Ogun state and T3 in Lagos, South west, Nigeria. The source of water to R. Ore is R. Owo which takes its major source from Ogun River. R. Ore empties into the Atlantic Ocean via Ologe lagoon and Badagry creek in Lagos. These water bodies constitute Ogun-Osun River Basin in Nigeria. The tributaries of R. Ore along some settlements are separated by discontinuity layer of mangrove swamps and influenced by tidal variation during seasonal changes.

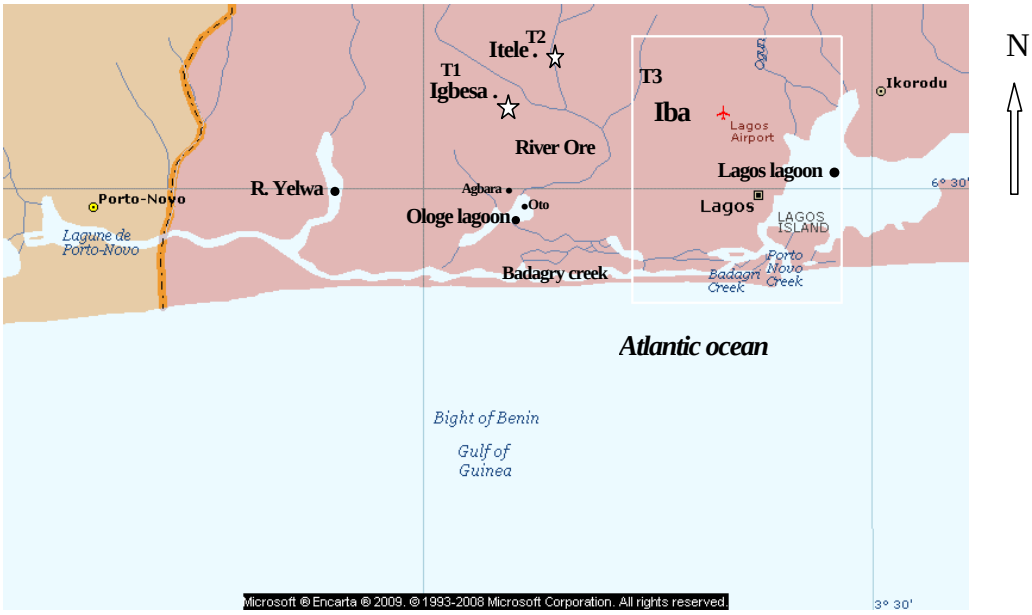

Fig. 1. River Ore showing the tributaries, T1, T2 and T3 (Igbesa, Itele and Iba marked **j**)

At the period of this study, the two seasons were: Wet (November-April) and dry (May-October), pH (6.3-7.9), water temperature (23-32°C), Dissolved oxygen (6.5-9.2mgLG^{1}) and salinity (0.0ppt). The river serves as a source of water for domestic use, transportation, logging and sand dredging. It is well known for its illegal bunkering and smuggling activities. There is dearth of information on this river especially on its ecology, ichthyofaunal composition and fisheries unlike the adjacent Ologe lagoon and Badagry creek where several works were reported.

Field Activities and Laboratory Procedures: The study was carried out in the three tributaries of R. Ore between June 2007 and May 2008. Fish species were caught with baited non return valve barrier traps. Gill nets of 20-45 mm mesh sizes were used to collect fish at depths not exceeding 25 m. Also used were cast nets of 10-22mm mesh sizes for collecting fish at depths between 0 and 5 m. These gears were set in T1, T2 and T3 tributaries at Igbesa, Itele and Iba towns respectively. Baits included earthworms and palm kernel fruits. Services of fishermen operating along the river were employed for the setting of gears. Fish were collected from the traps and nets at intervals of 72 hours and were preserved in 4% formaldehyde solution.

In the laboratory, identifications of the fish species were carried out following Reed *et al.* [26] , FAO[27,28], Oguzie [29]. Fish Base [30] software was used as a guide. Further descriptions of the species were carried out on Wikipedia [31], the free encyclopedia. The fishing gears were identified with reference to FAO [28] Catalogue of Small Scale Fishing Gears in Nigeria.

Occurrence and biometric data (such as total length, TL; and body weight, BW) of individuals in each taxon for each tributary were recorded. TL was measured to the nearest 1 mm and BW to the nearest 0.01 g. The relative species abundance which refers to the relative representative of a species was determined by dividing the number of species (n) from a tributary by the total number of species (N) from all tributaries. The abundance was described using a subjective acronym (ACFOR): (A) abundance or (C) common or (F) frequent or (O) occasional or (R) rare within the stations.

The faunal similarities at different sites based on nominal data, were analysed using indices of Jackson [32]. The relative abundance of taxa that were common among the tributaries was calculated using Renkonen similarity [33]. Simpson index (d) and Jackknife Estimator (S) were employed to evaluate species richness. The Shannon - Weiner index (H) and evenness index (E) of Shannon and Weiner [34] were used to evaluate species diversity. Jackknife index (S) estimate was employed to account for the probability of missing some of the actual total number of species present in any count based on a sample population.

RESULTS

In this study fish species composition comprised three hundred and ten (310) individuals from ten (10) families, ten (10) genera and eleven (11) species (Table 1). Species composition showed presence of fish of fresh and brackish water origins. Family Clariidae was represented by the *Clarias gariepinus* and *Clarias anguillaris*, Channidae by *Parachanna obscura*, Polypteridae by *Erpetoichthys calabaricus*. Families Bagridae, Cichlidae and Mormyridae consisted of *Chrysichthys nigrodigitatus*, *Tilapia mariae* and *Mormyrus macrophthalmus* respectively. However, *Ctenopoma kingsleyae*, *Hepsetus odoe*, *Synodontis budgetti* and *Heterotis niloticus* represented Anabantidae, Hepsetidae, Mochokidae and Osteoglossidae respectively. The Clariids were the most abundant group comprising *C. gariepinus* (32.26%) and *C. anguillaris* (7.74% of the total catch). The second most abundant species was *P. obscura* which comprised 20.65% of the fish population. The least abundant fish was *H. niloticus* comprising one individual (0.32%). It was caught from tributary T3. Seasonal variation was exhibited by the species. Wet season showed all species availability; *C. gariepinus*, *C. anguillaris* and *P. obscura* were available in both seasons. Higher animal taxa such as: egrets, *Ardea cinerea*; geese, *Nettapus auritus*; eagles, *Haliaetus vocites*; monitor lizards, *Varanus niloticus*; and Artiodactyla, *Tortoise* were also encountered, however their populations were not studied in this work but were observed in their large numbers and they formed part of the aquatic fauna in R. Ore.

Summary of relative species abundance in R. Ore is presented in table 2. The acronym (ACFOR) although may be subjective showed that *C. gariepinus* and *P. obscura* were the most abundant, commonest and most frequent fish species in R. Ore. *S. budgetti*, *E. calabaricus*, *H. odoe* and *C. kingsleyae* were occasional species, while *H. niloticus* appeared as a rare species. Highest number of species (8) was recorded in July 2008; December 2007 and February 2008 were each represented by *C. gariepinus* and *P. obscura*, June 2007 and May 2008 by *C. gariepinus*, *P. obscura* and *E. calabaricus* while *H. niloticus* with a representative was the only species that was caught in April 2008.

Table 1: Percentage composition and seasonal variations of fish from R. Ore, Nigeria.

Family	Species	Number (Percentage) of fish caught from tributaries T1	T2	T3	Sum total number (%) of fish caught
Clariidae	Clarias gariepinusa,b	30 (9.68)	36 (11.61)	34 (10.97)	100 (32.26)
Clariidae	Clarias anguillarisa,b	10 (3.23)	8 (2.58)	6 (1.94)	24 (7.74)
Bagridae	Chrysichthys nigrodigitatus,b	15 (4.84)	12 (3.87)	9 (2.90)	36 (11.61)
Mochokidae	Synodontis budgettib	8 (2.58)	10 (3.23)	2 (0.65)	20 (6.45)
Channidae	Parachanna obscuraa,b	18 (5.81)	25 (8.07)	21 (6.77)	64 (20.65)
Polypteridae	Erpetoichthys calabaricusb	8 (2.58)	5 (1.61)	11 (3.55)	24 (7.74)
Mormyridae	Mormyrus macropthalmusb	3 (0.97)	5 (1.61)	3 (0.97)	11 (3.55)
Cichlidae	Tilapia mariaeb	3 (0.97)	1(0.32)	5 (1.61)	9 (2.90)
Hepsetidae	Hepsetus odoeb	6 (1.94)	8 (2.58)	2(0.65)	16 (5.16)
Anabantidae	Ctenopoma kingsleyaeb	2 (0.65)	1 (0.32)	2 (0.65)	5 (1.61)
Osteoglossidae	Heterotis niloticusb	0	0	1(0.32)	1(0.32)
		103	111	96	310

[a] represent s dry season (May-October)

[b] represents wet season (November - April)

Table 2: Summary of Relative Species abundance in River Ore, Nigeria.

		2007						2008					
Family	Species	June	July	August	September	October	November	December	January	February	March	April	May
Clariidae	C. gariepinus A,C,F	*	*	*	*	*	*	*	*	*	*		*
Clariidae	C. anguillaris A,F			*	*	*						*	
Bagridae	C. nigrodigitatusA,O		*	*	*								
Mochokidae	S. budgettiA,O		*				*						
Channidae	P. obscuraA,C,F	*		*	*		*	*	*	*			*
Polypteridae	E. calabaricusC	*	*	*	*		*		*				*
Mormyridae	M. macrophthalmusO		*										
Cichlidae	T. mariaeC		*	*	*								
Hepsetidae	H. odoeO		*			*							
Anabantidae	C. kingsleyaeO		*										
Osteoglossidae	H. nilotcusR										*		

Legend: A -"Abundance" C-"Common" F-"Frequent" O-"Occasional" R-"Rare"

Table 3: Sizes of fish species in R. Ore

	Body weight (g)			Total length (cm)		
Species	Min	Max	Mean±SE	Min	Max	Mean±SE
C. gariepinus	18.23	34.72	22.02 ±2.01	7.4	15.6	13.35±3.34
C. anguillaris	10.24	28.29	13.45±4.03	8.7	13.9	9.98±1.09
P. obscura	27.69	45.2	32.32±5.08	12.8	16.5	13.98±8.08
E. calabaricus	76.27 -	90.2	82.64±9.23	20.2	24.2	21.98±3.09
T. mariae	3	6	4.00±0.23	2.5	5.3	3.83±0.21
C. nigrodigitatus	40.72	48.92	41.56±8.56	13.1	19.2	15.86±4.98
C. kingleyae	12.02	15.46	12.34±3.44	7.87	10.2	8.23±0.89
M. macrophthamus	18.02	30.05	24.89±9.08	7.4	13.7	10.78±2.56
H. odoe	6.25	45.65	36.89±10.80	4	18.5	9.45±4.90
S. budgetti	16.51	35.9	25.97±5.90	11.5	24	15.90±4.98
H. niloticus	125.45			45.7		

Table 4: Diversity indexes of fish species in the tributaries of R. Ore.

Diversity Index	T1 (Igbesa)	T2 (Itele)	T3 (Iba)
Total number of site visits	104	104	104
Number of species	10	10	11
Number of individuals	103	111	96
Simpson's index $(d) = \frac{\sum n(n-1)}{N(N-1)}$	0.155	0.257	0.196
Simpson's index of diversity=(1-d)	0.845	0.743	0.804
Simpson's reciprocal index=(1/d)	6.452	3.891	5.102
Shannon-Weiner index (H) = -E pi ln pi	2.015	1.899	1.896
Evenness (E) = e^H/s	0.74	0.659	0.6
Jackknife index (S) = n!+(n!-1/n)^k	19	9	11.9

Legends: N=Total number of organisms of all species found, n=number of individuals of a particular species, n!=total number of species present in sample population, k=number of unique species of which only one organism was found in sample population, D=diversity index, S=species richness. i = an index number for each species present in a sample. pi = ni/N = the number of individuals within a species (ni) divided by the total number of individuals (N) present in the entire sample. ln = natural log. E =sum the values for each species.

Overall sizes of fish species in R. Ore (Table 3) showed the presence of some fingerlings, juveniles and sub-adults among the fish population. The fish size was as small as 3.83± 0.21cm TL (4.00±0.23 g BW) in *T. mariae* and as large as 45.7 cm long and weighing 125.45 g BW in *H. niloticus*.

The diversity indexes of fish species indicated low fish species diversity in R. Ore (Table 4). The diversity indexes as estimated from the tributaries T1, T2 and T3 were d= 0.155, 0.257 and 0.196; H=2.015, 1.899 and 1.896; E=0.740, 0.659 and 0.600; and S=19.0, 9.0 and 11.9, respectively. The Simpson's index of diversity and reciprocal index were 0.845, 0.743 and 0.804; and 6.452, 3.891 and 5.102, respectively in the tributaries.

DISCUSSION

This study presents 310 individuals comprising 10 families, 10 genera and 11 species of fish. Species composition suggested the presence of fish of fresh and brackish waters in River Ore. The presence of *Tilapia mariae, Ctenopoma kingsleyae, Clarias gariepinus, Clarias anguillaris, Hepsetus odoe, Synodontis budgetti, Chrysichthys nigrodigitoutus, Parachanna obscura, Erpetoichythys calabaricus, Mormyrus macrophthalmus and Heterotis niloticus* is a characteristic feature of the West African lagoon system. Ravenga *et al*. [35] map classified West African Basins as neither high in number of fish species nor endemics. In this study Clariids and Channids were the most abundant and dominant groups. Species abundance was in favour of wet season. *C. gariepinus*, *C. anguillaris* and *P. obscura* were the species that occurred in both seasons. Dry season in South west, Nigeria is a period characterized by poor water quality, reduced water level, high temperature and salinity. Under these conditions, down stream migration of some fish species from R. Ore to adjacent Ologe lagoon and Badagry creek may be experienced until it rains. Down stream migration might be responsible for few species composition that was recorded in this study. Higher numbers of species were reported from the adjacent and down stream Ologe lagoon [36] and Badagry creek [37]. Presence of *Clarias* species and *P. obscura* in R. Ore in both sessions described high degree of hardness and tolerance these species could exhibit in fresh water such as river. They are known for their ability to withstand difficult environmental conditions that associate with poor water quality, especially during the dry season. Clariids possess accessory breathing organs that assist in respiration during the period of inactivity or hibernation when water level and dissolved oxygen are very low.

The presence of single specimen of *H. niloticus* among the populations suggested that the species was a rare or threatened or near extinct species in this water body. Presence of numbers of higher animal taxa such as reptiles (snakes, monitor lizards, crocodiles and tortoises) and fish eating birds like egrets, geese, eagles and kites confirmed that natural aquatic environments like rivers house a variety of aquatic lives [37]. Large numbers of these animals were reported by Odo *et al.* [24] in their review on R. Anambra in South eastern, Nigeria.

The preliminary data such as: pH (6.3-7.9), water temperature (23-32°C), Dissolved oxygen (6.5-9.2mgL^{-1}) and salinity (0.0ppt) that were recorded in this study fell within recommended values suggested by Boyd [38] that support aquatic life including fishes.

The array of juveniles and sub-adults in this work suggests this river as a breeding and nursery ground for fish species particularly those of brackish water origin. However, the absence of adults among other factors may be due to pressure exerted from overfishing by local fishermen or from down stream migration of the fish or both. Large numbers of adults were reported from Ologe lagoon [36] and Badagry creek [25] in Lagos.

Recent experience from IUCN [39-42] is that wherever fish faunas are studied, more species than suspected turn out to be threatened (i.e. species are at risk of extinction), or cannot be re-recorded at all.

To get a better description of fish diversity, a measure of species richness and evenness of their distribution were undertaken in R. Ore. Low species richness (d) in R. Ore might be a result of downstream migration of fish from the river to the adjacent Ologe lagoon and Badagry creek. In nature the value of d ranges between 0 and 1. With this, index 0 represents infinite diversity and 1, no diversity. The bigger the d value, the smaller the diversity. The Simpson's index of diversity (1-d) represents the probability that two individual fish randomly selected from a sample will belong to different species. The value of this index also ranges between 0 and 1, the greater the value, the greater the sample diversity.

The Simpson's reciprocal index (1/d), the value of this index starts from 1 representing a community with one species. The higher the value, the greater the diversity. The maximum value here was 10 representing the total number of species encountered in this study.

Shellfishes such as crabs, shrimps and prawn and other invertebrates were not encountered in R. Ore unlike Ologe Lagoon and Badagry creek where they were reported in large numbers. The distributions of individuals or species evenness (E) in the tributaries were uneven.

The unevenness was not significantly different (P>0.05) across the three tributaries. The value of E varied between 1 and 0. The closer to 1 the more even the populations of fish that form the community.

Shannon-Weiner index (H) affects both number of species and evenness of their population, diversity increases as both increase. Diversity is maximum when all species that made up the community are equally abundant (i.e. have a similar population sizes). The diversity is partly a function of the variety of habitats; the more varied habitats tend to be inhabited by a large number of species than less variable ones. Secondly the older habitats usually contain more species than younger ones. Warmer temperatures, availability and stability of food result in high level of diversity, others include latitudes and longitudes.

External factors affecting populations of freshwater species include: simple habitat loss resulting from withdrawal of water for human use such as irrigation, domestic and industrial use; impact of anthropogenic factors; and direct exploitation such as impoundment, wetland drainage and flood control causing the load of inorganic and organic pollutants in flowing waters to increase. The major challenge is to address the increasing volume of polluted waste water from industrial and agricultural processes. Dam construction and channelization strongly disrupt natural production cycles, including migration of fishes that ascend rivers from downstream areas or the sea in order to spawn. Fish production can be maintained or increased in some circumstances, in reservoir or floodplain canals, although natural aquatic biodiversity is expected to decrease.

In conclusion, increased fishing pressure exerted from overfishing activity of the artisanal fishermen that operating in this water body; and couple with the down stream migration of fish in search for food, shelter and spawning; industrialization, urbanization and farming activities around the river as factors that were probably responsible for low fish composition and diversity in R. Ore South west, Nigeria. This study could serve as baseline data in assisting relevant bodies in the management and conservation of fisheries resources of this water body where there are dearth of information relating to its fish and fisheries. Government must take immediate action through public awareness and education to regulate fishing, industrialization, urbanization and farming activities within and around this water body as preclude to conserving its resources that are fast depleting. Enactment and enforcement of laws and orders by regulating agencies in the management and conservation of the resources of our natural waters should be considered a top priority.

ACKNOWLEDGEMENTS

The Iba artisanal fishermen Association and its leader, Mr. Ismaila Ganiyu are hereby acknowledged for their assistance during our several field trip. We are also grateful to staff of fisheries laboratory, Lagos State University, Lagos, Nigeria.

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