



Aspects of the Biology of *Protopterus annectens* from Agenebode at River Niger, Nigeria

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ABSTRACT

The African lung fish, *Protopterus annectens* from Agenebode, in the Lower River Niger was investigated for aspects of its biology. Samples of the fish were collected from October 2016 to November 2017. Sex ratio of 1:1.4 (male to females) was obtained from the river. The results from the stomach analyses revealed that *P. annectens* consumed mud, detritus and sand (100%). Bird's foot was regarded as incident diet (0.01%) while grass was also observed to be part of the relevant diet (7.1%) of the fish, an indication that it is an omnivore. The Gonadosomatic Index (GSI) ranged from 12.34 to 13.33. The peak of GSI were observed during the months of September, October and November, coinciding with the end of wet season. Highly fecund fish were also observed in the months of October and November and then a decline in December, again these months experienced decline in rainfall thus suggesting the end of spawning periods. The changes in GSI revealed that *Protopterus annectens* has specific maturing, spawning and breeding periods. *Protopterus annectens* was found to be highly fecund with eggs range from 72,275 to 129,732 (mean value of $92,116 \pm 743$ eggs). This study also revealed that fecundity was more relative to body weight than length of fish.

INTRODUCTION

Nutrition in fisheries science is essential, the growth, fitness and performance of a fish species is to a large extent dependent on the kind of food taken and its feeding habit (Agbugui *et al.*, 2011). An understanding of the diet and morphological structure is relevant in predicting its relationship between feeding habits and food preference. The level of sustainability can go a long way in curbing the need and satisfying mans' quest for animal protein especially one of low cholesterol. Studies have shown that the diet composition of fish provides detailed information and about appropriate feed formulation for aquaculture practices (Agbugui *et al.*, 2004).

The type of dietary item that fish consume can only be known through investigatory studies on the food and feeding habits of fish. Dietary items and feeding habits of fish have been carried out by some researchers in Nigeria.

Such of these are the study of *Lates niloticus* by Balogun (2000), the food and feeding habits of *Tillapia zillii* by Azubuikwe *et al.*, (2015), the food and feeding habits of *Pomadasys jubelini* by Agbugui *et al.*, (2016), in the New Calabar-Bonny River.

The West African mudfish *Protopterus annectens* is common to the freshwaters of West Africa; it is the only known species of the genus Protopteridae (Froese and Pauly 2018). Available and reliable information on the food and feeding habits is often gotten from the stomach analyses to reveal its gut content. *P. annectens* are often caught in large quantities and make up a large part of the commercial catch at Agenebode Water side of the River Niger. Research into the biology of *P. annectens* will provide recent and viable information on the natural diet, feeding habit, growth structure, morphology, productivity and reproductive viability which will be useful for the possible breeding, rearing, culture and management. The results gotten from this study will provide necessary opportunity for the culture of this fish species especially in its natural environment (cage culture) or pond culture.

MATERIALS AND METHODS

The Microsoft Excel 2010 was to analyse the data obtained for this study

Study Area:

The River Niger at Agenebode is located at 7°06'N 6°42'E. Agenebode is a waterside town located by the banks of the River Niger. It is located at the lower River Niger, typically with a humid climate and weather of approximately 32°C. The area is marked by 2 seasons, the wet season and the dry season. The wet season is from April to October while the dry season is from November to March. The lower Niger River at Agenebode is a boundary between Idah in Kogi State and Edo State. The River serves the people of Edo and its environs with a route for transportation to other neighboring communities; a fishing spot and fishery; market and a source of water for domestic purposes, farm, irrigation, industrial purposes and trading location for local traders and the riparian localities at the popular Bode Market.

Collection of specimens and sampling:

A total of two hundred and ten (210) fish species were collected fortnightly for 12 months from October 2016 to September, 2017 from three stations (based on the landing sites of fishing localities) from catch landings of fisher folks by the use of canoes, outboard engines, gill nets, cast nets, drag nets, long nets, fish traps and calabashes. Samples of fishes were transported in an insulated box containing ice chips to the Laboratory of the Department of Biological Sciences, Edo University Iyamho, Edo State. Fishes were cleaned and identified to species level using guides, keys and pictures provided by Froese and Pauly 2007; Reed *et al.*, 1967; Idodoh Umeh (2003) and Pandey and Shukla (2005) and then preserved in 5% formalin.

Morphological Parameters

The standard length (cm) and weight (g) of *P. annectens* were obtained by using a graduated ruler and tape a measuring board and a digital electronic scale (Storius 177). These were recorded and analysed.

Determination of Sex

The stomach was split open from the lower abdominal region to determine the sex. Sex was determined by visual and microscopic observation of the gonads. Where there was the presence of two ovaries the fish was referred as females or the absence of ovaries and connoted as males. Sex could not be obtained from external observation.

Gonadosomatic Index (GSI)

The Gonadosomatic Index of samples of *P. annectens* were determined according to Ugwamba *et al.*, (1991) as follows

$$\text{GSI} = \frac{\text{weight of gonad}}{\text{Weight of fish}} \times 100$$

The monthly catches were sorted into sexes. The mature female ovaries were analysed and used to determine the GSI.

Fecundity

Both ovaries of the mature fish were removed and placed gently in boiling water and allowed to boil for 20 minutes. The eggs became hard enough for easy counting. The boiled eggs were then stored in 5% formalin.

1.00g of the whole ovaries was cut off. The cut section of the eggs were carefully counted and multiplied by the total weight of the ovary to give the total number of eggs.

The maturity stages of the ovaries were classified according to Nikolsky (1963):

Stage 1 – Immature, Stage II-Quiescent, Stage III - Maturing, StageIV-Mature, Stage V - Running, Stage VI -Spent.

Determination of Food and Feeding Habits:

Each stomach was split open and the contents emptied into a petri dish. The contents were observed under a hand lens and the food materials and identified.

Frequency of occurrence method (FO): In the frequency of occurrence method the individual food matter in the stomach were sorted and identified. The number of stomachs in which each food item occurred was expressed as a percentage of the total number of stomachs with food examined.

Numerical method:

This method involves counting the number of each food item present in the stomach of a fish and summing these numbers to obtain the total number of all food items found in the stomach. The number of each food item is then expressed as a percentage of the total number of all food items. It was expressed as

$$\text{Percentage number of a food item} = \frac{\text{Total number of a particular food item}}{\text{Total number of all food items}} \times 100$$

Importance of food index (IRI): The importance of various food items were determined with the index of food importance following a method Ugwamba and Ugwamba (2007)

$$\text{IRI} = (C_n + C_w) \times F \dots \dots \dots (1)$$

Where IRI = index of relative importance

C_n = percentage of numerical composition

C_w = percentage of gravimetric composition

F = percentage of frequency of occurrence

The dietary compositions for the species examined were expressed as percentages, that is

$$\% \text{ IRI} = \frac{(C_n + C_w) \times F}{\sum (\text{IRI})} \times 100$$

Food item with %IRI ≥ 3 are regarded as primary, ≥ 0.1 to <3 are secondary where as ≤ 0.1 are considered as incidental food items.

Prey-predator relationship: The relationship between the total body length and total weight of *P. annectens* and prey body weight was determined and described by the equation;

$$Y_L = a + b X_L \quad (\text{Ogari, 1988})$$

Where Y_L = Prey body weight (g), X_L = *P. jubelini* body length (cm) or body weight (g).

RESULTS

A total of 113 males and 158 females were examined with a ratio of 1:1.4. Out of the total 227 specimens that were examined for diversity of food items, 109 had food items while 118 had no food items in their stomachs. Table 1. shows the monthly percentage composition of food items obtained from *P. annectens* from October 2017 to November 2018.

Table 1: Monthly Analyses of Food Composition Consumed by *Protopterus annectens* at Agenebode in River Niger.

Months	Food species										
	Sand, Mud	Detritus	Blue green algae	Green grass	Diatoms	Unidentified and partly digested food items	Fish flesh	Crab parts	Birds foot	Total	%
2016											
Oct	21	21	12	3	3	12	12	3	0	87	11.9
Nov	16	16	9	2	3	5	6	1	0	58	7.6
Dec	19	19	3	2	1	7	4	2	0	57	6.8
2017										0	0.0
Jan	12	12	2	0	1	9	4	2	0	42	5.4
Feb	19	19	5	0	1	3	5	3	0	55	6.5
Mar	19	19	4	0	1	6	6	3	0	58	7.0
Apr	21	21	9	1	5	4	9	4	0	74	9.5
May	26	26	12	2	3	7	7	2	0	85	10.6
June	29	29	9	1	5	6	5	3	0	87	10.5
July	10	10	10	2	0	5	3	4	0	44	6.1
August	24	24	13	1	6	5	6	8	1	88	11.5
Sept.	11	11	7	3	4	5	3	3	0	47	6.5
Total	227	227	95	17	33	74	70	38	1	782	100

The dominant food items found were detritus (100%), mud and sand (100%) by FO. Bird's foot was regarded as incident diet (0.01%) while grass was also observed to be part of the relevant diet (7.1%) of the fish. Other food items of low importance were diatoms, algae and crab parts 0.3%, 0.8% and 4.2% respectively (Table 2).

Table 2: Percentage composition of various food species consumed by *Protopterus annectens*

Food items	NO	%NO	FO	%FO	W	%W	J	IRI	%IRI
Sand, Mud	227.0	29.0	227.0	100.0	29.0	26.1	55.2	5515.4	32.3
Detritus	227.0	29.0	227.0	100.0	29.0	26.1	55.2	5515.4	32.3
Green grass	95.0	12.1	99.0	43.6	17.0	15.3	27.5	1197.8	7.0
Blue green algae	17.0	2.2	17.0	7.5	5.0	4.5	6.7	50.0	0.3
Diatoms	33.0	4.2	33.0	14.5	5.0	4.5	8.7	126.8	0.7
Unidentified and partly digested food items	74.0	9.5	69.0	30.4	16.0	14.4	23.9	725.8	4.2
Fish flesh	70.0	9.0	73.0	32.2	16.0	14.4	23.4	751.4	4.4
Crab parts	38.0	4.9	39.0	17.2	19.0	17.1	22.0	377.6	2.2
Birds foot	1.0	0.1	1.0	0.4	4.0	3.6	3.7	1.6	0.0
Total	782.0	71.0	227.0	100.0	111.0	100.0	171.0	17097.2	100.0

Key:

NO = Numerical method FO = Frequency of occurrence method W = weight

$J = (C_N + C_W)$

IRI = Index of relative importance

Five stages of gonad development were found in *P. annectens* during the sample period; the quiescent, maturing, mature and running stages in both males and female fishes (Table 3).

Table 3: Stages of gonad developments of *P. annectens*

Gonad stage	Testis	Macroscopic character
		Ovaries
I Immature	Not encountered	Not encountered
II Quiescent	Testis were small and opaque in colour	Ovaries were translucent and very creamy in colour. Blood vessels seen on ovaries
III Maturing	Testes were large and opaque and whitish in colour	Ovaries were small, with tiny eggs, opaque, creamy and had blood vessels on the surface of ovaries (Fig. 2)
IV Mature	Testes were large and whitish in colour. Milt were released with the application of pressure	Ovaries had larger eggs that were wholly off-white or somewhat ash in colour (Fig. 3).
V Spawning/Running	Milt could be released with little pressure	The running stages had very enlarged eggs, off-white in colour and were easily expelled with a little pressure to the ventral region of the fish (Fig. 4).
VI Spent	Not encountered	Not encountered



Plate 1: Quiescent stage: arrow shows eggs still forming. (Mag. X2)



Plate 2: Maturing stage (Mag. X2)



Plate 3: Mature stage (Mag. X2)



Plate 4: Running stage (Mag. X2)

The quiescent stage had ovaries that were translucent and creamy in colour, oocytes were not visible to the naked eye, blood vessels were seen on the surface of ovaries. The maturing stage of the males had small milt that was milky in colour. The mature stage had larger milt that could be released with some pressure while the running stage had milky coloured milt that could be released easily under a little

pressure. Expelled eggs were very soft and observed to melt at room temperature (Plates 5 and 6). When the eggs were heated up in boiling water they became hard and easier to count.



Plate 5: Arrow showing eggs withdrawn from ovaries and melting at room temperature. (Mag. X2)



Plate 6: Expelled eggs (Mag. X2)

The Gonadosomatic Index ranged from 12.34 to 18.33 (Table 4).

Table 4: Gonadosomatic Index (GSI) of *Protopterus annectens*

	Weight (g)	Total Length (cm)	GSI (%)	no of eggs
	1800.60	60	14.61	94,178
	1670.80	53.2	14.07	92,167
	1500.20	50.8	15.89	91,625
	500.90	48.4	12.34	72,275
	670.11	70	14.53	88,367
	645.82	70	12.44	81,213
	731.77	86	12.69	89,714
	4230.00	84.9	18.33	129,732
	970.66	54.9	13.16	89,776
Mean	1413.429	64.24444	14.23	92,116

This study also revealed that fecundity is more relative to body weight than length of fish (Figs. 1 and 2).

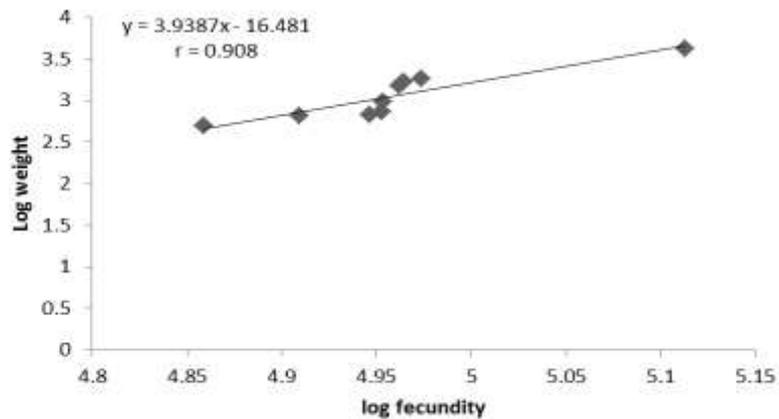


Fig. 1: Relationship between the total weight and fecundity.

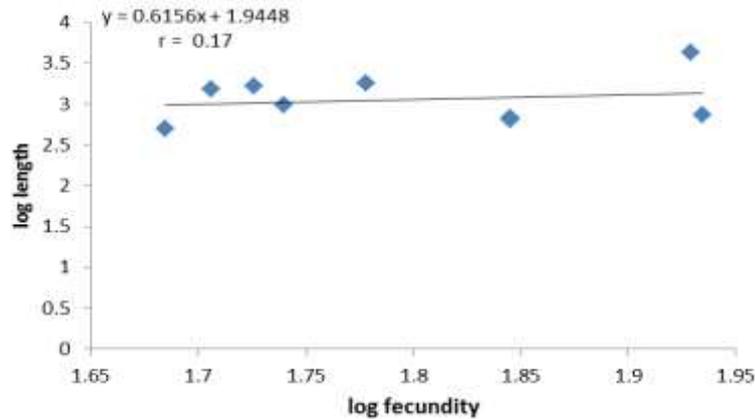


Fig. 2: Relationship between the total length and fecundity.

DISCUSSION

The diet compositions obtained in this study were shown to depend mainly on seasonal availability and abundance of food rather than preference of diet. Similar observations were made by Oniye *et al.*, 2006; Adeyemi *et al.*, 2009 and Onwuka *et al.*, 2017 in the diets of *P. annectens* in Jachi Dam, Katsina; Lake Bassa and from River Orashi and Sombereiro, Rivers; mud, algae, phytoplankton, detritus and mollusc were observed during the study period furthermore, that seasonal variation in the diet composition of *P. annectens* could be attributed to seasonal changes in food rather than food preferences. In this study, there was no specific preference in the size of prey and type of diet. All the sizes of prey obtained in the study had similar food items suggesting that diet specificity was not linked to size of fish as otherwise obtained in the study of the food and feeding habits of the Sompat Grunt *P. jubelini* in the New Calabar-Bonny River, and the food and feeding habits of the Nile Perch *Lates niloticus* in Lake Kainji (Balogun 2000; Agbugui *et al.*, 2014). The high percentage of detritus and mud and sand in the stomach of the fish species suggest strongly that *P. annectens* is a detritus feeder, consuming mainly bottom dwelling food items.

Highly fecund fish were also observed in the months of October and November and then a decline in December, again these months experienced decline in rainfall thus suggesting the end of spawning periods. The changes in GSI revealed that *P. annectens* have specific maturing, spawning and breeding periods. *P. annectens* were found to be highly fecund between 73,275 and 129,732 with a mean value of $92,116 \pm 743$ eggs. This study is in conformity with the findings of Onwuka *et al.* (2016) in the study of the aspects of the biology of *P. annectens* in Orashi and Sombereiro River where fecundity was between 32,009 eggs and 147,000 eggs furthermore, the weight of gonads were heaviest at the peak of the rainy season and at which time the fish were expected to spawn. It was also revealed that *P. annectens* is a highly fecund fish with its peak of fecundity towards the end of rainy season. The peaks of GSI were observed during the months of September, October and November, coinciding with the end of rainy season. *P. annectens* is considered to be a high fecund fish when compared to *Synodontis schall* with 1,530 eggs to 13,965 eggs and *P. jubelini* of 9,085 eggs to 37,926 eggs (Mekaway and Hassan 2011; Adebisi 2013; Agbugui and Oniye 2016). a finding that agrees with the study of the fecundity of *P. jubelini* in the Lagos coast, Nigeria and New Calabar-Bonny River (Adebisi 2013; Agbugui and Oniye 2016).

CONCLUION

P. annectens is a detritor, consuming a wide variety of bottom dwelling food items. The mouth, dentition and gastrointestinal tract are highly modified to accommodate the modes of feeding and feeding habits. The peaks of GSI and highly fecund fish were observed during the months of September, October and November, coinciding with the end of rainy season. thus suggesting spawning periods. It was also revealed that *P. annectens* is a highly fecund fish with its peak of fecundity towards the end of the rainy season and is more relative to body weight than length of fish. Mature fish eggs were easier to count after been heated up in boiling water for some minutes. This fish is thus highly recommended for culture.

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