OCCURRENCE, AGE, GROWTH PATTERN AND SEX RATIO OF MULLET SPECIES IN LAGOS LAGOON

***SOYINKA, O. O. & O. Y. ADEKOYA**
Department of Marine Sciences, University of Lagos, Nigeria.
*Corresponding author: soyinka.olufemi@gmail.com; +2348033808071

ABSTRACT
The occurrence, age, growth pattern and sex ratio of 334 specimens of mullets collected from the Lagos Lagoon were investigated from December 2007 – March 2008. Five species of mullets were identified and the relative abundance of species was: Liza dumerilii (35.02%), Liza falcipinnis (33.83%), Mugil cephalus (27.84%), Mugil curema (2.99%) and Liza grandisquamis (0.30%). The standard length of all mullet species ranged from 8.9 – 25.9 cm (total length range was of 11.7 – 27.6 cm) and the total body weight ranged from 11.52 – 269.84 g. The frequency polygon reflected five age groups in L. dumerilii, seven age groups in L. falcipinnis, four age groups in M. cephalus and two age groups in Mugil curema. The b- values were: 2.82 (L. dumerilii), 2.97 (L. falcipinnis), 3.60 (M. cephalus), and 4.60 (M. curema). The Liza species exhibited a negative allometric growth, while the Mugil species had positive allometric growth pattern. All the species had K-values above 1 except for L. grandisquamis. The sex ratio was in favour of the female fish in all the species examined except in M. curema. The present investigation has provided an assessment of the mullet species in the Lagos Lagoon, Nigeria, with relevant information that would be useful in the exploitation, cultivation and conservation of these under-utilised resources of this coastal community.
Keywords: abundance, mariculture, condition factor, length weight relationship

INTRODUCTION

The mullets, locally called 'Atoko' (Yoruba) belong to the family Mugilidae of ray-finned fish, and are found worldwide in temperate and tropical coastal waters while some species also inhabit fresh water. The family includes about 80 species in 17 genera (Lawson *et al.,* 2010). Mullets serve as important source of food in many coastal communities including the Mediterranean, Northwest Florida, Alabama gulf coast and West African countries, among others. Sixteen species of mullets have been identified in African waters occurring as pelagic, coastal fishes in estuaries and even in freshwater (Fowler, 1936). The sickle fin mullet, *Liza falcipinnis* (Valenciennes, 1836); grooved mullet, *Liza dumerili* (Steindacher, 1870); large scale mullet, *Liza grandisquamis* (Valenciennes, 1836); silver/white mullet *Mugil curema* (Valenciennes, 1836); banana mullet, *Mugil bananensis* (Valenciennes, 1836); and flat-head grey mullet, *Mugil cephalus* (Linnaeus, 1758), are some of the species reported in African waters. Although the species of this family are very similar in overall external morphology, features of morphology and morphometry are commonly employed to distinguish species (Soyinka, 2010). Other characters used for diagnosis are skeletal and muscular anatomy (Harrison & Howes 1991), protein or enzymes electrophoresis (Menezes *et al.*, 1992, Rossi *et al.*, 1998), and mitochondrial DNA sequence analysis (Caldara *et al.*, 1996).

The mullet resource in the Lagos Lagoon is currently exploited by artisanal fisherfolks using fish aggregating device known as 'acadja'. The information on the mullet species in the Lagos Lagoon is scanty. There are reports of overfishing (Solarin, 1998) of the Lagos Lagoon and the problem posed by hazardous anthropogenic activities such as pollution (Amund 2000; Akpata, 2002). According to Pauly *et al.* (2002) and Worm *et al.* (2006), the global conditions of major fish stocks are severe; recent studies showed evidence that more than 20 percent of fisheries resources have crashed, another 40 percent are overexploited, and the remaining are fully exploited. Thus, there is the necessity of taking fishery stock assessment of our water bodies in order to address the cases of depletion in stock appropriately and promptly.

The present investigation is to study aspects of the biology of mullet species in the Lagos Lagoon, Nigeria, and provide information that would be useful in the exploitation, cultivation and conservation of these resources of Lagos Lagoon,

DESCRIPTION OF STUDY AREA

The Lagos lagoon (Figure 1) is the largest of all four (4) lagoons emptying into the Gulf of Guinea located along the Southern – Western coastal region of Nigeria. It is the largest of the nine coastal lagoons of the south-western Nigerian, and having an estimated surface area of 208 km^2. The Lagos lagoon boarders the forest belt and receives a large number of important rivers like the Yewa, Ogun, Osun and Ona rivers draining more than 103,626 km of the country or land. The lagoon opens from an extensive harbor which serves as a major outlet of fresh water from the lagoon system during the rainy season. The lagoon opens throughout the year and exposed to semi-diurnal tides.

The Lagos lagoon is surrounded by swamp forest and riparian forest consisting of mangrove vegetation: *Rhizophora racemosa, R. harrisonii, Acrosticum aureum, Paspalum orbiculare, Langucularia sp* and *Avicenna germinans*. The lagoon empties into the Atlantic Ocean via the Lagos habour (Ogunwenmo and Kusemiju, 2004).

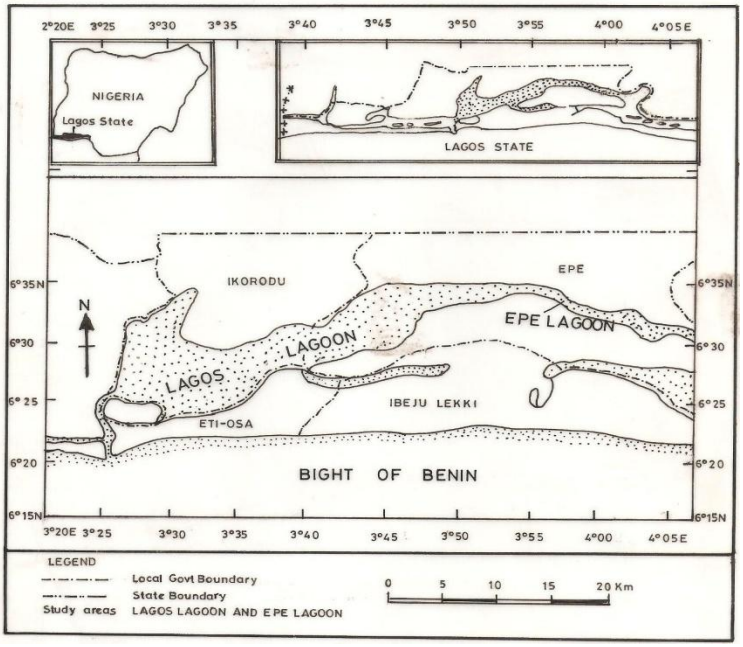

Fig. 1: Map of Lagos Lagoon, Nigeria

MATERIALS AND METHODS

Collection Method

The 334 specimens were collected from the Lagos lagoon in Lagos State of Nigeria by the local fisherfolks landing at the Makoko jetty for a period of four months of the dry season from December, 2007 to March, 2008. The collection was made fortnightly. The specimens were identified using appropriate texts such as Schneider, 1990, and sorted into different species of mullet collected. They were immediately transferred into a deep freezer at temperature of – 20 °C in the Marine Research Laboratory, University of Lagos.

Laboratory Procedures

The fish specimens were removed from the freezer and allowed to thaw; excess water was also removed with tissue paper. Standard morphological measurements taken were total length (TL) and standard length (SL) in cm, using measuring board, and body weight (W) in grams using a sensitive "Sartorious" weighing balance (Model 1106 2608053). The gonads were examined to differentiate the sexes.

Statistical analysis

The growth pattern was determined using the linear equation:

Log weight = Log a + b Log length, where 'a' and 'b' are regression constant and coefficient respectively

The male-female ratio statistical hypothesis of H_0 = 1:1 for male and female was tested using Chi-square:

$$\chi^2 = \sum \frac{(Observed - Expected)^2}{Expected}$$

RESULTS

Occurrence

Five species of mullet (*Liza dumerili, L. falcipinnis, L. grandisquamis, Mugil cephalus* and *M. curema)* were caught in the Lagos lagoon during the dry season from December 2007 to March 2008. Number of species collected were *Liza dumerili* (117 pieces), *L. falcipinnis* (113 pieces), *L. grandisquamis* (1 piece), *Mugil curema* (10 pieces) and *M. cephalus* (93 pieces). The relative abundance of the species collected was as follows: *L. dumerili* (35.02%), *L. falcipinnis* (33.83%), *M. cephalus* (27.84%), *Mugil curema* (2.99%) and *Liza grandisquamis* (0.30%). All the species were present throughout the sampling period except *M. curema* and *L. grandisquamis* which occurred only in January 2008.

Length-frequency distribution

The standard length of *L. dumerili* ranged from 8.9 – 25.9 cm (weight: 11.52 – 269.84 g), *L. falcipinnis* (SL: 10.5 – 23.1 cm; weight: 22.8 – 227.1 g), *L. grandisquamis* (SL: 14.6 cm; weight: 45.24 g), *Mugil curema* (SL: 14.5 – 19.6 cm; weight: 46.2 – 181.53 g) and *M. cephalus* (SL: 8.9 – 23.4 cm; weight: 11.52 – 180.38 g).

The standard length-frequency distribution is shown in Fig. 2. The frequency polygon reflected five age groups in *L. dumerili*, seven age groups in *L. falcipinnis*, four age groups in *M. cephalus* and two age groups in *M. curema*. The size group 18.5 – 19.4 cm formed the most abundant group in *L. dumerili*, *L. falcipinnis* and *M. cephalus*, while the more abundant group in *M. curema* was 14.5 – 18.4 cm.

Length-weight relationship

Fig 3 illustrates the length-weight relationship of the species, while the summary is presented below:

L. dumerili: Log W = -1.5435 + 2.8233 Log SL

(n = 117, r = 0.9101)

L. falcipinnis: Log W = -1.7114 + 2.9747 Log SL

(n = 113, r = 0.886)

M. cephalus: Log W = -1.5033 + 3.5971 Log SL

(n = 93, r = 0.9406)

M. curema: Log W = -3.7005 + 4.6032Log SL

(n = 10, r = 0.8555)

The *Liza* species exhibited negative allometric growth, while the *Mugil* species exhibited a positive allometric growth. High correlation (r) values between 0.8555 and 0.9406 of the mullet species in the lagoon is a strong indication that an increase in standard length of the species gave a corresponding increase in body weight.

Condition factor

The summary of the variations in condition factor by species of mullets from the Lagos Lagoon are presented in Table 1. The K-value for *L. dumerili* was 1.92; *L. falcipinnis*, 1.95*; M. cephalus*, 1.94, *M. curema, 2.07;* and *L. grandisquamis*, 0.69. The highest K-value was recorded for *M. curema*, while the lowest K-value was recorded for *L. grandisquamis*.

Sex Ratio

The sex ratio values are presented in Table 2. The sex ratio of *L. dumerili* was 1:1.19, *L. falcipinnis* was 1:1.33, *M. cephalus* was 1:1.41 while *M. curema* was 1:0.67. Chi-square (χ^2) test was carried out to test for the degree of significance between *L. falcipinnis* and *M. cephalus* due to the wide difference in number of male and female observed. The calculated $\chi^2_{[1df/5\%]}$ for *L. falcipinnis* was 2.27 and *Mugil cephalus* was 2.06 which were not significant to the tabulated $\chi^2_{[1df/5\%]}$ of 3.84. The females were however more abundant than the males in all the species except for *M. curema*.

Table 1: Condition factor (K) by species of mullets from the Lagos Lagoon (December 2007 – March 2008)

Species	Standard length (cm)	Weight (g)	$K = 100W/L^3$
L. dumerilii	17.9	110.20	1.92
L. falcipinnis	18.1	116.30	1.95
M. cephalus	17.1	97.05	1.94
M. curema	16.8	95.59	2.07
L. grandisquamis	14.6	45.24	0.69

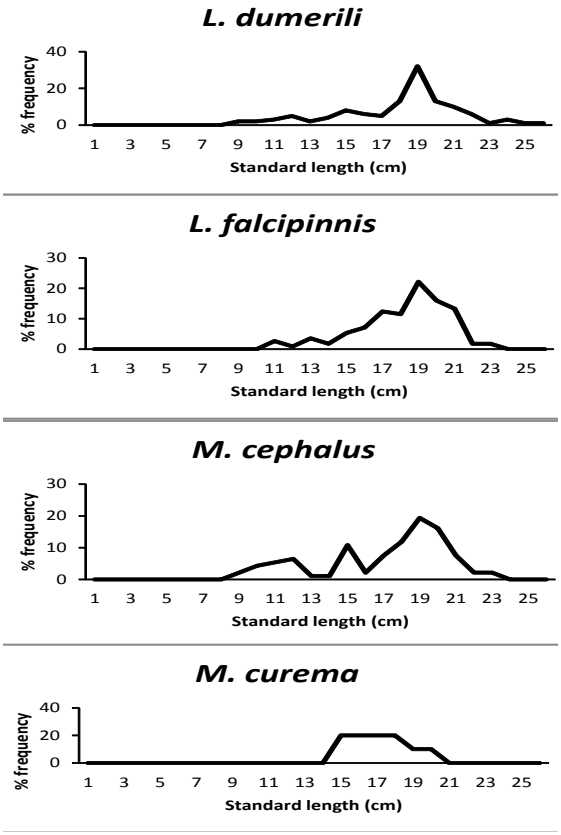

Fig. 2: Standard length-frequency distribution of mullet species from the Lagos Lagoon (December 2007 – March 2008)

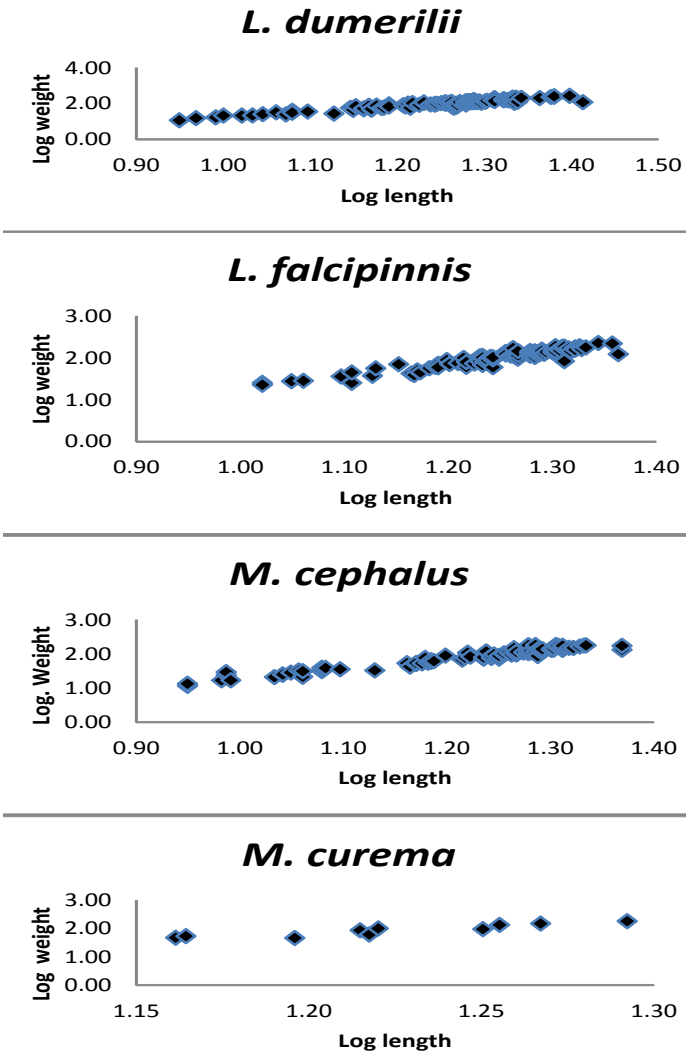

Fig. 3: Log standard length/Log weight relationship of mullet species from Lagos Lagoon (December 2007 – March 2008)

Table 2: Sex ratio of mullets in Lagos Lagoon (December 2007 – March 2008)

Species	Number of males	Number of females	Sex ratio
L. dumerilii	42	50	1 : 1.19
L. falcipinnis	39	52	1 : 1.33
M. cephalus	29	41	1 : 1.41
M. curema	6	4	1 : 0.67

DISCUSSION

The mullet species, *L. dumerili, L. falcipinnis, L. grandisquamis, M. cephalus* and *M. curema,* were found occurring *in* Lagos Lagoon during the dry season from December – March, in the present study. This agreed with the report by Fagade and Olaniyan (1974) who recorded all the species in the dry season except *L. falcipinnis* which was found occurring in the Lagos Lagoon throughout the year. Although Fagade and Olaniyan (1974) reported other mullet species such as *L. hoefleri* (a synonym of *L. dumerili*) and *M. bananensis, t*he absence of the species reported by them in this present study could be due to the short sampling period. Furthermore, *M. curema* and *L. grandisquamis* may be rare species in the lagoon as indicated in the collection, while *L. dumerili* and *L. falcipinnis* were most abundant. Soyinka (2010) reported the availability of *M. cephalus* throughout the year in the Lagos Lagoon. Mullet species are relatively abundant in the Lagos Lagoon and are likely among the next more abundant fish species after the tilapia species (Solarin, 1998). Sivalingham (1975) highlighted that *L. falcipinnis* was the most abundant of eight species identified along the Nigerian coast.

The modal progressions of the length-frequency polygons of the mullets, is indicative of fish at different ages occurring together in the lagoon at the same period. Chang *et al* (2000) reported multiple cohorts of the grey mullet in the Tanshui estuary, Taiwan, and Soyinka (2010) reported five age groups of *M. cephalus* in Lagos Lagoon. Arruda *et al,* (1991) mentioned that grey mullets formed transient populations of fish whose numbers were regulated by the immigration of 0+ group fish from the sea and the emigration of older groups. In the present study, the presence of mullets of different species with similar range in modal class-size suggested a possible schooling habit of the mullets. But the most abundant were the sub-adults or immature adults. This is similar to the findings of Lawson *et al,* (2010) who reported the dominance of the sub-adults of *L. falcipinnis* in Badagry creek, Lagos. The occurrence of table-sized mullets in the collection portrayed a good potential for brackish water culture in the lagoon and a good source of fish protein to the coastal communities.

According to Bagenal and Tesch (1978), Koutrakis and Tsikliras (2003), allometric coefficients (b) may range from 2 to 4. From the present findings, all the mullet species had 'b' which ranged between 2 and 4 except for *M. curema,* which was above 4. Length-weight parameters (a, b) of fish are affected by a series of factors such as season, habitat, gonad maturity, sex, diet, stomach fullness, health, preservation techniques and annual differences in environmental conditions (Bagenal and Tesch, 1978; Froese, 2006) . Such differences in value 'b' can be ascribed to one or a combination of most of the factors including differences in the number of specimens examined, area/season effects and distinctions in the observed length ranges of the specimens caught, to which duration of sample collection can be added as well (Moutopoulos and Stergiou, 2002).

The condition factors of the species were relatively high and could be an indication that the species fared well in the lagoon. Although, the K-value for *L. grandisquamis* was below 1, this could be as a result of the fact that only one specimen was involved and only the dry season was considered in the study. Soyinka (2010) reported a high K-value for *M. cephalus* in Lagos Lagoon, while Lawson *et al,* (2010) reported very low K-value for *L. falcipinnis* in the Badagry creek. The variations of K in fish according to King (1995) may be indicative of food abundance, adaptation to the environment and gonadal development.

The sex ratio for all the species except *M. curema* (Table 2) was in favour of the females above the males. Lawson *et al.* (2010) pointed out that sex ratio that favoured females of *L. falcipinnis* may account for its reproductive success in Badagry creek; large number of females was available to fewer males for reproduction and this may account for its all year presence in Badagry creek. Lawson and Jimoh (2010) reported a 1 male: 1.42 female ratio on the related species, grey mullet (*Mugil cephalus*) in the adjacent Lagos lagoon. This is very similar to the present 1: 1.41 ratio for *M. cephalus*. However, Soyinka (2010) recorded a sex ratio of 1: 0.53 for *M. cephalus* in the Lagos Lagoon. High percentages of sex ratios in favour of males during the spawning period were reported in *Elops lacerta* (Ugwumba, 1984; Lawson and Aguda, 2010) and *Chrysichthys walkeri* (Kusemiju, 1976) in some West African lagoons. The reasons may be ecological or genetical factors, or both. Females were suspected to leave the spawning grounds more rapidly, which may be considered as an adaptation to facilitate

preservation of the females or more rapid recovery of gonads (Ozcan and Balik, 2009). Males according to Nikolsky usually predominate in the younger groups because they mature earlier but live less long.

CONCLUSION

The success of the mullet species found in the Lagos Lagoon lied in their adaptability to euryhaline conditions in the lagoon, reproductive strategies, wide food spectra which were indicated in their abundance, age and growth pattern, condition factor and the sex ratio. The occurrence of this multi-species group of fish family with up to seven age-groups recorded in one of the species, in abundance, is a probable indication of their population dominance in the lagoon.

While the reports on the overfishing of the Lagos Lagoon remains a great concern, the lagoon can still sustain a viable mullet fishery, as implied in this study, with innovative approaches from mariculture practices and adherence to fishing gear regulations.

The present investigation has provided an assessment of the mullet species in the Lagos Lagoon, Nigeria, with relevant information that would be useful in the exploitation, cultivation and conservation of these under-utilised resources of this coastal community,

ACKNOWLEDGEMENT

The authors are grateful to the following staff of Department of Marine Sciences, University of Lagos: Dr. Emmanuel for the useful suggestions and Mrs. Ayinde, for her secretarial assistance.

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