Growth and reproductive parameters of *Polypterus senegalus* Cuvier 1829 in Eleiyele Lake

Adedolapo Abeke Ayoade and Juliet Avwesuruo Akponine

Department of Zoology, University of Ibadan, Oyo State, Nigeria.
*Corresponding author E-mail: kenpeadobece@gmail.com
Phone Number: +234-8033855807

Abstract: The Senegal bichir, *Polypterus senegalus* Cuvier 1829 is of commercial importance as food and ornamental fish. This study describes the growth pattern and aspects of reproductive biology for the species in the Eleyele Lake, Nigeria. One hundred and twenty nine specimens were collected from October, 2010 to April, 2011. For each individual, the total length, standard length and body weight were measured also aspects of reproductive biology (gonadosomatic index, fecundity, egg diameter) were determined. All the LWRs showed strong correlations ($r > 0.75$, $p > 0.05$). The b value obtained varies with body size and higher value was recorded for the smaller size group. The mean K for the combined sexes was 0.536 ± 0.007. Absolute fecundity ranged between 622 (for specimen with TL = 16.4 cm; total weight = 21.61 g) and 2593 eggs (for specimen with TL = 27.7 cm; total weight = 120.62 g). The frequency polygons of the egg diameter suggest the species is a multiple spawner.
[Adedolapo Abeke Ayoade and Juliet Avwesuruo Akponine. **Growth and reproductive parameters of *Polypterus senegalus* Cuvier 1829 in Eleiyele Lake.** *N Y Sci J* 2016;9(11):27-31]. ISSN 1554-0200 (print); ISSN 2375-723X (online). http://www.sciencepub.net/newyork. 5. doi:10.7537/marsnys091116.05.

Key word: Condition factor, Egg diameter, Eleyele Lake, Gonadosomatic index, Length weight relationship.

Introduction

Polypterus senegalus is widely distributed in Nile basin and West Africa, including Senegal, Gambia, Niger, Volta and Lake Chad basins (Goose, 1990) and Congo River basin (Goose, 1984). The fish (belongs to family Polypteridae) is a living representative that can be traced to the Devonian period (they are the most primitive of the ray finned fish}. (Rodrigo *et al*., 2012) found that *Polypterus* regenerates its pectoral fins with a remarkable accuracy (full limb regeneration is a property that seems to be restricted to urodele amphibians).

Polypterus species is of commercial importance being relish as food and as an indigenous ornamental fish in Nigeria, It's been exported. It is hardier and cost more than other ornamental fish being sold at $3 – 10 for 20 – 40/box (Mbawuike, 2011). Most Nigerian ornamental are wild caught and development of ornamental live fish breeding centre is recommended as problems of environmental degradation and lack of sustainable collection practices make this a more viable long term alternative.

Little is known about the biology, species variation and seasonal abundance of most ornamental fishes (Areola, 2003). Knowledge of the biology especially reproduction of these fish in the wild is required for successful breeding in captivity. (Britz, 1998) reported on the reproduction and early development of *Erpetoichthys calabaricus*, *Polypterus senegalus* and *P. ornatipinnis.*

Previous studies on aspect of biology of *Polypterus* species in Nigeria include (Raji *et al*., 2004) on the food habits of *P. endlicheri* and *P. senegalus* in Lake Chad; (Offem *et al*., 2008) on the length-weight relationship, condition factor and sex ratio in the Cross River. (Adebisi, 1987) in upper Ogun River; (Fawole and Arawomo, 2000) in Opa Reservoir and (Issa *et al*., 2005) in Kigera reservoir reported on some aspects of biology of many fish species including *Polypterus* species. This study is aimed at providing additional knowledge on biology of this species by investigating aspects of growth pattern and reproductive biology of *P. senegalus* in Eleyele reservoir for the first time. This should enhance effective management and conservation of the species in the reservoir. Effective propagation of the species in captivity will also be enhanced.

Materials and Methods

Study area and fish sampling

Polypterus senegalus were captured with cast nets of mesh size 25 – 30 mm from the Eleyele Lake by local fishermen. They were collected from the fishermen at the landing site (from October 2010 to April 2011) and transported in an ice chest to the laboratory.

Length – weight relationship

The total length (TL) and body weight (W) were measured from the fresh samples to the nearest 0.1 cm and 0.01 g respectively. The length – weight relationships were estimated from the formula, $W = a L^b$, where W is total body weight (g), L is the total length (cm), a and b are the coefficients of the functional regression between W and L (Ricker,

1973). This relationship was transformed into a linear form by the equation:

Log W = Log a + b log L

Condition Factor

The condition factor 'K' was calculated by the following formula given by (Pauly, 1983):

$$K = \frac{100\ W}{L^3}$$

where: W = total weight of fish in grams; K = condition factor; L= total length of fish in centimeters.

It was calculated for both sexes separately and then for the combined sexes. Variations of K with season and size groups were also determined.

Gonadosomatic Index (GSI).

Gonadosomatic indices were calculated using the formula:

$$GSI = \frac{\text{Gonad weight (g)} \times 100}{\text{Body weight (g)}}$$

Fecundity.

Fecundity in this study was taken as the number of ripened eggs in a female prior to the next spawning season. Ripe ovaries (stage IV) were used for the estimation. The method of (Nikolsky, 1963) for gonad classification served as a guide to picking only ripe ovaries for fecundity estimation. Ovaries were preserved in Gilson's fluid.

The gravimetric method (Nikolsky, 1963) which involves sub sampling by weight was used for fecundity estimation.

The parameters a (regression intercept) and b (regression exponent) of the allometric fecundity-length/weight relationships were estimated with the following formula by(Nikolsky, 1963):

$F = aL^b / aW^b$

This relationship was transformed into a linear form by the equation:

Log F = Log a + b log L/W

Where F = fecundity, W = total weight of fish in grams; L= total length of fish in centimeters.

Egg diameter. Egg diameter (mm) was measured with an ocular micrometer. A stage micrometer was earlier used to calibrate the microscope. Diameters of twenty eggs randomly selected from each ovary were measured and their mean was taken as the average egg diameter.

Statistical analyses. Descriptive statistics, Pearson product correlation coefficient (r), Student's t-test and Anova were used for data analysis.

Results

Length weight relationship

The correlation coefficient (r) between length weight relationships for the species was above 0.75 except for 0.37 and 0.118 obtained for 19.5 – 22.5 cm and 22.6 – 25.6 cm respectively. The ranges of the total weight and total length of the 129 specimens of *P. senegalus* examined were 21.61 - 120.62 g (mean = 53.5g ± 0.19) and 16.4 – 27.7 cm (mean = 21.35cm ± 0.19) respectively Table 1. The value obtained for b was higher in the smaller size group (2.851) than other size groups. The b value of the 22.6 – 25.6 cm size group differed significantly from 3 (t-test, $P<0.05$). Parameter 'b' of the combined sexes (3.097) was higher than female (2.651) and male (3.087) and also differed significantly from 3 (t-test; $P<0.05$). The b value recorded for the season did not differ from 3.

Table 1: Length weight relationship of *Polypterus senegalus* in the Eleyele Lake.

Parameters	N	a	b	r	b-3/SE(b)
Dry season	99	-2.443	3.126	0.882	0.563
Rainy season	37	-2.518	3.173	0.952	0.731
Size(cm)					
16.4-19.4	27	-2.114	2.851	0.752	-0.298
19.5-22.5	68	1.696	-2E.05	0.037	-0.745
22.6-25.6	38	1.656	0.137	0.118	-*14.90
Female	64	-1.791	2.651	0.779	-1.288
Male	82	-2.409	3.087	0.943	0.713
Combined	136	-2.407	3.097	0.904	-20.574

Condition Factor

The mean K value for the combined sexes was 0.536 ± 0.007. Females had a higher condition factor than males (0.509 ± 0.005) and this was shown to be statistically significant ($P<0.05$, F. = -4.268) Table 2.

The K further increased with size and slightly higher values was recorded in the dry season (0.54 ± 0.009) than rainy season months (0.525 ± 0.009). However, no significant difference occurred in the condition factor of the fish among size groups and between seasons.

Table 2: Condition factor of *Polypterus senegalus* in the Eleyele Lake.

Parameters	N	Range of GSI	Mean ±S.D	F/t-test
Dry	99	0.41-0.65	0.5399 ±0.009	
Rainy	37	0.21 – 0.92	0.525 ± 0.009	-1. 1565
Sex				
Male	81	0.32 – 0.6	0.509 ± 0.005	*-4.2678
Female	55	0.21 – 0.92	0.575 ± 0.014	
Combined	136	0.21 – 0.92	0.536 ± 0.007	
Size group(cm)				
16.4 - 19.4	25	0.32 – 0.57	0.505 ± 0.003	
19.5 - 22.5	68	0.43 – 0.86	0.545 ± 0.007	1.4959
22.6 - 25.6	39	0.21 - 0.91	0. 542 ± 0.01	
25.7 – 28.7	3	0.5 – 0.57	0. 547 ± 0.002	

Gonadosomatic index

The mean GSI of the female (2.785 ± 0.250) was higher than male GSI (0.542 ± 0.045). The GSI increased with size and the minimum GSI (0.431 ± 0.042) was recorded in the 16.4 – 19.4cm size group. Significant difference were recorded in the GSI between the seasons, size groups and sexes ($P<0.05$) Table 3.

Table 3: Variations in Gonadosomatic index of *Polypterus senegalus* with season, sex and size in the Eleyele Lake.

Parameters	N	Range of GSI	Mean ±S.D	F/t-test
Dry	99	0.05-10.8	1.250±0.165	
Rainy	37	0.25-4.28	1.895±0.231	*2.236
Sex				
Male	81	0.05-2.04	0.542±0.045	*8.837
Female	59	0.34-10.8	2.785±0.250	
Size group(cm)				
16.4-19.4	25	0.05-1.07	0.431±0.042	
19.5-22.5	67	0.08-8.07	1.280±0.176	*12.666
22.6-25.6	37	0.11-10.8	2.346±0.324	

Note: Fish in the 25.7 – 28.7 cm size group were few (3) in number so they were merged with the 22.6 – 25.6cm size group.

Fecundity

The absolute fecundity estimates ranged between 622 (for specimen with TL = 16.4 cm; total weight = 21.61g) and 2593 eggs (for specimen with TL = 27.7 cm; total weight = 120.62 g). The relationship between absolute fecundity and TL and absolute fecundity and total weight of *P. senegalus* was described by the following regression equation respectively:

$$Y = 16.36 X + 1926.5 \quad (r=0.049)$$

$$Y = -3.583 X + 1818.3 \quad (r = 0.110)$$

Where,

Y = absolute fecundity and X = total length (cm) / total weight of fish (g).

The relative fecundity for the species varied between 8.11g – 34.14g with mean of 20.22 ± 1.9321 eggs/g.

Egg diameter

The mean egg diameters of *P. senegalus* were 0.48 ± 0.03 mm; 0.47 ± 0.04mm and 0..48 ± 0.04mm for fish of total length 23.8 cm, 27.7 cm and 25.2 cm respectively. The frequency polygon reveals major peaks at 0.44 mm, 0.47 mm and 0.050 mm for fish of TL 23.8 cm; 0.45 mm, 0.47 mm and 0.49 mm (TL = 27.7 cm) and 0.45 mm and 0.50 mm (TL 25.2cm) Fig.1.

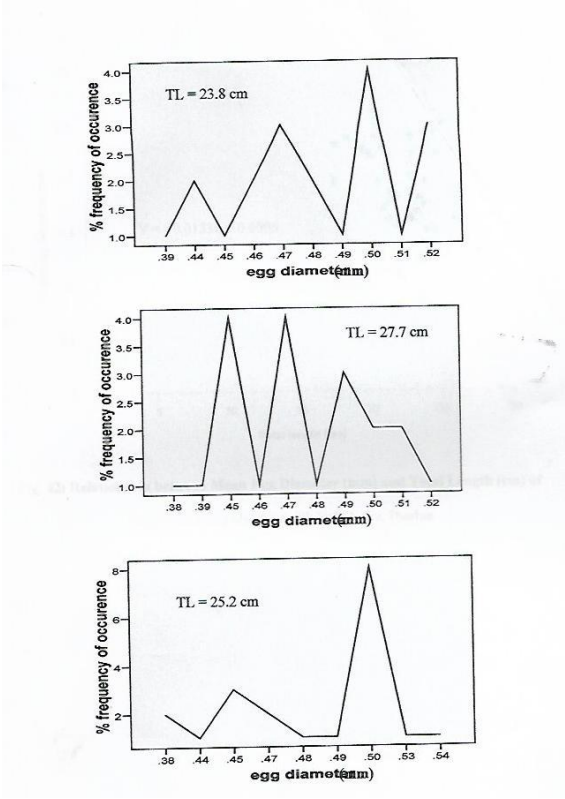

Fig.1: Frequency Polygon for Egg diameter of *Polypterus senegalus* from Eleiyele Lake.

Discussion

The values of b (except 19.5 – 22.5 cm) obtained in this study are within the range of values of this parameter 2.5 – 3.5 given by (Froese, 2006), thus the results are suitable for the estimation of length weight relationship. The higher b value (2.851) recorded for the smaller size did not differ significantly from 3 indicates isometric growth and the lower b value (0.137) for the larger size group indicates negative allometric growth. These changes in body form with size is because b value is directly related to weight affected by ecological factors such as, temperature, food supply, spawning conditions and other factors, such as sex, age, fishing time and area and fishing vessels (Ricker, 1973). According to (Khan *et al*., 2012), juvenile and adult stages of a fish may exhibit differences in the length weight relationships owing to changes in the body form with size, feeding habits and factors related to reproduction. Lower b values, 2.568, 2.824 and 2.9 were obtained for the unsexed (combined) of *P.senegalus* in the Volta River, Ghana; Chad Basin, Chari and Cross River Nigeria respectively (Daget and Ecoutin, 1976; Entsua-Mensah *et al*., 1995; Offem *et al*., 2009) while (Dankwa, 2003) in Oueme River Basin and(Lalèyè, 2006) in the Pru River, Ghana recorded higher b values, 3.1031 and 3.177 respectively. According to Bagenal and Tesch, 1978; Froese, 2006) LWRs parameter may vary significantly due to biological, food availability, temporal and sampling factors, health and sex. Also differences in b values could be attributed to one or more of the following factors; differences in the number of specimens examined; area/season effects and differences in the observed fish length ranges and the type of length used (Moutopoulo and Stergiou, 2002; Froese, 2006). The lower b value recorded in the present study may be attributed to the smaller sized specimens (16.4 – 27.7 cm TL) compared to 6.2 – 33.0 cm TL reported by ((Lalèyè, 2006).

Condition Factor: The condition factor is used for comparing the body condition, gonadal development, fatness or welfare of fish, based on the assumption that heavier fish of a given length are in better condition (Gomiero and Braga, 2003; Froese, 2006).

The mean K obtained for the species being less than 1 (0.535 ± 0.007) suggests that the fish is below average condition (Wade, 1992). Fish in good condition are expected to have fast growth rates, high reproductive potential and or survival (Anderson and Neumann, 1996) which indicates favourable conditions and ample prey availability (Ayoade and Ikulala, 2007). Raji *et al*., 2004 also reported condition factor of 0.96 and 0.79 for *Polypetrus endlicheri* and *P. senegalus* respectively in Lake Chad. They said that the higher K factor for *P. endlicheri* might be due to the bigger size. The record of higher K for female *P. senegalus* could be due to differences in the gonadal development of the sexes.

The slightly higher K value obtained during the dry season months agreed result of Ayoade and Ikulala, 2007 on *Hemichromis bimaculatus* in the Eleyele Lake. They suggested this could be due to the breeding activities of the fish that occurs during rainy season which led to depletion of reserves.

Gonadosomatic Index (GSI):

The significantly higher GSI values obtained for the female is related to being known to put more energy / resources into gamete production. The higher GSI values during the rainy season months suggests gonadal development is at the peak Offem and Omonjyi (2008) also reported that peak breeding season of *Polypterus senegalus* occurred in September to October.

Fecundity:

The absolute fecundity{622 (TL = 16.4 cm) – 2593 (TL = 27.7 cm}obtained in this study for the species is higher than 175 – 487 for size range 20.5 – 51.7 cm standard length recorded by (Offem *et al*., 2008) & fecundity of 200 – 300 for *P. ornatipinnis* in

Congo River, Central Africa Republic (Riehl and Baensch, 1991).

The differential fecundity could be attributed to disparity in the availability of food and environmental factors (Fagade *et al*., 1984; Issa *et al*., 2005) and sizes of the fishes in the water bodies.

References

1. Goose JP. Polypteridae. In: Leveque C, Paugy D and Teugels G (eds.). Faune des poissons deaux douces et saumatres d' Afrique de l' Quest. Tome l. coll. Faune Trop. no xxvii. Musee Royal de lafrique central, Tervuren and Editions de l'ORSTOM. Paris, 1990:79 – 87.
2. Gosse JP. Polypteridae. In Daget J, Gosse J.-P, Thys van den Audenaerde DFE. eds. Check-list of the freshwater fishes of Africa. Volume I. ORSTOM, Paris, 1984:18-29.
3. Rodrigo C, Rocio HM, Jesús C-M, Horacio M-L, Luis C. Full regeneration of the tribasal *Polypterus* fin. *Proceedings of the National Academy of Science* 2012; 109(10):3838 - 3843.
4. Mbawuike BC, Ukaonu SU, Williams AB, Oyebanji MO, Omogoriola HO, Ajuonu N, Oluwajoba EO, Olakolu FC, Ayorinde, AO. Assessment of the mortality rate of some ornamental fish species in Nigeria export trade. *American Journal of Social and Management Sciences* 2011; 2(3): 325 – 8.
5. Areola FO. Export potential of ornamental live fishes in Nigeria. In: 18th Annual Conference of the Fisheries Society of Nigeria (FISON) 8 - 12 December, 2003, Owerri Nigeria. 2003: 589 – 596.
6. Britz R, Bartsch P. On the reproduction and early development of *Erpetoichthys calabaricus*, *Polypterus senegalus*, and *Polypterus ornatipinnis* (Actinopterygii: Polypteridae). *Ichthyological Exploration of Freshwater* 1998; 9(4): 325-334.
7. Raji A, Saidu AK, Maryam AT. Preliminary studies on food and feeding habits of *Polypterus endlicheri* and *Polypterus senegalus* in Lake Chad. In: 18th Annual conference of Fisheries Society of Nigeria(FISON), 8-12 December, Owerri, Nigeria, 2004:186-193.
8. Offem BO, Samsons YA, Omoniyi IT. Reproductive aspects of common freshwater fishes in the Cross River, Nigeria. *Journal of Animal and Plant Scienc*e 2008; 18(4): 130 – 138.
9. Adebisi AA. The relationships between fecundities, gonadosomatic indices and egg sizes of some fishes of Ogun River, Nigeria. *Archiv fuer Hydrobiologie* 1987; 111:151-156.
10. Fawole OO, Arawomo GAO. Fecundity of *Sarotherodon galilaeus* (Pisces Cichlidae) in the Opa Reservoir, Ile-Ife, Nigeria. *Revue Biologia de Tropical* 2000; 48(10): 201-204.
11. Issa EA, Olufeagba SO, Raji A. Effects of some environmental factors on the fecundity of Tilapia species (Family Cichlidae) in Kigera Reservoir, New Bussa. In: 19th Annual Conference of the Fisheries Society of Nigeria (FISON), 29 Nov - 03 Dec 2004, Ilorin, Nigeria, 2005: 861-8.
12. Ricker WE. Linear regression in fisheries research. *Journal of Fisheries Research Board Canada* 1973; 30: 409-434.
13. Pauly D. Some simple methods for the assessment of tropical fish stocks. *FAO Fisheries Technical Paper* 1983; 234: 52p.
14. Nikolsky GV. The ecology of fishes. London and New York Academy: Academic Press, 1963.
15. Bagenal TB, Tesch FW. Age and growth. In: T.B. Bagenal, (ed) Methods for assessment of fish production in freshwater, 3rd edition. Blackwell Scientific Publication, Oxford, UK, 1978: 101–136.
16. Froese R. Cube law, condition factor and weight length relationship: history and meta – analysis and recommendations. *Journal of Ichthyology* 2006; 22: 241 – 253.
17. Khan MA, Khan S, Miyan K. Studies on Length-weight and Length-length relationships of four freshwater fishes collected from River Ganga. *Journal of Fisheries and Aquatic Science* 2012; 7: 481-4.
18. Daget J, Ecoutin JM. Modèles mathématiques applicables aux poissons tropicaux subissant un arrêt prolongé de croissance. *Cah. ORSTOM, sér. Hydrobiol.* 1976; 10(2): 59-69.
19. Entsua-Mensah M., Osei-Abunyewa, A. and Palomares, M.L.D. Length-weight relationships of fishes from tributaries of the Volta River, Ghana: Part 1. Analysis of pooled data sets. *Naga ICLARM Quarterly*. 1995;18(1): 36-38.
20. Offem OB, Samsons AY, Omoniyi IT. Length-weight relationship, condition factor and sex ratio of forty six important fishes in a tropical flood river. *Research Journal of Fisheries and Hydrobiology* 2009; 4(2):65-72.
21. Dankwa HR. Biology of *Polypterus Senegalus* (Pisces, Polypteridae) in the Pru River, Ghana. In: Palomares MLD, Sainb B, Diouf T. 2003: 23 – 4.
22. Lalèyè PA. Length-weight and length-length relationships of fishes from the Ouémé River in Bénin (West Africa). *Journal of Applied Ichthyology* 2006; 22:330-333.
23. Moutopoulos DK, Stergiou KI. Length – weight and length – length relationships of fish species from the Aegean Sea (Greece). *Journal of Applied Ichthology* 2002; 18: 200 – 203.
24. Gomiero LM, Braga FMS. Relacaopeso – comprimento e fator de condicao para cichla monoculus (Perciformes: Cichlidae) no reservatorio de volta Grande, rio Grande MG/SP. *Acta Scientianium Biological Sciences* 2003; 25: 79 – 86.
25. Wade JW. The relationship between temperature, food intake and growth of brown trout, *Salmo trutta* (L); Fed. Natural and artificial pelted diet in earth pond. *Journal of Aquatic Sciences* 1992; 7: 59-71.

26. Anderson RO, Neumann RM. Length, Weight and associated structural indices. In: Murphy BR and Willis DW. (eds.), Fisheries technique, 2nd edition. American Fisheries Society, Bethesida, Maryland, 1996: 447 – 482.
27. Blackwell BG, Brown ML, Willis DW. Relative weight (Wr) status and current use in fisheries assessment. Reviews in Fisheries Science 2000; 8: 1 – 44.
28. Ayoade AA, Ikulala AOO. Length weight relationship, condition factor and stomach contents of *Hemichromis bimaculatus*, *Sarotherodon melanotheron* and *Chromidotilapia guentheri* (Perciformes: Cichlidae) in Eleiyele Lake, Southwestern Nigeria. *Revista de Biologia Tropical* 2007; 55:1-10.
29. Riehl R, Baensch HA. Aquarien Atlas Band. 1 Melle, Mergus, Merlag Verlang Fur Natur-und Heimtierkunde, Germany 1991.
30. Fagade SO, Adebisi AA, Atanda AN. The breeding cycle of *Sarotherodon galilaeus* in the IITA Lake, Ibadan, Nigeria. *Archiv fuer Hydrobiologie* 1984; 100: 493-500.

11/4/2016