

The Reproductive Biology of *Auchenoglanis biscutatus* and *Protopterus annectens* from Lower River Benue Wadata, Makurdi-Nigeria

Abstract

Data on the reproductive biology of *Auchenoglanis biscutatus* and *Protopterus annectens* were collected between April 2019 to March 2020. Reproductive parameters including sex ratio was determined as number of males by number of females, gonadosomatic index as total gonad weight by body weight and expressed in percentage while fecundity was obtained via volumetric and gravimetric methods. There was a slight dominance of males over females of both species (1.1:1) with more immature individuals caught within the study period. Higher GSI, gonad length and gonad weight (0.87 ± 0.06 , 15.94 ± 0.89 and 3.01 ± 0.19) were recorded in *Auchenoglanis biscutatus* during dry season while GSI and gonad weight (4.06 ± 0.62 , 5.63 ± 0.45) of *Protopterus annectens* and number of mature fishes (0.35) were higher during rainy season. The relative fecundity for *Auchenoglanis biscutatus* investigated had no significant difference in both seasons (7.99 ± 0.94 , 8.22 ± 0.78) while the relative fecundity for *Protopterus annectens* differed significantly among the wet and dry seasons (3.43 ± 0.94 , 0.48 ± 0.22). The relative fecundity of *Protopterus annectens* (11.59 ± 2.04) was higher than that of *Auchenoglanis biscutatus* (8.04 ± 0.75). It was concluded that the study of the sex ratio indicates that males were higher than females. The relative fecundity of *Protopterus annectens* was higher than that of *Auchenoglanis biscutatus* during the study period. Based on the findings of the study, I recommend that this fish species be domesticated.

Key words: Reproductive biology, Seasons and Indices

Introduction

Commented [U1]: Kindly mention a line for the importance of the study and why the research have been taken into.

Commented [U2]: Remove italics for and

Commented [U3]: Since it is an abstract, its not necessary to explain the methods here.

Commented [U4]: Kindly rewrite the sentence, giving more emphasis on the importance of such study.

Commented [U5]: More keywords can be included

Increase in human population and the attendant increase in demand for animal protein has continued to raise the demand for and consumption of fish and fish products worldwide. Freshwater fishery has an important bearing on the lives of many African communities primarily as an important source of dietary protein and secondarily as a source of subsistence income. Fish provides a good source of high quality protein and contains many vitamins and minerals. Scientific knowledge and understanding of key population characteristics such as feeding and reproduction of fish are very necessary in the assessment and formulation of prudent management policies for fish stocks (Froese *et al.*, 2017, Novaese and Carvalho 2012).

Commented [U6]: Rewrite the sentence

According to Umaru *et al.*, (2015), domestication and culture of commercially important fish species remains the key to mitigating further decline and possible extinction of these fishes. One of the important aspects of fish that needs to be focused for a successful domestication program includes the aspect of the biology of the fish. Okafor *et al.*, (2012) opined that most commercially important fish species have not been successfully cultured on a commercial scale due to insufficient knowledge of the biology of these fishes; hence, in order to cultivate any of these fish species successfully in captivity, a good knowledge of their biology is important.

Reproduction in fishes is one of the fundamental biological processes that enable survival and continuity of species in the aquatic environment. Reproductive patterns of fish, according to Pauly (2002), differ when factors such as habitats, geographical zone and species are considered, which are influenced by environmental and biotic factors. These reproductive parameters include sex ratio, stage of maturity, gonad index (GI), gonadosomatic index (GSI), and fecundity. Knowledge on the reproductive patterns of fishes as well as growth and mortality characteristics will define the regenerative capacity of a population. Gonad maturation stages have become increasingly important in

fish production, especially in induced spawning and hybridization in addition to determine the stock that is, mature, and the size or age at first maturity. This work seek to determine the reproductive parameters of *Auchenoglanis biscutatus* and *Protopterus annectens* in Lower River Benue at Wadata-Makurdi.

Commented [U7]: Mention a line, why you have selected this two species out of many. Why a catfish and a lung fish? Kindly include the reason in the introduction part. Kindly cite recent references. The last recent reference of the introduction part is from 2017. Kindly include more references.

Materials and Method

Study Area

Commented [U8]: Remove the 'full stop'

The study was conducted at the lower River Benue axis at wadata landing site in Makurdi. Makurdi is the capital of Benue State in Nigeria, is located at Longitude 7°43'N and Latitude 8°32'E (Figure 1). The town is divided into the North and the South bank by the River Benue. The samples were collected for further analysis at the general purpose Laboratory Department of Fisheries and Aquaculture Joseph Sarwuan Tarka University Makurdi.

Commented [U9]: Figure 1?

Fish Collection

Commented [U10]: Kindly mention the fish collection methods and preservation technique

Fish were collected from April 2019 to March 2020, fish samples were collected from Wadata landing site between 08:00 to 09:00 hours.

Commented [U11]: Study area and fish collection can be combine together and make it one as Study area and fish collection.

Fish Measurement

Commented [U12]: Mention the sample size for each fish for the study

This was done with the aid of measuring board, measuring rule, weighing balance, pair of divider and thread of varying lengths. Measured in centimeters (cm) and grams (g), recorded on data collection sheets for each sample separately. Validation of the two species was done by comparing the values of the body proportions obtained with standard keys by De Vos (1995) and Pauly *et al.* (2003).

Commented [U13]: Kindly provide standard method for measurement

Reproductive Parameters

Sex Ratio Determination

The sex of each specimen obtained during the sampling period was determined. This was done by visual observation of the external features. Females were recognized by round inflammation around the genital aperture and the distended

aperture, slightly sticky skin, and, by the presence of testes in the case of males. The number of the identifiable males and females of the samples for each sampling period was recorded and used to determine the sex ratio. Sex ratio was calculated using the formula:

$$\text{Sex ratio} = \frac{\text{number of males}}{\text{number of females}} \text{ (Akombo } et al. 2013)$$

Gonadosomatic Index (GSI)

The body weights of the samples with their corresponding gonad weights was taken and used to calculate the gonadosomatic index (GSI). This was determined as:

$$\text{GSI} = \frac{W}{B} \times 100 \text{ (Allison } et al. 2008)$$

Where

W=weight of the gonads

B = weight of the fish (g)

Fecundity Estimation and Oocyte/Egg Diameter

This is the number of eggs in the ovaries that was matured during a particular spawning season.

Ripe eggs were removed from gravid fish, weighed and preserved in Gilson's fluid. The preserved ovaries were washed several times in distilled water to get rid of the preservative, then eggs were separated from the ovaries, placed on filter paper to remove excess water. Clumped eggs were carefully separated and air dried at room temperature. The diameters were determined using an electronic microscope. Volumetric and gravimetric methods were employed to estimate the number of eggs in each of the gravid fish.

Statistical Analysis

All the data obtained on gonads were subjected to independent sample t-test to determine the mean values. This was done at $p < 0.05$.

Commented [U14]: Correct the spelling

Results

Reproductive indices

Figure 1 showed mean gonad weight of *Auchenoglanis biscutatus* and *Protopterus annectens* from Lower River Benue at wadata which indicated that *Auchenoglanis biscutatus* female gonad was heavier than the male, same thing in the case of *Protopterus annectens*, the female gonad was heavier than the male, and in general the gonads of *protopterus annectens* were higher than that of *Auchenoglanis biscutatus*.

Commented [U15]: You have already mentioned figure 1 in study area. Kindly check the figure numbering.

Commented [U16]: Capital for species name.

Commented [U17]: What was the size of the mature fishes. Whether the gonad weight is size dependent? Kindly mention the average size of the fishes along with their maximum and minimum length and weight of the fishes.

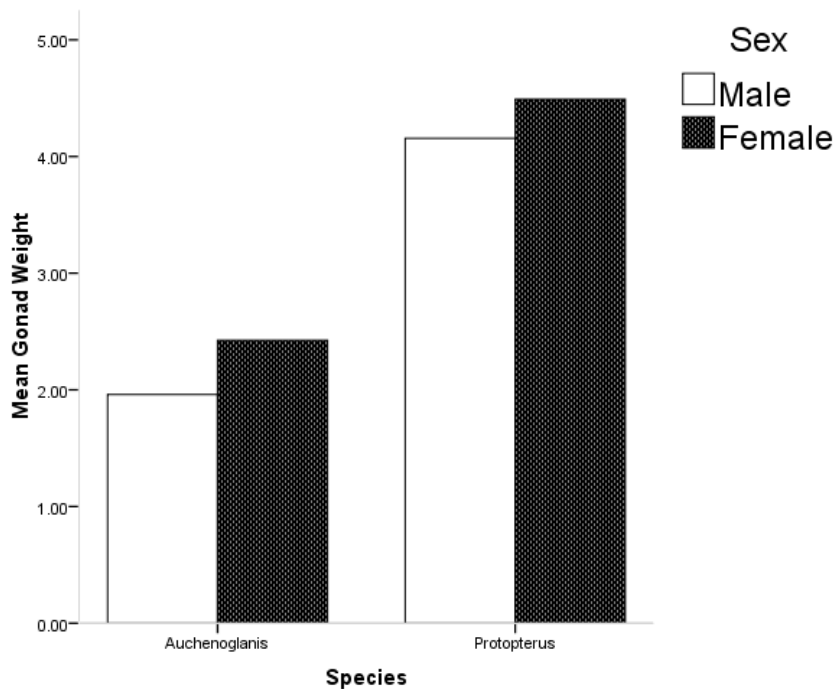


Figure 1: Mean gonad weight of *Auchenoglanis biscutatus* and *Protopterus annectens* from Lower River Benue at Wadata.

Table 1 explained the mean reproductive indices of *Auchenoglanis biscutatus* and *Protopterus annectens* from Lower River Benue, this showed all parameters differs significantly at ($p < 0.05$) with the sex ratio for both species as Male:Female (1.1:1) and the maturity ratio for both species showed the immature fishes were more than the matured fishes during the study period.

Table 1: Some reproductive indices of selected fishes from Lower River Benue

Parameters	<i>Auchenoglanis</i>	<i>Protopterus</i>	P-Value
Gonad Length	11.87±0.60 ^b	17.62±0.44 ^a	0.00
Gonad Weight	2.13±0.13 ^b	4.31±0.27 ^a	0.00
GSI	0.66±0.04 ^b	2.35±0.32 ^a	0.00
Sex Ratio (Male: Female)	1.1 : 1	1.1 : 1	
Maturity Ratio(Matured : Immature)	0.23 : 1	0.24 : 1	

*means in the same row with different superscripts differ significantly

Table 2 showed mean seasonal reproductive indices of *Auchenoglanis biscutatus* from Lower River Benue, which revealed that all Gonad length, Gonad weight and GSI differs significantly across the two seasons and the maturity ratio also showed the immature fishes were more than the matured fishes for both seasons.

Commented [U18]: Mention the full species name here or else given the common name for both the fish species

Commented [U19]: Mention the unit of measurement

Commented [U20]: Mention the unit of measurement

Table 2: Seasonal reproductive indices of *Auchenoglanis biscutatus* from Lower River Benue.

Parameters	Wet Season	Dry Season	P-Value
Gonad Length	7.79±0.41 ^b	15.94±0.89 ^a	0.00
Gonad Weight	1.24±0.11 ^b	3.01±0.19 ^a	0.00
GSI	0.48±0.05 ^b	0.87±0.06 ^a	0.00
Sex Ratio (Male: Female)	1 : 1	1 : 1	
Maturity Ratio (Matured : Immature)	0.40 : 1	0.09	

Commented [U21]: Mention the unit of measurement

Commented [U22]: Mention the unit of measurement

*means in the same row with different superscripts differ signific

Table 3 showed mean seasonal reproductive indices of *Protopterus annectens* from Lower River Benue, the results revealed Gonad length, Gonad weight and GSI differs significantly in both wet and dry season and the immature fishes were more than the mature fishes for both seasons.

Table 3: Seasonal reproductive indices of *Protopterus annectens* from Lower River Benue

Parameters	Wet Season	Dry Season	P-Value
Gonad Length	15.74±0.58 ^b	19.49±0.59 ^a	0.00
Gonad Weight	5.63±0.45 ^a	3.00±0.21 ^b	0.00
GSI	4.06±0.62 ^a	0.83±0.06 ^b	0.00
Sex Ratio (Male: Female)	1 : 1	1 : 1	
Maturity Ratio (Matured : Immature)	0.35 : 1	0.16 : 1	

*means in the same row with different superscripts differ significantly

Table 4 explained the mean seasonal reproductive indices of female *Auchenoglanis biscutatus* which indicated that for Egg diameter there was no significant difference across the two seasons. For Egg circumference also there was no significance difference in both wet and dry seasons, it was the same with Egg surface across the two seasons where there was no significant difference and also Relative fecundity showed there was no significant difference in both the wet and dry season. However Egg diameter, Egg circumference and Egg surface were higher in wet season why Relative fecundity was higher in dry season.

Table 4: Mean seasonal reproductive indices of female *Auchenoglanis biscutatus* from Lower River Benue

Parameters	Wet Season	Dry Season	P-Value
Egg Diameter	2.38±0.17 ^a	2.37±0.13 ^a	0.97
Egg Circumference	7.48±0.53 ^a	7.44±0.41 ^a	0.97
Egg Surfaces	4.67±0.70 ^a	4.43±0.49 ^a	0.87
Relative Fecundity	7.99±0.94 ^a	8.22±0.78 ^a	0.91

*means in the same row with different superscripts differ significantly

Table 5 showed mean seasonal reproductive indices of female *Protopterus annectens* which indicated that Egg diameter showed no significant difference in both seasons, Egg circumference also showed no significant difference, Egg surfaces had no significant difference in both wet and dry seasons, however Relative fecundity differs significantly across the seasons at ($p < 0.05$).

Table 5: Mean seasonal reproductive indices of female *Protopterus annectens* from Lower River Benue

Parameters	Wet Season	Dry Season	P-Value
Egg Diameter	1.64±0.16 ^a	1.99±0.08 ^a	0.25
Egg Circumference	5.16±0.50 ^a	6.24±0.26 ^a	0.25
Egg Surfaces	2.48±0.35 ^a	3.13±0.27 ^a	0.32
Relative Fecundity	3.43±0.94 ^a	0.48±0.22 ^b	0.00

*means in the same row with different superscripts differ significantly

Table 6 showed mean reproductive indices of *Auchenoglanis biscutatus* and *Protopterus annectens* from Lower River Benue; the results indicated that all parameters differ significantly among the two species except for relative fecundity that had no significant difference.

Table 6: Some reproductive indices of selected female fishes from Lower River Benue

Parameters	<i>Auchenoglanis</i>	<i>Protopterus</i>	P-Value
Egg Diameter	2.38±0.13 ^a	1.73±0.13 ^b	0.00
Egg Circumference	7.47±0.42 ^a	5.42±0.39 ^b	0.00
Egg Surfaces	4.62±0.55 ^a	2.64±0.27 ^b	0.00
Relative Fecundity	8.04±0.75 ^a	11.59±2.04 ^a	0.21

*means in the same row with different superscripts differ significantly

Gonadosomatic Index

Figure 2 showed gonadosomatic indices of *Auchenoglanis biscutatus* male was high in dry season with (0.8) compare to (0.6) wet season while in *Protopterus*

Commented [U23]: Kindly mention why you have compared some of the reproductive indices of both the species together in Table 6, since you have already mentioned in Table 4 & 5.

Commented [U24]: Write the full fish species name

annectens male, the GSI was high in wet season with (4.0) compare to dry season (1.00). For female *Auchenoglanis biscutatus*, GSI was low in wet season (0.2) compare to dry season (0.8) while for female *Protopterus annectens*, the GSI was high in wet season (4.00) compare to dry season (0.7).

Figure 3 showed the mean relative fecundity and length relationships of *Auchenoglanis biscutatus* which indicated that the lowest number of mean relative fecundity of 4.32kg was found in fishes that ranged 30.1-40cm and the highest was relative fecundity of 9.87kg was found in fishes ranged of 20.1-30.0cm.

Figure 4 showed mean egg diameter and relative fecundity of *Auchenoglanis biscutatus* that indicated there was no known trend.

Figure 5 showed the mean relative fecundity and length relationship of *Protopterus annecten* that showed that the least mean relative fecundity of 7.85kg was found in fishes ranged of 10-20.0cm and the highest mean relative fecundity of 22.92kg found in fishes ranged of 20.1-30.0cm. However, this also showed that almost all the relative fecundity increases with increase in the length of the fish.

Figure 6 showed mean egg diameter and relative fecundity of *Protopterus annectens* that indicated there was no known trend.

Commented [U25]: Correct the species name here

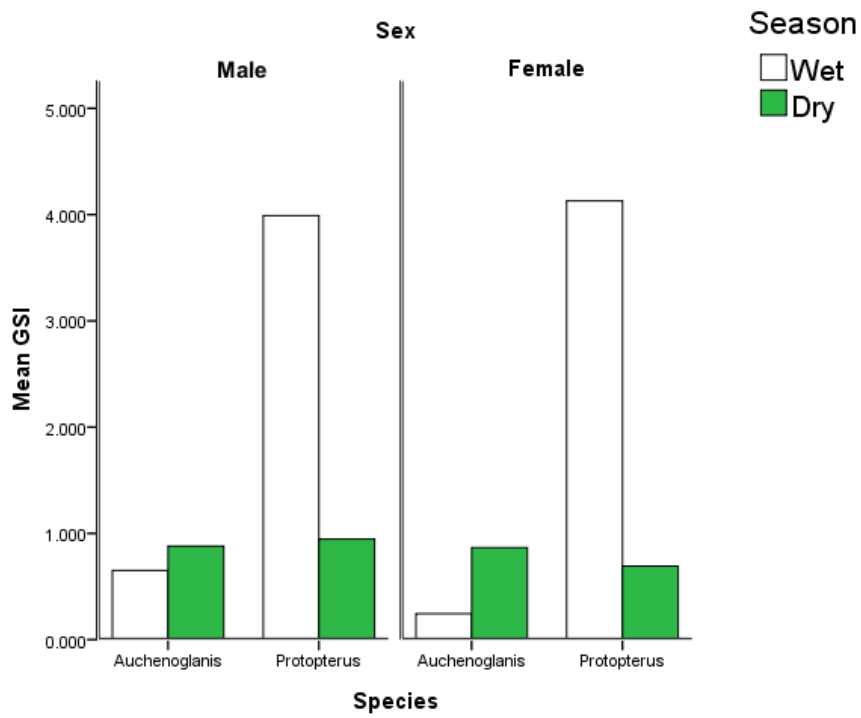


Figure 2: Seasonal variation of the Gonadosomatic Indices of *Auchenoglanis biscutatus* and *Protopterus annectens* from Lower River Benue

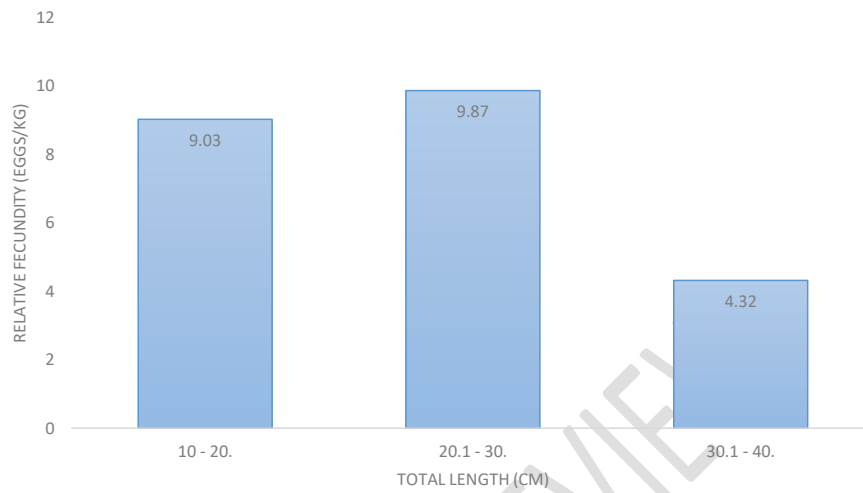


Figure 3: Mean relative fecundity and length of *Auchenoglanis biscutatus* From Lower River Benue at Wadata.

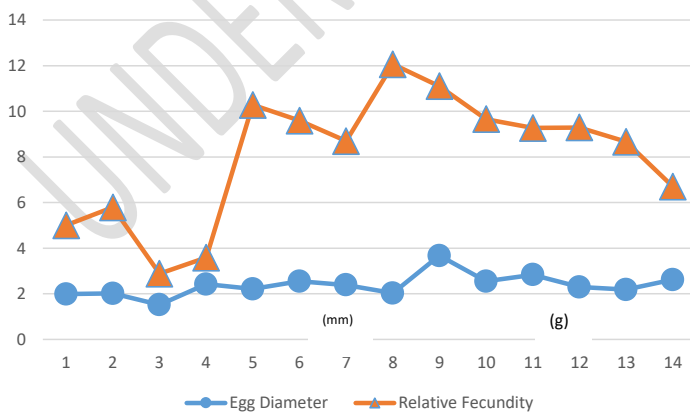


Figure 4: Mean egg diameter and relative fecundity of *Auchenoglanis biscutatus* From Lower River Benue at wadata

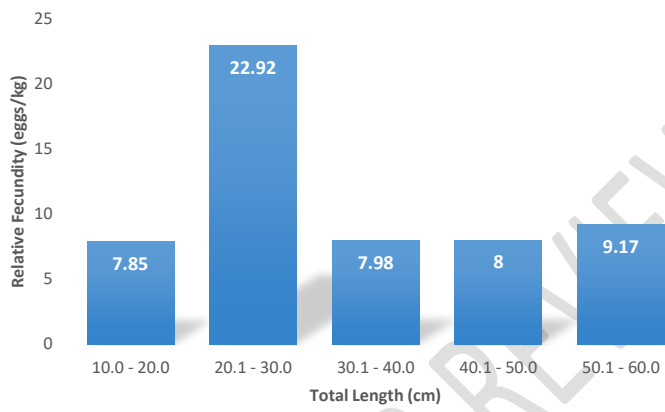


Figure 5: Mean relative fecundity and length of *Protopterus annectens* From Lower River Benue at Wadata.

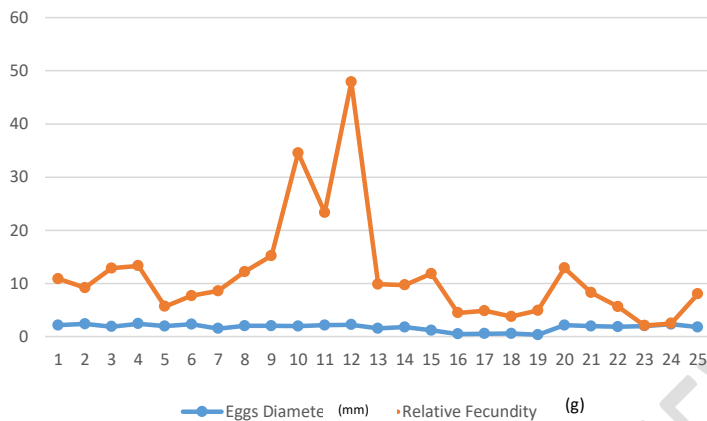


Figure 6: Mean egg diameter and relative fecundity of *Protopterus annectens* From Lower River Benue at Wadata.

Discussion

Stage of gonad maturity or development is a key factor to the understanding of the dynamics of gonads as they develop in order to assess the reproductive mechanism of any fish species. Egg development stages I-VI was recorded during the period of study, and as the ovaries develop there is increase in volume and also differences in size and form. The distribution revealed that there were more males at the developing (II) and maturing (III) stages, more females at the matured stages (IV), and maturing stage (III). This showed that females were more matured than males during the period of the study. This is unlikely connected with the period of breeding or spawning activities and food availability. Dada and Araoye (2008) reported high abundance of stages I-III, VI-VIII though IV-V was the highest. Offem *et al.*, (2008) reported males and females of total lengths (11.50cm) and (16.70cm) to have reached first maturity and concluded that male's attained maturity earlier than females, which disagrees with the present study. The mean Gonado-somatic index showed that combined sexes of *Protopterus annectens* were higher in wet season. Female *Auchenoglanis biscutatus* had the least mean values.

Commented [U26]: Highest in which species? Complete the sentence

Commented [U27]: Which fish species, kindly mention.

Commented [U28]: Explain

Gonadosomatic index (GSI) indicates gonadal development and maturity of fish (Rheman *et al.*, 2002). The difference between male and female GSI suggests that energy invested in gamete production by male is probably less than that invested by females Partmar, (2008). Generally, the results show that GSI of males were lower than those of the females. This could be due to physiological and hormone effects on the gonadal development of fish. The present study also showed that the GSI increase for both sexes of *Protopterus annectens* during rainy season. This could be due to spawning period and development gonads. Fecundity is important in the estimation of stock size and stock discrimination of fish. It reveals useful information about the reproductive potential of fish. Ekamem (2000) reported 28,086 eggs as absolute fecundity for species, while Offem *et al.* (2008) did report 10,816 eggs; absolute and mean fecundity of 6,844-25,905 eggs and 4,522-20,321 eggs, respectively; which was high during April-June and fall sharply during August - September, which agrees with the findings of this study on *Auchenoglanis biscutatus* which showed the relative fecundity was higher in dry season (8.22 ± 0.78) than wet season (7.99 ± 0.94) but disagrees with the findings on *Protopterus annectens* which showed that the relative fecundity was higher in wet season (3.43 ± 0.94) than dry season (0.48 ± 0.22).

The result from this study also showed that *Protopterus annectens* had a higher relative fecundity during the period of study than *Auchenoglanis biscutatus*.

This could be due to the sizes and number of gravid fish caught, location, abundance of food, and physico-chemical parameters.

Adeyemi and Akombo (2010) reported that low fecundity could be due to fishing intensity and possibly strong intra and inter specific food competition. Adeyemi (2011) reported food and environmental factors apart from genetic factor to influence fecundity of fish. There was also increase in the number of eggs as the fish increase in size. The dissimilarities in the fecundity observed in

Commented [U29]: Mention the fish species for which study was carried out.

Commented [U30]: Reconstruct the sentence

Commented [U31]: Mention the fish species studied on. Fecundity of which fish species?

this study could be due to the samples examined. Offem *et al.*, (2008) reported that the volume of eggs a fish can produce depended on space available in the body cavity that accommodate the eggs before spawning.

The mean egg diameter of the species ranged from 1.73 ± 0.13 - 2.38 ± 0.13 mm. These results is in disagreement with the findings of other researchers on *Synodontis* species.

Halim and Guma'a (1989) observed the egg diameter of 0.6-0.9mm for *S. schall* from the White Nile. Araoye (2001) observed the diameter of 0.80-1.0mm (mean 0.99mm) for *S. schall* in Asa Lake, Ilorin. Laleye *et al.*, (2006) reported the diameter of 0.8-1.5mm for *S. nigrita* and 0.5-1.0mm for *S. schall* from Oueme River. The difference in egg diameters in this study with the others could be as a result of the different methods used in determining the size. Another reason could be the nutritional status of the fishes in the different localities.

However this study revealed there was no known trend for egg diameter and relative fecundity. The reason for this might be the order which they were captured as older fishes may be caught at some point and younger fishes at another point during the sampling period given that non-uniform trend.

Sex ratio provides information on the proportion of male to female in a given fish population, necessary for fish reproduction, stock size assessment, and the dominance of sex (Vicentini and Araujo, 2003). According to Laleye *et al.*, (2006), 1:1 is the ideal value of sex ratio. However, it may vary according to the year of captures, the season, the type of gear (Laleye *et al.*, 2006) and length group. Geographical location can also influence sex ratio (Wicconghby, 1997). In some cases, males may prevail in some population.

The results indicated the dominance of males over females. The reason for the male dominance could be that males move away from areas of spawning to

where they are captured once fertilization of eggs is established while the females probably go towards submerged vegetation and other areas around the reservoir to evade predators and also continue brooding and protection of the offspring. Related results were observed by Oso *et al.*, (2013) for two dominant fish species in Ado reservoir, Southwest Nigeria.

The findings from this study are in line with the works of Midhat *et al.*, (2012) who worked on *Synodontis* species in Egypt where they found that the number of males exceeded that of the females with the sex ratio of 1:0.83 (males 361, females 298). Offen *et al.*,(2009) observed in river Benue at Makudi, that *Synodontis clarias* and *E. resupims* had more males than female with the sex ratio of 1:2:1 and 8:1 respectively. The presence of more male than females according to Offen *et al.*, (2009) could be favourable to the fishery as it could serve as a regulatory mechanism for the sex ratio.

Commented [U32]: Kindly cite some recent references of reproductive biology study of fishes for wet and dry breeders.

Conclusion and Recommendation

It was concluded that the study of the sex ratio indicates that males were higher than females. The relative fecundity of *Protopterus annectens* was higher than that of *Auchenoglanis biscutatus* during the study period. Based on the findings of the study, I recommend that this fish species be domesticated.

Commented [U33]: Rewrite the conclusion part. Giving a summary of the study along with the comparison study of the two species. Future study and its importance in fisheries and aquaculture study.

References

- Adeyemi S.O. (2011). Study of some physico-chemical parameters and their effect on potential Fish Yield in Gbdikeren Lake. Bassa Kogi State, Nigeria. *Pakistan Journal of Nutrition*, 10(5):475-479.
- Adeyemi, S. O. and Akombo, P. M. (2010). Inter and intra-specific feeding competition among fish species in Gbedikere Lake, Kogi State, Nigeria. *International Journal of Lakes and Rivers*, 2 (1): 125-132

- Akombo, P.M., Atile, J.I., Adikwu, I.A. and Araoye, P. A. (2013). Morphometric measurements and growth patterns of four species of the genus *Synodontis* (Cuvier, 1816) from Lower Benue River, Makurdi, Nigeria. *International Journal of Fisheries and Aquaculture*, 3(15):263-270
- Allison, M. E., Sikoki, F. D. and Vincent - Abu, I. F. (2008). Fecundity, sex ratio, size at first maturity, maturity stages, breeding and spawning of *Parailia pellucida* (Boulenger, 1901) in the lower nun River, Niger Delta, Nigeria. *Cadernode Pesquisa serie Biologia*, Universidade de Santa Cruz do Sul.20(2): 31- 47.
- Araoye, P.A. (2001). Morphology of the gonads in the reproductive cycle of *Synodontis schall* (Teleostei: Mochokidae) in the environment of Asa Dam, Ilorin, Nigeria. *Nig. Journal of pure and applied Science*, 17:n 1235-1243.
- De Vos (1995). A systematic revision of the African Schilbeidae (Teleostei, Siluriformes) with an annotated bibliography. *Annals of Royal African Museum Centre*, no. 271, 450p.
- Ekanem, S. B. (2000). Some reproductive aspect of the biology of *Chrysichthys nigrodigitatus*. (lacepede) from Cross River, Nigeria.
- Froese, F Palomares,M.L.D, Pauly,D, Estimation of life-history key facts. <http://www.fishbase.us>. 12 June, 2017.

Commented [h34]: Kindly follow similar format for all the references

Halim, A.I.A. and Guma'a. S.A. (1989). Some aspects of the reproductive biology of *Synodontis schall* (Bloch and Scheider, 1801) from the white Nile near Khartoum. *Hydrobiologia*, 178: 243-251.

Laleye, P., Chikou, A., Gnohssou, P., Vandewalle, J.C.P. and Teugels, G. (2006). Studies on the biology of two species of catfish *Synodontis schall* and *Synodontis nigita* (Ostariophysi: Mochokidae) from the oueme River, Benin. *Belg. J. Zool.*, 136 (2): 193-201

Midhat, A.E.K., Mohammed, M.N., A. and Seham, A.I. (2012). Environmental studies on *Synodontis schall* (Bloch and Schneider, 1801), (Pisces: Mochokidae) in the River Nile at Gzza Sector, Egypt: Biological aspect of Population Dynamics, *Journal of Fisheries and Aquatic*, 7:104-133.

Commented [h35]: Correct the format

Novaes, J.L.C; and Carvalho, E.D; Reproduction, food dynamics and exploitation level of *Oreochromis niloticus* (perciformes: cichlidae) from artisanal fisheries in Barra Bonita reservoir, Brazil. *Revista de Biologia Tropical*. 60(2) (2012) 721–734.

Commented [h36]: Follow similar format

Offem, B. O., Samson, A. Y. and Omoniyi, I. T. (2008). Diet, size and the reproductive biology of the silver catfish *Chrysichthys nigrodigitatus* (Siluformes: Bagridae) in the Cross River Nigeria. *International Journal of Tropical Biology*, 56 (4):1785-1799.

Offem, B.O., Samsons, Y,A., Omonyi, I.T. and Ikpi, G.U. 2009). Dynamics of the Limnological features and diversity of Zooplankton populations of the Cross River System, South East Nigeria.

Knowledge and management of Aquatic Ecosystems,. 2:1-19.

Okafor, A. I., Egonmwan, R. I., Chukwu, L. O., (2012). Behavioural Ecology of the African Lungfish, *Protopterus annectens* (Owen, 1839) of Anambra River, Nigeria. *International Journal of Environmental Biology*, 2, 208- 214.

Commented [h37]: Follow similar format

Oso J.A. Fecundity of two dominant fish species in Ado reservoir, Southwest Nigeria. *Albanian Journal Agricultural Science*. 12(4) (2013) 603–

Patimar, R.(2008). Some Biological Aspects of the Sharpnose Mullet *Liza saliens* (Risso, 1810) in Gorgan Bay-Miankaleh Wildlife Refuge (the southeast Caspian Sea). *TrJFAS*, 8: 225-232.

Commented [h38]: Follow similar format for all the references

Pauly, D. (2002). Reproductive strategies of Fishes in a Tropical temporary stream of the Upper Senegal Basin: Baoulé River in Mali. *Aquatic Living Resources*, 15: 25-35.

Pauly, D., Leveque, C. and Teugels, G.G. (2003). *The Fresh and Brackish water Fishes of West Africa*, Volume I, Institute of Research and Development Editions. Collection Faune et Flore tropicales 40, Paris. 457p.

Rheman, S., Islam M.L, Shah M.M.R, Monda S. and Alan M.J. 2002. Observation on the fecundity and gonadosomatic index (GSI) of gray mullet *Liza parisa* (Ham.). *J. Biological Sci.*, 2(10): 690-693.

Umaru, J. A., Annune, P. A., Cheikyula, J. O., Okomoda, V. T. (2015). Some Biometric Parameters of Four Selected Fish Species in Doma Dam, Nasarawa State, Nigeria, *International Journal of Aquaculture*, 5, 1-7.

Vicentini, R. N. and Araujo, F. G. (2003). Sex ratio and size structure of *Micropogonias furneiri* (Desmaarest, 1823), (Perciformes, Sciaenidae) in the Sepetiba Bay, Rio de Janeiro, Brazil. *Brazilian Journal of Biology*, 3: 559- 566.

UNDER PEER REVIEW