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Research Article

Morphometric and Meristic Characteristics of *Protopterus annectens* (Owen, 1839) in River Niger at Agenebode, Edo State, Nigeria

Agbugui Marian Onwude and Abhulimen Ehizokhale Fran

Department of Biological Sciences, Edo University Iyamho, Edo State, Nigeria

Abstract

Background and Objective: The West African Lung Fish are common to the waters of West Africa. It is the only species in the genus *Protopterus* of the family Protopteridae found in the West African Swamps, studies have shown that the distribution and abundance of *P. annectens* are often affected by the construction of dams causing shift in salinity, flood, a significant rise in pollution. Investigation into the morphometric characteristics of *P. annectens* may provide steps into understanding the phylogeny, growth pattern and morphometric features responsible for survival of this economically important fish species in Nigeria. **Materials and Methods:** Ten morphometric and meristic characteristics of West African lung fish *Protopterus annectens* collected from river Niger at Agenebode between the periods of November, 2016 to October, 2017 using different fishing gears were analyzed. Out of the 345 specimens collected, 45 were analyzed to obtain the desired characteristics using graduated ruler and a digital scale. **Results:** The body weight and total length of fish ranged from 27.48-4230 g and 12.00-86.70, cm respectively. Negative allometric growth ($b < 3$) was obtained for length-weight relationship with growth values of 0.12 and 0.34 for males and females, respectively. The relationships between the meristic and morphometric parameters measured for *P. annectens* were linear. Strong positive correlations (0.70; 0.88) were obtained between pelvic fin, pectoral fin and total length. The relationship between the head length and head width was positive where, $b = 1.95$ and the correlation coefficient was $r = 0.73$, positive correlations were also obtained for total length-pelvic fin with $b = 3.17$ and $r = 0.70$ and the relationship between the mouth gape and head length was also positive where, $b = 0.86$ and $r = 0.66$. **Conclusion:** River Niger is a good breeding ground for this fish species. *P. annectens* exhibits negative allometric growth pattern although *P. annectens* is not faring well in this water body. The morphometric parameters measured for *P. annectens* revealed that linear growth rates is obtained for *P. annectens*. The differences in parameters obtained for weight and length showed that *P. annectens* exhibits sexual dimorphism and also that the weight of fish is the most important component in the proper growth and well being of fish.

Key words: Lung fish, total length, morphometric parameters, linear growth rates, *Protopterus annectens*, allometric growth

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Corresponding Author: Agbugui Marian Onwude, Department of Biological Sciences, Edo University Iyamho, Edo State, Nigeria

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Protopterus annectens of the family Protopteridae is commonly called the West African Lung Fish. This fish species are common to the waters of West Africa^{1,2}. 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 over fishing of the younger and immature population of this fish species¹. 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 researcher and the fisher folks 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 effected 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 species³⁻⁹. Biodiversity has become prominent in recent years as a result of a worldwide high rate of extinction of some species of animals including fish, the study of the meristics of fish species is ambiguously misused or overused to describe population dynamics of a location or community, it is in any case considered to be one of the most important aspects of fishery organization and management. Morphometry, is a fundamental character of every biodiversity and should be considered at every level of taxa. Research has been carried out on the food and feeding habit of *Protopterus annectens*¹⁰ and by other researchers in different study areas but further research in the dynamic characteristics of this species is still necessary. The length-weight relationship of a fish is basically a measure of its growth pattern and its age. It also helps to evaluate the condition factor, reproduction history, life cycle and the general health of the fish species¹¹. Negative changes in growth rates may result in increased risk of predation and mortality¹² and pollution. Studies on the length-weight relationship provides the basis for estimation of the average weight of fish of a given length group and also provides the understanding of morphological comparisons between populations. The length-weight relationship of *P. jubelini* in the New Calabar-Bonny River showed positive correlations in both males and females, indicating an increase in weight with increase in length, again, the mean condition

factor (K) varied during different months and was higher during the dry months which coincided with when the level of turbidity of the river was lowest; with the period when larger sizes and less number of fish were caught; non gravid fish indicating non spawning activities^{12,13}. Such diversity studies based on morphometrics may prove necessary in obtaining key points in areas of conservation and management of fish. This work therefore aimed to study the meristic and morphometric characters of *Protopterus annectens* in River Niger at Agenebode which will give more information for the potential, the possible culture and management of *P. annectens*.

MATERIALS AND METHODS

Study area: The Niger river is the principal river of Western Africa. Its source is in the Guinea Highlands in southeastern Guinea. It runs in a crescent through Mali, Niger, on the border with Benin and then through Nigeria, discharging through the Niger Delta and in to the Atlantic Ocean. The Niger is the third-longest river in Africa, it is a relatively "clear" river, which floods yearly; this begins in September, peaks in November and finishes by May. The seasonal floods make the Delta and Agenebode which is a village along the river an extremely productive land for both fishing and agriculture.

The river is located on latitude 7°07 N and longitude 6°44 E. The water temperature range between 22 and 31 °C, Agenebode has a tropical savannah climate with two clearly marked season of wet between April and October and dry between November and March. The cold harmattan wind is experienced between November and February when the hot season start and last until the rain begins. The highest water levels are between August and September and the lowest are between March-April. River Niger serves as a boundary between Kogi State and Edo State.

Fish sampling: Fish samples were obtained from fishermen at landing sites along the river. Samples were collected from November, 2016 to October, 2017. A total of 345 species of *Protopterus annectens* were obtained and 45 out of the total sample collected were used for the morphometric and meristic analyses.

Fish identification: Fish samples were taken to the Department of Natural Sciences Laboratory (Animal and Environmental Biology Unit). Identification was carried out using pictures and keys¹⁴. Fish were examined while still fresh and parameters taken immediately.

Morphometry and meristics: The weight was taken by weighing the fish on a digital electronic scale (Storius 177) and lengths were measured using a graduated meter rule:

- **Weight (w):** Weight of fish in grammes.

Total length of each fish (cm): From tip of snout to maximal extent of caudal fin.

Body depth (girth-length): This was taken round the deepest point of the fish exclusive of fleshy or bony structures.

Head length: This was measured with the mouth closed from the tip of the snout to the posterior edge of the opercular opening.

Head width: This was the greatest dimension from one gill opening to the other in closed position.

The lengths of the pectoral and pelvic fins were measured to the nearest centimeter using a measuring tape.

The length-weight relationship of the fish was estimated by the equation:

$$W = aL^b$$

where, W is weight (g), L is length of fish (cm), a and b are regression coefficient and slope, respectively. The logarithm-transformed data will give the linear regression equation¹²:

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

Length-girth relationship: Length-girth relationship was determined by adopting the general power function used by Adeyemi¹³:

$$M = a(TL)^j$$

where, M is Girth, a is initial growth constant, j is growth rate exponent, TL is Total length. Coefficient of a and j shall be estimated by using Krkosek *et al.*⁶ after logarithmically transforming all data into form¹³:

$$\text{Log } M = \log a + j \log TL$$

The relationships of pectoral and pelvic lengths, total lengths, head and girth lengths were determined by the adoption of the length-weight relationship formula of Abowei and Davies¹⁵.

RESULTS

The morphometric parameters taken for the fish samples are given in Table 1. The length-weight relationship

of *P. annectens* studied revealed that significant differences ($p < 0.05$) exists between total length and body weight of the specimens (Table 1). The regression co-efficient 'b' in Table 2 revealed negative allometric growth (0.26).

The condition factor of *P. annectens* revealed fluctuating differences which were mostly less than 1 (<1) throughout the study period (Fig. 1). There was not a steady pattern during the seasons or as related to sex.

The length-girth relationship of *P. annectens* exhibited negative allometric growth ($J = 0.12$ and 0.43 for males and females, respectively). Correlation coefficients (r) for male and female were 0.62 and 0.74 , respectively. The "r" was positive for both sexes (Table 3).

The total-pectoral fins' length relationship showed positive proportionate growth rate ($b = 5.99$) and $r = 0.72$ (Table 4). Positive proportionate growth was also obtained for total-pelvic fin's length, relationships were $b = 3.17$ and $r = 0.70$ (Table 4). A negative allometric growth $b = 1.07$ and

Table 1: Meristics of *Protopterus annectens* in the river Niger at Agenebode, Edo state

Parameters measured	Range
Weight (g)	27.48-4230
Total length (cm)	12.00-86.70
Girth length (cm)	5.00-19.00
Pectoral fin length (cm)	6.00-18.50
Pelvic fin length (cm)	3.00-14.00
Head length (cm)	3.00-13.50
Head width (cm)	3.00-9.00
Dorsal fin (cm)	6.00-22.00
Gape width (cm)	1.50-12.00
Inter-orbital distance (cm)	2.00-7.00

Table 2: Length-weight relationship for male and female *P. annectens*

Sex	Weight (g)	Total length (cm)	a	b	r
Male	27.48-1500.00	12.00-50.80	0.58	0.12	0.74
Female	73.53-4230.00	21.00-86.00	0.44	0.34	0.62
Combined	27.48-4230.00	12.60-86.00	0.48	0.26	0.62

Table 3: Length-girth relationship for male and female *P. annectens*

Sex	Total length (cm)	Girth length (cm)	a	J	r
Male	12.60-50.80	5.00-15.00	0.58	0.12	0.74
Female	21.00-86.00	5.00-19.00	0.39	0.43	0.62
Combined	12.60-86.00	5.00-19.00	0.48	0.26	0.62

Table 4: Relationship between morphometric parameters of *P. annectens*

Parameters	a	b	r
Total length-weight	0.48	0.26	0.62
Total-girth length	0.48	0.26	0.62
Total-pectoral fin length	0.13	5.99	0.72
Total-pelvic fin's length	0.11	3.17	0.70
Pelvic-pectoral fin length	0.71	0.38	0.88
Head width-head length	0.40	1.96	0.71
Total length-mouth gape	0.06	1.07	0.63
Weight and mouth gape	0.61	1.29	0.48
Total length and inter orbital distance	0.56	0.03	0.85
Weight and inter orbital distance	0.59	-0.34	0.45
Mouth gape and head length	0.41	0.86	0.66

Table 5: Correlation coefficient showing correlation between parameters measured

Parameters	W (g)	TL (cm)	PFL (cm)	VFL (cm)	HL (cm)	HLDF (g)	MG (cm)	GL (cm)	ID (cm)	HW (cm)	CF
Weight (w)	1										
Total Length (TL)	0.5801	1									
Pelvic Fin Length (PFL)	0.5636	0.6983	1								
Ventral Fin Length (PFL)	0.5498	0.7158	0.8818	1							
Head Length (HL)	0.6686	0.8095	0.8155	0.7345	1						
Dorsal Fin Length (DFL)	0.4716	0.8596	0.7162	0.7081	0.8156	1					
Mouth Gape (MG)	0.8289	0.5919	0.4507	0.4214	0.6603	0.5463	1				
Girth Length (GL)	0.4770	0.6283	0.4108	0.5480	0.5836	0.5636	0.5215	1			
Inter-Orbital Distance (IOD)	0.4929	0.8458	0.5139	0.5659	0.6670	0.7231	0.5169	0.6411	1		
Head Width (HW)	0.6940	0.6227	0.6090	0.5706	0.7141	0.5512	0.6075	0.5714	0.5142	1	
Condition Factor (CF)	0.0439	-0.5580	-0.1796	-0.2644	-0.3061	-0.4211	-0.0361	-0.2463	-0.3845	-0.0631	1

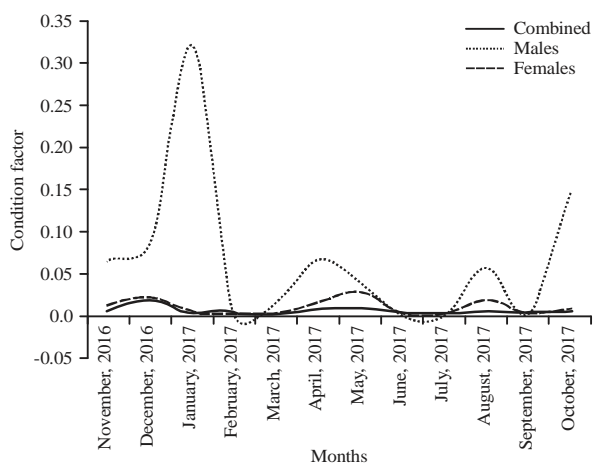


Fig. 1: Mean condition factor for *Protopterus annectens*

$r = 0.63$ was obtained for the relationship between the total length and mouth gape. Again, negative allometric growth patterns $b = 1.29$, $r = 0.48$, was obtained for weight and mouth gape. Negative allometric growth patterns $b = 0.03$, -0.34 and 0.86 and correlation coefficients $r = 0.85$, 0.45 and 0.66 were obtained for total length-inter-orbital distance, weight and inter-orbital distance, mouth gape-head length, respectively. Table 5 showed the correlation coefficient of the parameters analyzed with particular reference to the coefficient between condition factor and weight which was the best value of 0.0439 .

DISCUSSION

The maximum length of *Protopterus annectens* obtained in this study (86.00 cm) and weight (4230 g) are much more than the length of 59.20 cm, with a range of 19.30-46.60 cm and weights of 397 g, with a range of 13.00-42.50 g, obtained in Idah Area of river Niger and Jachi lake¹². This showed that the species used for the study were relatively more mature. These differences could be attributed to the condition of the fish caught during different

seasons, location, sex, nature of the aquatic environment availability and abundance of food for the fish species, the level of exploitation of the fish species in different water bodies and predation by other fish species. Variations in length and weight may be related to the growth stages of different types of fish species, these variations in data may also be location specific¹⁰. The differences observed in the length and weight of the specimens used for this study show that *P. annectens* exhibits sexual dimorphism¹⁶, also noted that the female population of *Pomadasys jubelini* in the New Calabar-Bonny river grew heavier and longer than the males. These findings however, are in contrast with the result obtained by Safi *et al.*¹⁷ where *Pomadasys maculatus* showed no sexual dimorphism. The condition factor < 1 obtained in this study revealed that *P. annectens* were not in good condition throughout the study period in this river. The male, female and combined population mostly had values < 1 . This is also in agreement with the findings of Adeyemi¹³ where the condition factor of *P. annectens* in Idah river (Agenebode boarder) 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 insecticide by farmers along the river course resulting into pollution and possible bioaccumulation of pollutants. The correlation coefficients of 0.74 and 0.62 for length-weight relationship (LWR) for males and females obtained in this study are lower than the values 0.86 and 0.84 obtained by Oniye *et al.*¹¹, for male and female *P. annectens*, respectively and 0.92 obtained by Adeyemi¹³, for *P. annectens*. Nevertheless, the negative correlation coefficient ($b < 3$) obtained 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 was not proportional to the increase in body weight. It is important to note that the specimens used for this study were larger than the specimens used by Adeyemi¹³ and Oniye *et al.*¹¹.

The value of the length-breadth relationship in this study ($J < 1$) implies that the girth length of the fish does not increase as its total length increases. This further confirms the negative allometric growth ($b > 3$) obtained in the length-weight relationship. The results of length-girth relationships of *P. annectens* in this investigation are particularly useful for gill net selectivity in Fisheries management. Fish species with larger body breadth were caught in larger mesh sizes, while fish with small body breadth swim across nets with larger mesh sizes because of its small size.

The relationship between the meristic and morphometric parameters measured for *P. annectens* was linear, it was also observed that some lengths taken were highly and positively correlated. For instance strong positive correlations (0.70 and 0.88) were obtained between pelvic fin, pectoral fin and Total length. The correlation coefficient also reveals that the individual parameters increase at the same rate. This indicated that the growth of fish in one area of the body is co-related to growth in another area of the body^{16,11}. Weak and negative correlation coefficients ($b = 0.03$ and -0.34) were obtained for relationships between total length, weight and inter-orbital distance, an indication that the growth rate of the inter-orbital distance is not directly proportionate to the weight and total length of *P. annectens*. Correlation coefficients between the Condition Factor (CF) and all the other ten parameters were weak and negative except for weight. This confirms that the weight of fish is the most important component in the proper growth and well being of fish.

CONCLUSION

The maximum length of *Protopterus annectens* obtained in this study is an indication that the species used for the study were relatively mature and that the River Niger is a good breeding ground for this fish species. The regression coefficient reveals that *P. annectens* exhibits negative allometric growth pattern, an indication that the fish grows more in length than in weight. The condition factor revealed that *P. annectens* is not faring well in this water body. The relationship between the meristic and morphometric parameters measured for *P. annectens* was linear and growth rates of parameters were correlated. The differences in parameters obtained for weight and length showed that *P. annectens* exhibits sexual dimorphism and also that the weight of fish is the most important component in the proper growth and well being of fish.

SIGNIFICANCE STATEMENT

This study discovered that mature specimens were obtained in this study area and indication that the river Niger can be beneficial for growing and managing *P. annectens*; help researchers to uncover the critical areas of needed in improving the present state of the river to make it habitable for fisheries management practices.

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