STUDY ON LENGTH-WEIGHT RELATIONSHIPS AND REPRODUCTIVE BIOLOGY OF *SYNODONTIS NIGRITA* (VALENCIENES, 1840) IN KANGIMI RESERVOIR, KADUNA STATE, NIGERIA.

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ABSTRACT

The length-weight relationships and reproductive biology of *Synodontis nigrita* was studied. Fish specimens were collected from fishermen catch at the landing site. Estimated exponent (b) varied between 1.949 and 2.845 (2.3092±0.08). Correlation (0.915±0.01) between length and weight indicated a strong positive relationship. There were more females than males in the fish species, the difference was not significant (P>0.05). Male fish recorded gonadosomatic index range from 0.253±0.03 to 2.715±0.15 and 0.410±0.05 to 5.352±0.72 for females. The gonadosomatic index of the male fish was not significantly different from that of the female. Rainy months gonadosomatic index were significantly higher than the dry months (P<0.05). The fish was observed to exhibit negative allometric growth. The species investigated recorded higher values of GSI in the wet season indicating the breeding period of the fish.

Key words: LWR, Sex Ratio, *Synodontis nigrita*

INTRODUCTION

Fish is an important source of dietary protein. *Synodontis nigrita* is commonly called upside-down catfish is a common freshwater fish in Nigeria. The body is dark to grey-brown in colour (Idodo-Umeh, 2003) with small dark spots on the body and fins (Olaosebikan and Raji, 2013).

In fisheries management, one important tool used is length weight relationship (*LWR*) estimate of fish. The length -weight relationship of fish is an important fishery management tool (Abowei, 2010). Estimate of *LWR* is useful in fish stock assessment and proper management of a fishery (Andreu-Soler *et al*., 2006). Standard measures of *LWR* determination for fish species render the results more reliable when making comparisons between populations (Kara and Bayhan, 2008). Parameter *b* of the *LWR* describes the growth pattern of fish species. Literature is available which indicate isometric and allometric growth pattern can be exhibited by freshwater fish species (Abowei, 2010; Ibrahim, 2012; Usman *et al*., 2014).

Sex ratio indicates the proportion of male and female in a population and in nature the ratio is expected to be 1:1. In the culture and reproduction of fish species inhabiting fresh water one important consideration should be sex ratio (Mekkawy and Hassan, 2011). Study on sex ratio of fish species in rivers, lakes or reservoirs have been conducted (Oboh *et al*., 2013; Shinkafi *et al*., 2013; Akombo *et al*. (2016).

Reproductive biology is an important factor that influences the dynamics of a given population. Spawning is one of the most significant phases of the reproductive cycle. It comprises ovulation and oviposition in the female and spermiation and sperm release in the male (Agarwal, 2008).

Knowledge of some reproductive traits such as sexual dimorphism, egg size, fecundity and spawning time are fundamental to understanding how these traits should be adopted to maximize reproductive success in a particular environment (Mazzoni *et al.,* 2005). Information on fish reproduction is also important in aquaculture. Lack of documented information on the length-weight relationships and reproductive biology of this species in the reservoir made the study imperative. The information is key to proper management of the fishery.

MATERIALS AND METHODS

Study Area

Kangimi reservoir was the study area (Figure 1). It is located between latitude 10°42'30''N and longitude 7°42'30''E. River Kangimi was impounded mainly for potable water supply to Kaduna metropolis and irrigation. Fishermen from nearby villages catch fish from the reservoir.

Fish specimen collection and Identification

Fish samples were collected from Goro and Kangimi. *Synodontis nigrita* from fishermen catch. The fishermen used traps and gill nets with stretched mesh size ranging from 1.00cm to 5.00cm. Sample was collected once monthly. The duration of sampling was June, 2015 to May, 2016. Text by Reed *et al.* (1967); Idodo-Umeh (2003); Olaosebikan and Raji (2013) was used to identify fish.
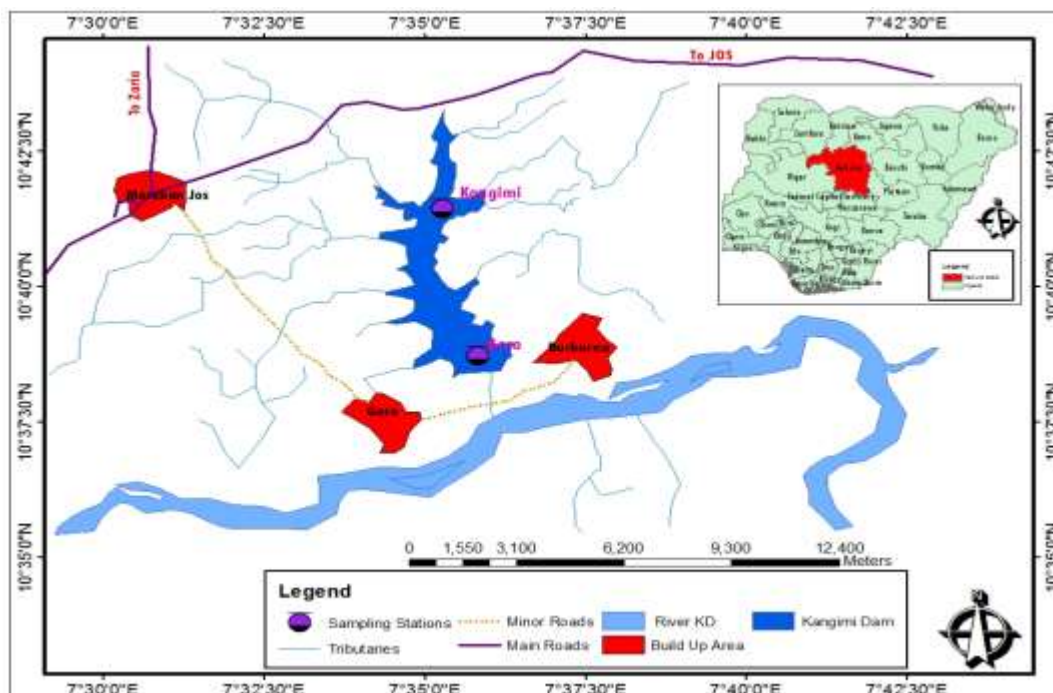
Figure 1: Map of Kangimi Reservoir Showing Sampling Stations. Source: G.I.S & Remote Sensing Lab Geography Department & Environmental Management A.B.U. Zaria.

Sex determination, Length and Weight Measurement

Sex of fish was determined based on the possession of a genital papilla by the male using a binocular dissecting microscope. The sex of some specimens was done by dissecting the abdomen, open ventrally from the anus to the pectoral fin, with a scalpel or knife to examine the gonad. The sex ratio (male: female) was calculated as:

Sex Ratio = No. of males/No. of females

Total length of the fish was measured from the tip of the snout to the end of the caudal fin. Both Length measurement was done with a meter rule and recorded in centimeter. Body weight was measured with Ohaus sensitive electric balance (Model: SE3001F) to the nearest gramme. The weight of the gonads was measured.

The total length was related with body weight of fish using the equation:

$W = aL^b$ in logarithmic form: Log W= Log a + b Log L. Where: W= fish weight in grams, L= total length of fish in centimeter, a= intercept, and b= slope, geometric growth pattern value (Froese, 2006).).

Gonado somatic index

The spawning period was calculated as: GSI=Weight of gonad/Weight of fish x 100 (Hirpo, 2012).

DATA ANALYSIS

The mean and standard error of body weight, total length and gonadosomatic index determined. Least squares regression analysis was used to estimate the values of intercept (a) and slope (b) for length-weight relationship. Chi-square was employed to test whether there is significant difference in the observed from the expected

1:1 sex ratio at 95% probability. Student's t-test was used to test for significant difference in the sexual and seasonal of GSI. Variation observed in the mean values of GSI was tested to determine significant difference using Analysis of Variance (ANOVA) at 0.05 levels. Duncan Multiple Range Test (DMRT) was introduced to rank the means when the difference is significant.

RESULTS

Table 1 presents the length weight relationship of the fish. Estimated exponent (b) in *S. nigrita* was lowest (1.949) in August and highest (2.845) in January with mean of 2.3092±0.08. The mean (0.915±0.01) correlation coefficient (r) determined indicated a strong positive relationship. The proportion of males to females indicate there was no significant difference (P>0.05) in all the months (Table 2). Length exponent *b* of *LWR* that equal 3 is indicative of isometric growth, values less than 3 show negative allometric and more than 3 exhibit positive allometric growth. The parameter *b* estimate suggests negative allometric growth in *S. nigrita* (2.3092). Fish with negative allometric growth suggests their length increase faster than the width (Dutta and Banerjee, 2016). The negative allometric growth observed in the present work is consistent with negative allometric *b* value 2.73 for *S. schall*, 2.79 for *S. clarias* and 2.86 for *S. membranaceus* from the lower Nun River, Niger Delta (Hart and Abowei, 2007). According to Bagenal and Tesch, 1978 the length exponent in most species of fish is from 2.0 to 4.0. The geometric growth pattern of *S. nigrita* is within the range of 2.0 to 4.0.

The strong positive correlation coefficient (r) for the length-weight relationship of *S. nigrita* indicates

increase in length with increase in body weight. Hart and Abowei, 2007 also reported positive correlation coefficient between the length and weight of *S. schall*, *S. clarias*, *S. membranaceus*. The variation observed in *b* value estimate in this work and those of other study may be due to difference in environmental factors imposed by local weather conditions. Oliva-Paterna *et al*. (2009) suggested that sex, method of preservation, stage of gonad development and size of specimens included in the analysis may have an effect on length–weight relationship in fish.

Sex ratio is calculated to indicate the proportion of male and female in a given ecological system.

There were more males than females. The proportion of males and females did not differ significantly. This indicates that there was equal distribution of males and females in all the months.

The migratory behavior of the male in search of mate, couple with condition of the environment and error during sampling might have been the reason for the deviation from 1:1 ratio observed.

Work by other researchers has indicated female dominance over male. Adebiyi (2012) documented sex ratio 1: 1.11 (male to female) in *Brachydeuterus auritus* from Lagos coast. Oboh *et al*. (2013) observed sex ratio of 1:1.35 (male to female) for *Synodontis schall* from Jamieson River, Nigeria. The sex ratio differed significantly (P<0.001) from the expected 1:1 ratio.

Mean monthly gonadosomatic index in *S. nigrita* is presented in Table 3. The mean values of gonadosomatic index in males fluctuated from 0.253±0.03 (February) to 2.715±0.15 (July) and from 0.410±0.05 (December) to 5.352±0.72 (June) for females. The monthly gonadosomatic index values variation in males and females was significant at P<0.05. The gonadosomatic index of the male fish was not significantly different from that of the female. The mean gonadosomatic index for males, females and combined sex in the rainy season was significantly higher than the dry season (P<0.05) Table 4.

High GSI indicate breeding and was considered the spawning period. Fish with low GSI were collected during the dry season.

The month of June to October marked the breeding period of *S. nigrita*. The maximum GSI value for male was observed in July. The female fish GSI was at the peak in June. Males GSI (0.253 – 2.715) is lower than that of the females (0.410 – 5.352). The month of June to October marked the breeding period of *S. nigrita*. The maximum GSI value for male was observed in July. The female fish GSI was at the peak in June. Males GSI (1.51) is lower than that of the females (2.02). The species investigated recorded higher values of GSI in the wet season. This implies that the species in the rainy months deployed huge energy to produce reproductive cells. Generation of energy for the process of reproduction is supported by the increase of nutrients. All the specimens recorded higher GSI values in the rainy months. It means that the fish invest more energy towards gamete production in rainy season. Run-off water during the rainy season introduces nutrients in the reservoir thereby stimulating the important process of primary production which serves as the base for trophic energy transfer.

Gonadosomatic index in this study was observed to be high in the wet season is similar to Oboh *et al.* (2013) who noted male and female specimens of *Synodontis schall* from Jamieson River, Nigeria start breeding activities at the onset of the rains. Furthermore, Olele and Etim (2011) suggest that fish with heavy gonad were collected from in rainy season.

Females were observed to have GSI that is higher than males. This fact agrees with the finding of Shinkafi *et al.* (2013) who reported the GSI of female *Distichodus rostratus* in River Rima was higher than that of the male.

TABLE 1: LENGTH-WEIGHT RELATIONSHIP OF *SYNODONTIS NIGRITA* FROM KANGIMI RESERVOIR

Month	N	Body Weight (g)			Total Length (cm)			*LWR*			Growth Pattern
		Min.	Max.	Mean±SE	Min.	Max.	Mean±SE	a	*b*	*r*	
June	64	35.6	255.6	107.33±6.13	13.3	30.3	20.36±0.50	-0.649	2.029	0.921	NA
July	48	27.3	333.6	118.47±10.47	11.8	27.5	19.38±0.68	-0.923	2.296	0.903	NA
August	41	35.3	482.6	189.52±20.79	10.0	36.2	21.67±1.15	-0.377	1.949	0.916	NA
September	43	37.2	373.3	122.76±10.17	10.3	35.7	19.34±0.74	-0.512	1.997	0.942	NA
October	43	46.2	426.7	155.45±0.87	12.6	36.1	23.11±0.87	-0.850	2.246	0.933	NA
November	33	51.7	343.8	137.79±11.12	15.1	32.7	23.61±0.71	-0.738	2.070	0.884	NA
December	38	40.8	397.6	144.49±12.13	14.7	37.2	23.82±0.75	-1.455	2.609	0.961	NA
January	20	46.3	393.5	153.71±22.47	15.2	34.4	24.24±1.12	-1.811	2.845	0.937	NA
February	40	21.8	432.5	139.21±13.03	15.8	36.1	22.91±0.75	-0.943	2.238	0.889	NA
March	26	51.7	391.4	181.5±18.92	18.3	36.2	26.69±1.01	-1.502	2.591	0.918	NA
April	39	52.4	394.3	150.25±14.01	14.3	30.9	22.61±0.84	-0.709	2.187	0.897	NA
May	38	50.8	376.8	149.00±12.36	16.2	32.5	25.02±0.62	-1.571	2.654	0.881	NA
Total				145.79±6.87			22.73±0.64	-1.003±0.13	2.3092±0.08	0.915±0.01	NA

SE = Standard Error; NA = Negative Allometric

TABLE 2: MONTHLY SEX RATIO OF *SYNODONTIS NIGRITA* FROM KANGIMI RESERVOIR

Month	N	Males	Females	Ratio	Chi sq	P-value
June	42	22	20	1:0.90	0.095	0.758
July	18	7	11	1:1.57	0.889	0.346
August	19	6	13	1:2.16	2.579	0.108
September	16	6	10	1:1.66	1.000	0.317
October	30	17	13	1:0.76	0.533	0.465
November	24	10	14	1:1.40	0.667	0.414
December	33	18	15	1:0.83	0.273	0.602
January	12	5	7	1:1.40	0.333	0.564
February	31	11	20	1:1.81	2.613	0.106
March	20	12	8	1:0.66	0.800	0.371
April	26	10	16	1:1.60	1.385	0.239
May	16	9	7	1:0.77	0.250	0.617
Total	287	133	154	1:1.16		

*Significant difference (P < 0.05)

TABLE 3: MONTHLY GONADO SOMATIC INDEX (GSI) OF *SYNODONTIS NIGRITA* COLLECTED FROM KANGIMI RESERVOIR

Month	Male			Female			P-Value
	Min.	Max.	Mean±SE	Min.	Max.	Mean±SE	
June	0.288	7.219	$2.170^{de}\pm0.25$	0.806	14.74	$5.352^{d}\pm0.71$	
July	1.067	3.969	$2.715^{e}\pm0.15$	0.593	8.075	$3.907^{c}\pm0.34$	
August	1.856	3.763	$2.328^{de}\pm0.13$	1.595	6.383	$3.512^{cd}\pm0.35$	
September	1.255	4.272	$2.517^{e}\pm0.15$	1.214	7.156	$4.134^{b}\pm0.33$	
October	1.071	4.394	$2.177^{de}\pm0.16$	0.498	3.82	$1.925^{b}\pm0.21$	
November	0.995	2.878	$1.800^{d}\pm0.14$	0.152	2.537	$1.023^{ab}\pm0.18$	
December	0.147	1.887	$0.628^{abc}\pm0.11$	0.160	0.838	$0.410^{a}\pm0.05$	
January	0.254	1.059	$0.531^{ab}\pm0.09$	0.272	0.826	$0.430^{a}\pm0.05$	
February	0.042	0.477	$0.253^{a}\pm0.03$	0.118	1.828	$0.416^{a}\pm0.07$	
March	0.232	1.262	$0.683^{abc}\pm0.09$	0.174	2.215	$1.041^{ab}\pm0.21$	
April	0.306	2.517	$1.123^{bc}\pm0.17$	0.288	1.364	$0.705^{ab}\pm0.06$	
May	0.327	2.600	$1.154^{c}\pm0.14$	0.470	3.966	$1.370^{b}\pm0.23$	
Total			1.51 ± 0.25			2.02 ± 0.50	0.375

Means with different superscript in each column are significantly different (P<0.05); * = Significant difference (P < 0.05

TABLE 4: COMPARISM OF SEASONAL GONADOSOMATIC INDEX (GSI) OF *SYNODONTIS NIGRITA*

Season	Sex		
	Male±SE	**Female±SE**	**Combined±SE**
Dry	1.03± 0.27	0.85 ± 0.20	0.93± 0.23
Wet	2.17± 0.27	3.66± 0.65	2.96± 0.43
P-Value	0.015*	0.001*	0.001*

Mean ± S.E.M; * = Significant difference (P < 0.05)

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