ASPECTS OF THE REPRODUCTIVE BIOLOGY OF HATCHERY-RAISED *Clarias gariepinus* I: FECUNDITY

[1]EGWUI, Peter Chuks [2]MGBENKA, Bernard Obialo and [1]NWUBA, Lucy Afulenu
[1]Department of Zoology, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria
[2]Department of Zoology, University of Nigeria, Nsukka, Enugu State, Nigeria

Corresponding Author: Egwui, P. C. Department of Zoology, Nnamdi Azikiwe University, Anambra State, Nigeria. Email: pc_egwui@yahoo.com, Phone: +2348033702555.

ABSTRACT

The fecundity of four batch weights (10 samples each) of gravid Clarias gariepinus weighing 60 ± 0.17159 g, 125 ± 0.15092 g, 250 ±0.20683 g and 500 ± 0.15670 g raised from the hatchery was investigated. The paired ovary of each fish was dissected out, weighed (g) and its length measured (mm). Each paired ovary was stored in a solution of 1 % formalin in 0.6 % saline solution for at least 3 weeks for the solution to harden the eggs and remove egg clumping. After 3 weeks, each paired ovary was torn apart on a 2 mm mesh circular fabricated sieve over a stream of water. The eggs passed through the 2 mm mesh sieve into a receptacle. Sub sample of the eggs from each paired ovary was taken, counted and all the eggs in each paired ovary were determined thereafter by volumetric method. The total fecundity of 40 gravid fish studied ranged from 6,450 to 71,450 eggs per fish. The mean fecundities of the 60 g, 125 g, 250 g and 500 g fish were 8,501.9 ± 295.5, 13,364.0 ± 1734.3, 41,087.9 ± 12258.1 and 51,186.0 ± 13851.0 eggs respectively. The relationships between fecundity and fish weight (FW) (n = 40, r = 0.8761), fish total length (TL) (n= 40, r = 0.8266), fish ovarian weight (OW) (n = 40, r = 0.7609), fish ovarian length (OL) (n = 40, r = 0.7236), gonadosomatic index (GSI) (n = 40, r = 0.5992) and fish condition factor (K) (n = 40, r = 0.9046) obtained were linear and positive and the condition factor appeared to be the best predictor of fecundity in C. gariepinus studied. The higher fecundity of C. gariepinus (range: 6,450 to 71,450) obtained from this study when compared with the range of 9,000 to 25,000 earlier reported from the wild stock indicates that hatchery-raised C. gariepinus is more fecund than the wild fish in the Anambra area of the sub-region. Therefore, hatchery-raised C. gariepinus appears to be better for fish breeding in fingerlings production than the wild fish.

Keywords: Fecundity, Gonadosomatic index, Condition factor, Hatchery-raised *Clarias gariepinus*

INTRODUCTION

Begenal (1978) defined fecundity as the number of vitellogenic oocytes in mature females prior to the next spawning season. This worker considered only the ripe spawnable eggs (> 1.0 mm) in the Ovary of the fish. However some other workers (Holl, 1966; Bowmaker, 1973; Clay, 1979; Eyo and Mgbenka, 1992; Ezenwaji, 1998) considered fecundity to include all available eggs in the ovary of the fish (total fecundity).

Studies on fish fecundity is important to evaluate the reproductive potentials of the species, (Duarte and Araujo, 2002) and it gives prerequisite information needed to plan a breeding programme so as to determine how many eggs would be spawned or stripped, the amount of rearing facilities required and the extent to which various culture equipment would be put to use (Eyo and Mgbenka, 1992). Reproductive biology of the clariids and other culturable species has been studied by many researchers across the globe particularly in Africa and there has been specific research on fecundity (Yalcin *et al*., 2001).

Awachie and Ezenwaji, (1981) reviewing the status of both the capture and culture fisheries of the Anambra river basin of South Eastern Nigeria reported that *Clarias* species dominated the fisheries within the basin accounting for up to 70 % of the total fish production within the basin. Regarding the fecundity of the paired ovary of gravid *Clarias gariepinus* from different sub regions of Africa, Nawar and Yoakim (1962) found the range to be from 13, 900 to 164, 800 eggs per fish in river Nile, North Africa; while Mulder, (1971) in the Transvaal South Africa recorded 293, 000 to 446, 000 eggs per fish. Micha (1973) in the Ubangui river, West Africa recorded 3,000 to 328,000; Richter (1976) in Central and West Africa recorded 10,000 to 120,000; Gaigher (1977) in Hardep Dam, South West Africa found 70,000 to 1,100,000 and Bruton (1979) in Lake Sibaya, South Africa reported a figure of 5000 to 163,000 and Eyo and Mgbenka (1992) for Anambra river, Nigeria, West Africa reported a fecundity range of 9,000 to 25,000 eggs per female *C. gariepinus*. All these researchers worked on *C. gariepinus* collected from the wild and their overall fecundity range lies between 3000 and 1,100.000. Little has been reported on the fecundity of gravid *C. gariepinus* raised from the hatchery. Secondly, most workers on fecundity failed to give information on the length and weight of the brood fish used. The aim of this work is

to give information on the mean fecundities and fecundity ranges of different batch weights of hatchery-reared gravid *C. gariepinus.*

MATERIALS AND METHODS

Collection and Care of brood fish: Fifteen fish samples each of gravid *C. gariepinus* weighing 60 ± 0.17 g, 125 ± 0.15 g, 250 ± 0.21 g and 500 ± 0.16 g were randomly collected in mid May from Felisenco intensive fish farm, Ogbunike near the former toll-gate along Enugu-Onitsha Express Way Nigeria for four treatments. Out of each 15 batch weights collected, 10 samples each of the four treatment groups were randomly selected for the fecundity experiment. The brood fish were held separately in four brood fish concrete ponds according to weights and fed two times (0800 h and 1600 h) at a daily rate of 5 % fish biomass (Legendre *et al.*, 2003) with 45 % crude protein pelleted feed.

Ovary Collection: Forty sexually maturing gravid *Clarias gariepinus* (10 samples each) were netted out from the four brood ponds in the last week of May. When gently pressed, none of these brood fish released eggs showing that they were not yet in a running ripe stage (Eyo and Mgbenka, 1992).

Ten samples of each batch weight were placed in a bath of water and the experimental fish stunned with electric current passed through the water. Each brood fish was weighed (g) with 1-kg top loading balance and its total length measured (g). The paired ovary of each fish was dissected out (Figure 1), dried in between filter papers, weighed (g) and separately stored in a solution of 1 % formalin in 0.6 % saline solution(Shehadeh *et al.*, 1973) in a labeled specimen bottle for not less than 3 weeks before further work on the eggs was carried out. The solution hardened the eggs and removed clumping of eggs and made them to separate individually similar to Gilson's solution. The gonadosomatic index of each fish was calculated by the GSI = wet weight of gonad ÷ weight of fish X 100, while the Fulton's condition factor of each fish was calculated by the formula: $K = 100W/L^3$, where w = weight of fish (g) and L = length of fish (cm). The mesentery of each paired ovary was removed by pulling the ovary apart in a stream of water over a 2 mm sieve (Figure 1). Fecundity was determined for the forty (40) females by counting sub samples of eggs contained in each of the paired ovary, the total number of eggs per paired ovary determined volumetrically (Salt and Hollick, 1944). All the eggs in each paired ovary were added into a 250 ml capacity measuring cylinder and water added to the cylinder to bring the volume to the mark. The egg content was poured into a 400 ml beaker and mixed thoroughly by constant agitation. During the agitation, 3 samples of 2.4 ml were drawn into a standard micro pipette and delivered into 3 clear and clean Petri dishes. Each Petri dish was placed over a black background and the eggs were counted by means of eye aided by a hand lens. The mean count of the 3 samples was taken as the number of eggs

Figure 1: Preserved sample of paired ovary of *C. gariepinus* indicating proximal-, mid-, and distal sections of the ovary

(n) in the 2.4 ml sample (v). Since the total volume (V = 250 ml) was known, the total number of eggs per fish (N) or its total fecundity (Fec.) was calculated using the formula: Total fecundity = total volume of eggs per fish (V) x mean egg number in sub sample (n) /volume of eggs in the sample (v).

Data Analysis: Data collected were analyzed using Statistical Package for Social Sciences (SPSS). Mean fecundities and standard error of means as well as fecundity ranges for the different batch weights of gravid *C. gariepinus* used were determined. Analysis of variance (ANOVA) was used to compare the mean fecundities from the four batch weights used. The mean fecundities were further subjected to the Fisher's Least Significant Difference (F-LSD) multiple comparisons at 5 % probability. Relationships between fish length and weight, fish ovarian length and weight, gonadosomatic index (GSI), condition factor (K) and fecundity were determined using regression Pearson's statistics (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

The mean fecundities and the fecundity ranges for the four batch weights of brood *C. gariepinus* are shown in Table 1. The resulting fecundity for the forty gravid fish ranged between 6,450 and 71,450 eggs per fish. Fecundity had linear relationships with gonadosomatic index (GSI) and fish condition factor (K) (Figures 2 and 3) better described by the linear equations: Y = 35.677 – 0.0003x (n = 40, r = 0.5992); Y = 158.89 + 0.0177x (n = 40, r = 0.9046), respectively showing that condition factor is a better predictor of fecundity than gonadosomatic index in *Clarias gariepinus* tested. The mean fecundity increased from 8,501.9 **±** 295.5 to 51,186.0 **±** 3851.0 eggs per fish as the fish size increased from 60 ± 0.17 g to 500 ± 0.16 g (Table 1) agreeing with Bagenal (1978) that fish species exhibit wide fluctuations in fecundity among fish of the same species, size and age. It also agrees with MacGregor (1975) who stated that smaller fish tended to have lower relative numbers of eggs than larger fish.

Table 1: Mean fecundity ± SEM[1] of different weights (g) of *Clarias gariepinus* brood fish

Weight of fish (g)	Total number of fish	Mean fecundity	Fecundity range
60	10	8,501.9 ± 295.5[a]	6,450 – 10,087
125	10	13,364 ± 734.3[a]	11,650 – 19,400
250	10	41,087.9 ± 2258.1[b]	31,973 – 59,819
500	10	51,186.0 ± 3851.0[c]	22,995 – 71,450

Means in the same column with different superscript have significantly different fecundity (P < 0.01).

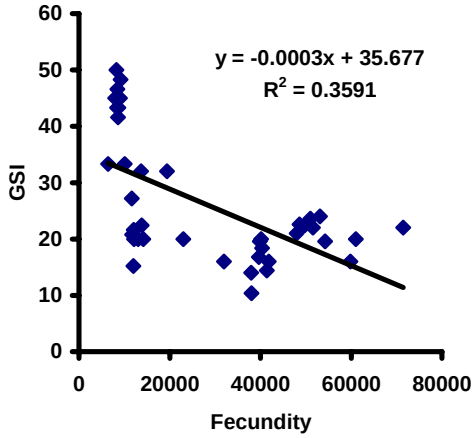

Figure 2: Gonadosomatic index (GSI) versus fecundity of *Clarias gariepinus*

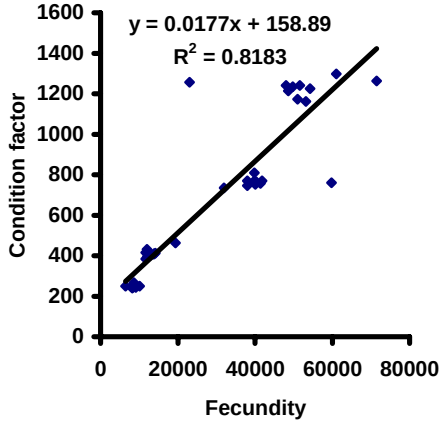

Figure 3: Condition factor (k) versus fecundity of *Clarias gariepinus*

There was significant difference (P < 0.05) between all the groups of mean fecundities of the varying weights of the fish tested. Mean fecundities of the 60 ± 0.17 g and 125 ± 0.15 g fish separated by F-LSD were not significantly different (P > 0.05) from each other but were significantly different from those of the 250 ± 0.21 g and 500 ± 0.16 g fish. The mean fecundity of 500 ± 0.16 g fish was significantly different (P < 0.05) from all other mean fecundities tested.

The high fecundity of *C. gariepinus,* obtained from this study could be explained by the non-parental care of the species (Viveen *et al.*, 1985). These workers reported the large volumes of fertilized eggs deposited by a shoal of males and females of *C. gariepinus* at shallower areas of the river bank during spawning runs and they abandoned these eggs to their fate. In the end, only a few juveniles survive out of millions of larvae produced. The high fecundity, therefore, might be an attempt by this species to ensure that some young ones survive from season to season to perpetuate the generations of the species.

Table 2: Fecundity ranges of wild and farm-raised *Clarias gariepinus*

Fecundity range per female	Location in African sub region	Reference
13,900 - 164,800	Nile river, North Africa	Nawar and Yoakim (1962)
293,000 - 446,000	Transvaal South Africa	Mulder, (1971)
3,000 – 328,000	Ubangui river, West Africa	Micha (1973)
10,000 - 120,000	Central and West Africa	Richter (1976)
70,000 - 1,100,000	Hardep Dam South West Africa	Gaigher (1977)
5000 – 163,000	Lake Sibaya South Africa	Bruton (1979)
9,000 – 25,000	Anambra river, Nigeria	Eyo and Mgbenka (1992)
8,501.9 - 51,186	Felisenco fish farm, Anambra, Nigeria	This study

The fecundity range of 6,450 to 51,450 eggs per fish obtained in this study appears to fall within the over all range of 3000 and 1,100,000 eggs per fish reported for wild *C. gariepinus* from all the sub regions of Africa (Table 2). As most reports on fecundity range for wild *C. gariepinus* showed no weight ranges of the fish, it would be difficult to make any useful comparison between the fecundity range of wild *C. gariepinus* and that of hatchery-raised gravid *C. gariepinus.* Finally, it is concluded that fecundity increased with increase in fish weight and that the 500 ± 0.16 g *C. gariepinus* had the highest number of eggs in the four batch weights of fish studied.

ACKNOWLEDGEMENTS

The researchers are grateful to the Chief Executive of Felisenco fish farms for providing the study fish samples and the enabling environment for this research. We also acknowledge all the authors cited in this paper.

REFERENCES

AWACHIE, J. B. E. and EZENWAJI, H. M. G. (1981). The importance of *Clarias* spp. in the fisheries development of Anambra Basin, Nigeria. *Committee on Inland Fisheries of Africa Technical Paper,* 8: 212 - 224.

BAGENAL, T.B. (1978). Aspects of fish Fecundity. Pages 75 – 101. *In* GERTING, S. D. (ed.). *Ecology of freshwater fish production,* Blackwell Scientific, Oxford.

BOWMAKER, A. P. (1973). *An hydrobiological study of the Mwend River and its mouth, Lake Kariba. Ph. D.* Thesis, University of Witwatersrand, Republic of South Africa. 352 pp.

BRUTON, M. N. (1979). The breeding biology and early development of *Clarias gariepinus* (Pisces: Clariidae) in Lake Sibaya, subgenus *Clarias* (*Clarias*). *Transactions of Zoological Society of London,* 35: 1 - 45.

CLAY, D. (1979). Sexual maturity and fecundity of the African Catfish (*Clarias gariepinus*) with an observation on the spawning behaviour of the Nile catfish (*Clarias lazera*) *Zoological Journal of the Linean Society,* 65: 351 - 365.

DUARTE, F. and ARAUJO, F. G. (2002). Fecundity of the *Hoplostomus affinis* (Siluriformes, Loricariidae) in the Lajes Reservoir, Rio de Janeiro, Brazil. *Revised Biology*, 50(1): 197 – 200.

EYO, J. E. and MGBENKA, B. O. (1992). Aspects of the biology of *Clarias gariepinus* in Anambra River basin I: oocyte diameter, fecundity and sex ratio. *Journal of Agriculture Science and Technology,* 2(1): 47 - 51.

EZENWAJI, H. M. G. (1998). The breeding biology of *Clarias albopunctatus* Nicholas and La Monte, 1953 in semi intensively managed ponds in the flood plain of the River Anambra, Nigeria. *Ecology of Freshwater Fish*, 1: 101 - 107.

GAIGHER, I. G. (1977). Reproduction in the catfish (*Clarias gariepinus*) in the Hardap Dam, South West Africa. *Madoqua,* 10: 55 - 59.

HOLL, E. A. (1966). Some notes on the spawning behaviour of the catfish (*Clarias gariepinus*) Burchell in Rhodesia. *Zoological Society of South Africa*, 7: 38 - 41.

LEGENDRE, M., SLEMBROUCK, J., SUBAGJA, J. and KRISTANTO, A. H. (2000). Ovulation rate, latency period and ova viability after GnRH- or hCG-induced breeding in the Asian catfish, *Pangasius hypophthalmus* (Siluriformes, Pangasiidae). *Aquatic Living Resource*, 13: 145 - 151.

MACGREGOR, J. S. (1975). Ovarian development and fecundity of five species of California. *Current Fishes, California Co-operative Oceanic Fisheries Investigations Report*, XVIII: 181 - 187.

MICHA, J. C. (1973). Etudes populations. Pages 1 – 110. *In* Bruton, Piscioles de L'ubangui et Tentatives de selection et d'Adaptation de Adaptation de quelques Especes a I'Etang de Pisciculture. Notes Docum. Peche Piscic, Centre Techn. Forest. Trop.

MULDER, P. F. S. (1971). 'n Ekologiese studie van die hengelvisfauna in die Vaalriversisten met spesiale Thompson. M. Sc. Thesis. Rand Africans University, South Africa.

NAWAR, G. and YOAKIM, E.G. (1962). A study on the fecundity of the Nile catfish, *Clarias lazera* Valenciennes and Cuvier 1840. *Annals and Magazine of Natural History, 5(13):* 385 – 389.

RICHTER, C. J. J. (1976). The African mudfish, *Clarias lazera* (C. and V.), a new possibility for fish culture in tropical regions? *Miscellaneous papers Land bou.-whogeschool, Wageningen*, 13: 51 - 70.

SALT, G. and HOLLICK, F. S. J. (1944). Studies of wireworm populations I: A census of wireworms in pasture. *Annals of Applied* Biology, 31: 52 - 64.

SHEHADEH, Z.H., KUO, C.M. and MILISEN, K. K. (1973). Validation of an *in vivo* method for monitoring ovarian development in the grey Mullet (*Mugil cephalus* L.). *Journal of Fish Biology*, 5: 489 - 496.

STEEL, R. G. D. and J. H. TORRIE (1980). Principles and procedures of statistics: with special reference to biological sciences. McGraw-Hill, New York, NY. 481 pp.

VIVEEN, W. J. A. R, RICHTER, C. J. J., VAN OORDT, P. G. W. J., JANSEEN, J. A. L. and HUISMAN, E. A. (1985). *Practical Manual for the Culture of the African Catfish* (*Clarias gariepinus).* Joint publication of Directorate General International Cooperation of the Ministry of Foreign Affairs, The Hague, the Netherlands, Department of Fish Culture and Fisheries of the Agricultural University of Wageningen, the Netherlands and Research Group for Cooperative Endocrinology, Department of Zoology of the University of Utrecht, the Netherlands. 94 pp.

YALCIN, S., KEMAL, S. and IHSAN, A. (2001). Certain reproductive characteristics of the catfish (*Clarias gariepinus* Burchell, 1822) living in the River Asi, Turkey. *Turkey Journal of Zoology,* 25: 453 – 460.