RELATIONSHIP BETWEEN SELECTED REPRODUCTIVE PARAMETERS OF *Bagrus bayad* IN KIRI RESERVOIR SHEL LENG, ADAMAWA STATE, NIGERIA

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ABSTRACT

The study is aimed at investigating the relationship between maturity stages, fecundity, length-weight relationship and condition factor of Bagrus bayad. A total of 282 samples of B. bayad were collected over a period of 6 months and the data collected from its reproductive analysis were subjected to one-way analysis of variance (ANOVA), descriptive statistic, regression analysis, graph (bar chart) mean and standard deviation were used for analyzing and presenting the data for analysis. Result from the data analysis showed the b value for male = 1.996 which is less than 3.0, hence the male fish showed a negative allometric growth pattern. While that of the female showed that the b value was 3.297 which is positive allometric growth pattern and the combined sexes analysis shows that b= 2.330, which indicated a negative allometric growth pattern. The condition factors showed that the Male has K = 2.893, Female has K = 3.122 and the Combined Sexes Condition factor is K = 3.002. Male and female gonad maturing stages is III and IV. Stage I II and VI, no fecundity for these stages and mean total fecundity ranges from 44135.18 – 90908.25. However, the increase in fecundity is related with the increase in condition factor,

Keywords: Species, Aquatic, Environmental, Quantitative, Parameter, Reproductive

INTRODUCTION

Reproduction in fishes is one of the fundamental biological processes that enables survival and continuity of species in the aquatic environment (Yem, 2014). Maturity in fishes is very much governed by age, the type and quantity of food and certain environmental conditions. On attaining the proper age, the gonads start maturing gradually with the advent of breeding season. The gonadal development depends on several external factors in addition to the internal pituitary and gonadal (hormone) secretions (Gubta and Gubta, 2006). 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 and 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 (Ahmad *et al.,* 2021). According to Wooton (1992), the volume of eggs produce depends upon the space available in the body cavity to accommodate the eggs before spawning. He also observed that in fishes generally large body size does not mean production of large size eggs; so, fecundity increases with increase in body size or body cavity. Length-weight gives information on the condition and the growth pattern of fish (Olurin and Adenibigbe, 2006). Length and weight measurement in conjunction with age data can give information on the stock composition, age at maturity, life span, mortality, growth and reproduction (Fafioye and Oluajo, 2005).Anderson and Neumann, (1996) ascertain that Condition factor refer to length weight data of population, or the ratio of length to the weight of fish which are the basic parameter for any monitoring study of fishes, since it provides important information concerning the structure and function of populations. Condition factor gives a picture of the general wellbeing of fish (Abubakar, 2006). The combination of the biological parameters of *B. bayad* considered in this study is important. Moreover, understanding the reproductive biology of *B. bayad* will aid the proper management strategies to sustain this valuable fish species. This rationale underpins the justification of this study.

MATERIALS AND METHODS

Study Area

The study area is Kiri reservoir in Shelleng Local Government Area of Adamawa State, Northeastern Nigeria. Kiri reservoir is a manmade lake from river Gongola and lies between 9^0 40.47" N, 12^0 0015" E. The reservoir has a total capacity of 615 million M^3. It is 1.2km long.

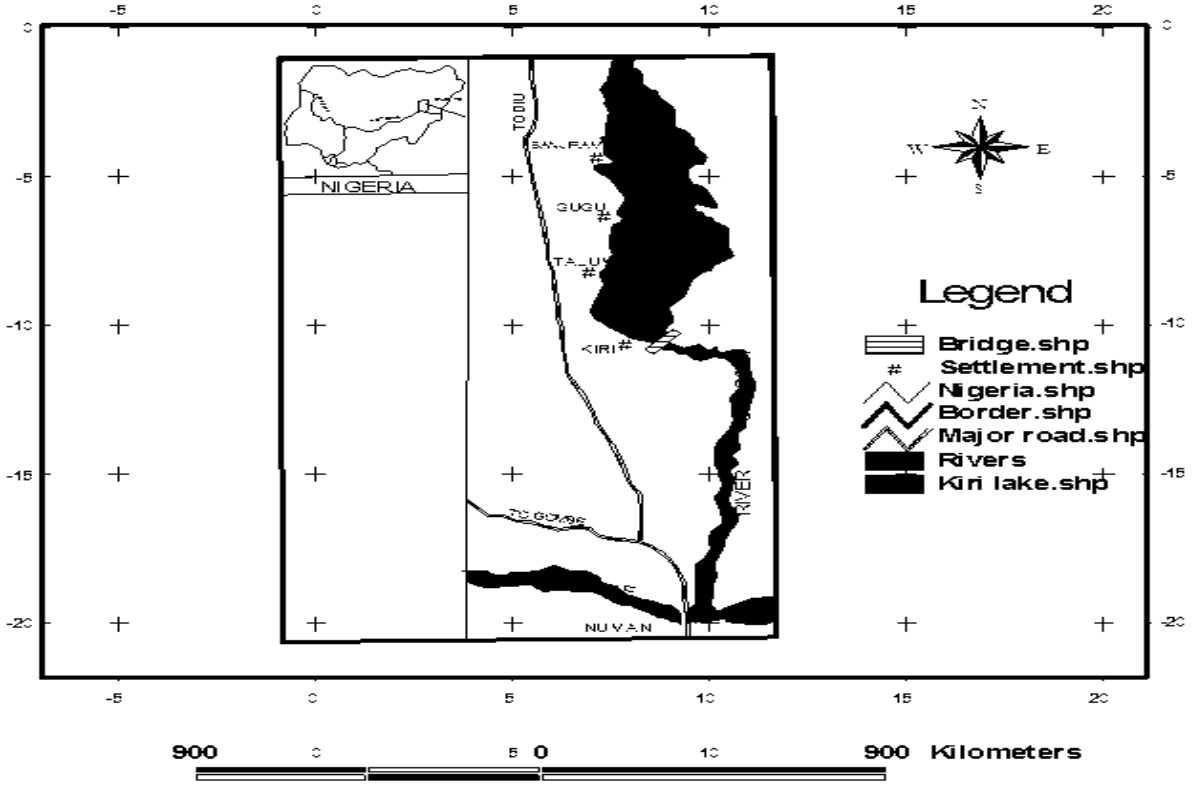

Figure 1: Map of Nigeria Showing the Location of Adamawa state, Kiri Town and Kiri Reservoir (Source: Google, 2016)

The reservoir was created from the damming of River Gongola, which was constructed in 1982, aimed at providing irrigation for Savannah Sugar Company (Institute of Civil Engineers, 1990). The host town Kiri is a River side resort with a unique feature and scenic of savannah landscape supplemented by the famous River Gongola with extensive Fadama flood plain. Kiri has a tropical savannah climate with two clear marked seasons of wet from April to October and dry from November to March.

Sample Collection

A total of 282 individuals of *Bagrus bayad* were randomly sampled monthly for 6 months and usually in the morning between 8:00am to 10:00am, and in the evening between 3:00pm and 5:30pm. A total of 47 males and female *B. bayad* samples were collected from the reservoir each month. The sample specimen was preserved with ice in a cooler and conveyed to laboratory where analysis for gonad maturity stages, length-weight measurement, fecundity and condition factor, were done. The duration for the study was 6 months from November 2016 to April, 2017. The fish used for the study were obtained from fishermen operating along kiri reservoir. The fishermen used various fishing gears ranging from hand nets, cast nets and gill nets of various standard mesh sizes (20.2, 25.4, and 30.5mm) as well as canoe and calabash were used as fishing craft. The Total Length (cm) of each fish was taken using a measuring ruler to the nearest 0.1 cm. Standard Length (cm) for each fish was taken to the nearest 0.1 cm. The total body weight in grams was measured for each fish sample to the nearest 0.01 g using a top loading Mettler balance (Mettler Toledo-ML204T). The sex of each fish sample was determined by visual observation of genitals.

Determination for Maturity Stages

Following Abbas (1982) techniques, the maturity stages of the ovaries and testis were identified and distinguished as follows: -

i. Stages I (Immature): Gonads are small, ovary is transparent, and eggs are small and cannot be detected by the naked eye. Testis is thread like.
ii. Stage II (Resting stage): Gonads are still small and extend along a ½ the length of the abdominal cavity. The ovary is still transparent and not thick. The eggs still cannot be distinguished with naked eye. Testis still without well define side lobes.
iii. Stage III (Maturation): The gonad begins to develop and extend along ¾ of the abdominal cavity length, ovary is yellowish. Eggs are distinguished to naked eye; Testis start to have side lobes.
iv. Stage IV (Maturity): Sexual products are clear the gonads nearly extend along the whole length of the abdominal cavity and reach their maximum weight. Ovaries are orange but the eggs still not extruded while tests lobes are clear, finger like and full of sperms.
v. Stage V (reproduction): Ovaries are voluminous with large viable eggs which could be seen through the thin ovarian wall. Testis is whitish in colour with stout lobes which are distended with sperms.
vi. Stage VI (Spent): The ovary is flaccid, reddish black in colour and much reduced in size, the testis is yellowish, white in colour, soft, empty and fleshy in its appearance.

Determination for Length-Weight Relationship

The length – weight relationship was determined using the conventional formula described by Le-Cren (1951).

$W = aL^b$

The equation and the data were transformed to logarithm before the determinations were done. The equation was therefore transformed into

Log W = log a + b log L

Where:

W = Weight of fish in grams

L = Standard length of fish in cm

a = a constant

b = an exponent

Determination for Condition Factor

The condition factor "K" was determined for individual fish using conventional formula described by Worthington and Richardo (1931). The ratio of length to the weight of the fish was determined by the formula:

$$K = \frac{W \times 100}{L^3}$$

Where

K = condition factor

W= weight in grams

L = standard length in centimeters

Determination for Fecundity

Fecundity was determined as described in Gravimetric methods by Khanna and Singh (2003). Matured ovaries were carefully removed (after making an incision from the vent to the lower jaw to expose the visceral organs of the fish) and preserved in 10% formalin in Petri dish. The weight of ovaries was determined and 3 samples of 100mg each were taken at random from interior, middle and posterior, and were counted under a binocular microscope.

Fecundity was determined by the formula;

$$F = \frac{S \times OW}{100}$$

Where;

F = Fecundity

S = Average number of eggs from 3 samples 100mg each

OW = Total weight of Ova

Statistical Analyses

One-way analysis of variance (ANOVA), descriptive statistic, regression analysis, graph (bar chart) mean and standard deviation were used in presenting and analysing the data. 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

Length-Weight Relationship of *Bagrus bayad*

The result as presented in Table 1 showed that b value = 1.996 for the male which is less than 3.0, hence the male fish showed a negative allometry growth. A correlation value $r^2 = 0.545$, N=162; $p<0.05$ is significant, while the female b value is 3.2971, which is a positive allometric, with very high and significant r value, $r^2 = 0.833$, N=120; $p<0.05$**,** however combined sexes analysis shows that b=2.330 which indicated a negative allometric

growth and the r^2= 0.622, N=282; p<0.05 is a significant correlation.

Table 1: Length-Weight relationship, Growth Pattern and Mean Condition factor of *Bagrus bayad*

Sex	L-W relationship equation	Growth pattern (b-value)	r^2	Mean K value
Male	LogW=Log5.795-1.996LogL	1.996 (Negative Allometric)	0.545	2.893
Female	LogW=Log10.87– 3.297Log L	3.297 (Positive Allometric)	0.822	3.112
Combined	LogW=Log7.079+ 2.330LogL	2.330 (Negative Allometric)	0.622	3.002

Gonad Maturity of Male and Female *Bagrus bayad*

The Male gonad maturity showed stages I-V while the females were from stages I –VI as presented on Figure 1. More females were in stages I, III and V while more Males in Stages II and IV. Majority of the *B.bayad* were in stages III with 30.0% of Males were and 32.8% of the Females.

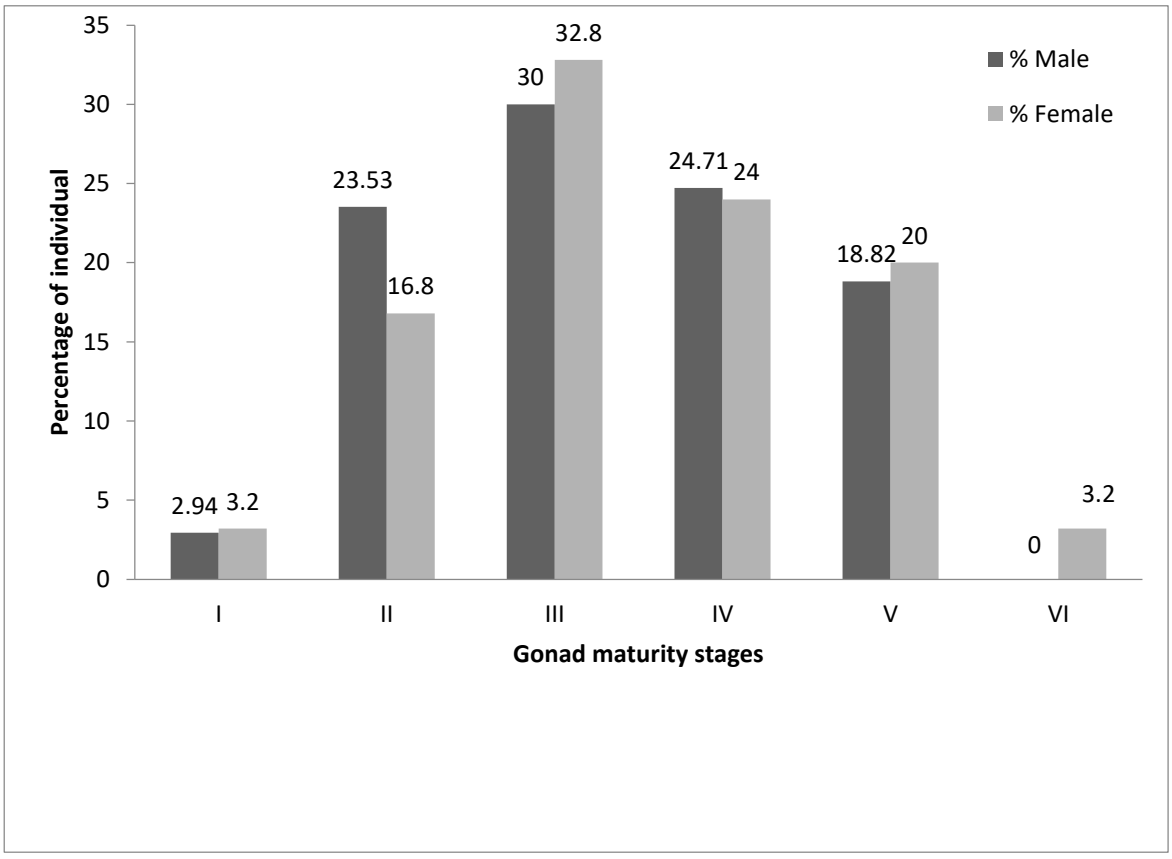

Figure 1: Gonad maturity comparison between the male and female *Bagrus bayad* from Kiri Reservoir

Gonad Maturity, Length-Weight and Condition factor of Male *Bagrus bayad*

The relationship between the gonad maturity, length, weight, and condition factor of Male *B. bayad* in Kiri reservoir is presented in Table 2. The Condition factor of fish improves from Stage I to Stage V. The stages I and II were found immature while III and IV were maturing and stage V matured. The Mean weight is from 0.282kg to 3.4kg for stage I and V respectively while the lengths were 19.8 cm and 66.48cm for stages I and V respectively.

Table 2: Relationship between Gonad maturity stages with length – weight and condition factor of males

#	Mean weight(kg)	Mean length (cm)	Condition factor	Remark
I	0.282	19.80	1.116	Immature
II	0.647	32.08	1.621	Immature
III	1.374	45.94	2.456	Maturing
IV	2.505	57.50	3.620	Maturing
V	3.400	66.42	4.484	Mature

Gonad Maturity, Length-Weight and Condition factor of Female *Bagrus bayad*

The relationship between the gonad maturities, length, weight, and condition factor of Female *B. bayad* in Kiri reservoir is presented in Table 3. The Condition factor of fish improves from Stage I to Stage VI. The stages I and II were found immature while III and IV were maturity, stage V matured and stage VI were spent fish. The weight ranged from 0.323kg to 3.2kg for stage I to VI respectively while the lengths ranged between 23.03 cm and 62.5cm for stages I to VI respectively.

Table 3: Relationship between gonad maturity stages with length – weight and condition factor of females

Gonad stages	Mean weight (kg)	Mean length (cm)	Condition factor	Remark
I	0.323	23.03	1.171	Immature
II	0.705	34.37	1.589	Immature
III	1.560	48.24	2.694	Maturing
IV	2.615	60.22	3.736	Maturing
V	3.328	65.42	4.416	Matured
VI	3.200	62.50	4.592	Spent

Relationship between Fecundity and Condition factors of Female *Bagrus bayad*

Stages I, II and VI were found with empty ovary hence no fecundity for these stages. The fecundity and Total Fecundity in stages III, IV and V increased with increase in Condition factor (Table 4)

Table 4: Relationship between Gonad maturity stages, fecundity and Condition factor in female

Gonad stages	Fecundity/g of ovary	Total Fecundity	Condition factor	Remark
I			1.171	Immature
II			1.589	Immature
III	1637.46	44135.18	2.694	Maturing
IV	1653.27	86207.32	3.736	Maturing

V	1666.75	90908.25	4.416	Matured
VI			4.592	Spent

DISCUSSION

The size and age of sexual maturity and sex ratio are fundamental biological parameters use in stock assessment and useful in management to calculate the reproductive potential of fish population (Wang *et al*., 2003). In the present investigation on the maturity stages of *B. bayad* species, indicates that there is relationship between the length weight and maturity stages, it also reveals that female *B. bayad* has more length and weight at first maturity stage than the male *B. bayad.* During the period of this study it was observed that 30% of male reached the first maturity stage while 32.8% of female reached first maturity stage. This is evidence that more female of *Bagrus bayad* reached first maturity stage than the male with a sex ratio of 1:1.09, this is in agreement with the findings of Imam *et al*. (2011) who reported sex ratio of 1:1.04 for Male and Female *S. Schall* in Assiut. However, in Lake Nasser. The length-weight relationship of any fish is basically known to measure its growth pattern which is an important component of biological production (Fafioye and Oluajo 2005).

The growth pattern exhibited by *B. bayad* as presented in the results showed negative allometry for male and positive allometry for female. This pattern of growth has been earlier reported by Offem *et al*., (2008) who recorded mean b values of 3.206, and 2.040 in Cross River, which depicted negative and positive allometric growths. There was observed variation in the "b" value of the fish under study. It showed that the rate of increase in body length is not proportional to the rate of increase in body weight. The values obtained for the length-weight relationship showed that both sexes of *B. bayad* exhibited allometric growth pattern. This agrees with "b" value 2.911 and 2.794 recorded for *Clarias gariepinus* (African sharp tooth catfish) (King, 1996). Ogbe *et al*., (2006) reported positive allometric growth pattern for *B. bayad* from Lower Benue River. In a similar study, Ogbe and Ataguba, (2008) also reported an isometric growth pattern for *Malapterurus electricus* from Lower Benue River. The "b" value obtained for the species in this study were within the range (1.996-3.297), similar to what has been reported for Volta River Bagrids (Entsua-Mensah *et al.,* 1995). The assessment of fecundity is the corner stone of the reproductive biology, since it is not a stable character due to changes in environmental condition and species-specific factors (Khallaf and Authman, 1991). This study reveals that maturity stages of *B. bayad* ranges from III – V stages, with mean fecundity per gram of ovary ranges between 1637.46 – 1666.75 and mean total fecundity ranges from 44135.18 – 90908.25. However, the increase in fecundity is related with the increase in condition factor, as shown in the result of this study, which indicate that as the fish moves from stage III of gonad stage to IV or V its condition factor increases as a result of increase in length and weight of the fish, from stage I – V with mean weight of 0.323kg – 3.2kg respectively and mean length ranges from 23.03 – 62.5cm for stages I – V respectively. These are similar to findings of Tsadu, *et al*., (2014) who reported that *B. bayad* species do not reach reproductive stage until they are about 1kg and above in total body weight. The present result is in contrast with Abayomi and Arowomo, (1996) recorded 650,625 eggs for C. *Gariepinus* in Opa reservoir, Nigeria. However, variation in fecundity of individual's fish may be due to differential abundance of food. Nutritional resources are known to play critical roles in regulating variations in fecundity.

It was observed in the present study that mean condition factor for *B.bayad* were of values above 1.0 which indicated that fish species are doing well in the reservoir. The condition factor of the fish species in this study is favorably comparable with condition factors of different tropical fish species investigated and previously reported (Saliu, 2001 and Lizama*et al.,* 2002). The condition factors of male, female 2.893, 3.112 respectively and combined sexes was 3.002 of *B. bayad* in the present study is similar to what was reported by Lawal *et al*., (2010). The high condition factor is an indication of food availability and good water quality in the reservoir. A very high and significantly different Pearson Correlation, r^2= 0.833 between the male and female condition factors. The monthly variations in condition factors for female showed that the values were very low and some were negatively correlated such as January and March having r^2=-0.0740; p>0.05 N=120 and November and March r^2=-

0.07405; p>0.05, N=162. The highest correlation r^2=0.345108; p>0.05, N=120 was recorded between the condition factor in the months of February and April while the lowest r^2=0.011576; p>0.05, N=120 was from January and April. On the other side, the correlation of the monthly mean condition factor of male *B. bayad* from Kiri reservoir indicated that four months showed negative correlations of r^2= -0.12431, r^2= -0.1874, r^2= -0.1479 and r^2= -0.00707 for December and February, November and April, January and April and March respectively. The highest Monthly mean correlation r^2=0.51993 was computed between November and December while the lowest r^2=0.001393 was from November and March. This type of variations agreed with the report of Ikongeh *et al*., (2012).

CONCLUSION

It was obvious based on the result obtained from the study that there was no significant relationship between the length and weight of the fish (*B.bayad*), hence growth pattern is negative allometric for male and positive allometric for the female. The gonad first maturing stage of the fish is stages III and IV, while stage V is matured, and there is a significant relationship between gonad maturity stages with length-weight. Fecundity increases with increase in condition factor of fish. However, condition factor of the fish in this study is favorably comparable with condition factors of any tropical fish.

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