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Research Article

Reproductive Biology of *Bagrus bayad* (Forskal, 1775) from Jibiya Dam of Katsina State, Nigeria

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ABSTRACT

Investigation on the Reproductive Biology of Bagrus bayad in Jibiya Dam from Katsina State, Nigeria was carried out from July – December 2019 using standard procedures. One hundred and sixteen (116) samples of B. bayad were harvested and collected during the study period in order to determine sex ratio, fecundity and Gonadosomatic Index (GSI) of the fish species. Results indicated that the male:female sex ratio was 1.3:1 which was not significantly different from the hypothetical 1:1 ($p>0.05$). It was also found that the GSI of B. bayad was highest in July (0.23) and lowest in October (0.12). The relationship between fecundity and ovary weight was positively significant ($p<0.05$). Similarly, there was a significant positive relationship between fecundity and body weight as well as between ovary weight and age ($p<0.05$). However, no significant relationship was found between ovary weight and body weight, body weight and age and between fecundity and age ($p>0.05$). It is recommended that comparative study on the stages of maturity of male and female B. bayad in Jibiya Dam be investigated.

Keywords: *Age, Fecundity, Gonadosomatic Index (GSI), Reproductive Biology.*

INTRODUCTION

Freshwater is a very important natural resource crucial for the survival of life on earth and essential for sustainability of the earth's crust ecosystem (UNESCO, 2003). Water bodies in Nigeria which are mostly freshwater are homes for various aquatic organisms such as phytoplankton, zooplanktons, crustaceans, and vertebrates (Atobatele & Ugwumba, 2008) as such, provide food and recreational values to mankind. The rate of growth as well as reproduction rate of any organism including fishes depends on food and other factors such as genetic and environmental factors.

Reproduction in fishes is one of the fundamental biological processes that enables survival and continuity of species in the aquatic environment (Yem, 2014).

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In the study of reproductive biology of fish, parameters such as sex ratio, stage of maturity, gonad index (GI), gonadosomatic index (GSI), and fecundity are usually considered. Regenerative capacity of fish population is within the confinement of the reproductive patterns, growth and mortality of fish. Gonad maturation stage is associated with maturity, age at first maturity and size. Fecundity is influenced by the fish size, kind of species, season and reproductive behavior. Marked differences in fecundity among fish often reflected different reproductive strategies (Murua & Saborido-Rey, 2003). The knowledge about these parameters is necessary for the determination of reproductive potential of fish populations and monitoring of changes in biological features of fish stock (Williams, 2007). The combination of the biological parameters of *B. bayad* considered in this study is quite auspicious. Moreover, understanding the reproductive biology of *B. bayad* will aid the proper management strategies to sustain this valuable fish. This rationale underpins the justification of this study.

MATERIALS AND METHODS

Study Area

Jibiya dam is located in Jibiya Local Government Area of Katsina State, Nigeria. It is located on River Gada at coordinates 13^{o} 04`18"N and 07$^{o}$ 15`06"E (Figure 1). The dam has a depth of 23.5 m, embankment volume of 2,000,000 m^{3}, storage capacity of 142,300,000 m^{3} and a crest length of 3,660 m. The dam is used for fishing and domestic activities.

Samples Collection of *B. bayad*

A total of one hundred and sixteen (116) fish samples of *B. bayad* were purchased randomly from the fishermen of the dam. The samplings were made twice per month between the months of July and December, 2019. The samples were collected in the early morning (7-8am) from the fisher men at the dam site. Immediately after capture the fish samples were chilled with ice and placed in a vacuum flask to maintain freshness. They were then taken to the Postgraduate Laboratory Department of Biology of Umaru Musa Yar'adua University, Katsina (UMYUK) for proper identification and further analyses.

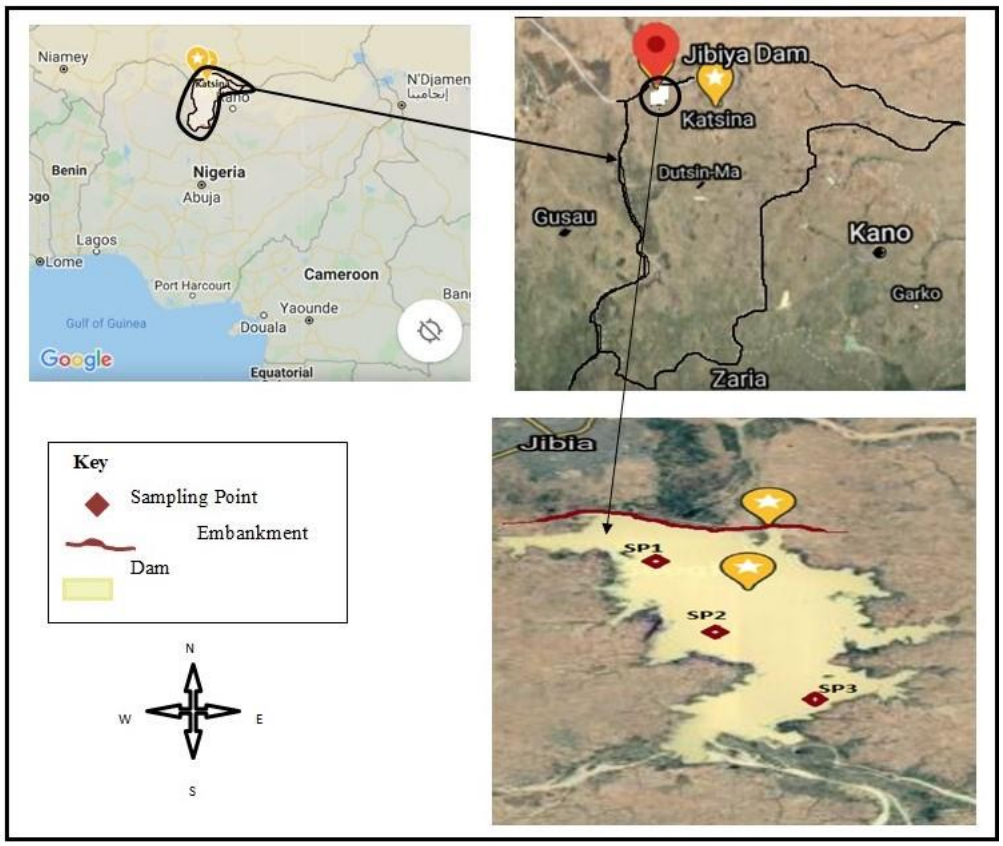

Figure 1: Map of the Study Area and Sampling Zones on Jibiya Dam (Source: Google Map)

Sex Ratio Determination

Sexes of *B. bayad* samples were determined following the methods of Akombo et al. (2013) by visual observation of the external features and binocular dissecting microscopic examination of the various gonads. Females were distinguished from the male by the presence of reddish round inflammation around the genital aperture while the male were recognized by the presence of testes, broader mouth part with larger heads. The number of males and females of *B. bayad* for each sampling period was recorded and used to determine the sex ratio by the given formula below (Akombo et al., 2013).

$$\text{Sex Ratio} = \frac{\text{Number of Males}}{\text{Number of Females}}$$

Determination of Gonadosomatic Index (GSI)

GSI of *B. bayad* was determined by substituting the body weight of the sample with their corresponding gonad weight into the formula suggested by Allison et al. (2008) as follows.

$$\text{GSI} = \frac{\text{Weight of Gonad (g)}}{\text{Weight of the Fish (g)}} \times 100$$

Fecundity Estimation

To estimate the fecundity of *B. bayad*, volumetric method of Cailliet et al. (1986) was employed. Eggs obtained from the ovaries of 14 gravid *B. bayad* were extracted and preserved in 10% formalin over night to unclog the eggs. A dropper was used to pick drops of the eggs in the formalin and placed under a dissecting microscope while the number of eggs was counted. The number of counted eggs was multiplied by the number of drops to determine the fecundity of the fish.

Statistical Analyses

Microsoft excel (2016) and Statistical Package for Social Sciences (SPSS) were employed in the data analyses Chi-square test was used to test for significant difference in sex ratio, while Pearson Product Moment Correlation was used to determine the relationship between data on GSI and fecundity of *B. bayad* in the study area. P> 0.05 was set up as the confidence level.

RESULTS AND DISCUSSION

Sex Ratio of *B. bayad* from Jibiya Dam

Out of the total catch, 55.17% were males, while 43.10% were females (Table 1). There were more males in July (1.8:1), September (1.5:1) and December (2:1) than the females, while there were more females in October (1:1.5) than their counterpart. The sex ratio was equal in August and November. The total sex ratio was not significantly different from the hypothetical 1:1 ($\chi^2 = 8.25; p>0.05$).

Findings of this study have shown that the sex ratio of *B. bayad* in Jibiya Dam varied across the study period. The sex ratio across the months apparently showed that males *B. bayad* were more abundant than the females. This result contravenes what was observed for *P. senegalensis* where more females than males were observed in Tombo, Western Rural District of Sierra Leone (Olapade & Tarawallie, 2014). However, Yem (2014) argued that, it is a common phenomenon in animals like fish that males are more in abundance than females. This is due to the fact that female fishes move to hidings during spawning seasons. Offem et al. (2008) reported that females could go towards submerged vegetation and rocky areas to avoid fishermen, spawn and protect their offspring, while the males possibly migrate from spawning areas to feeding grounds where they could be captured. However, the total sex ratio for male to female was found not deviating from the hypothetical 1:1 (p>0.05). This result is similar to what was obtained for *B. docmak*

in Lake Chamo, Ethiopia (Anja et al., 2009). The result disagrees with the finding of Yem (2014) that male silver catfish were more in abundance than the females.

Table 1: Sex Ratio of *B. bayad* from Jibiya Dam

Month	No. of Male (%)	No. of Female (%)	Sex Ratio
July	18(64.28%)	10(35.71%)	1.8:1
Aug	8(50.00%)	8(50.00%)	1.1
Sept	12(60.00%)	8(40.00%)	1.5:1
Oct	6(40.00%)	9(60.00%)	1:1.5
Nov	10(50.00%)	10(50.00%)	1:1
Dec	10(66.67%)	5(33.33%)	2:1
Total	64(55.17%)	50(43.10%)	1.3:1

Gonadosomatic Index (GSI) of *B. bayad* from JIbiya Dam

Mean GSI for males was highest in September (0.26) followed by July (0.24) and December (0.22) while the lowest (0.14) was in October (Figure 2a). For females, mean GSI was highest in November (0.22) and July (0.21) and lowest in August (0.11) (Figure 2b) For the combined sexes, GSI was highest in July (0.23) and lowest in October (0.12).

Findings of this study on GSI are quite different from what was obtained for other catfish species such as the silver catfish which had GSI ranging from 1.25 to 7.91 in females, and 0.57 to 3.17 in males (Offem et al., 2008). This study also reveals a higher GSI in males than in females agreeing with the findings of Anja, et al. (2009) who reported higher GSI in male than in female. The finding however contradicts Dada and Araoye (2008) previously reported higher GSI for female than for male Silver Catfish. One reason that may account for this difference could be due to the age of the fish and the rigorous fishing activities going on in the study area.

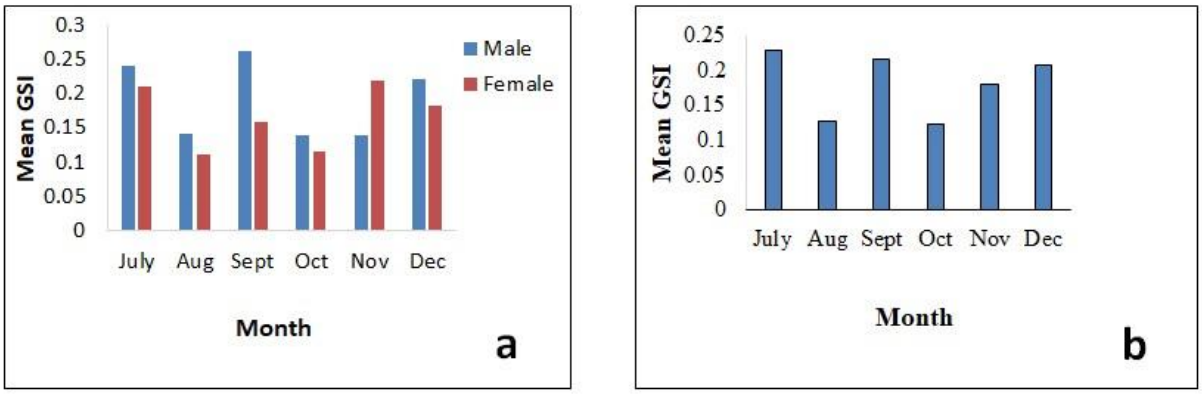

Figure 2: Monthly Mean GSI of *B. bayad* from Jibiya Dam. (a) Male and female; (b) Combined sexes

Fecundity of *B. bayad* from Jibiya Dam

Mean fecundity was highest (110,867.00) in August and lowest (22,018.86) in December (Figure 3). There is no significant difference among the monthly mean fecundity ($F_{5, 14}$ = 1.697; p>0.05). Hence, monthly mean fecundity was statistically the same.

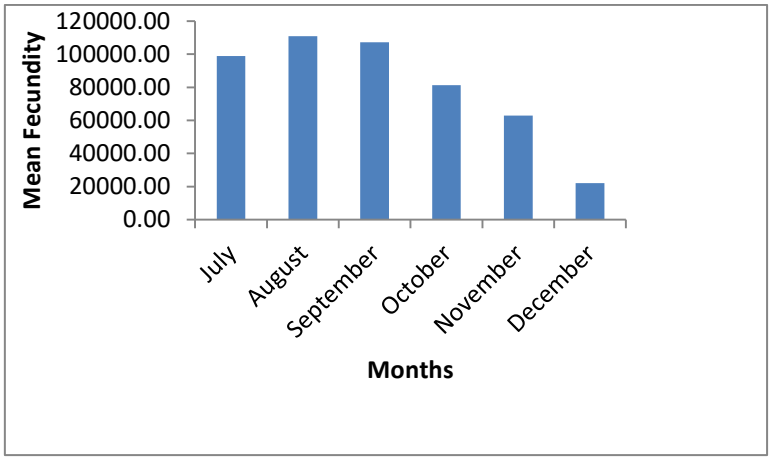

Figure 3: Monthly Mean Fecundity of *Bagrus bayad* from Jibiya Dam

Results of this study showed that there is significant positive relationship between ovary weight and fecundity and between fecundity and body weight. The relationship between ovary weight and fecundity and between fecundity and body weight were positive and significant. This means that, a unit increase in ovary weight leads to an increase in fecundity. Also, an increase in fecundity leads to an increase in body weight and vice visa. This finding proves that ovary weight defines the validity of *B. bayad* fecundity. Anja et al. (2009) reported that fecundity positively relates not only to ovary weight but also the total weight body weight and full length of *B. docmak*. Tsadu et al. (1996) previously reported a positive relationship between fecundity, body size and gonad weight. It can therefore be inferred that, the weight of ovary adds more weight to the body and as well increases the potential for large number of egg production.

Relationship among Reproductive Parameters of *B. bayad*

There was a significant positive relationship between ovary weight and fecundity ($r = 0.461; p<0.05$), fecundity and body weight ($r = 0.483; p<0.05$) as well as between age and ovary weight ($r = 0.981; p<0.05$) of the fish species (Table 2). However, no significant relationship was found between ovary weight and body weight ($r = 0.230; p>0.05$), body weight and age ($r= 0.198; p>0.05$) and between fecundity and age ($r=0.498; p>0.05$).

Table 2: Relationship among Reproductive Parameters of *B. bayad* from Jibiya Dam

		Ovary Weight	Fecundity	Age	Body Weight
Ovary Weight	Pearson Correlation	1			
	Sig. (2-tailed)				
	N				
Fecundity	Pearson Correlation	.461**	1		
	Sig. (2-tailed)	.002			
	N	15			
Age	Pearson Correlation	.981**	.498	1	
	Sig. (2-tailed)	.000	.059		
	N	15	15		
Body Weight	Pearson Correlation	.230	.483**	.198	1
	Sig. (2-tailed)	.409	.000	.479	
	N	15	15	15	

**. Correlation is significant at the 0.01 level (2-tailed).

The relationship between age and ovary weight in this study was very high, suggesting a strong linear relationship between the two parameters. The age of fish at maturity would invariably affect the weight of ovary. As the fish increases in age, the size also increases. Agarwal (2004) stated that, fishes vary in terms of number of eggs produced in the ovary depending on their ages. The volume of eggs a fish can produce depends on space available in the body cavity to accommodate the eggs before spawning (Yem, 2014). However, this study revealed no significant relationship between ovary weight and body weight.

CONCLUSION

This study revealed that the age of males and females *B. bayad*. differed, and fall within the range 0+ and 3 with more females aged than males. *B. bayad* were found to be omnivores as they feed mainly on fishes and insects. The sexes of *B. bayad* were equal in the population with GSI peak at July. Increase in ovary weight added to the body weight and higher fecundity potential of *B. bayad*.

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Conflict of Interest

The authors declare no competing of interest.

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Availability of Data and Materials

The data sets generated and analyzed during this study are available from the corresponding author on reasonable request.

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