World Journal of Fish and Marine Sciences 5 (5): 575-581, 2013
ISSN 2078-4589

DOI: 10.5829/idosi.wjfms.2013.05.05.74144

Aspects of Biology in Round Sardinella, *Sardinella aurita* (Valenciennes, 1847) from Majidun Creek, Lagos, Nigeria

E.O. Lawson and P.A. Doseku

Department of Fisheries, Faculty of Science, Lagos State University, Lagos, Nigeria

Abstract: The present study investigates aspects of the biology of round sardinella, *Sardinella aurita* (Valenciennes, 1847) from Majidun Creek, Lagos, Nigeria between January and December 2010. *S. aurita* is a clupeid, a group of fish commonly referred to as sardine. Its fishery is commercially exploited worldwide. A total 256 specimens of *S. aurita* were caught from Majidun creek at depths between 6-15 meters, with gill and cast nets. The fish abundance was determined monthly; data on fish total length (TL), body weight (BW), eye diameter (ED), head length (HL) and body depth (BD) measurements were obtained from the specimens. The length-weight relationship (LWR), condition factor (K) and sex ratios were estimated using standard methods. Relative abundance showed that 58.20 and 41.80 % of fish were caught in the dry and wet seasons respectively. The species was most abundance (22.27%) in May while July-November 2010 were the meager months. The specimens measured between 10.8 and 17.1(13.72±0.88 cm TL) and weighing 12.32 and 49.91 (22.90±4.71 g body weight) respectively. The morphomeric data included: ED measuring 7-9, 0.7859±0.0789 mm; HL, 3.4-3.9 (3.6829±0.168) mm and BD, 3.4-4.6 (4.0746±0.322) mm. The LWR indicated negative allometric growth ($W=-0.733L^{(1.83)}$), K=0.501-1.56 (0.888±0.159) with females showing better K values. The sex ratio was 1male:1.33 females, with no significant departure ($P \leq 0.05$) from the theoretical 1:1 sex ratio ($X^2_{cal}=1.00>X^2_{tab:n=1,\alpha=0.95}=3.84$). The fish abundance was greatly influenced by water temperature, rainfall and salinity. Therefore, the study provides baseline data on abundance, growth patterns and sex ratios of the *S. aurita* from Majidun Creek.

Key words: Clupeidae · Upwelling · Stenohaline · Salinity · Sardine

INTRODUCTION

Round sardinella, *Sardinella aurita* (Valenciennes, 1847) is a member of the Family Clupeidae occurring in the tropical and subtropical marine, brackish and reef waters often associated with major upwelling systems [1]. Some related members include *Sardinella fimbriata, S. longiceps, S. gibbosa, S. brasiliensis* and *S. maderensis*. Its distribution extends to the Western and Eastern Atlantic Ocean, the Pacific and the Mediterranean Sea [2]. It schools in coastal waters from inshore to edge of shelf. Juveniles tend to stay in nursery areas, but on maturity rejoin adult stocks offshore. *S. aurita* is a strongly migratory fish which often rising to surface at night and dispersing.

Sardine fishery is one of the most important fisheries worldwide, the *S. aurita* is profitable species and commercially exploited in several countries such as Egypt, Algeria, Tunisia and Nigeria. Importance of *S. aurita* especially in the Gulf of Guinea lies on the fact that it forms one of the major fisheries of this area. Its commercially exploitation has steadily increased because of its high demand by the Nigerian populace for food and as bait for the thriving tuna fishery by both artisanal and offshore fishermen. In Nigeria, it is marketed fresh, smoked or frozen.

Round sardinella has attracted attentions of numerous fisheries biologists and remains one of the thoroughly studied species in the tropical, subtropical and Mediterranean regions. Its reviews include Bouaziz *et al.* [3] and Gaamour *et al.* [4] on size and age studies in Algerian and Tunisia waters respectively; Tsikliras and Antonopoulou [5] on its reproduction in the Kavala Gulf, Greece. However, information on its fisheries including aspects of its biology is not available in Majidun Creek; the present study is probably the first

Corresponding Author: Lawson, Emmanuel O., Department of Fisheries, Faculty of Science, Lagos State University, P.O. Box: 001, LASU Post Office, Lagos, Nigeria.
Tel: +2348089667387 - +2348033051152.

reported work on this clupeid in this water body. Therefore, it is imperative to carry out study on biological aspect of this highly priced, profitable and commercially important species.

MATERIALS AND METHODS

Description of Majidun Creek: Majidun Creek is a narrow and shallow water body. It is one of the numerous aquatic habitats in Lagos, Nigeria. It lies within latitudes 3° 48'E and 4° 48'E and stretches between longitudes 6° 61'N and 7° 12'N. Adjourning water bodies include Ologe, Lagos, Lekki and Epe Lagoons; Yewa and Ogun Rivers; Badagry and Ogudu Creeks. However, Majidun Creek drains directly into Lagos Lagoon and empties into the Atlantic Ocean via Lagos Harbor. It is a narrow and shallow Creek with average depth of 6 meters. It is of importance to artisanal fisheries, transportation, sand and log mining, recreation and domestic purposes. Major source of water into the Creek is from Ogun River. Due to seasonal distribution of rainfall, the creek experiences seasonal flooding which introduces a lot of detritus, domestic and industrial wastes and pollutants from the land.

The shore of the creek is denticulate and surrounded with forest, typical of those found in the mangrove swamps and brackish water system. Its major biotopes include the mangroves (*Rhizophora racemora*, *Avicennia nitida*); the sedges (*Cyperus articulatus*, *C. papyrus* and *Paspalum vaginatum*); the ferns (*Achrosticum* sp., *Marsilea* sp., *Cyclosorus* sp. and *Ceratopleris* sp.) and the palms (*Pandanus candelabrum*, *Raphia hookeri* and *Phoenix reclinata*).

Collection of Samples: Specimens of round sardinella, (*Sardinella aurita*) were caught from the Majidun Creek, Lagos, Nigeria between January and December 2010. Gears used for their collection included cast nets (12-22 mm mesh sizes) for collecting specimens from the shallow waters (0-6 m), gill nets (18-45 mm mesh sizes) for collection of specimens at depths not exceeding 15 m. Services of canoed local fishermen with motorized outboard engines were employed in this study. In the field the specimens were preserved in 10% formaldehyde buffer solution, water temperature (°C) and salinity (‰) were determined with mercury-in-glass thermometer and salinometer respectively. Data on rainfall for Majidun area of Lagos was obtained from Nigerian Meteorological (NIMET) Centre, Ministry of Aviation, Oshodi Lagos, Nigeria.

Identification of Fish Samples: In the laboratory, identifications of fish species was carried out using [1, 6-8] as guide. The fishing gears were identified with reference to Catalogue of Small Scale Fishing Gears in Nigeria by FAO [9].

The Seasonal abundance of *S. aurita* in Majidun creek was obtained from the pools of its monthly occurrence.

Morphometric Measurements: The morphometric measurements were implored to determine taxonomic variations among the populations of fish in the Creek. The morphometric data such as eye diameter (ED), head length (HL) and body depth (BD) measurements were carried out on the individual specimen using Vernier caliper with fish's head turning left. ED was taken as the diameter of the eye orbit; HL as a distance between the snout and a point directly behind the operculum; BD represented the deepest part of the body (a vertical distance between a dorsal fin base and the ventral fin base). ED, HL and BD measurements were in nearest 1 mm.

Length-Weight Relationship (LWR): The biometric data involving the total length (L) and body weight (W) measurements of the individual fish were recorded. L was taken as a distance from the tip of the snout to the tip of tail fin. L was measured to the nearest centimeters (cm) with measuring tape and W to the nearest 0.01 gram (g) with sensitive 'Sartorious' electric balance (Model 1106). The length-weight relationship was derived from equation: $W=aL^b$ [10, 11].

The logarithm transformation of the equation was expressed as:

$$\text{Log } W = \text{Log } a + b\text{Log}L$$

where, W=fish body weight in grams, L=fish total length in centimeters, a=intercept or constant and b=slope or length exponent.

The "a" and "b" and "r" values were calculated from linear regression of the fish length and weight measurements. Growth was regarded as isometry when the value of b=3 and allometry when less or greater than 3.

Length Frequency Distribution: The length frequency distribution of the species in the creek was represented by percentage length frequency histograms at intervals of 1 cm. Thus: 10, 11, 12… 17 cm total lengths.

Condition Factor (K): The Fulton condition factor, K was estimated to determine the state of well being of the fish from equation:

$K=W/L^3$ [10].

where W=fish body weight in grams (g), L=fish total length in centimeters (cm) and K= Condition factor.

Sex Ratios: The sex was determined by making incisions from the vent through the throat or chest of the fish to reveal gonads. The gonads were examined microscopically and by naked eye for sex differentiation. All the discernable gonads were differentiated as males or females. The sex ratio was expressed in term of the total numbers of males to females. The Chi-square (χ^2) test of fitness was applied to determine a departure from the expected or theoretical 1male:1female ratio. χ^2 was expressed as:

$$\chi^2 = \Sigma_i(O_i-E_i)^2/(E_i)$$

where, Σ_i=Summation, O_i =Observed ratio, E_i=Expected ratio. The calculated and tabulated χ^2 values were compared at α=0.05 to determine level of significance.

Statistical Methods: Data processing was derived from the Statistical Package for Social Sciences (SPSS, version 7).

RESULTS

Temperature, Salinity and Rainfall Profile of Majidun Creek: The temperature, salinity and rainfall profile of Majidun Creek, Lagos is presented in Table 1. The profile showed distinct periods of dry and wet seasons, each with six (6) months duration. Water temperature varied between 25.1 in August and 28.6° C in February 2010 with mean value of 27.53±0.27°C. Dry season was hotter with temperature variations 27-28.6 (27.98 ±0.54°C); the wet period was characterized by lower temperature profile of 25.1-28.2 (27.08±1.04°C). However, the monthly variations were not significantly different ($p \leq 0.05$) in this creek.

The salinity was as low as 0.20‰ in July and August and reached its peak (16.80 ‰) in May 2010. The mean value was 6.92±1.93‰. The salinity variations were 2.25-15.5 (10.41±5.14 ‰) in dry and 0.2-16.8 (3.43±6.57 ‰) in wet seasons.

The rainfall was 40 mm in January and 336 mm in July 2010 (mean=130.25±27.82 mm). Dry season was characterized by lower rainfall 40 -77 (54.33±15.95 mm). Dry months included January-April, November and December 2010. The wet months were May-October 2010, when rainfall was 100-336 (206.17±79.59 mm).

Seasonal Abundance of Fish: Table 2 presents the seasonal abundance of *Sardinella aurita* from Majidun Creek. The species was most abundance in May 2010 (22.27%) while July to November 2010 were the meager months where there were no fish. More fish were caught in dry (January-April, November and December 2010) than wet (May-October 2010) months. A total of 58.20 % of the total fish catch were in dry at salinities 2.25-15.5 (10.41±5.14 ‰) and rainfall of 40-77 (54.33±15.95 mm) while 41.80% were caught in wet season when salinities were 0.2-16.8 (3.43 ±6.57 ‰) and rainfall varied between 100 and 336 (206.17±79.59 mm).

Morphometric Measurements: Summary of the morphometric measurements in *S. aurita* from Majidun Creek is presented in Table 3. The eye diameter (ED) varied between 7 and 9 (7.859 ±0.79 mm); HL, 34-39 (36.829±1.68 mm) and BD, 34-46 (40.746±3.22 mm). However, the ratios of ED to HL was 1:4.33-1:5.14 (mean=1:4.71±0.50) and HL: BD, 1:1.0-1:1.18 (mean=1:1.11±0.04).

Length-Weight Relationship: The logarithm of length-weight relationship in *S. aurita* from Majidun Creek is given in Figure 1. The fish size ranged from 10.8 to 17.1 (13.72±0.88 cm) total lengths for specimens that weighed 12.32-49.91 (22.90±4.71 g) respectively. The logarithm transformation of the length-weight relationship is presented as: LogW=Log-0.733+1.83LogL. The regression coefficient (r) was 0.606, while the specimens exhibited allometric growth (b=1.83) in the creek.

Length Frequency Distribution: Figure 2 presents histograms of length frequency distribution in *S. aurita* from Majidun Creek. The specimens showed three (3) size groups: small (10-11 cm TL), medium (12-15 cm TL) and large (16-17 cm TL); these groups constituted 2.73, 96.10 and 1.17 % of the population respectively. The smallest fish was 10.8 and the largest 17.1 cm. The histograms exhibited a binomial distribution. 44.92 % of the fish population were 13 cm long and 0.39 measured 17 cm TL, however, 31.25 and 12.89 % were 14 and 12 cm long.

Table 1: Temperature, salinity and rainfall profiles of Majidun Creek, Lagos, Nigeria

Month/year	Water temperature (°C)	Salinity (‰)	Rainfall (mm)
January 2010	27.0	11.30	40**
February 2010	28.6	12.50	41**
March 2010	28.1	14.60	57**
April 2010	28.3	15.50	69**
May 2010	28.2	16.80	100*
June 2010	27.2	0.80	215*
July 2010	27.3	0.20	336*
August 2010	25.1	0.20	214*
September 2010	27.3	1.25	150*
October 2010	27.4	1.30	222*
November 2010	27.9	2.25	77**
December 2010	28.0	6.30	42**
Mean ± S.D	27.5±0.27	6.92±1.93	130.25±27.82

Data are represented as mean ±SD, *=wet month, ** =dry month

Table 2: The seasonal abundance of Round sardinella, *Sardinella aurita* from Majidun Creek, Lagos, Nigeria

Month/year	Abundance	Percentage abundance (%)
January 2010	19	7.42
February 2010	44	17.19
March 2010	40	15.63
April 2010	36	14.06
May 2010	57	22.27
June 2010	50	19.53
July 2010	0	0
August 2010	0	0
September 2010	0	0
October 2010	0	0
November 2010	0	0
December 2010	10	3.91
	256	100 %

Table 3: Summary of the Morphometric measurements in Round sardinella, *Sardinella aurita* from Majidun Creek, Lagos, Nigeria

	Range (mm)		
Morphometric features	Minimum	Maximum	Mean±SD (mm)
Eye diameter (ED)	7	9	7.859 ±0.79
Head length (HL)	34	39	36.829±1.68
Body depth (BD)	34	46	40.746±3.22
Total length (TL)	10.8	17.1	13.724±0.88
ED:HL ratio	1:4.33	1:5.14	1:4.71±0.50
HL:BD ratio	1:1.00	1:1.18	1:1.11±0.04
HL:TL ratio	1:3.18	1:4.39	1:3.73±0.11
BD:HL ratio	1:3.18	1:3.72	1:3.37±0.09

Data are represented as mean ±SD, ED=Eye diameters, HL=Head length, BD=Body depth, TL=Total length.

Table 4: Summary of the condition factor in *Sardinella aurita* from Majidun Creek, Lagos, Nigeria

	Range (cm)		
Sex	Minimum	Maximum	Mean±SD
Males	0.121	0.148	0.135±0.034
Female	0.501	1.56	0.734±0.156
Sex combined	0.121	1.56	0.888±0.159

Data are represented as mean ±SD.

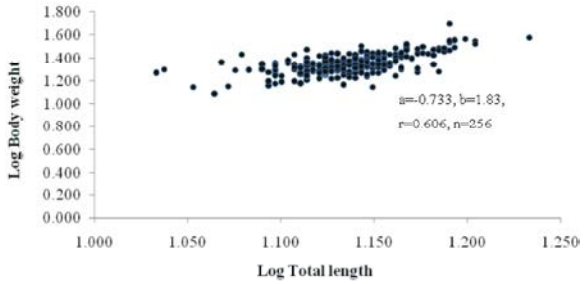

Fig. 1: Log Total length - Log Body weight relationship of *Sardinella aurita* from Majidun Creek, lagos Nigeria

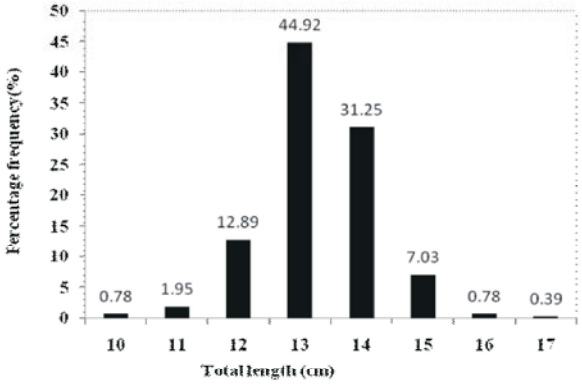

Fig. 2: Histograms of Length frequency distribution of *Saradinella aurita* from Majidun Creek, lagos, Negeria

Condition Factor (K): Summary of the Condition factor in *S. aurita* is presented in Table 4. K values varied between 0.121 and 1.56 in Majidun creek, higher values were obtained in females. In males, the K ranged from 0.121 to 0.148 (0.135±0.034) and between 0.501 and 1.56 (0.888±0.159) in females.

Sex Ratios: The present study showed that *S. aurita* was gonochoristic and monomorphic species, with no external features and colors to differentiate between sexes. All the 256 specimens showed discernible organs, of these 120 (46.87%) were males and 136 (58.13%) females, giving an overall ratio of 1male:1.13female. The sex ratio was in favor of female individuals. A Chi-square test revealed insignificant ($P>0.05$) departure from the theoretical and expected 1 male: 1 female ratio ($X^2= 1.00<X^2_{1, 0.05}=3.84$).

DISCUSSION

Percentage abundance of *Sardinella aurita* in Majidun Creek varied between 7.42 % in January and 22.27 % in May 2010. Temperature, salinity and rainfall

determined fish seasonal abundance in the Creek. The total catch was 58.20 (for dry) and 41.80 % (for wet) when the mean salinities were 10.41±5.14 and 3.43±6.57 ‰ respectively. The meager months were July to November 2010 (Tables 1 and 2). Similar report was documented in mudskipper, *Periophthalmus papilio* from Lagos lagoon by Lawson [12]. The aquatic habitats in dry season are characterized by low rainfall, low water level, dry and hazy wind, low turbidity, high transparency and high salinity. These conditions may probably account for presence of more fish during this period. Water temperatures (25.1-28.6, 27.5±0.27 °C) that were recorded in the present study were typical of tropical and subtropical waters, which clearly support growth, survival, metabolism and reproduction of *S. aurita*.

In the presence study the morphometric measurements of the fish (Table 3) showed some variations, however, these variations were not significant ($P>0.05$) enough to make a submission that they were genetically or morphologically different. Data on eye diameter, head length and body depth measurements may not be fully relied on as determinants for genetic diversity, but their importance in taxonomic characterization of this species cannot be overemphasized. Data from these parameters suggest that the population this species was not separable taxonomically. Therefore, there were no racial variations in *S. aurita* from Majidun based on the stated methodology. Data obtained from this work may also serve as template in systematic study and taxonomy of fishes.

The present study shows that the species was as small as 10.8 cm with body weight of 12.32 g and as large as 17.1 cm, weighing 49.91 g. Total length measurements of 5.0-32.0 cm were reported in Senegal [1]. The maximum published body weight is 229 g and length at first maturity ranges from 14 to 21.5 cm according to FishBase. The negative allometry (b=1.89) recorded in this study was not within the expected range of 2-4 that was recommended by Bagenal and Telsch [13]. When b equals 3, growth is isometric, it is allometric when on the contrary. Allometric growth is an indication of changes in bodily proportion as a result of changes in the environment, individual metabolism, sexual maturity and fish age. Different growth types in fishes have been reported from many waters. Positive allometric growths were reported in some related and non related fish species, Froese and Pauly [1] reported b=3.290 in *S. aurita* from Senegal. Gaamour *et al* [4] reported b=3.064 and 3.084 respectively for both male and female *S. aurita* in the northern Aegean Sea. In Lagos lagoon, negative allometry values of b=2.86 and 2.92 were reported in male and female mudskipper (*Periophthalmus papilio*) [12]. However, Lawson and Olagundoye [14] documented b= 2.92 (male) and 2.27 (female) in the Giant African threadfin, *Polydactylus quadrifilis* from Ologe lagoon, Lagos. Isometric growth (b=3) was documented in *E. fimbriata* from some Nigerian coastal waters [15]. Differences in parameters 'b' of the LWR may be attributed to several factors which include season, habitat, gonad maturity, sex, diet stomach fullness, health, preservation techniques and annual differences in environmental conditions [13, 16]. In addition, growth increment, differences in age, stage of maturity, food temperature, salinity and seasonality can also affect the value of b for the same species [17].

The length frequency distribution showed there were small, medium and large fish in Majidun creek. Presence of few adults (1.17 %) and large number of juveniles or medium size fish (96.10 %) may be related to its migratory nature and indication that the creek served as a veritable spawning, breeding or feeding ground for some marine species. Migratory movements of this fish into the Creek from Lagos Coast via Lagos Lagoon and back to the sea again is suspected. Leveque [18] reported presence of some marine fish species (including *S. aurita*) in West African lagoons and lower rivers of coastal basins.

Condition factor expresses the well being of fish in their environment. In the present study K varied between 0.121 and 1.56 (0.888±0.159) (Table 4). K values vary from species to species and change according to morphology, sex, age, reproductive state associated with gonadic maturity stages variations [19, 20]. Variations in K may also be indicative of food abundance, adaptation to environment and gonadal development of fish [21]. Low K means the fish are light for their lengths and indication of low feeding intensity and spawning activity. High K value is an assumption of high feeding intensity and gradual increase in accumulated fat that also suggests preparation for a new reproductive period [22].

The overall sex ratio of 1male:1.33females reported in the present study is an indication that the population was dominated by female individuals. This is in agreement with reports of Bensahla-Talet *et al.* [23] on Northern Aegean water in Algerian and Gaamour *et al.* [4] in Tunisian water on *S. aurita*. Tsikliras and Antonopoulou [5] reported 1male:1.02female sex ratio in *S. aurita* from north-eastern Mediterranean Sea. On non related species, Lawson *et al*. [24] reported 1male:1.13females sex ratio in Sicklefin mullet, *Liza falcipinnis* from Badagry Creek, Lagos. However, Lawson and Jimoh [25] in Lagos lagoon reported 1male: 1.09 females in grey mullet, *Mugil cephalus*. Sex ratio could be influenced by the availability

of food [26, 27]. Nikolsky [27] reported that when food is abundant, females predominate, with the situation inverting in regions, where food is limited. Feeding activity, in this case, would be influencing metabolism through hormonal activity, resulting in changes in production of individuals of a given sex. Females requiring better environmental conditions than males and suffering in their development when environmental conditions deteriorate had been reported. Accounts of sex ratios in favor of male fish were documented in some Nigerian waters, 1male:0.49 female was reported in the Giant African threadfin, *Polydactylus quadrifilis* [14] and 1male:0.41female in Ten pounder, *Elops lacerta* [28] in the adjourning Ologe lagoon. Ugwumba [29] reported a sex ratio in *Elops lacerta* that was in favor of males from Lekki, Lagos Lagoon and Lagos Coast. The spawning activities may contribute to the high male to female ratios in favor of the males. Higher percentages of male to female fish during spawning seasons have been noted in *Chrysichthys walkerii* [30].

Data from this study suggest some significant variations compared with reports from some water bodies. The present study for the first time provides useful source of information on abundance, growth patterns, condition factor and sex ratios of Round sardinella, *Sardinella aurita* from Majidun Creek, Lagos. The information further provide useful tool for fish sampling programs, to estimate growth rates, length and other components of fish population dynamics and fish stock assessment.

In furtherance of this study, we have embarked on a research program at molecular level of analysis (e.g. Randomly Amplified Polymorphic DNA (RAPD) primers, RAPD markers) to provide better or more precise results on genetic and morphological diversities among the populations of round sardinella, *S. aurita* from Majidun Creek.

ACKNOWLEDGMENTS

Authors acknowledge contributions of Mr. Ajepe, R.G. and Mrs. Adetiloye, R.O. for their laboratory assistance. Also acknowledge is the services of Mr. Jekansi, O. and his team for setting of gears and collection of specimens.

REFERENCES

1. Froese, R. and D. Pauly, 2010. FishBase, World Wide Web electronic publication. www.fishbase.org Accessed: 1 March, 2010.
2. Bauchot, M.L., 1987. Bony fish. In W. Fischer, M. Schneider and L. Bauchot, (eds) FAO Fishes species identification for fishery purposes: Mediterranean and Black Sea. Fishing Area 37, Volume II. Vertebrae, Food and Agricultural Organization of the United Nation, Rome. (In French).
3. Bouaziz, A., B. Bennoui, B. Brahmi and R. Semroud, 2001. The estimation of the state's operating sardinella (*Sardinella aurita* Valenciennes, 1847) of the region centre of the Algerian coast. Rapp. Comm. int. Mediterranean Sea, 36: 244. (In French).
4. Gaamour, A., H. Missaoui, I. Ben-Abdullah and A. El-Ahmed, 2001. Biological parameters of the round sardinella (*Sardinella aurita* Valenciennes, 1847) in the region of Cap Bon (Channel Sicilian-Tunisian). GFCM, 26-30 March 2001. Kavala, Greece (www.faocopemed.org/en/sac/docs.htm) (In French).
5. Tsikliras, A.C. and E. Antonopoulou, 2006. Reproductive biology of Round sardinella (*Sardinella aurita*) in the North Eastern Mediterranean. Scientia Marina, 70(2): 281-290.
6. Reed, W., T. Burchad, A.J. Hopson, U.J. Jenness and I. Yaro, 1967. Fish and Fisheries of Northern Nigeria. Publication of Ministry of Agriculture, Northern Nigeria.
7. Food and Agriculture Organization FAO, 1990. Field guide to commercial marine resources of the Gulf of Guinea. FAO/UN Rome (Italy).
8. Wikipedia, 2010. Fauna of Africa. http:// en.wikipedia.org/wiki/Fauna_of_Africa. [Accessed: 1 March 2010].
9. Food and Agriculture Organization FAO, 1994. Catalogue of small scale fishing gear in Nigeria RAFR/014/F1/94/02.
10. LeCren, E.D., 1951. The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). Journal Animal Ecology, 20: 201-219.
11. Ricker, W.E., 1975. Computation and interpretation of biological statistics of fish populations. Bulletin of Fisheries Resources of Board Canada, 191: 1-382.
12. Lawson, E.O., 2011. Length-weight relationships and fecundity estimates in mudskipper, *Periophthalmus papilio* (Bloch and Schneider, 1801) caught from the mangrove swamps of Lagos lagoon, Nigeria. Journal of Fisheries and Aquatic Science, 6(3): 264-271. doi:10.3923/ jfas.2011.264.271.

13. Bagenal, T.B. and F.W. Tesch, 1978. Age and growth. In: T. Bagenal, (ed) Methods for assessment of fish production in freshwaters. 3rd Edn. IBP Handbook No. 3, Blackwell Science Publications. Oxford, pp: 101-136.
14. Lawson, E.O. and A.U. Olagundoye, 2011. Growth patterns, diet composition and sex ratios in giant African threadfin, *Polydactylus quadrifilis* from Ologe lagoon, Lagos, Nigeria. International Journal of Agriculture and Biology, 13: 559-564.
15. Marcus, O., 1984. Biology of Bonga fish, *Ethmalosa fimbriata* (Bowdich) in the Nigerian coastal and brackish waters. Project NF 1,2 Annual report, Nigeria Institute for Oceanography and Marine Research, Lagos.
16. Froese, R., 2006. Cube law, condition factor and weight-length relationships: history, metal-analysis and recommendations. Journal of Applied Ichthyology, 22: 241-253.
17. Weatherley, A.H. and H.S. Gill, 1987. The Biology of Fish Growth. Academic press, London, pp: 443.
18. Leveque, C., D. Paugy and G.G. Teugels, 1992. Faune des poisons d'eaux douces et saumatres de l'Afrique de l'Ouest. Collection Faune Tropicale, XXVIII, Tome 2, MRAC (Tervuren) and ORSTOM (Paris).
19. Frederick, C.S. and D.M. Thomas, 1987. Species profile: Life histories and environmental requirements of coastal fishes and invertebrates (Gulf of Mexico), sand sea trout and silver sea trout. Fish and Wildlife Services, Biological Report, 82: 11-72.
20. Wootton, R.J., 1999. Ecology of Teleost fishes. Fish and Fisheries Series Kluwer Academic Publishers.
21. King, M., 1995. Fisheries Biology, Assessment and Management. Fishing News Books, Oxford, England.
22. Braga, F.M.S. and O. Gennari-Filho, 1990. Contribution to the knowledge of reproduction *Moenkhausia intermedia* (Characidae, Tetragonopterinae) in the Barra Bonita, Rio Piracicaba, SP. Naturalist, 15: 171-188.
23. Bensahla-Talet, A., Y. Mortet and J.A. Tomasini, 1988. Relations masse-longueur, sex ratio et reproduction (saison de ponte, fecondites) de *Sardinella aurita* (Val. 1847) des cotes Oranaises (Algerie). Rapp. Comm. int. Mer Medit., 31 V-II: 14.
24. Lawson, E.O., S.O. Akintola and O.A. Olatunde, 2010. Aspects of the Biology of Sickle fin mullet, *Liza falcipinnis* (Valenciennes, 1836) from Badagry creek, Lagos, Nigeria. Nature and Science, 8(11): 168-182.
25. Lawson, E.O. and A.A. Jimoh, 2010. Aspects of the biology of grey mullet, *Mugil cephalus*, in Lagos lagoon, Nigeria. AACL Bioflux, 3(3): 181-193.
26. Nikolsky, G.V., 1963. The Ecology of Fishes (Translated by Birkett L). Academic Press, New York.
27. Nikolsky, G.V., 1969. Theory of Fish Population Dynamics (Translated by Bradley, J.E.S.). Oliver and Boyd Limited, Edinburg.
28. Lawson, E.O. and A.F. Aguda, 2010. Growth patterns, diet composition and reproduction in the ten pounder, *Elops lacerta* from Ologe lagoon, Lagos, Nigeria. Agriculture and Biology Journal of North America, 1(5): 974-984. doi:10.5251/abjna.2010.1.5.974.984
29. Ugwumba, O.A., 1984. The Biology of Ten- pounder *Elops lacerta* (Val) in freshwater, estuarine and marine environments. Ph.D. Thesis, University of Lagos, Nigeria.
30. Ikusemiju, K., 1973. A study of the catfishes of Lekki Lagoon with particular reference to *Chrysichthys walkerii* (Bagidae). Ph.D. Thesis, University of Lagos, Nigeria.