Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.5, No.2, 2015

Investigation of aspects of reproductive cycles of some selected fish species in River Hadejia, Jigawa State, Nigeria.

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Abstract
This work aims to analyse some aspects of reproductive cycles of some selected fish species in River Hadejia was carried out from July 2012 at June 2013.
The following aspects were considered, reproduction and breeding cycles, sex determination, fecundity and Gonado – Samatic Index (GSI). Table 1 and 2 show the summary of the results obtained. While tables 3-12 show the detailed results obtained for the different stages of maturity and gonad development. The Gonado Somatic Index (GSI) was calculated as the percentage of Gonad-weight per body weight. Fecundity was determined by direct enumeration using a digital counter and egg diameter was determined using ocular eye piece with stage micrometer.
Keywords: Reproduction, fecundity, Gonad Somatic Index (GSI).

1.0 Introduction

The number of ripening eggs contained in the ovary of a fish prior to the next spawning, season is termed fecundity. The most fecund fishes are those, which have floating pelagic eggs, for example in the genius Labeo. The second are those which lay their egg and spawn on plants, for example, hepsetus odoe fishes, those which protect or hide their eggs usually, have a low fecundity, for example, Gymnarchus niloticus. In majority of fishes, the number of eggs at first gradually increase with age and then as the individual approaches senility, it usually begins to decrease.
Fecundity in a single population which has a greater food supply usually, has a higher fecundity. Increase in the fecundity of fishes may arise from Fecundity in a single population may undergo considerable fluctuations in relation to the supply of nourishment (Nikolsky. 1966). A less numerous population which has a greater food supply usually, has a higher fecundity. Increase in the fecundity of fishes may arise from several causes. It may be due to a reduction in the reserves of the yolk in the egg and consequent reduction of the passive feeding period of the embryo. Secondly, by an increase in the density of the yolk and thirdly, by an increase in the volume of the gonad (Kryzhanovsky, 1949). Fecundity is also increased by fractional spawning when only part of the eggs present in the ovary together is ripe at anytime (Bardach et al, 1972). Fractional and prolonged spawning periods are mainly characteristic of tropical and sub-tropical species of fishes. In temperate latitudes, there are only insignificant numbers of species with partial spawning. The partial spawners in the tropics are explained by the fact that there is no clear seasonal variation in the supply of food materials. Fractional spawning may not only be an adaptation to increased food supply. It also ensures the preservation of the death of the spawn of phytophyllic species when the spawning ground dries up. For example, in the carp from Amur, Nikolsky (1967) or through the death of eggs during storms. If these fishes had only a single spawning, the whole generation would have perished in some years, with fractional spawning only a part of it perished, for example in some cichlids, O. niloticus. The occurrence of small eggs together with large ones in the ovary does not always indicate fractional spawning. In many fishes, small eggs remain in the ovary after spawning and are gradually re-absorbed. Changes in fecundity are regulated by changes in the food supply. Faster growing individuals have a higher fecundity than slower growing ones of the same size. Fecundity is also influenced by environmental factors.
The need to harness the abundant fish protein resources in our river, lakes, burrow pits and other aquatic habitats to feed people becomes necessary, if malnutrition and hunger are to be checked. This is only possible if basic information on the biological and ecological of all fresh water fish species is available for use in the formation of a rationale fishery management strategy.
This work aims to investigate some aspects of reproductive cycles of some fish species in the river.

2.0 Materials and Methods

2.1 Reproduction and Breeding Cycles

Aspects of the reproductive cycle of the most economically important species were investigated. Such aspects studied and determined included fecundity for females; size at first maturity and breeding behavior for both males and females (Bagenal, 1973; Ali and Kadir, (1996).

The species selected were those caught in experimental gillnets. Gonado- somatic index (GSI) was calculated as the percentage of gonad weight per body weight (Caillet et al., 1986, Gunn et al., 1989).

2.2 **Sex Determination**

Sex was determined and gonad maturity stages were classified as in Kesteven (1960). Female ovaries in gonad stages IV to VI were removed and preserved in Gilsons fluid (Simpson, 1957). Egg diameter was determined using occular eyepiece with a stage micrometer.

2.3 Fecundity

Fecundity or number of eggs in each ovary was determined by direct enumeration using a digital counter. In some cases enumeration was done by volumetric sub sampling method. This was done using wet eggs 250cm^3 of eggs and water were put in 500cm^3 flat bottom flask. The mixture was stirred so that eggs were well distributed through the water. Then a sub-sample was quickly taken with 1cm^3 glass pipette. Sub-samples were taken five times and counted separately. The mean of the five sub-samples were found and this was used to estimate the fecundity relative to the total volume of the mixture.

2.4 Gonad – Somatic Index (GSI) was determined using the formula.

$$\frac{W}{B} \times 100 \quad \text{..... (Cailliet ef at 1986)}$$

Where: W = weight of both gonads and B - Weight of the fish

3.0 Results

3.1 Reproduction

Tables 1 and 2 show the summary of the results obtained for different sizes of fish at first maturity and the reproductive Parameters Respectively. Details of the results obtained for the different stages of maturity and gonad development for the various species caught in experimental gills-nets are shown in tables 3 – 12.

Family Protopteridae

Protopterm annectens

3.2 Size at First Maturity.

The smallest matured male had a total length of 24.5em and a weight of 160gm.The smallest matured female (Table 1) had total length \ of 19cm and a weight of 150gm..

3.3 Time of spawning

The species made nests in weedy areas. It is however not certain whether it is the male or the 'female that made the nests. Thus it behaves similar to Heterotis niloticus (Omorinkoba/pers. Comm..)

Sixty-one females were examined. Thirty-eight of them were matured at stages TV - VI. There were also ten matured males caught within the period. These were found between July and September (table 3).

Table I: Observed sizes at first maturity for River Hadejia fish species

Species	Male (cm)	wt(g)	Female (cm)	wt(g)	Mean standard length at entry with 2" mesh net
Protopterus annectens	24.5	160	19.0	150.0	20.45cm
Marcusenius senegalensis	10.1	33	9.0	32.0	10.0cm
Brycinus nurse	12.3	38	9.5	35.0	10.40cm
Schilbe intermedium	14.0	95	11.0	75.0	12.50cm
Siluranodon aurilius	11.0	55	8.0	58.0	10.10cm
Clarias s gariepinus	22.0	170	17.0	146.0	19.0cm
Brachisynodontis nigrita	16	60	8.0	45.0	9.4cm
Tilapia zilli	14.3	70.1	8.7	63.3	1 1 .60cm
Oreochromis niloticus	14.1	70.0	8.5	39.3	10.80cm
Sarotherodon galilaeus	13.8	58.5	8.0	36.0	10.20cm

Table 2: Summary of reproductive parameters of fish species at River Hadejia

SPECIES	No of female examined	No. of mature female	Minimum standard length (cm)	Mean wt (g)	Mean Ovary wt (gm)	Gonadosomatic index = mean wt/body wt x	Mean diameter of egg (mm)	Mean fecundity
Protopterus annectens	61	38	19.0	12.5	3.40	2.71	0.80	2300
Malcusenius senegalensis	85	40	9.0	35.20	.052	2.06	0.40	4200
Brycinus nurse	120	40	9.5	45.15	0.6	1.33	0.40	2800
Schlibe intermedius	105	45	11.0	60.98	80	1.31	0.50	3250
Siluranodon auritius	89	50	8.0	40.10	0.50	1.25	0.45	2300
Clarias gariepinus	95	42	17.0	110.66	4.6	4.16	1.1	4600
Brachisynodontis nigrita	85	32	8.0	40.76	0.4	0.98	0.43	1920
Tilapia zilli	80	47	8.7	70.50	1.5	2.13	0.9	940
Oreochromis niloticus	88	51	8.5	71.34	1.90	2.66	0.43	790
Sarotherodon galilaeus	110	60	8.0	65.44	1.65	2.55	0.9	680

Table 3: Time of spawning/maturity of Protopterus annectens in experimental gill nets catches in River Hadejia.

	STAGES					
	Males			Females		
Month	IV	V	VI	IV	V	VI
July	4	-	-	10	2	2
Aug	1	2	1	7	4	-
Sept	-	2	-	3	6	4
Oct						
Nov						
Dec						
Jan						
Feb						
Mar						
Apr						
May						
Jun						
Sub totals	5	4	1	20	12	6
Total		10			38	

Table 4: Time of spawning /maturity of Marcusenius senegalensis in gill nets catches in River Hadejia

	STAGES					
	Males			Females		
Month	IV	V	VI	IV	V	VI
July	2	4		6	8	1
Aug	1	1	3	4	2	4
Sept		2		4	5	2
Oct		1		3	1	
Nov						
Dec						
Jan						
Feb						
Mar						
Apr						
May						
Jun						
Sub totals	3	8	3	14	18	8
Total		14			40	

Table 5: Time spawning/maturity for Schilbe intermedius in experimental gill nets catches in River Hadejia

	STAGES					
	Males			Females		
Month	IV	V	VI	IV	V	VI
July	2	-	-	5	5	2
Aug	-	-	-	1	7	1
Sept	3	5	2	1	3	5
Oct	1	1	-	4	2	3
Nov				2	3	1
Dec						
Jan						
Feb						
Mar						
Apr						
May						
Jun						
Sub totals	4	8	2	13	20	12
Total		12			45	

Table 6: Time of spawning/maturity for Brycinus nurse in experimental gill nets catches in River Hadejia.

	STAGES					
	Males			Females		
Month	IV	V	VI	IV	V	VI
July	-	-	-	4	-	4
Aug	1	2	3	4	2	6
Sept	3	4	1	6	2	-
Oct	1	2	1	-	8	-
Nov						
Dec						
Jan						
Feb						
Mar						
Apr						
May						
Jun						
Sub totals	5	8	5	14	12	10
Total		18			40	

Table 7: Time of spawning/maturity for Siluranodon auritius in experimental gill nets catches in River Hadejia.

	STAGES					
	Males			Females		
Month	IV	V	VI	IV	V	VI
July	1	2	2	8	12	4
Aug	2	3	0	8	6	3
Sept	-		-			
Oct	-		-			
Nov	-		-			
Dec	-		-			
Jan	-		-			
Feb	-		-			
Mar	-		-			
Apr	-		-			
May	-		-			
Jun	-		-			
Sub totals	3		2	5	2	2
Total		10			50	

Table 8: Time of spawning/maturity for Clarias gariepinus in experimental gill nets catches in River Hadejia

	STAGES					
	Males			Females		
Month	IV	V	VI	IV	V	VI
July	-	-	-	-	-	-
Aug	2	3	1	4	7	3
Sept	4	1		6	10	2
Oct	2	1	1	2	6	2
Nov						
Dec						
Jan						
Feb						
Mar						
Apr						
May						
Jun						
Sub totals	8	5	2	12	23	7
Total		15			42	

Table 9: Time of spawning/maturity for Brachisynodontis nigrita in experimental gill nets catches in River Hadejia.

	STAGES					
	Males			Females		
Month	IV	V	VI	IV	V	VI
July				5	7	2
Aug				1	2	
Sept				1	3	1
Oct						
Nov						
Dec						
Jan						
Feb						
Mar						
Apr						
May						
Jun						
Sub totals				3	5	2
Total					32	

Table 10: Time of spawning/maturily for Tjlapia zilli in experimental gill nets catches in River Hadejia.

	STAGES					
	Males			Females		
Month	IV	V	VI	IV	V	VI
July	4	7	1	7	4	3
Aug				6	8	2
Sept						
Oct				2	4	1
Nov				3	2	-
Dec						
Jan						
Feb						
Mar						
Apr						
May						
Jun				3	2	-
Sub totals	4	7	1	21	20	6
Total		12			47	

Table 11: Time of spawning/maturity for Oreochromis niloticus in experimental gill nets catches in River Hadejia

	STAGES					
	Males			Females		
Month	IV	V	VI	IV	V	VI
July	2	5	2	5	7	2
Aug	-	-	-			
Sept	-	-	-	3	6	1
Oct	4	3	1	6	9	2
Nov						
Dec						
Jan						
Feb						
Mar						
Apr						
May						
Jun				4	5	1
Sub totals	6	8	3	18	27	6
Total		17			40	

Table 12: Time of spawning/maturity for Sarotherodon galilaeus in experimental gill nets catches in River Hadejia

	STAGES					
	Males			Females		
Month	IV	V	VI	IV	V	VI
July	1	5	2	5	7	2
Aug	3	0		2	4	3
Sept				3	5	-
Oct				1	4	2
Nov						
Dec						
Jan				2	4	-
Feb				1	1	2
Mar						
Apr						
May						
Jun	4	4	1	7	3	2
Sub totals	8	9	3	21	28	11
Total		20			60	

3.4 Fecundity.

Matured females at stages V and VI were used for fecundity counts. These had a mean egg count of 2340eggs (Table 2). Egg size in the stage V ranged from 0.63mm to 0.86mm. Egg size in the stage VI females ranged from 0.780 - 1.70mm Egg size in the species ranged from 0.63m to 1.70mm. The overall mean egg size was 0.80mm. **(Table 2**). Gonado - somatic index for the' species was 2.71. this s for the case of protopterus annectens.

Family Mormyridae

Marcusenius senegalensis

Size at first maturity.

The smallest matured female had a standard length of 9.0cm (Table 2) and a weight of 32.20g. The mean ovary weight was 0.52g.

Time of spawning: Eighty-five females were examined between July and October. Forty specimens were matured between stages IV and VI. (Table 2).

Fecundity

The mean fecundity for this species was 4200. Mean egg diameter was 0.40mm and the Gonado somatic index was 2.06.

Egg size in stage V females were smaller and more numerous than in the VI stage females. The mean egg diameter in the stage V females was 0.36mm.

This ranged from 0.32mm - 0.39mm. In the stage VI the egg size ranged from 0.37mm-0.46mm

Family Characidae

Brycinus nurse:-

Size at first maturity. The smallest mature male had a standard length of 12.3cm while the smallest matured female was 9.5cm.

Time of spawning

One hundred and twenty females were examined and forty were matured between stages IV - VI. Eighteen matured males were found in August and September while matured females were caught between July and October. (Table 4)

Fecundity

Fecundity in the females examined ranged from 2200 to 5850 with a mean of 2800. egg size ranged from 0.33mm to 0.590mm with a mean of 0.40mm. gonado somatic index was found to be 1.33. (Table 2)

Family Schilbeidae

Schilbe intermedius

Size at first maturity

The smallest matured male had a standard length of 14cm and a weight of 35.09 The smallest matured female had a standard length of 11.00cm and a weight of 75.Og.

Time of spawning

One hundred and five females were examined out of which 45 were matured. Twelve males were matured out of 52 examined. All the matured males were obtained in September and October. The females were obtained between July and November. (Table 5)

Fecundity

Egg count in this species ranged from 3010 - 5,225. The mean was 3250 (Table 1). The mean ovary weight was 0.8g. The mean egg diameter was 0.50mm with a range of 0.37mm - 0.65mm.

Siluranodon auritius

This is the second member of the family Schilbeidae in River Hadejia.

Size at first maturity.

The smallest matured male was 11.0cm standard length (Table 2) while the smallest matured female was 8.0cm standard length with a weight of 58.5g.

Time of spawning

Eight females were found matured and these were caught between June and August. Ten matured males were found and these were also obtained between July and August.

Fecundity

Fecundity estimate was found to range from 2,020 to 4,862. Mean fecundity was 2,300. Mean egg diameter was 0.41mm. (Table 2)

Family Clariidae

Clarias gariepinus

Size at first maturity

The smallest matured male had a standard length of 22cm.while the smallest matured females had a standard length of 17.0cm and a weight of 146g(Table 1)

Time of Spawning

Forty-two matured females were found between stages IV and VI. Only 15 matured males were obtained. Both males and females were obtained between August and October. (Table 8)

Fecundity

The egg count for the species ranged from 3,760 - 5,480 with a mean of 4,600. Mean egg diameter was l.lmm and the gonado somatic index was 4.16.

Family Mochokidae

Brachisynodontis nigrita

Size at first maturity

The smallest matured female had a standard length of 8.0cm, while the biggest one had a standard length of 16cm. It weighed 60g. (Table 1)

Time of spawning

Thirty two matured females were found and these were found between June and September. No matured male was caught. (Table 9)

Fecundity

Fecundity in this small species ranged between 1,805 and 2,910 egg. The mean was 1920 eggs. Mean egg diameter was 0.43 while the gonado somatic index was 0.98.
(Table 2)

Family Cichlidae

Tilapia zitli

Size at first maturity

The smallest matured female was 8.7cm standard length, while the smallest matured male was found to have 14.3cnstarrdai l length (Table1). These weighed 70.Ig and 63.3g respectively.
/

Time of spawning

Forty-seven matured females of this species were obtained. These were obtained between June, August, October and November. Twelve matured males were recorded in August. (Table10)

Fecundity

Egg counts for this species ranged between 800 - 2,210 eggs. The mean was 940 eggs. Gonado -somatic index was found to be 2.13, while the mean egg diameter was found to be 0.90mm. (Table 2)

Oreochromis niloticus size at first maturity.

Fifty-one females with ripe gonads were assessed. These had a minimum standard length of 8.5 and weighed 39.3g. Seventeen matured males were assessed. The smallest had a standard length of 14.1cm and a weight of 47.5g. (Table 1)

Time of spawning

Fifty-one females with ripe gonads were obtained. These were obtained; in June - July, September -. October and February - March. The males were obtained in July and October. (Table 11)

Fecundity

Eggs count for this species averaged 790 eggs. This ranged from 760 -2120 eggs. Egg size ranged from 0.83mm to 1.4mm the mean was 1.0mm. Gonado - somatic index for the species was 2.66. (Table 2)

Sarotherodon Galilaeus

Size at first maturity

The smallest matured female had a standard length of 8.0cm. Twenty males were assessed and the smallest one had a standard length of 13.8cm. (Table 1)

Time of spawning

The matured females of these species were more numerous than the fother species. They were 60 in number and were found about three times June - August, October - November, Feb - March. However the peak period of spawning appears to be June - August and November. (Table 12)

Fecundity

Fecundity in the species averaged 680 (Table 2). It ranged between P473 - 1815. Egg size ranged between 0.53mm - 0.95mm. The mean was 0.90mm. Gonado - somatic index was found to be 2.55. (Table 2)

4.0 Discussion and Conclusion

The mean fecundity ranged from 680 to 4600 eggs (Table 2). The least fecundity of 680 was recorded for Sarotherodon galilaeus (range 680-1230) while the highest was recorded for Clarias gariepinus (range 3100 - 4600). The smallest mature females recorded at 8cm standard length were Siluranodon auritius and Sarotherodon galilaeus weighed 37.5g and 48.5g respectively. The highest minimum standard length was recorded for Protopterus annectens (19.0cm). The highest gonadosomatic index of 4.16 was recorded for Clarias gariepinus while the least of 0.98 was observed for Brachsynodontis nigrita. B. nigrita has a lower gonadosomatic index (GSI) than a species like Sarotherodon galilaeus because GSI is more dependent on the gonad weight of the fish. Being a smaller sized fish its gonads are also smaller compared with S. galilaeus.

Both the fecundity and gonadosomatic index reflect the measure of success of the stock in the water body. The success of Tilapia in this water body could be due to their multiple spawning behaviors. They spawn many times in the year. Oreochromis niloticus, for example and Tilapia zilli were found to spawn about three times in the year while Sarotherodon galilaeus spawned four times. The period of spawning was also found to be extended or prolonged. The other species spawned once while Clarias gariepinus was also observed to have an extended breeding period.

Reproduction is very vital to the sustenance, replenishment and progeny maintenance of every living organism. Fish stocks as renewable natural resources get replenished from incessant cropping by fishermen through reproduction. The conservation and survivability of any fish species depend more importantly on its reproductive potential. The River Hadejia species are exposed to a daily vigorous harvesting regime by the fishermen. Yet the fish stock had been able to sustain itself even in the face of such onslaught through their resilience. This resilience is made possible through their reproduction potentials.

Mature Protopterus annectens, were observed in the catches between July and September. The mean egg count of 2,340 eggs was low. The low egg count in the species seemed to be compensated for by its ability to aestivate, which ensures its survival during adverse periods. Its survival at such time is enhanced because it is endowed with accessory breathing organs — (lungs as lungfishes) hence they could stay inside or even escape into grasses to breathe. This helps them to survive better than most of the other species.

The Mormyrid, Marcusenius senegalensis had better fecundity with a mean of 4,200. Even though the species is small in size it made up for its poor representation in River through the fair fecundity.

Generally all the species had low fecundities. A low fecundity could mean a low recruitment. Recruitment is a vital factor in determining the subsequent adult number. In the case of the Cichlids, they are mouthbrooders. Mouthbrooders had been observed to lay few eggs but the young are cared for by the parents during their growth. Hence their mortality is reduced through parental involvement (Hart and Pitcher, 1 982)

Higher fecundities had been observed elsewhere by other workers. Imevbore, 1970, observed higher fecundities for these species in the River Niger. Also Akintunde (1976) for Cichlids and Blake (1977) for Mormyrids.

Apart from genetic factors, environmental factors could also affect fecundity. Such environmental factors could act through food. The low fecundity observed in the river could be related to the fishing intensity and possibly the strong intra and interspecific food competition. This is in agreement with Rickter and Efanov (1976). McFadden et al (1 965) also related fecundity to food. They found that fish from infertile streams had lower egg Production. Legget and power (1969) also correlated fecundity and food supply in salmon.

The intensity of fishing on the River, fish species could possibly be responsible for the reproductive strategy adopted by them. This is in agreement with Pitcher and Hart (1982). They stated that fish could change their reproductive strategies according to the intensity of mortality, they are subjected to. They further claimed that the size at first maturity, numbers of eggs and ability to escaped nets and body proportions could be affected by fishing intensity.

Conclusion

Fecundities generally was low; this could be attributed to mean a low recruitment. Recruitment is a vital factor in determining the adult number. Reproduction in very vital to the Sustenance, replenishment and progeny maintenance of every living organism. The River Hadejia species are exposed to a daily vigorous harvesting by fishermen, yet the fish stock had been able to sustain itself. The mean fecundity ranged from 680 to 4600 eggs (Tables 1&2). The highest Gonad Somatic Index (GSI) of 4.16 was recorded and the least of 0. 98 was also observed. (Tables 3-12).

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