Fecundity Correlations; Critical Allometric Determinant for Spawning of Clarias Gariepinus from River Uke, Nasarawa State, Nigeria

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Abstract- For fecundity assessment, the Morphometric measurement of fish samples were determined and recorded, fish were dissected to determine the sexes while eggs were collected, weighed and preserved in specimen bottles using 5% formalin prior to estimation. Biologically Viable parameters were equally examined such as; Gonadosomatic Index (GSI), condition factor (K), fecundity and water parameters. A total of 67 samples were collected with total length ranging from 13.5cm – 46.9cm and weight ranged between 70g -1800g. Overall sex ratio for male and female was 2:1 and chi square showed no significant difference in the ratio of males to females. ($p<0.05$) Positive correlation exists between the following; fecundity and length ($r = 0.97$). Fecundity and weight (r - 0.98), fecundity and condition factor ($r = 0.95$), fecundity and GSI ($r = 0.98$). Fecundity ranged from 864eggs - 16,625eggs. Generally,, results portray positive correlation between fecundity and other body parameters of the fish species. it is important to state that, the size suitable for fish culture(spawning range) falls between 1kg - 2.5kg for species of Clarias gariepinus which can be used as source of brood stock for production in hatchery to boast aquaculture enterprise and meet nutritional demands of the immediate community, State and Nigeria at large .

Index Terms- Condition factor (K), Fecundity Correlation, Gonasomatic index (GSI), Sex Ratio, Spawning size range,.

I. Introduction

The study was design to cover fish species of *Clarias gariepinus* in River Uke located at Karu Local Government area in Nasarawa State, which is in the North Central Part of Nigeria. Karu Local Government is located between latitude 8°-37° North and 8°-2° east. The Local Government is bordered by Abuja in the east, Kaduna in the North, Keffi-Kokona at the west and in the South by Nasarawa Local Government.

The description of reproductive strategies and the assessment of fecundity are fundamental topics in the study of the biology and population dynamics of fish species and also for evaluation of the reproductive potential of individual fish species. Moreover, the availability of data based on reproductive parameters and environmental variation leads to a better understanding of observed fluctuations in reproductive output and enhances our ability to estimate recruitment (Yem, 2007).

The fecundity of fish is defined as the number of ripening eggs in the female prior to the next spawning period, (Bagenal, 1973). Irrespective of its various applicability and number of purposes, it's still the same; for example, either as part of systematics in racial studies, in connection with total population estimation or in studies of population dynamics or productivity. For all this fecundity determinants, the methods are similar and rail conveniently into three processes namely; catching an unbiased sample, estimating the number of eggs and analyzing the result in relation to other population statistics, (Dickel, *et al*, 2004).

Fecundity data are instrumental in the calculation of reproductive potential of a population, which aids estimation of the minimum adult population needed to maintain and or increase recruitment for commercial purposes, more so, used (along with the adult sex ratio) to estimate stock size (Bagenal. 1968).

Egg preservation usually facilitates counting, though it is still possible to count eggs from unpreserved ovaries even though, difficult and perhaps not too accurate. Most fecundity studies utilize hardened preserved eggs that are easier to count (Offem. 2007).

Olatunde, (2008) reported that, environmental factors were found to cause location – related differences in the fecundity of certain species like catfish. Gonad Maturity Stages in *Clarias gariepinus*, *Chrysichthys nigrodigitanus* and salmon.

For most accurate estimate of fecundity, we embark on total count of eggs in a fish, even though a more tedious and time consuming exercise. Fecundity estimates are based on sub-sampling (Khan, et al., 2002). Other methods include volumetric and gravimetric methods.

Over the years, many African countries have a considerable population growth that has taken place, accompanied by a steep increase in urbanization, industrial and agricultural land use, this has entailed a tremendous increase in discharge of wide diversity of pollutants to receiving water bodies and has caused undesirable effects on different components of the aquatic environment of fisheries (FAO. 1992 and Authman, 1998). The damage done by pollution to the environment is irreversible (Miles, 1999 and Omoregie, 2000). The awareness of harm caused by several pollutants to the natural environment has led to political and legislative authorities of the industrially developed countries to introduce or renew regulations to protect the environment as reported by Biney *et'al*., (1987).

The main problem of culture fisheries in Nigeria is due to insufficient supply of fry and fingerlings, environmental degradation and drought. This could be attributed to the breeding and culturing of various fish which appears more dependent on the environment that is; marine, brackish or freshwater (FAO, 2007). Fishes in the tropics and some of the tropical water bodies usually experience growth fluctuation due to many factors, some of which are; environmental changes, availability of food, spawning rate, amongst others.

Length-weight relationships of fish play an important role in fishery management (Haimovici and Velasco, 2000). It gives an estimate of average fish weight at a given body length (Haimovici and Velasco. 2000) and also assesses the relative well being of the fish produced. Several studies on length-weight relationship were carried out by Ochkiya (2000) on snake-head fish also known as *Channa obscura* Niger Delta freshwater swamps, Lawrence (2000). Knowledge about fecundity (egg production capacity) of fishes is important for comprehension of their life history. Fecundity assessment of fishes has been useful in racial distinction, progeny survival studies, stock evaluation and aquaculture-based induced spawning and egg incubation. (Fafioye *et al*. 2005)

The absolute fecundity, which is the total number of ripe eggs in the ovaries prior to spawning of an individual female fish (Bagenal and Braum,1978) is a function of its body length. This length-fecundity relationship is a critical allometric function in fisheries biology due to the relevance of the parameters in various pragmatic applications including: assessments of population fecundity (Bagenal,1978).

Fecundity and spawning habitats are the important aspects of the biology of fishes which must be understood to explain the variation of the level of population as well as to make efforts to increase the amount of fish harvest. To evaluate the commercial potentialities of fish stocks, information on the fecundity of the fish *(C. gariepimis)* composing the stock is essential. In bio-ecological studies. In practical fish culture, it is very desirable to know the number of eggs, fry and young produced. The knowledge of fecundity estimation may also be used to assess the abundance and reproduction potential of the spawning stock (Khan, *et'al*, 2002). Bagenal (1978) define fecundity as the number of vitellogenic oocytes in mature female prior to the next spawning season. This work considered only the ripe spawnable eggs in the ovary of the fish. However, some other works (Holl, 1966;Bowmaker, 1973; Clay 1979; Eyo and Mgbenka, 1992 considered fecundity to include all available eggs in the ovary of the fish (total fecundity).

Studies on fecundity is important to evaluate the reproductive potentials of the species (Duarte and Araujo 2002) and it gives prerequisite information needed to plan a bridging program 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 equipments would be put to use (Eyo and Mgbenka 1992). Reproductive biology of the clariids and other culturable species have been studied by many researchers across the globe particularly in Africa and there have been specific research on fecundity (Yalcin, 2001).

Mshella et al., (2009) and Bagenal (1978), stated that enormous fecundity in fisheries is related to enormous mortality. They also reported that an increase in fecundity of an individual within the population represents an adaptive response of the population to environmental changes where an increase in fecundity ensures preservation and notation of the species, it ensures its relative stability both in space and time, in the event of fairly wide fluctuation in the environmental conditions and it means that fecundity showed increase with increasing environmental harshness.

Condition factors of different populations of the same species gave some information about food supply and the timing and duration of breeding. It is also used in assessing the well-being of a fish (Ekanem, 2000). This value (K) is used in assessing the health condition of fish of different sex and in different seasons.

II. Literature Review

Ecology and Culture of *Clarias gariepinus*

The African catfish *(Clarias gariepinus}* is widely distributed t hroughout Africa. It has a Pan-African distribution ranging from the Nile Basin to West Africa and from Algeria to Southern Africa. It also occurs in Asia Minor (Israel, Syria and South of Turkey). They are termed "Potamodromous"' which means they migrate within streams and rivers (Teugels, 1986). It inhabits tropical swamps, lakes, rivers, lagoons, basins and some of which are subject to seasonal drying thereby forming creeks and holes to hibernate and wait for due season (rainy season rainfall) Viveen et al., 1 986.

Aquaculture is simply the farming of aquatic organisms in enclosed water bodies such as ponds, dams, pens, raceways, aquaria etc. One can hardly talk about aquaculture today without the mentioning of artificial propagation of fish seed of a cultivable species (e.g. *Clarias gariepinus)* for commercial purposes. This fish species is most often chosen for its fast growing nature and its acceptability to consumers especially in Africa with Nigeria included. Huisman (1976) stated that *Clarias gariepinus* have proved to be a very suitable species.

Clarias gariepinus is one of the most cultured fish as to *carps* and salmonids and tilapias. Over few decades, the production of farmed *Clarias*(cat fish) has shown a tremendous increase, jumping from 383, 654 metric tons m 1990 to 1,505, 804 metric tons in 2002 (FAO, 2007). The value of farmed cat fish *(Clarias)* has also witnessed a great increase during the past two decades, going from $154 million in 1984 to 1800.7 million in 2002 (El-Hafway, *et'al*., 2007).

In Nigeria, the national demand for fish is established to be 1.18 million metric tons annually and the potential yield is estimated at 1.83mil!ion metric tons (Holl, 1993). However, the actual fish supply in 1993 report was 619, 211 metric tons with a decline of 515, 135 metric tons in 1994 (FAO, 1995). This short decline in the fish supply have been attributed to the inefficiency in fisheries management, development and poor post harvest technology in terms of handling, processing, preservation and storage,. Distribution and sales aid sustainable aquaculture. Aquaculture which promises the most renewable option only supplies 2% of national demand now (Fafioye, 2006).

The big *Clarias (anguillaris;* Linnaeus and. *Gariepinus;* Burchell) occupy unique and prominent position in commercial fisheries and as such, fishermen seek the *Clarias Species because* it could attain biggest size (7kg) and it's very tasty (Holden and Reed, 1972). Thus commands greater commercial value and fetches a higher price. Aquaculturist seek out the wild fry and fingerlings *of C. gariepinus* to stock their ponds because in fish culture trials, it grows fast and has an efficient feed conversion in especially the males (Henken *et al.,* 1987); It is tough and can tolerate poor water quality conditions (Hogendoorn *et'al.,* 1983). It can **also** mature and reproduce in captivity (Hogendoorn. 1980; Viveen *et'al,* 1985). *Clarias gariepinus* is in the family *claiidae,* it is a highly sophisticated cat fish with a massive skeletal system, used in its mastery of defense and offence, they are found in a variety of ecosystem particularly at the Niles and fresh water(s). They feed on phytoplankton, periphytons, aquatic plants, small invertebrate, debris and con-specifics and are also known to be carnivorous. Nile *Clarias* can filter feed by entrapping suspended particles including phytoplanktons and bacteria on mucous in the buccal cavity, although its main source of nutrition is obtained at the bottom and therefore are termed bottom feeders.

Members of the family *claridae*a among the commercial fishes found in Uke river of Nasarawa State, ranks second in terms of number and weight when total fishery of the area is considered. Both small-scale and commercial production of *Clarias* is rapidly expanding in many countries, while remarkable progress has been made in improving the productivity of crops and livestock in the last three to four decades through breeding and selection. It is only in the last few decades that efforts has been made to harness the benefits of genetic improvement in fish (Oftem, *et al.,* 2007).

Biological Backgrounds, *of Clarias gariepinus.*

Morphology

The African catfish are elongated with fairly long dorsal and anal fins. The dorsal fins have 46-65 soft rays. They have strong pectoral fins with spines that are serrated in the outer side (Tuegels. 1986). These species can attain a sizeable length of 1.7 meter from tip of the snout to the end tip of the anal fin (tail) and can weigh up to 60kg (Eyo *et'al,* 1992) when fully grown. They possess anal and maxillary barbells, somewhat smallish eyes, they are dark or grey in coloration dorsally and creamy coloured ventrally. Adults possess dark longitudinal lines on either side of the head. However, this is absent in young fish, adult heads are coarsely granulated, while the head is smooth in the young. Their heads are large, depressed and heavily boned. The mouth is quite large and sub-terminal (Omeregie *et'al,* 2000). They are also obligate breathers which mean they spend some time on the surface. These species can live in very poor oxygenated water and is one of the last species to live in such an inhabitable place (Ekanem, 2000). They also secrete mucus to prevent drying and are able to burrow- in muddy substrate of a drying body of water (Kariman, 2008).

The classification of *clarias gariepinus* is thus;

Kingdom	Animalia
Phylum	Chordate
Subphylum	Vcrtebrata
Class	*Actinopterygii* (Rayfinned fishes)
Order	*Suluriformes* (Cat fish)
Family	*Claridaea*
Genus	*Clarias*
Species	*gariepinus*

Hence, Binomial name: *Clarias gariepinus* (Teugels. 1986).

III. METHODOLOGY

Sample Collection

Clarias gariepinus were randomly collected (purchased) from Artisanal fishermen in Uke Rivers, Nasarawa State, Nigeria. The collection of the samples look place between February and April which is a twelve weeks period encompassing the spawning season of most species. Fish species were caught using gill net, and cast net during the period at sample collection. Fresh (live) samples were transported to the Zoology Laboratory, Department of Biological Sciences, and Nasarawa State University. Kcffi.

IV. SAMPLE ANALYSIS

Determination of Weight

Weight of each fish was determined using a weighing balance (Camry Emperors 44lb x 2oz or 20kg x 50g) and measured to the nearest 0.lg. The ovaries were weighed using sensitive metla-balance (pm 2000), (Nikolsky, 1963).

Determination of Total and Standard Length

Total length of each fish sample was obtained by placing the fish laterally on the dissecting board, using a meter rule, from the mouth (tip of the snout] to the end (tail) which is the total length, while from the tip of the snout (mouth) to the end of the caudal penduncle is the standard length. The total length was measured to the nearest 0.1 cm and recorded for statistical analysis (Kariman, 2008).

Dissection of Fish

Each fish sample was placed dorsally on the dissecting board, using the dissecting tools to eviscerate the fish and the ovaries isolated. The gonad was recorded and as well gonad weight was taken and recorded to the nearest 0.1g (Kariman, 2008).

Estimation of Fecundity of Fish Samples

The fecundity of collected *Clarias gariepinus* was estimated using gravimetric method. The following parameters were kept for each individual fish separately: The fish length, body weight and gonad weight. The fish was cut open to determine the sex and mature gonads were removed and preserved in 5% formalin, (Kariman. *et al;* 2008).

Preparation of 5% Formalin

The chemical used in preparation of the preservative are; formaldehyde and water. For every 100ml of formalin it will contain 5ml of formaldehyde and 95ml of water. This preservative was prepared in the laboratory of the Department of Biological Sciences Zoology Unit). Ovaries were preserved in labeled sample bottles.

Counting of Preserved Eggs

To clean the eggs, the formalin was decanted and replaced by water followed by a periodic vigorous shaking which liberated most of the eggs but the remainder were removed manually. The ovarian tissues free of eggs were removed using forceps. The sample bottle now containing the free eggs in 5% formaldehyde made cloudy by minute fragments of tissue. By repeated filling with water and decanting the supernatant, the eggs became sufficiently washed.

Egg Count

The preserved and washed eggs were poured into a filter paper in a funnel. When the liquid has drained away the paper and eggs were spread to remove excess moisture. After 3 minutes the eggs were spread until the)' can be moved without raising the surface of the paper. When they were thoroughly dried, they were counted. Eggs in 1 gram subsample were counted. Fecundity estimate for each fish sample was obtained by multiplying the total weight of eggs by the number of eggs per gram weight (Nikolsky, 1963), (Kariman, 2008).

V. RESULTS

Table 1. Gonad Maturity Stages in *Clarias gariepinus*

S/N	GONAD CONDITION	FEMALE/MALE
I	Immature	Young individual which have not yet engage in reproduction: gonads of very small size.
II	Resting stage	Sexual products have not yet began to develop; gonad of very small size; eggs not distinguishable to the naked eye.
III	Mature stage	Eggs distinguishable to the naked eyes: a very-rapid increase in weight of the gonad is in progress; testes changes from transparent to a pale rose color.
IV	Maturity stage	Sexual products ripe: gonads have achieved their maximum weight, but the sexual products are still not extruded when light pressure is applied.
V	Reproductive stage	Sexual products are extruded in response to very light pressure on the belly; weight of the spawning to its completion.
VI	Spent condition	The sexual products have been discharged, genital aperture inflamed; gonads have the appearance of deflated sacs, the ovaries usually containing a few left-over eggs and the testes some residual sperm.
VII	Resting stage	Sexual products have been discharged; inflammation around the genital aperture has subsided; gonads of very small size, eggs not distinguishable to the naked eye. According to

Table 2. Relationship between fecundity and body parameters of female *Clarias gariepinus* from River Uke, Nasarawa. Length (cm)

Total length (cm)	Standard length (cm)	Total weight (g)	Gonad weight (E)	GSI	Condition Factor	Fecundity (f)	$LogT_L$	Log Wt	Log f
25.6	23.20	400	1.00	0.25	2.40	1,680	1.24	2.69	2.00
17.60	13.20 10.00	500	1.00	0.22	7.17	980	1.13	2.60	2.95
13.50	37.00	400	1.00	0.25	6.00	901	1.62	2.90	3.51
42.00	38.00 34.50	800	2.00	0.25	1.10	3,250	1.60	2.95	3.17
40.00	29.00	900	1.00	0.11	1.40	1,480	1.57	3.14	4,22
38.00	27.00	1,400 1000	4.00	0.28	2.60	16,625	1.50	3.00	3.92
32.00	38.00	1000 1400	3.00	0.30	3.10	8,350	1.47	3.00	4.01
30.00	34.50	1000	3.00	0.16	3.70	10,250	1.61	3.14	3.35
41.00	15.30	400	4.00	0.28	2.00	2,250	1.60	3.00	2.98
40.00	17.10	200	3.00	0.30	1.50	960	1.30	2.60	2.93
20.00	13.10	100	1.60	0.40	4.90	864	1.34	2.30	-
22.00	11.60	500	1.00	0.50	1.90	-	1.25	2.00	-
18.00	12.80	310	1.00	1.00	1.70	-	1.21	2.69	3.04
16.50	15.20	280	3.00	0.60	6.00	1,106	1.24	2.49	-
17.40	16.40	400	2.00	0.65	1.70	-	1.29	2.44	3.00
19.50	15.10	200	1.50	0.54	5.90	1,008	1.34	2.60	3.23
22.20	38.00	1,400	2.00	0.50	3.70	1,732	1.28	2.30	3.21

19.40 41.00 42.80 29.30 43.00	37.00 25.10 37.50	1,400 1,400 600	1.50 4.00 1.00 3.00 3.00	0.75 0.28 0.07 0.23 0.50	3.70 2.00 1.80 5.60 0.70	1,630 12,080 - 8,320 6,302	1.61 1.63 1.46 1.63	3.14 3.14 3.14 2.77	4.08 - 3.92 3.79
511						**79,768**			

r(Length -Weight)=0.998,
r(Fecundity -lenght)=0.972,
r(Fecundity-Weight)=0.981,
r(Fecundity -Gonad)=0.980

VI. RESULT INTERPRETATION

Statistical Analysis

Correlation and Regression analysis were used to calculate length-weight relationship and also -body parameters relationship.

VII. DISCUSSION

LENGTH-WEIGHT

There were more males than females of *Clarias gariepinus* and they can probably be attributed to the relative few spawnable females susceptible to catch. The low population of this fish species in the river might be responsible for the production of large sizes of fish, there is however an assurance that every mature female will get a male to mate it.

The variations recorded among the Morphometric characteristics assess are due to the seasonality associated with spawning, which is an indication of a cyclic pattern of maturation. A similar cyclic pattern of maturation has been demonstrated for *Clarias gariepinus* in lake Kabira. Mcllwaine and Kyle and in Zimbabwe as reported by (Holl,1968). Thus the variation could be associated with the onset of rains as an indicator of spawning and development of a fish interplay with other factors. This also agrees with the observation of Green wood, (1955), Holl(1968) and Clay. (1979) who also reported that the onset of spawning of *Clarias spp* was short after heavy rain.

Many tropical fishes are reported to breed at the beginning of the rainy season(Greenwood, 1958; and VanderWal,1978).*Clarias gariepinus* bred throughout the year, reason for this patter may be due to the large varieties of food items in the river which is an advantage for gonad material production to meet the all year round egg or milt production. The availability of suitable environment may also be responsible for extended breeding in the river.

VIII. SEX RATIO

Observation made on 67 *Clarias gariepinus* caught showed that 44 were males and 23 were females giving a male/female ratio of 2:1. The smallest mature male had a total length of 20.2cm while the female was 16.5cm. The length frequency of all *Clarias*gariepinuson spawning runs in fig. 2.

The fecundity (F) was expressed in relation to the log of total length (T,) and the relationship was linear.
The fecundity was also linearly related to the fish body weight (BW) and condition factor .

The sex ratio for *Clarias gariepinus* in River Uke is approximately two males to one, Eyo. J.E and Mgbenka, (1992) observed a ratio of one male and one female in Anambra River Basin. Fafioye (1996) observed a sex ratio of approximately one male to one female in S. *galilaeus(a* cichlid) of Oba reservoir.

IX. CONDITION FACTOR

The condition factor values varied between males and females specimen of the same size group showcase high k-values in the small size fishes and decreased in the larger fish. Nikolsky, suggests that the condition factor is not stable but rather fluctuate depending on the health statue which is ecologically determined. The k-values obtained in this study indicate that the relatively smaller sized fishes are better adapted to the ecological statues of the river. This may be in terms of their predatory or feeding activities. Mgbcnka and Eyoalso attributed the decline in condition factor to the deposition of materials for gonad formation which lead to increase in weight and actual spawning which lead to reduction b weight respectively.

Condition factor (k) = $\frac{100W}{L^3}$

Where W= Weight of fish in grams
L = length in cm

X. GONADSOMATIC INDEX (GSI)

The very low GSI values obtained, showed that the fish species uses a good percentage of its body for egg production. Imevbore (1970) remarked that an increase in the frequency of ling of African fishes is usually accompanied by a fall in GSI of females fishes. This probably explains the very low GSI values of *Clarias gariepinus* in river Uke.

Gonado-Somatic **Index (GS1)** =

$$\frac{\text{Gonad weight x 100}}{\text{Weight of fish}}$$

XI. FECUNDITY

In the fecundity studies, the average number of eggs per females was 4431. The result obtained in this work is lower than that observed by other workers. Fecundity in C. *gariepinus*was reported to be up to 25000 eggs by Eyo and Mgbenka(1992), while Adikwu. I.A and Zaki, G.M. (2001) reported a fecundity of 38000 in Nguru wetland of Northern Nigeria.

A relatively lower fecundity obtained in this study might be attributed to degree of parental care in the fish species. As a rule, the fecundity of a fish is inversely related to feed degree of parental care it exhibits (Lagler *et'al*, 1977; Nikoisky,l963). The relative low fecundity in this study as compared to other works could be as a result of low water level due to dry season.

In this study, fish species of the same length or weight had variable fecundities. Bagenal,1957) asserted that fish species exhibit wide fluctuation in fecundity among fish of the same species, size and age. Bagenal (l966, 1969) suggested that variation in fecundity may be due to differential abundance of differential feeding success within the members of the population.

Fecundity =

$$\frac{\text{Total weight of ovary xnumber of eggs in sub sample}}{\text{Weight of sub sample}}$$

XII. CONCLUSION

In conclusion, the positive allometric growth and condition factor exhibited by *Clarias gariepinus*, indicated that River Uke had suitable water environment for its survival and growth in relation to physio-chemical parameters of the water, thereby showing a very strong and positive correlation between fecundity and other body parameters of the fish. Hence, succinctly recommended that, to ensure the continuous survival and growth of this species in the river**,** a management in place is required for proper and constant monitoring, as well as control of the physiochemical parameters, such as temperature, Dissolved Oxygen (DO), Total Suspended Solid (TSS). Biological Oxygen Demand and Electrical conductivity, etc of the River, while brook stocks which falls within sizes suitable for fish spawning between 1kg - 2.5kg are better induced in hatchery for aquaculture enterprise, given a good mimicking of physiochemical parameters are made to maintain the existing suitable conditions in pond for ensured survival and or good productivity for the wellness of the *Clarias gariepinus* species.

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