

Seasonal distribution and richness of fish species in the Badagry Lagoon, south-west Nigeria

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Received 12 March 2009, revised 13 November 2009

Abstract. We recorded 37 fish species representing 21 families in the Badagry Lagoon, south-west Nigeria. Adult stages of 13 (35.14%) of them were freshwater, 7 (13.51%) estuarine, and 19 (51.35%) near-shore marine species. The seasonal variation in the fish catch composition of the lagoon was attributed to the seasonal fluctuation in salinity. Availability of food organisms was also noted to affect the seasonal distribution of the fish fauna. Other physical features such as temperature and pH varied slightly, while the concentration of dissolved oxygen was higher in the dry season than in the rainy season. The highest species richness was observed in September with 11 species, while the lowest with the smallest abundance was observed in February with 5 species. The most abundant species during their occurrence were *Cynoglossus senegalensis* (7.92%), *Tilapia mariae* (7.17%), and *Ilisha africana* (6.04%). Species richness and total abundance were found to increase during the rainy season.

Key words: fish species, rainy season, dry season, salinity, lagoon.

INTRODUCTION

Several publications are available on the fish fauna and fisheries of the south-western lagoons of Nigeria. The United Nations Food and Agricultural Organization Report (FAO, 1969) gives a survey of the fisheries of the Badagry Lagoon. Ezenwa & Kusemiju (1985) studied the reproductive biology of the catfish, *Chrysichthys nigrodigitatus*, from the Badagry Lagoon. Solarin & Kusemiju (1991) documented the day and night variations in the fish and shellfish caught in the Badagry creeks. Ajado & Edokpayi (2003) worked on the comparative racial study of *Clarias gariepinus* (Burchell, 1882) from the Niger River and the Badagry Lagoon. Lagoons of south-western Nigeria are characterized by seasonal fluctuation in salinity (Olaniyan, 1957; Hill & Webb, 1958). On this basis Williams (1962) discussed the seasonal distribution of the fishes in relation to their salt tolerance. Olaniyan (1969) suggested salinity as an ecological factor in the Lagos Lagoon. While salinity may be an important ecological factor in the distribution of the fish fauna, Fagade & Olaniyan (1974) postulated that the availability of the food of the fish species can also influence their distribution. Other works on the fisheries of the Badagry

Lagoon include, among others, Lawal-Are (2001) and Lawal-Are & Kusemiju (2000). In this study, the seasonal occurrence and distribution of fish species in the Badagry Lagoon in south-west Nigeria is investigated.

MATERIALS AND METHODS

Study area

The Badagry Lagoon (Fig. 1), which is approximately 60 km long and 3 km wide, lies between longitudes 3°0' and 3°45' E and between latitudes 6°25' and 6°30' N. It is part of a continuous system of lagoons and creeks along the coast of Nigeria from the border with the Republic of Benin to the Niger delta. Its water depth ranges from 1 m to 3 m. The lagoon experiences two broad seasons: the dry season (December–May) and the wet season (June–November). Most of the year it is characterized by fresh and slightly brackish water. The lagoon is approximately equidistant from the entrances of Lagos and Cotonou harbours. As a result, it is influenced by tides and floods from the Lagos Lagoon and Cotonou harbour through Lake Nokue and Lake Porto-Novo (Anyanwu & Ezenwa, 1988). The Yewa River with its tributaries Isalu and Ijomo is the major river emptying into the lagoon. Creeks connected to the lagoon include Bawa and Doforo. Major weeds occurring in the lagoon yearly in December and January include the common water hyacinth *Eichhornia crassipes* and *Ceratophyllum* and *Pistia* sp. The lagoon is surrounded by large areas of swamps covered with vegetation among which the Raphia palm (*Raphia sudanica*), the African oil palm (*Elaeis guineensis*), and the coconut palm (*Cocos nucifera*) are dominant (FAO, 1969).

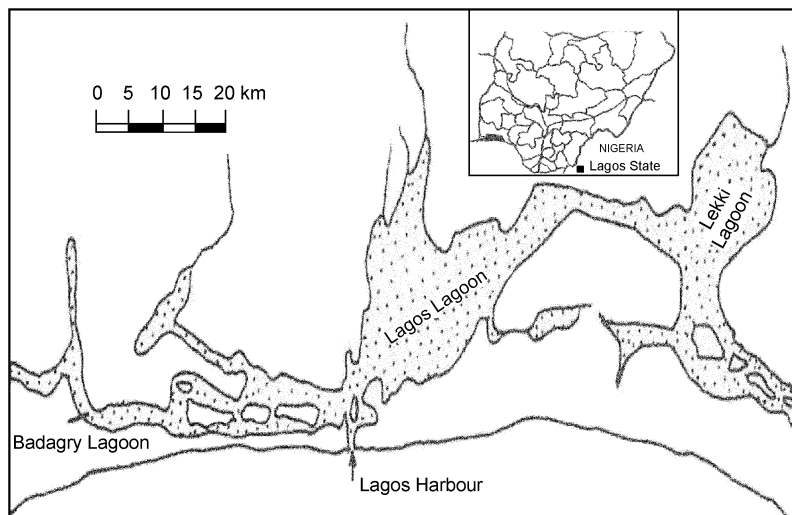


Fig. 1. Map showing the Badagry Lagoon with a map of Nigeria inserted.

Collection of specimens and field studies

The 795 fish specimens used for this study were caught with cast nets with varied mesh sizes (37, 67, and 76 mm) in the Badagry Lagoon from September 2006 to May 2007. (A bloom of water hyacinth and macro-algal plants obstructed transportation and fishing activities over the lagoon in December 2006 and so there was no collection in that month.) The specimens were preserved in an ice-chest containing ice cubes in the field and later transferred into a deep freezer (temperature -20°C) in the laboratory after sorting and identification prior to further examination. Appropriate texts used in fish identification include Schneider (1990) and Olaosebikan & Raji (1998). During each trip, surface water, bottom water, and air temperatures were recorded using a mercury-in-glass thermometer. Water samples were collected just below the water surface for the determination of salinity (refractometer) and pH (Jenway pH-meter) in the laboratory and dissolved oxygen (DO) concentration (Jenway DO-meter) in the field.

Laboratory procedures

The preserved specimens were thawed and wiped dry before laboratory analysis. The standard and total lengths (in centimetres) were measured on a measuring board and the weights (in grams) were determined using a sensitive 'Sartorius' electric balance (Model 1106).

RESULTS AND DISCUSSION

Physical features of the lagoon

Table 1 presents the major physical parameters of the Badagry Lagoon. The surface water temperature was high ranging from 29.5 to 31.7°C , while the air temperature ranged from 28.0 to 31.5°C . Higher values in the slightly varying temperature were obtained in the dry season and lower values in the wet season.

The salinity ranged from 1.0 to 8.0, decreasing slightly in the rainy season from September to November. The salinity was lowest in January, a dry season month (Fig. 2). It did appear that the waters of the Badagry Lagoon had increased

Table 1. The ranges, means, and standard deviations of ecological parameters of the Badagry Lagoon in September 2006–May 2007 (number of observations = 7)

Parameter	Range	Mean \pm SD
Air temperature, $^{\circ}\text{C}$	28.0–31.5	29.51 \pm 1.50
Water temperature, $^{\circ}\text{C}$	29.0–31.7	30.49 \pm 1.07
Dissolved oxygen, mg/L	4.4–8.5	7.04 \pm 1.42
Salinity	1.0–8.0	4.39 \pm 2.74
pH	7.2–8.8	7.80 \pm 0.60

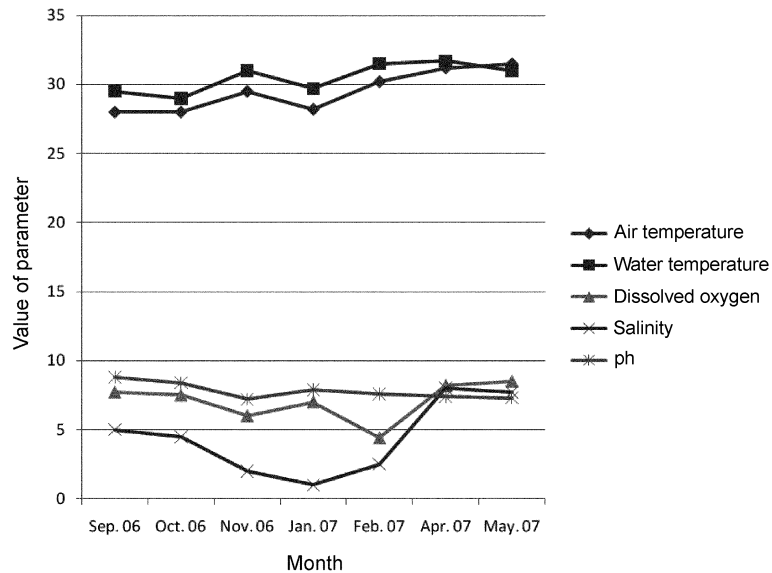


Fig. 2. Variation in monthly ecological factors in the Badagry Lagoon (Sep. 2006–May 2007).

salinity during the rainy season but decreased salinity in the dry season. An increase in salinity was noticed again from around March to May, which coincides partly with both the dry and the wet season. The increase in salinity in the dry season was probably due to the influence of Lagos harbour, which causes a saline condition in the lagoon although with a reduced influence over a long distance. Low salinity, which however was never zero, was probably due to the slight influence of the Cotonou harbour during the rainy season when there is little mixing of saline water with the large volume of freshwater discharge from adjacent rivers into the lagoon. Anyanwu & Ezenwa (1988) reported the influence the Lagos and Cotonou harbours have on the Badagry Lagoon.

The water was relatively neutral and slightly alkaline. The pH was between 7.2 and 8.8 and the lagoon was never acidic during the period of investigation. The water had an almost clear colouration and was quite transparent.

The DO concentration was high enough, ranging between 3.2 and 8.5 mg/L. The lower values were registered in the rainy season while the higher DO level was in the dry season when the surface water temperature was slightly higher. The lagoon was relatively habitable for several species.

The present study, in which 37 species of fish were collected from the Badagry Lagoon, and that by Fagade & Olaniyan (1974), in which 72 species were obtained from the Lagos Lagoon, further confirm the species richness in warm waters as compared with cold waters (Breber, 1996). The species richness observed in the Strymon estuarine system – 43 species – is so far the highest recorded in the Mediterranean (Koutrakis et al., 2000a). In the Porto-Lagos Lagoon 35 species

were recorded (Koutrakis et al., 2000b), in the Po estuary 28 (Vitali & Braghieri, 1981) and in the Gialova Lagoon 16 species were found (Dounas & Koutsoubas, 1996). The temperature is virtually within close range in the air and surface water of the Badagry Lagoon. However, salinity was the key factor in the distribution of the fishes in the Badagry Lagoon.

The fishes collected during the investigation

Thirty-seven species distributed among 21 families (Table 2) were caught during the investigation. Solarin & Kusumijuw (1991) recorded 14 species of fish from the Badagry creeks, 6 of which were not caught in the present investigation. These include the following: *Cytharichthys stampfilis*, *Decapturus punctatus*, *Gerres melanopterus*, *Polydactylus quadrifilis*, *Pseudolithus elongatus*, *Tilapia melanoptera*. This brings the fish fauna of the Badagry Lagoon and creeks to 43 species.

Seasonal occurrence of the fish species

When all the fish species were classified according to the season of their occurrence in the lagoon, they formed two broad groups. Besides there was a narrow group made up of a species occurring both in the rainy and the dry season. It was only the lesser African threadfin *Galeoides decadactylus* that represented this likely group. In the lists below it is included both in the first and the second group.

The first group comprises those fishes that occurred only in the rainy season when the salinity ranged from 1.4 to 2.0. These fishes were found during the rainy season from June to November. These included the following 19 species:

<i>Batanga lebretonis</i>	<i>Chloroscombrus latus</i>	<i>Clarotes laticeps</i>
<i>Bathygobious soporator</i>	<i>Chrysichthys auratus</i>	<i>Cynoglossus senegalensis</i>
<i>Brachydeuterus auritus</i>	<i>Chrysichthys</i>	<i>Drepane africana</i>
<i>Caranx carangus</i>	<i>nigrodigitatus</i>	<i>Eleotris vittata</i>
<i>Caranx</i> sp.	<i>Chrysichthys walkeri</i>	<i>Elops lacerta</i>
<i>Chloroscombrus</i>	<i>Citharus linguatula</i>	<i>Ethmalosa fimbriata</i>
<i>chrysurus</i>	<i>Clarias</i> sp.	<i>Galeoides decadactylus</i>

The following species were reported by Fagade & Olaniyan (1974) as those found in the Lagos Lagoon when the water is brackish (salinity 0.5–28.0): *Caranx carangus*, *Chloroscombrus chrysurus*, *Drepane africana*, and *Galeoides decadactylus*. Like other brackish-water species, only the immature stages occurred in the Badagry Lagoon. The sexually mature stages are found in the sea. The juvenile stages of many marine species are known to be able to live in water of reduced salinity (Fagade & Olaniyan, 1974). Some of the species found occurring throughout the year in the Lagos Lagoon by Fagade & Olaniyan (1974) were caught in the Badagry Lagoon at this low salinity. These species include *Bathygobious soporator*, *Chrysichthys nigrodigitatus*, *Cynoglossus senegalensis*, *Elops lacerta*, and *Ethmalosa fimbriata*, which were able to tolerate variations in salinity and other physical features. The big-eye grunt *Brachydeuterus auritus*, which is a

Table 2. Fish species collected in the Badagry Lagoon and their relative abundance in 2006–2007

Family	Species	Habitat (in adult)	Time					Frequency of abundance, %	
			Sep- 06	Oct- 06	Nov- 06	Jan- 07	Feb- 07		Apr- 07
BAGRIDAE	<i>Chrysichthys auratus</i>	Freshwater	5						0.62
	<i>Chrysichthys nigrodigitatus</i>	Freshwater	21						2.64
	<i>Chrysichthys walkeri</i>	Freshwater	1	26					3.4
	<i>Clarotes laticeps</i>	Freshwater	2						0.25
CARANGIDAE	<i>Caranx carangus</i>	Marine	12						1.51
	<i>Caranx</i> sp.	Marine	13						1.64
	<i>Chloroscombrus chrysurus</i>	Marine	15						1.89
	<i>Chloroscombrus latus</i>	Marine	13						1.64
CICHLIDAE	<i>Hemichromis fasciatus</i>	Freshwater			24				3.02
	<i>Sarotherodon melanotheron</i>	Freshwater					30	8	4.78
	<i>Tilapia guineensis</i>	Freshwater						13	1.64
	<i>Tilapia mariae</i>	Freshwater						57	7.17
	<i>Tilapia zillii</i>	Freshwater						33	4.15
	<i>Citharus linguatula</i>	Marine		3					0.38
CLARIIDAE	<i>Clarias</i> sp.	Freshwater		18	14				4.03
	<i>Ethmalosa fimbriata</i>	Marine			38				4.78
CLUPEIDAE	<i>Ilisha africana</i>	Marine				36	12		6.04
	<i>Cynoglossus senegalensis</i>	Marine		63					7.92
CYNOGLOSSIDAE	<i>Parachanna obscura</i>	Freshwater					21		2.64
CYPRINODONTIDAE	<i>Drepane africana</i>	Marine		13	2				1.89
ELEOTRIDAE	<i>Batanga lebretonis</i>	Estuarine Lagoon	1						0.13
	<i>Eleotris vittata</i>	Estuarine Lagoon			21				2.64

Table 2. Continued

Family	Species	Habitat (in adult)	Time					Frequency of abundance, %		
			Sep- 06	Oct- 06	Nov- 06	Jan- 07	Feb- 07		Apr- 07	May- 07
ELOPIDAE	<i>Elops lacerta</i>	Estuarine Lagoon		25				3.14		
GOBIIDAE	<i>Bathygobius soporator</i>	Estuarine Lagoon	5					0.62		
	<i>Gobioides africanus</i>	Marine			29			3.65		
MONODACTYLIDAE	<i>Psettias sebae</i>	Estuarine Lagoon					20	2.52		
MORMYRIDAE	<i>Marcusenius senegalensis</i>	Freshwater					28	3.52		
MUGILIDAE	<i>Liza falcipinnis</i>	Marine					36	4.53		
	<i>Mugil cephalus</i>	Marine					5	0.62		
OPHICHTHIDAE	<i>Ophichthus rufus</i>	Marine					12	2.26		
OSTEOGLOSSIDAE	<i>Heterotis niloticus</i>	Freshwater			3			0.38		
POLYNEMIDAE	<i>Galeoides decadactylus</i>	Marine			21	10		3.9		
POMADASYIDAE	<i>Brachydeuterus auritus</i>	Marine	34					4.28		
	<i>Pomadasyus jubelini</i>	Marine					6	0.75		
	<i>Pomadasyus peroteti</i>	Marine					11	1.38		
SCIAENIDAE	<i>Pseudotolithus typus</i>	Marine					14	1.76		
SPHYRAENIDAE	<i>Sphyraena barracuda</i>	Marine					3	1.89		
Total			122	123	121	102	93	111	123	Total = 100% 795

marine species, was caught in the Badagry Lagoon in the wet season (September). Large specimens of the freshwater mud-catfish *Clarias* sp. were landed at the fish jetty during the wet months, which indicated that sexually mature species occurred in this lagoon.

The freshwater silver catfish *Clarotes laticeps* was also caught during this investigation in the rainy season. Only one specimen of the goby, *Batanga lebretonis* (*Eleotris lebretonis*), was collected in a wet month (September). Chukwu & Kuton (2001) reported that the species occurs throughout the year in a eutrophic creek in south-western Nigeria with peak abundance during the flood period (May–November). A few specimens of *Eleotris vittata* were also collected in the late rainy season (November). The goby favours a soft organic muddy substratum among submerged riparian vegetation.

The second group consisted of fishes found during the dry season from December to May. These fishes were caught when the lagoon had a relatively higher salinity range of 1.0 to 8.0. The group also included 19 species:

<i>Galeoides decadactylus</i>	<i>Mugil cephalus</i>	<i>Sarotherodon</i>
<i>Gobioides africanus</i>	<i>Ophichthus rufus</i>	<i>melanotheron</i>
<i>Hemichromis fasciatus</i>	<i>Parachanna obscura</i>	<i>Sphyraena barracuda</i>
<i>Heterotis niloticus</i>	<i>Pomadasys jubelini</i>	<i>Tilapia guineensis</i>
<i>Ilisha africana</i>	<i>Pomadasys peroteti</i>	<i>Tilapia mariae</i>
<i>Liza falcipinnis</i>	<i>Psettias sebae</i>	<i>Tilapia zilli</i>
<i>Marcusenius senegalensis</i>	<i>Pseudotolithus typus</i>	

Freshwater species in this group include *Marcusenius senegalensis*, *Tilapia guineensis*, *T. mariae*, *T. zilli*, *Hemichromis fasciatus*, and *Heterotis niloticus* (Fagade & Olaniyan, 1974; Leveque et al., 1991). However, Fagade & Olaniyan (1974) recorded the presence of *H. fasciatus* throughout the year in the Lagos Lagoon and reported *Sarotherodon melanotheron* from a brackish environment. The other species are either brackish-water or marine species (Fowler, 1936; FAO, 1969). *Gobioides africanus*, *Hemichromis fasciatus*, *Heterotis niloticus*, and *Ilisha africana* occurred in the early part of the dry season (January) at reduced salinity (1). The cichlids *Sarotherodon melanotheron*, *Tilapia guineensis*, *T. mariae*, and *T. zilli* occurred in the late part of the dry season (April–May) at a relatively higher salinity (7–8). In the middle of the dry season (February) at a salinity of 2.5 *Liza falcipinnis*, *Mugil cephalus*, and *Ophichthus rufus* were caught. *Galeoides decadactylus* was found both in the dry season (January) and in the rainy season (November) at salinities of 1 and 2, respectively. *Pomadasys jubelini*, *Pomadasys peroteti*, and *Pseudotolithus typus* occurred in the late dry season (April) at a salinity of 8. Fagade & Olaniyan (1974) reported *Galeoides decadactylus*, *Gobioides africanus*, *I. africana*, *Mugil cephalus*, *O. rufus*, and *Pseudotolithus* sp. to occur when the Lagos Lagoon is brackish (salinity 0.5 to 28.0). All these were sexually immature, while their sexually mature stages occur in the sea. The authors reported that *O. rufus* was caught only on baited hooks.

The groups of fishes found in the Badagry Lagoon are freshwater species, estuarine species, and marine species (Table 3).

Table 3. Fish species richness of the Badagry Lagoon

Habitat	Dry season		Rainy season		Both seasons	
	No.	%	No.	%	No.	%
Fresh water	8	42.11	5	26.32	13	35.14
Estuary/Lagoon	1	5.26	4	21.05	5	13.51
Sea/Near-shore area	10	52.63	10	52.63	19	51.35
Total	19		19		37	

The importance of the studied lagoon as a nursery ground is supported by the presence of young individuals of several species such as *Ethmalosa fimbriata*, *Pseudotolithus typus*, *Ilisha africana*, etc. The lagoon serves probably as a feeding ground for the juveniles of those species and it is reasonable to assume that the presence of suitable food also influences the occurrence and distribution of all species. For instance, predatory species like *Caranx* sp., *Elops lacerta*, *Hemichromis fasciatus*, *Sphyraena barracuda*, etc. were caught among schools of the juvenile clupeid *Ethmalosa fimbriata* (4.78%), the shad *Ilisha africana* (6.04%), and *Tilapia* spp. (20.73%). The presence of large specimens of some fishes such as *Clarias* sp., *Sphyraena barracuda*, etc. indicated that some of the fishes are permanent residents in the Badagry Lagoon and some complete their life cycle in the lagoon. *Pseudotolithus typus* was caught at the peak of the dry season in April when salinity was 8. During that period some shrimps and other crustaceans were landed at the fish jetty. During their occurrence the most abundant species were *Cynoglossus senegalensis* (7.92%), *Tilapia mariae* (7.17%), and *Ilisha africana* (6.04%) (Table 1). Seasonality seemed to determine the temporal distribution of these fish species too. The percentage species richness of the marine species (51.35%) that spend part of their life cycle in the lagoon indicates that a large number of marine species migrate to inland water of less saline conditions than the sea (Fagade & Olaniyan, 1974). However, a few freshwater species (29.73%) move from rivers to more saline water in the lagoon.

ACKNOWLEDGEMENT

The assistance of Dr. B. E. Emmanuel of the Department of Marine Sciences in the identification of the species is greatly appreciated.

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Kalade sesoonne levik ja liigirikkus Badagry laguunis Nigeeria edelaosas

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Nigeeria edelaosas paiknevas Badagry laguunis kirjeldati 37 kalaliiki ja 21 sugukonda. Täiskasvanud isenditest olid 13 liiki (35,14%) mageveelise, 7 (13,51%) riimveelise ja 19 (51,35%) rannikumere päritoluga. Soolsuse ja saakloomade muutlikkus kirjeldas kõige paremini kalaliikide sesoonset varieerumist. Teised füüsilised tegurid, nagu temperatuur ja pH, varieerusid vähesel määral ning kuiva perioodiga võrreldes oli lahustunud hapniku sisaldus väiksem vihmaperioodil. Kalade liigiline mitmekesisus oli suurim septembris, kui laguunist leiti kokku 11 liiki. Madalaim liigirikkus koos väikseima arvukusega oli veebruaris, mil laguunist leiti vaid 5 kalaliiki. Kõige arvukamad kalaliigid olid *Cynoglossus senegalensis* (7,92%), *Tilapia mariae* (7,17%) ja *Ilisha africana* (6,04%). Kalade liigirikkus ja üldarvukus suurenesid vihmaperioodi jooksul.