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Some Aspects of the Biology of *Distichodus rostratus* (GUNTHER, 1864) in River Rima, North-western Nigeria

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ABSTRACT

Study was carried out to determine some aspects of the biology of *Distichodus rostratus* (GUNTHER, 1864) in River Rima, North-western Nigeria. This is with a view to provide information on the species in River Rima which has not been documented elsewhere. These include morphometric measurements, growth pattern, diet composition, gonad maturation stages, gonadosomatic index (GSI) and fecundity of the species. A total of 66 samples were collected from Kwalkwalawa fish landing site of River Rima between July and December, 2012. Total length of the samples ranged from 18.70±0.99SE to 46.20±0.99SE with a mean value of 31.18±0.99SE while total weight ranged from 104.20±32.65SE to 892.60±32.65SE with a mean value of 473.92±32.65SE. The b values of 2.461, 2.476 and 2.292 for all samples, females and males respectively indicate negative allometry. Mean condition factor was 1.52±0.517SD, indicating that the species are in good condition. Analysis of the stomach contents revealed that the species are herbivorous feeding mainly on leaves and roots of aquatic plants, grasses, algae and deadwood. Observation of the structural feeding adaptations such as the sub-inferior mouth, the fine and numerous gill rakers, the U-shaped stomach and the long intestine further confirms the herbivorous nature of the fish. Four stages of gonad maturation were established in females and three stages in males. Gonadosomatic index values for males ranged from 0.08 to 1.20% with mean value of 0.25±0.0211SE and for females 0.25 to 2.29%, with a mean value of 1.89±0.829SE. Fecundity ranged from 2,980 – 21,010 eggs.

INTRODUCTION

Distichodus rostratus, commonly known as the grass eater, belongs to the Family Distichodontidae. According to Nelson (2006), the species are found in fresh water. The species plays an important role in the ecosystem and fisheries of West Africa and other inland waters, as it constitutes an important trophic web of ecosystem and has been introduced into many artificial lakes and reservoirs such as Kiru, Kariba and Tiga Dams in parts of Africa (Coulter, 1970). The species are among the major exploitable fish species and are widely distributed in Nigeria, Nilo-Sudan, Niger, Volta, Chad and Nile basins (Teugels *et al,* 1992). Prior to their introduction into artificial lakes, they had colonized artificial lakes from natural riverine habitats (Abowei, 2010). *Distichodus rostratus* lives along the grassy banks of rivers and swamps and they are extremely fecund with their ovaries containing a great number of eggs and can attain a length of more than 60cm and above 6kg in northern Nigerian waters (Reed *et al*., 1967; Motwani and Kanwai, 1970). In Nigeria, Distichodus *spp* are cultured in fish farms and numerous lentic water bodies due to their ability to feed on grasses and weeds (Nwani and Ude, 2005).

Comprehensive knowledge of growth and reproduction of fish populations is important for increased fish production in natural waters and in aquaculture. Growth parameters are important in the selection of fishes for culture and in estimating food consumption of fish populations (King, 1997). The mathematical parameters of the relationship between the length and weight of a fish furnish further information on the weight variation of individuals in relation to the length; that is condition factor, which estimates the general well-being of an individual (Benedito-Cecilio *et al*., 1997).

Reproduction is of special interest to fisheries managers, since successful reproduction ensures recruits for the fisheries for years to come, and thus, fisheries managers must consider anything that concerns reproduction when regulating fisheries (Williams, 2007). Fecundity assessments have been useful in racial distinction , progeny survival studies, stock evaluation and aquaculture-based induced spawning and egg incubation (Bagenal, 1978; Marcus, 1982; Coates, 1988). Gonadosomatic index has been used thoroughly as an indicator of the spawning period of teleosts, and its use in reproductive biology has been considered more appropriate when used with other indicators of reproduction such as macroscopic observations (De Vlaming, 1972). A record of the stage of gonad maturity is required for many purposes, such as for determining the proportion of stock that is mature, or the size or age at first maturity (Bagenal, 1978). Maturity stage is also employed by biologists to determine the reproductive potential of fish populations and monitor changes in biological characteristics of exploited fish stocks (Williams, 2007).

Many studies were carried out on various aspects of the biology of *D. rostratus* in water bodies from Nigeria (Arawomo (1982); Inyang and Nwani (2004); Nwani and Ude (2005); Nwani, (2006); Abowei and Hart (2009) and Abowei, 2010). So far, no work has been reported on the biology of this important fish species in River Rima. This study therefore is intended to provide a baseline data on some aspects of growth and reproductive biology of *D. rostratus* in River Rima, North-western Nigeria.

2. MATERIALS AND METHODS

2.1 Study Area

The fish samples were collected from River Rima, in Sokoto, North-western Nigeria. Sokoto lies between longitudes 4º8'E and 6º5'E, and latitudes 12ºN and 13º58'N (Mamman, 2000). The climate of Sokoto is tropical continental, with much of the rains between June and September, while the long dry season is from October and May (Ita *et al*., 1982).

River Rima flows in a South-western direction over 100km and joins the major River Sokoto to form the Sokoto-Rima river system. The Sokoto-Rima River flows South-westerly in a direction up to Zogirma, where it changes direction and run Southwards before emptying into River Niger. The River is seasonal, usually over flooding its banks during the rainy season in August and September, and up to October at times (Mock, 1963).

2.2 Collection of Specimens

Samples of *Distichodus rostratus* were collected in batches from Kwalkwalawa fish landing site. Identification was based on the descriptions of Reed *et al*. (1967), Holden and Reed (1972) and Olaosebikan and Raji (1998). The fishing gears used was mainly cast nets, gill nets and seine nets. Samples were collected on monthly basis for a period of six months (July-December, 2012).

2.3 Laboratory procedures and data collection

In the laboratory, samples were examined fresh immediately after collection. On each sample, length parameters such as total length (TL) and standard length (SL), were all measured using a metric ruler (in cm) and weight parameters such as the total weight (TW) and gutted weight (GW) were all weighed using Metler top-loading balance (in g). Sex of the specimens was determined after dissection based on the presence of testis and ovary.

The gut of the fish was removed by making a longitudinal incision along the mid-ventral line from the

mouth to the anus to expose the visceral organs. The gut was removed carefully by detaching it from other internal organs and fatty tissues. The gut length (GL) was then measured to the nearest cm on a graduated measuring board. The stomach was cut off from the gut and scored 0%, 25%, 50%, 75% or 100% according to its fullness as described by Olatunde (1979). This will also give an insight on the feeding intensity of the fish (Ogbeibu and Ezeunara, 2005). Stomachs were sliced open and its contents placed into a Petri dish and analysed using frequency of occurrence method as described by Hynes (1950). Each food item was identified, and the number of stomachs in which the food item occurred were counted and expressed as a percentage of all the stomachs with food. The structural feeding adaptations such as the mouth, the gill rakers, the stomach and the intestine were observed to further confirm the feeding nature of the species.

Gonads were detached and weighed (in g). Length and width (cm) of each gonad lobe were measured. Other morphological features of the gonads such as the degree of opacity of the gonads, consistency and vascularization, oocytes or sperm visibility and overall colouration of the gonads were observed. Same features were used to determine the gonad maturity stages (White *et al*., 1998). Fecundity was determined by gravimetric sub-sampling method (wet method) as described by Bagenal (1978).

2.4 Statistical Analysis

2.4.1 Growth studies

- Growth pattern was analyzed based on the formula: $W = L^b$.

Logarithmic transformation equation of length-weight relationship was made to give a linear one as:

$$Log\,W = Log\,a + b\,Log\,L$$ (Bagenal and Tesch, 1978).

Where: W = Weight of fish (g); L = Length of fish (cm); a = constant; b = exponent.
The values of 'a' and 'b' are estimated by least squares regression analysis (Zar, 1984).

- The condition factor (K) was calculated by using the equation:

$$K = \frac{100W}{L3}$$ (Bagenal and Tesch, 1978).

Where: W=Weight of the fish samples (g); L= Length of the samples (cm).

2.4.2 Food and feeding habits studies

- The stomach contents were analyzed by frequency of occurrence method as follows:

$$P = (b/a) \times 100$$ (Hynes, 1950)

Where: P= Percentage of occurrence of each item; a= Total number of fish examined with food in their stomach; b= Number of fish containing a particular food item.

- Relationships between Total Length and Gut Length, and Total Weight and Stomach Weight

These relationships were computed using a linear regression model as follows:

$$Y = a + bX$$ (Steel and Torrie, 1980)

Where: Y=Gut length (cm) or stomach weight (g); X= Fish total length (cm) of fish total weight (g); a=constant; b=exponent.

2.4.3 Reproduction studies

- The Gonad Somatic Index (GSI), was determined using the formula:

$$GSI = \frac{ovary\ weight}{body\ weight} \times 100$$ (Gabr *et al.,* 1998).

- The formula: $Y = aX^b$ (Steel and Torrie, 1980) was used to determine the relationships between Fecundity (F) with total length (TL) and total weight (TW) as well as GSI with total length (TL).

Where: X= total length (TL) or total weight (TW); Y= Fecundity and GSI.

3.0 RESULTS

3.1 The fish samples and their morphometric measurements

A total number of 66 samples of *D. rostratus* were analyzed, 24 (36.36%) were females, while 42 (63.64%) were males. The largest sample among the males has total length of 39.2cm (TL) and a total weight of 698.9g (T W) the smallest sample measured 18.7cm (TL) and total weight of 102.2g (TW). In females, the largest had a total length of 46.2cm and total weight of 846g while the smallest measured 20.2cm (TL) and total weight of 322g.

Table 1 present the values of the body length and weight measurements of *D. Rostratus.* The minimum total length (TL) was 18.70cm, while the maximum was 46.20cm with overall mean of 31.18 ± 0.99SE. The total weight (TW) ranged from 104.20 – 846.00g, with a mean value of 473.92 ± 32.65SE. The

minimum, maximum, mean and standard errors of all the other body dimensions are presented in the Table.

3.2 Length – Weight Relationship of D. rostratus in Rima River

Table 2 shows the relationship between total length and total weight based on all samples, females and males. The b values for all samples, males and females were all indicative of negative allometric growth pattern as they are all <3. All equations are significant (P< 0.05).

3.3 Condition Factor of D. rostratus in River Rima

The mean condition factor for all samples examined is 1.52. This indicates that *D. rostratus* in river Rima are in good condition, with the males in better condition than the females and larger samples in better condition than smaller ones as shown in Table 3.

3.4 Stomach Fullness of D. rostratus in River Rima

Table 3 shows the percentage of stomachs with food. About 68% of the stomachs were empty, while only about 5% had full stomachs.

3.5 Frequency of Occurrence of Food Items Based on Sex and 2 size classes of D. rostratus in River Rima

Based on sex, females feed more on water hyacinth (*Eichhornia crassipes*) while males prefer dead wood to the other food materials. The small samples (<20cm TL) examined were found to have empty stomachs. All the food items were found in the larger samples, with water hyacinth and dead wood being the dominant food materials followed by grasses as shown in Table 4.

3.6 Monthly Analysis of Stomach Content of D. rostratus in River Rima

Table 6 shows the monthly analysis of stomach fullness. The fish species were observed to contain more food during the month of peak rainy season, which is July and August. Samples with empty stomachs were more encountered during the dry season in December.

3.7 Structural feeding adaptations of D. rostratus in River Rima

The position of the mouth is observed to be sub-inferior and the teeth are palatine. The gill rakers which are numerous and fine can be used to sieve small food materials such as phytoplankton and algae present in water. The intestine is extremely long and coiled, indicating the herbivorous feeding nature on aquatic plants, algae and deadwood of the species.

The very high correlation (r) values for the TL-GL and TW-SW relationships for the whole samples (Table 7) suggests proportional increase in gut length due to increase total length and increase in stomach weight with increase in total weight is further confirmation of herbivorous feeding in *D. Rostratus.*

3.8 Gonad dimensions and gonad maturation stages of D. rostratus from River Rima

The mean values for the length and width of the ovary are 7.316±0.29SE and 0.45±0.0092 respectively, while those of the testes were 4.49 ± 0.07SE and 0.28±0.0032, respectively.

Four gonad maturation stages were observed for females while three were observed in the males. The gonads were classified as immature (I), maturing (II), mature (III) and spent (IV). Table 8 describes each of the gonad maturation stages of the samples.

3.9 Gonad Somatic Index (GSI) and its relationship with TL in D. rostratus from Rima River

The mean GSI value of female was significantly higher than that of the male (Table 9). There was higher correlation in females for the GSI-TL relationship than in males as shown by r values in Table 10, but all the equations are significant (P<0.05).

3.11 Fecundity and its relationship with TL and TW

Of the total number of 24 females analyzed, 23 were fecund. The highest fecundity was (21,010), was found in a sample with 45.5cm TL and 846.g TW and gonad weight of 14.9g. The lowest fecundity (2,930) was found in a sample with 32.0cm TL and TW of 289.6g and gonad weight of 2.9g. In this study, the largest number of eggs was found in the largest fish and the lowest number of eggs in the smallest fish. Fecundity showed higher correlation with total weight than with total length as shown by the r values in Table 11.

Table 1: Body measurements of *D. rostratus* in Rima River (N=66)

Parameter	Minimum	Maximum	Mean	SE
Total length (cm)	20.20	46.20	31.18	0.99
Standard length (cm)	15.20	43.00	26.93	0.99
Fork length (cm)	16.80	44.80	28.94	0.99
Head length (cm)	2.90	6.60	4.97	0.15
Girth (cm)	6.00	15.50	10.56	0.41
Total weight (g)	104.20	846.00	473.92	32.65
Gutted weight (g)	71.90	772.80	385.71	26.86

Table 2: Total lengths– total weight relationship of *D. Rostratus* in River Rima

Parameter	No. of samples	a	b	SE of b	R	Test of b
All Samples	66	-2.424	2.461	0.122	0.993	S
Male	42	-4.143	2.292	0.208	0.931	S
Female	24	1.129	2.476	0.199	0.819	S

Equation Log TW= a +b log TL; All equations are significant (P<0.05)

Table 3: Condition Factor of *D. rostratus* in River Rima

Parameter	Number	Mean
All samples	66	1.52
Sex		
Males	42	1.59
Females	24	1.39
Size class		
≤ 20cm	12	1.43
≥ 20cm	54	1.93

Table 4: Categorization of Stomach Fullness of *D. rostratus* in River Rima

Stomach Fullness	No. of samples	(%)
0 (empty)	45	68.18
25	11	16.67
50	6	9.09
75	1	1.51
100	3	4.54
Total	**66**	**100.00**

Table 5: Frequency of occurrence of food items based on sex and 2 size classes of *D. rostratus* in River Rima

Food items	Whole samples		Sex				Size class			
			Male		Female		<20cm TL		≥20 c	
	F	%	F	%	F	%	F	%	F	%
Eirchonia crassipes	7	10.06	3	4.54	4	6.06	0	0	7	10.6
Grasses	4	6.06	2	3.02	2	3.03	0	0	4	6.06
Unidentified materials	2	3.03	1	1.51	1	1.51	0	0	2	3.02
Spirogyra	2	3.03	2	3.03	0	0.00	0	0	2	3.02
Dead wood	6	9.09	4	6.06	2	3.03	0	0	6	9.09

Key: F= Frequency

Table 6: Monthly Analysis of Stomach Content of *D. rostratus* in River Rima

Month	No. of samples	No. of stomach with food	%	No. of empty stomach	%
July	14	8	57.1	6	42.8
August	15	7	46.6	8	53.3
September	12	2	16.6	10	83.3
October	12	2	16.6	`0	83.3
November	10	2	20.0	8	80.0
December	03	0	0.0	3	100.0

Table 7: Relationships between TL-GL and TW-SW in *D. rostratus* from River Rima (N=66)

Equation	a	b	SE of b	R
Log GL= a + b TL	-12.307	3.469	0.124	0.961
Log SW= a + b TW	-1.536	0.031	0.002	0.895

All equations significant (P<0.05)

Table 8: Descriptions of gonad maturation stages of samples of *D. rostratus* from Rima River

Maturity stages	Female	Male
Immature (I)	Ovary is small, transparent and brownish in colour with very minute brown eggs.	Testes are slim, thread like in structure and somehow sticky.
Maturing (II)	Ovary is elongated, brownish and egg is visible externally. Eggs are yellow in colour, size of eggs bigger. Ovaries highly vascularised.	Testes are elongated, thicker and fatty. The colour is milky.
Mature (III)	Ovaries are oval in shape and yellow eggs are visible.	The testes are rope-like, longer and white in colour.
Spent (IV)	Ovary is light red and empty.	Not found

Table 9: Mean GSI (%) values of both males and females of *D. rostratus* in River Rima

Sex	No. of Samples	Minimum	Maximum	Mean	SE
Male	42	0.08	1.20	0.25	0.0211
Female	24	0.25	2.29	1.89	0.829

Table 10: Relationship of GSI with Total length of *D. rostratus* in River Rima

Parameter	No. of Samples	a	b	r	Test of b
All Samples	66	0.148	0.19	0.385	S
Male	42	0.143	0.010	0.231	S
Female	24	0.42	0.18	0.232	S

Table 11: Fecundity, Fish length and weight relationships

Parameter	No. of Samples	a	b	SE of b	r
Log F = a + b log TL	23	3.337	1.568	0.387	0.479
Log F = a + b log TW	23	2.751	0.968	0.331	0.660

4. DISCUSSION

4.1 Fish size, growth parameter and condition factor

Maximum size of samples of this study of 46.2cm total length was smaller than those reported for *D. rostratus* in Nun River (Abowei, 2010) but larger than those of same species from Anambra River (Nwani and Ude, 2005) and Cross River Inland Wetlands (Offem *et al*., 2009). The maximum size attainable by any fish species is location specific (King, 1996) and may be due to factors such as pollution, high fishing pressure and environmental degradation (Abowei and Hart, 2009).

Same negative allometric growth pattern was also reported for *D. rostratus* from Nun River (Abowei, 2010) and Cross River Inland Wetlands (Offem *et al*., 2009) as is the case with samples of this study whose b value was 2.46. In contrast, Nwani (2006) reported isometric growth pattern for *D. rostratus* in Anambra River, with b value of 3.051. This may be attributed to differences in location and food availability of the different places of the study.

The value of 1.52 for condition factor shows that the *D. rostratus* are in better condition in River Rima than in other water bodies where the species had lower values (Nwani, 2006; Offem *et al*., 2009 and Abowei, 2010). Better condition factor in males than in females was also reported by Ikomi and Odum (1998) as in the case of samples of this study. Better condition in larger specimens than in smaller ones has also been reported by Ikomi and Sikoki (2003), Shinkafi and Ipinjolu (2010) and Shinkafi and Hassan (2011), and this may be due to better foraging ability and conservation of stored food energy in the adults, or possibly due to increasing weight of maturing gonads in the larger samples.

4.1 Food and feeding adaptations

The high percentage (68.18%) of empty stomachs found in this study might be attributed to the time of feeding of the fish. *Distichodus rostratus* is a day time feeder (Arawomo, 1982) and samples caught in the night will have their stomach either empty or with few food materials and thus, this may be the reason why the samples of this study have high percentage of empty stomachs, as they were mostly caught by gillnets set over night by the fishermen. The presence of high percentage empty stomachs could also be attributed to post harvest digestion (Fagade, 1978).

The variation of food items found in the stomachs of the specimens examined might be attributed to the potamodromous nature of the fish as it has free movement in the water. The result of this study also shows that *D. rostratus* is purely herbivorous, feeding mainly on aquatic plants, algae and some dead wood and this is in accordance with the findings of Bakare (1968) from River Niger; Medani (1968) from Jebel-Aulia Reservoir in Sudan; Motwani and Kanwai (1970) and Arawomo (1982) both studies from Kainji Lake. On the contrary, Inyang and Nwani (2004) and Offem *et al*. (2009) reported omnivorous feeding in the species from Anambra River Basin and Cross River respectively. The structural feeding adaptation such as the numerous and fine gill rakers can be used to sieve small food materials such as phytoplankton and algae present in water. The extremely long and coiled intestine is also an indication of the herbivorous feeding nature of the fish (Lagler *et al*., 1977).

4.3 Reproduction studies

The sex of the samples of species in this study could not be determined externally and that was done only after dissection. This is in conformity with the findings of Reynolds (1970) on the same species from Ghana, who reported that the species do not exhibit sexual dimorphism.

Gonads of females were observed to be larger than those of males and that in both sexes the gonads appear to increase in size with increase in gonad maturation stage. Four stages for gonad maturation were observed for females while, three stages of gonad maturation were observed for the males. This may be due to the fact that the study was carried out within six months and as such, some stages were missed. Shinkafi and Daneji (2011) and Shinkafi and Ipinjolu (2012) reported six stages of gonad maturation in *Synodontis eupterus and Auchenoglanis occidentalis* from River Rima, respectively, in a year-round study. Similarly, Otobo (1978) also reported six stages for *Pellonula afzeliusi* and *Sierrathrissa leonensis* in Lake Kainji, and Oboh (2006) reported six stages in four fish species from Jamieson River.

The Gonad Somatic Index values in this study showed that the GSI of females is higher than those of the males. Araoye (1999), Laleye *et al*. (2006) and Offem *et al*. (2008) also reported higher GSI in females than in males and the authors associated it with heavier weight of the ovaries in the females. Highest GSI in the mature stages in both sexes of the species was due to increase in gonad weight at that stage compared to other stages of gonad development. The high r value of the GSI-TL relationship in both sexes indicated that GSI tend to increase with increase in size of the fish as also observed by Ikomi (1996); Saliu and Fagade (2003) and Brylinska *et al.* (2002).

The fecundity of this fish ranges from 2,980–21,010 eggs which is lower than the 81,048-100,747 reported by Berte *et al.* (2008) from Bandama River for the species. Higher r value in the F-TW than in F-TL relationship suggests that fecundity of *D. rostratus* can be more easily predicted from its total weight than from its total length in River Rima. The findings of Balogun (1987) on *Pellonula afzeliusi*; Laleye *et al*. (2006) on *Synodontis schall* and Musa and Bhuiyan (2007) on *Mystus bleekeri* lend credence to this report.

5.1 Conclusion

This study is on the growth pattern, food and feeding habits and some aspects of the reproduction of *D. rostratus* in River Rima. The findings of the study can be used as a baseline data of the species from North-western Nigeria and can be used in the proper management of the species in River Rima and other water bodies with similar eco-climatic conditions.

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