

Research Article

Length-weight relationship, condition factor and sex ratio of *Protopterus annectens* in Goronyo reservoir, Sokoto, Nigeria

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Received 18 October 2025; Revised 27 October 2025; Accepted 28 October 2025

Abstract

The study was conducted to investigate the length-weight relationship, condition factor and sex ratio of West African lungfish *Protopterus annectens* (Owen), in Goronyo reservoir north western Nigeria. 128 fish samples were collected from the Rimawa landing site of Goronyo reservoir for a period of three months. Samples were collected weekly from the fishermen from the month of September to November 2019, and the samples were examined fresh, while those that could not be treated immediately were preserved in a freezer until the next day. The total length of the fish samples ranged from 20.0cm to 56.0cm and the total weight ranged from 30.5g to 510.7g the mean condition factor ranged from 0.33 to 0.40 throughout the study period while the overall mean sex ratio was 1.13:1 male to females. The result of this study demonstrated that the condition factor of *P. annectens* is <1 procured in this study revealed that the species are not in good condition throughout the study period. In terms of growth pattern *Protopterus annectens* also exhibits a negative allometric growth pattern, which means the fish grows more in length than in weight, the rate of increase in body length is not proportional to the increase in body weight. The sex ratio in this study shows that the males are more numerous than the females in the study area.

Keywords: Condition factor, Goronyo reservoir, Length-weight relationship, Sex ratio, *Protopterus annectens*

1. Introduction

The fish family Lepidosirenidae, survivors from a very ancient group remotely related to modern fishes is represented by only once species in West Africa that is *Protopterus annectens* (Owen), commonly known as the African lungfish. As their name suggest, *Protopterus annectens* possess a pair of true lungs which are used for breathing seemingly in preference to their gills, as when they are kept in a well oxygenated aquarium, they will nevertheless surface occasionally to take a gulp of air (Reed *et al.*, 1967). Although this species is not of significant commercial status, they are of great interest to conservationists due to their primitiveness (Kees *et al.*, 2002), good candidates for the aquarium industry (Reed *et al.*, 1967), and biological control agents of the vector snails of schistosomes (Daffala *et al.*, 1985). Holden and Reed (1972) reported some natural food substances of the species as frogs, fish molluscs and seeds in River Niger. The species grow to a length of about 1 metre, but the most common sizes seen in the markets are from 300-400mm in length (Reed *et al.*, 1967).

Protopterus annectens (Owen), commonly called African lungfish, is the only species of the genus *Protopterus* occurring in West African swamps (Irvine, 1947; Bond, 1979) while *P. dolloi* and *P. aethiopicus* are found in the Congo basin and Upper Nile of the Sudan, respectively (Nichols and Griscom, 1917; Sandon, 1950). *Protopterus annectens* grows to a length of about 100 cm (Reed *et al.*, 1967), length of 200 cm has been reported (Webb *et al.*, 1981), but most common length in the market ranged from 30.00 to 40.00 cm (Reed *et al.*, 1967). Initially this fish was assumed to be of minor commercial importance, but its occurrence in high number in recent times in the

landings of fishermen in northern Nigeria has changed its status to a species worthy of study.

Protopterus annectens of the family Protopteridae is commonly called the West African Lung Fish. This fish species is common to the waters of West Africa (Abowei and Davies, 2009, Adeyemi, 2010). They mainly inhabit marshy grounds where they are able to burrow and aestivate for several months of the dry season. Over time and in the recent past, a decline in catch, distribution and more importantly the growing size of *P. annectens* is on the increase. This had led to an overwhelming overfishing of the younger and immature population of this fish species (Abowei and Davies, 2009). It is also evident that anthropogenic factors could also result in the low catch of these fish species but in any case, studies to investigate the morphometric and meristic characteristics of *P. annectens* will enable researchers and the fisherfolks to have an in-depth understanding into the morphology, phylogeny, and structural characteristics of this fish species.

The constant change in environmental and weather conditions can result in a shift in the distribution and abundance of *P. annectens*. These changes are often affected by the construction of dams causing shift in salinity, flood, a significant rise in pollution. Increased human activity such as farming and fumigation along the river banks have destroyed aestivation sites and has also contributed to the decline in catch of this fish species (Agbugui and Oniye, 2013.).

There are several reports on length-weight relationship and condition factor of fish, and in particular, *Protopterus annectens*, from different regions of the world including Africa (Maradun, *et al.*, 2019; Adeyemi, 2010; Daffala, *et*

al., 1985). This study, therefore, was undertaken to address the information and knowledge gap in fish length-weight relationship, condition factor and sex ratio of Goronyo reservoir to help in the management of fish species (*Protopterus annectens*) for reservoir fishery development, food security and sustainable socio-economic development.

2. Material and methods

2.1 The study area:

The study area, Goronyo Reservoir, is located between latitudes 13°30'N to 14°N and longitudes 5°30'E to 6°E (Ita et al., 1982). The Reservoir has a length of about 20km with a width of about 10km and an area of about 200km² with a storage capacity of 942 million cubic meters (Ita et al., 1982). The study area is in Goronyo Local Government Area, Sokoto State Northwestern Nigeria. The study area is part of the Sokoto Rima Basin, which has a total catchment area of about 193,000km² distributed in Nigeria and the Niger Republic (Gill, 1974).

2.2 Data Collection

128 fish samples were collected from the Rimawa landing site of Goronyo reservoir for a period of three months. Samples were collected weekly from the fishermen from the month of September to November 2019, and the samples were examined fresh, while those that could not be treated immediately were preserved in a freezer until the next day.

The Total Length (TL) of each sample (distance from the tip of the snout to the distal tip of the caudal fin) and the standard length (distance from the tip of the snout to the point of emergence of the dorsal and anal fin) were measured to the nearest centimetre on measuring board graduated in centimetres. The weight of the samples was also obtained (in g) using electric top-loading balance to the nearest gram.

2.3 Length-weight Relationship (LWR)

The Length-weight Relationship (LWR) was calculated by using the following formula as described by Tesch (1968):

$$W = aL^b$$

The data were logarithmically transformed to

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

Where W = Weight of fish in grams.

L = Total length of fish in centimetres

a = constant

b = an exponent.

Condition Factor (K)

The condition factor (K) was calculated according to equation by Bagenal and Tesch (1978) as;

$$K = 100 W/L^3$$

Where: W = Total Weight (g)

L = Total length (cm).

Sex ratio

The Sex Ratio of the experimental fish was estimated from the formula:

$$\text{Sex Ratio} = \frac{\text{Number of males}}{\text{Number of females}} \quad (\text{Akombo, et al., 2013})$$

2.4 Statistical Analysis

2.4.1 Length-Weight Relationship

The length-weight relationship of *Protopterus annectens* is established using the equation $W = aL^b$ (Bagenal and Tesch, 1978), where W is the weight, L is the total length, and a and b are constants determined through regression analysis. The exponent b signifies the growth pattern of the species. When b is greater than 3.0, fish becomes heavier showing a positive allometric growth and reflecting optimum conditions for growth.

$$W = aL^b,$$

was estimated through logarithms transformation. It's expressed as follows:

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

The analysis was formed using SPSS software package.

3. Results

3.1 Length-weight relationship of *Protopterus annectens*

A total of 128 samples of *Protopterus annectens* were sampled for the study. The maximum length of *Protopterus annectens* procured in this study was 56.00 cm and maximum weight of 510.7 g, whereas the minimum length obtained was 20 cm and minimum weight of 30.5 g. The “a” value for the month of September for male samples was 71.67 and 104.66 for the female samples, “b” value for the male samples 2.50 and 3.40 for the female, while the “r” value for the male samples was 0.42 and 0.009 for the female samples respectively. The “a” value for the month of October for male samples was 85.52 and 95.74 for the female samples, “b” value for the male samples was 3.25 and 4.25 for the female samples, while the “r” value for the male samples was 0.27 and 0.37 for the female samples respectively. The “a” value for the month of November for male samples was 100.74 and 97.44 for the female samples, “b” value for the male samples 2.63 and 2.60 for the female samples, while the “r” value for the male samples was 0.40 and 0.40 for the female samples respectively (Table 1).

Table 1: Length weight relationship of *Protopterus annectens* from Goronyo Reservoir in the September (Field Survey 2019)

Variables	Sex	
	Male	Female
September		
A	71.67	104.66
B	2.50	3.40
R	0.42	0.009
October		
A	85.52	95.74
B	3.25	4.25
R	0.27	0.37
November		
A	100.74	97.44
B	2.63	2.60
R	0.40	0.40

a= Constant (intercept)

b=Slope (change in weight per unit change in length)

r=Correlation coefficient

3.2 Condition factor of *Protopterus annectens* from Goronyo Reservoir

Table 2 shows the result of condition factor (K value) for the three months study period from Goronyo reservoir. The mean condition factor throughout the study period ranged from 0.33 for the month of September to 0.40 obtained in the month of November.

Table 2: Condition factor of *Protopterus annectens* from Goronyo Reservoir (Field Survey 2019)

Months	No. of samples	Mean K value	Minimum K	Maximum K
September	40	0.35	0.14	0.51
October	31	0.33	0.24	0.56
November	55	0.40	0.20	0.63

3.3 Sex Ratio of *Protopterus annectens* from Goronyo Reservoir

Table 3 shows the data of Sex Ratio for the three months study period from Goronyo reservoir. The sex ratio in September was 1.0:1, that is, 40 specimens were analyzed (20 males and 20 females), the sex ratio in the month of October was 1.4:1, that is, 31 specimens were analyzed (18 males and 13 females), and the sex ratio for the month of November was 1.0:1. That is, 55 specimens were analyzed (28 males and 27 females).

Table 3: Sex Ratio of *Protopterus annectens* from Goronyo Reservoir (Field Survey 2019)

Months	No. of Males	No. of Females	Sex Ratio
September	20	20	1.0:1
October	18	13	1.4:1
November	28	27	1.0:1
Total/Ratio	68	60	1.13:1

4. Discussion

4.1 Length weight relationship

The b value in length-weight relationships determines the growth pattern of the fish species. According to Bagenal and Tesch (1978) when b is equal to 3 or close to 3, growth in the fish is said to be isometric i.e., fish becomes more robust with increasing length. Similarly, when b is far less or greater than 3, growth is said to be allometric, i.e., the fish becomes thinner with increase in length. The exponent of b value of 2.8 for males and 3.4 for females in this study showed that 0000+ exhibited an isometric growth for the males while the females exhibited positive allometric growth. Adeyemi (2010); Maradun, et al. (2019) reported a negative allometric growth in *P. annectens* with a value of 2.552 in Idah area of River Niger and 1.579 in River Rima Sokoto respectively. Allometric growth pattern for *B. docmac*, from Lake Akata, Benue State, Nigeria was also reported by Ikongbeh, et al. (2012). Isometric growth pattern was also reported for *C. auratus* by Fafioye and Oluajo (2005) and for *C. nigrodigitatus* (Offem, et al., (2008). Nevertheless, the negative correlation coefficient ($r < 3$) recorded in this study revealed that *P. annectens* exhibits a negative allometric growth pattern, which means the fish grows more in length than in weight or better still, the rate of increase in body length is not proportional to the increase in body weight.

4.2 Condition factor

Condition factor is influenced by several factors such as adaptation of the population, reproductive behavior, food availability and environmental conditions. The condition factor of less than 1 recorded in this study revealed that *P. annectens* were not in very good condition throughout the study period. This result is similar to the findings of Adeyemi (2010) where the condition factor of *P. annectens* in Idah River was < 1 . This result revealed that over time the river is still not a good nursery ground for the growth of this fish species. Again, the low and fluctuating differences in values could be as a result of eutrophication and the increase in use of pesticides and insecticides by farmers along the river course resulting into pollution and possible bioaccumulation of pollutants.

4.3 Sex ratio

The sex ratio in this study for the first month was 1.10:1, the sex ratio for the second month was 1.4:1, not deviating from the expected sex ratio of 1:1. And for the third month the ratio was 1.0:1; throughout the study period males were significantly more numerous than the females. Information on sex ratio is important for understanding the relationship between individuals, the environment and the state of the population (Vicentini and Araújo, 2003).

5. Conclusion

The result of this study demonstrated that the condition factor of *P. annectens* is < 1 procured in this study revealed that the species are not in good condition throughout the study period in Goronyo reservoir. In terms of growth pattern *Protopterus annectens* also exhibits a negative allometric growth pattern, which means the fish grows more in length than in weight, the rate of increase in body length is not proportional to the increase in body weight. The sex ratio in this study shows that the males are more numerous than the females in the study area (Goronyo Reservoir) during the study period.

6. Statements and Declarations

Ethical Approval: Not Applicable

Conflict of Interest Declaration: The authors in this article declare that they have no known competing financial interests or personal relationship that could have appeared to influence the work reported in this article.

Funding Statement: Not applicable

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How to Cite: Jibrin, H., Muhammad, U., Omotoyo, I.A., Awonuga, A.A. and Rabi'u, M.2026. Length-weight relationship, condition factor and sex ratio of *Protopterus annectens* in Goronyo reservoir, Sokoto, Nigeria. *Journal of Fisheries and Zoological Sciences*, 1(1), 1-7.

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