The Morphometry, Sex Ratio and Fecundity of Fishes of the Coastal River, Qua Iboe River, Akwa Ibom State, Nigeria

Oribhabor, B. J. and Archibong, A. O
Department of Fisheries and Aquatic Environmental Management, Faculty of Agriculture, University of Uyo, Uyo, Akwa Ibom State, Nigeria

Article Information

Article # 01005
Received date: 2nd Jan., 2020
Revision: 10th March, 2020.
Acceptance: 24th April, 2020
Published: 11th May, 2020

Key Words
Morphometry, Fecundity, Sex ratio, Qua Iboe River, Length-weight relationship

Abstract

The fish species of a coastal Nigeria River, Qua Iboe River, Akwa Ibom State, Nigeria, were investigated for morphometry, sex ratio and fecundity. The fish species were caught by different fishing techniques such as hook and line, non-return vale traps, and set nets. A total of 221 individuals comprising of 26 species in 15 families were encountered. The sample size per species ranged from 1 to 44 individuals. Length-weight relationship was estimated for only 10 species of fishes due to the low abundance of other species. The allometry coefficient (b value) for the 10 species raged from 1.84 for *Brycinus leuciscus* to 3.81 for *Parachanna obscura.* Sex ratio was estimated for 202 individuals belong to 11 species that had sample size range of 2 to 44. The ratio of males to females ranged from 1:0.6 for *Arnoldichthys spilopterus* to 1:4.8 for *Tilapia mariae*. A total of 26 fecund females comprising *Papyrochranus afer* (1), *B. leuciscus* (4), *A. spiloterus* (3), *Chrysichthys nigrodigitatus* (1), *P. obscura* (5), *Tilapa mariae* (8). *Tilapia. guineensis* (3) and *Ctenopoma kingsleyae* (1) were examined for fecundity. Estimated fecundity ranged from 423 for *P. afer* to 1300 for *C. kingsleyae.* Since few reports are recorded about the reproductive biology of fishes in freshwater bodies, and this report being the first in this study area, more research should be carried out and recorded for future use in fisheries conservation and management

***Corresponding Author**: Oribhabor, B. J.; oribhaborblessjuls@yahoo.com

Introduction

The relative contribution from freshwaters may even be higher taking into account that perhaps only as much as 30% - 50% of the inland capture production is officially reported: many countries do not consider their inland capture fisheries important enough to collect data and often it is very difficult to collect them due to the small scale, highly complex environments in which fisheries are done (Funge-Smith, 2018). Nigeria is endowed with many species of fish in rivers, lakes, streams, etc. Understanding of the biology and ecology of these fishes of the body of waters is required in optimum management strategies for production purposes. Morphometry is defined as the study of variation and change in the form (size and shape) of organisms. The morphometric analysis of fish is an important key in the study of biology of fish (Hussain *et al.*, 2012). Morphometric relationships and spawning pattern are two important data inputs in fishery management (Udo, 2002). The relationship between the length and weight of fishes are related with the metabolism in each species and the environment where they live (Claro and Garcia Arteaga, 1994). The length-weight relationship is also used in estimating the average weight of fish at a given length group and in assessing the relative well-being of fish population (Abowei *et al.*, 2009). Consequently, length-weight studies on fish are extensive. Sex ratio is the ratio of males to females in a population. There are primary, secondary and tertiary sex ratios. The primary sex ratio is the ratio at a time of conception, secondary sex ratio is the ratio at the time of birth and tertiary ratio is the ratio of mature organisms. The fecundity of fish is defined as the number of ripening eggs in the female prior to the next spawning period (King, 1998). A thorough knowledge of fecundity of fish is essential for the management of the fishery (Bhuiyan *et al.*, 2006). The reproductive capacity of a population is a function of the fecundity of the females (Abowei et al., 2006; Deecae and Abowei, 2010). Several parameters are commonly used for evaluating fecundity in fishes. The first is the individual (absolute) fecundity, which illustrates the number of eggs for the generation of that year present (i.e., the number that should be laid that year). The second is the relative fecundity which is the number of eggs per unit body weight, which reflect the state of the female and the quality of the eggs (Kant *et al*., 2016). The relative fecundity permits comparisons of individuals and populations within species (Bhukaswan, 1980). The third parameter called standard fecundity highlight number of eggs produced per centimetre length

There have been studies on the fish populations of tropical rainforest streams and rivers (Ikomi and Sikoki, 2003). The importance of length-weight relationships in population assessments as a morphometric relation and spawning pattern inputs in fishery management has been expressed (Lawson, 2011). The study of fish catch composition of selected small scale fishing gears used in Bonny River, Rivers State, Nigeria revealed that sampling season is very important and determines the abundance of fish caught in the field (Olopade *et al*., 2017). Studies have revealed a progressive increase in the size of female mudskipper during sexual maturation (Crocos and Kerr, 1993; Chu *et al*., 1993), which is at variance with *Tilapia guineensis* and *Penaus merguiensis* (Etim et al., 1989). This is because of the energy required by the female for reproduction. The study of size and reproductive investments in cichlids in Ikpa River, Akwa Ibom State, Nigeria revealed that there were remarkably intraspecific variations in total length and weight of sexually active female cichlids albeit there was evidence of certain overlaps (King, 1996a). The interspecific variation in size composition exhibited by these cichlid fishes may impose corresponding differences in resources exploitation, including reproduction niches. This is because body length and weight are correlates of reproductive investment, sexual maturity and egg production capacity (Jonsson t stages (Park *et al*., 2014). Studies on oocyte structure, fecundity and sex ratio of *Heterobranchus longifilis* revealed the presence of mature gonads in *H. longifilis* all year round (Anibeze and Inyang, 2000). The bimodal peak in oocyte distribution and the high fecundity found in the study indicated that multiple spawning could occur under favourable environmental conditions. Bimodal distribution of ova in *C. gariepinus* has been related to restricted spawning in catfish (Eyo and Mgbenka, 1992). This means that even when endogenous conditions are favourable, spawning does not take place until it is triggered off by the right exogenous factors. Thus, the major and minor spawning of *H. longifilis* and Jonsonn, 1999; King, 1991). Ali (1999) in his study on aspects of reproductive biology of female snakehead (*Channa striata*) form irrigated rice agroecosystem, Malaysia revealed that multimodial oocyte distributions indicated that snakeheads are capable of multiple extended spawning provided conducive environment conditions are present. This type of spawning is common in many tropical fish species (Ali and Kadir 1996). This characteristic is useful for seed production since it allows for year round reproduction and tropical fish have been shown not to deposit their eggs at one time but rather in stages in which eggs spawned would be replaced with those in earlier development stages (Park et al., 2014). Studies on oocyte structure, fecundity and sex ratio of Heterobranchus longifilis revealed the presence of mature gonads in H. longifilis all year round (Anibeze and Inyang, 2000). The bimodal peak in oocyte distribution and the high fecundity found in the study indicated that multiple spawning could occur under favourable environmental conditions. Bimodal distribution of ova in C. gariepinus has been related to restricted spawning in catfish (Eyo and Mgbenka, 1992). This means that even when endogenous conditions are favourable, spawning does not take place until it is triggered off by the right exogenous factors. Thus, the major and minor spawning of H. longifilis reported in Idodo River basin from March to September and January/February when gonads were in breeding condition were only possible because of the exogenous environmental factors in the basin which triggered off spawning in catfish. These exogenous factors which include rainfall, flooding which is reflected in water levels in the basin and conductivity were adequate in Idodo River during the recorded breeding activities of the species. Similar observation was reported on C. albopunctaus in Anambra River basin (Ezenwaji, 1998). Spawning capacity of a fish is a function of fecundity (Inyang et al., 1997). Hence, the high fecundity observed in *H. longifilis* of Idoho River basin is indicative of high reproductive capacity of the species, a feature that ensures the species survival, as the Clariids do not exhibit parental care. Study on biology of snakehead, *Channa obscura* in a Nigerian pond under monoculture revealed that sex ratio of male to female was unbalanced (Victor and Akpocha, 1992). There were more females than males. All species of *Channa* are monogamous and both sexes exhibit parental care (Alikunhi, 1953; Parameswaran and Murugesan, 1976). Study on fecundity and ovarian characteristics of *Puntius gonionotus* (Cypinidae) revealed that fecundity vary from 1434 in a fish having a total length 159 mm and body weight of 45 g to 42032 in a fish having total length 210 mm and body weight of

159 g (Bhuiyan *et al*., 2006). It was found that the bigger size fishes have higher number of fecundity and smaller size fishes have smaller number of fecundity. Probably nutrition also affects the fecundity of this fish. During the estimation of fecundity, it was found that *P. gonionotus* spawned once in a year, mainly from July and March and indicating that the lake's population has a lower fecundity. Findings by Ezenwa *et al*. (1986) on population of *Chrysichthys* at Badagry Lagoon, Warri River and Imo River confirmed that there is regional difference in the fecundity of *C. nigrodigitatus* as found in other fish species (Nagasaki, 1958; Pitt, 1964; Leone, 1967; Offem et al., 2008).

Although morphometry, sex ratio and fecundity have been reported for some fishes in aquatic ecosystems in Nigeria, no data on these parameters exist on the fishes of Qua Iboe River. However, the river has received attention in terms of physio-chemical characteristics (Akpan, 2004a); profiles of total hydrocarbons and trace metal concentrations (Akpan, 2004b); gastrointestinal parasites of the fish species (Oribhabor and Etim, 2015); radiological assessment of recent sediments (Osabor et al., 2017); and total petroleum hydrocarbon content in surface water and sediment (Inyang *et al*, 2018). The objective of this study was to provides information on the morphometry and determine length-weight March to June respectively. The fish was moderately fecund. Ekanem (2000) on his study on the reproductive aspects of *Chrysichthys nigrodigitatus* noted a great disparity between the fecundity of fish at Cross River and the *C. nigrodigitatus* population of Lake Adejire where maximum number of eggs counted was 2884 (Fagade and Adebisi, 1979), relationship of fishes in Qua Iboe River; determine the sex ratio, condition factor, and fecundity of the fishes and relate it to their length, weight and other characteristics.

Materials and Methods

Description of the Study Area

The Qua Iboe River located between longitude $7^0\,30^1$ and $8^0\,20^1$E and latitude $4^0\,30^1$ and $5^0\,30^1$N (Figure 1) is the dominant hydrographic feature in Akwa Ibom State, Nigeria and drains a catchments area of 7,092km^2 with a short course to the sea (150.6km). It is among the coastal rivers that empty into the Atlantic Ocean at the Bight of Bonny. It is one of the short rivers with small basin which drain the coastal plain and forms part of the eastern group of the South Atlantic Drainage basin (Illeje, 1981; Tahal Consultants, 1982). The river flows through different physiographic land forms ranging from level to gently undulating (up and down) coastal plain. It is surrounded by aquatic macrophytes with oil palm and raphia palm dominating (Akpan, 1992).

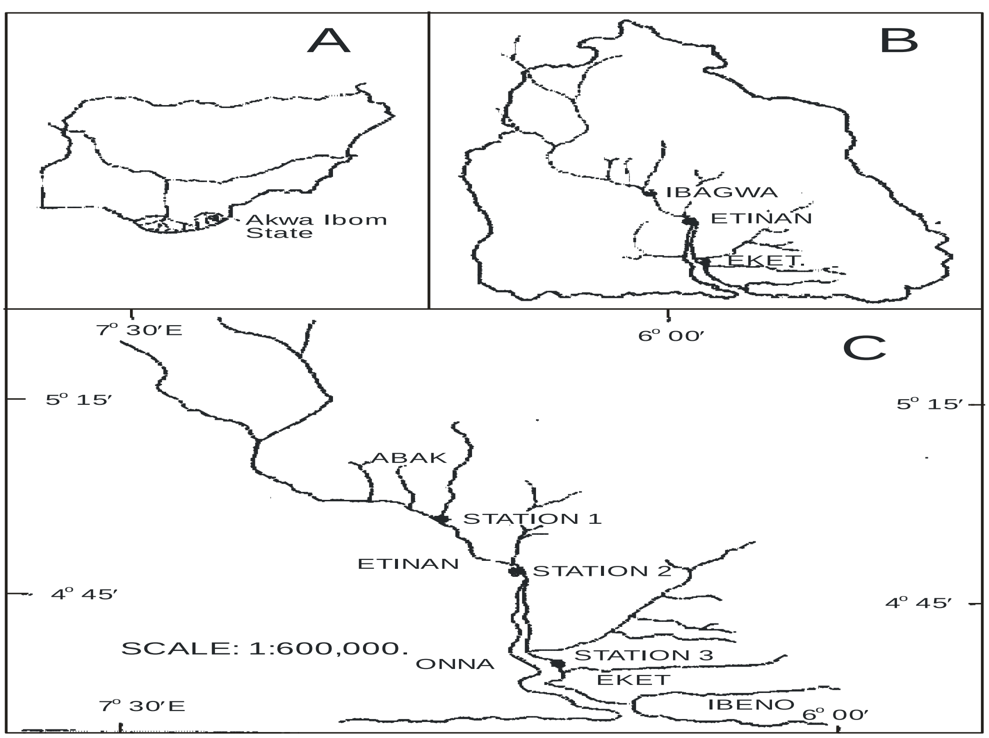

Fig. 1: Map of the study area: A. Nigeria showing Akwa Ibom State, B. Akwa Ibom showing Qua Iboe River communities sites sampled, C. The Study River showing study stations

Sampling Procedure: The fish samples collected monthly from January to August, 2009 at three sampling stations (Fig 1) were caught by the use of set net, non-return valve traps, hook and line. The fish samples were ice-packed, kept chilled under ice-blocks in a plastic cooler, and immediately transported to the laboratory.

Laboratory Procedure:The specimens were pooled together and carried to the laboratory in a plastic bucket. In the laboratory, the fish specimens were sorted and identified using the keys and descriptions of Olaosebikan and Raji, (2004) and Teugels *et al*. (1992)

Morphometry: In the laboratory, specimens were sexed and morphometric characters measured. Total length (distance between tip of snout and causal penduncle) were measured to the nearest 0.1cm by means of a measuring board. Each specimen was blotted dry and its body weight (BW) was measured to the nearest 0.1g using a scout pro spu 401 ohiu 400g top loading balance.

Length-weight Relationship and Condition Factor: The length-weight relationships were calculated using the formula

$$W = aL$$

$Log\ W = \log a + b log\ L$ ………………Equation 1

..Where W = body weight of the fish (g), L = total body length of fish (cm), a and b = values estimated by regression. Fulton's condition factor (kf) were calculated as

$$\frac{100W}{L^3}$$

Sex Ratio: Sex of fish was determined by using genital papilla or the gonads after dissection. Sex ratio was expressed as ratio of males to females. The chi-squared test was employed on the observed male and female specimens to show whether the proportions significantly deviated from the expected 1:1 ratio (Anyanwu, 1990).

Fecundity: After dissection, in females with ripe ovaries (i.e., maturity stages IV and V), the ovaries were taken out and then moisture was thoroughly wiped out from the ovaries with blotting paper, measured to the nearest 0.1cm ovary length (OL) and weighed to the nearest 0.01g ovary weight (OW) (Udo, 2002). The gonadosomatic index (GSI) was calculated by expressing the gonad weight as a percentage of somatic weight. Condition factor (K) was determined by the equation

$K = \frac{SW - 100}{TL^3}$ ………………………Equation 2

Where, SW = somatic weight (i.e., body weight minus gonad weight) and TL = total length.

Liver from each fish was weighed to the nearest 0.01g liver weight (LW). Hematosomatic Index (HIS) was calculated by the equation

$HSI = \frac{LW - 100}{BW - LW}$ …………………………Equation 3

Where LW = liver weight and BW = body weight.

Functional equation for the relationships between absolute fecundity and independent variable of some fecund fish species were calculated using

$f = aX^{bi}$ ...……………………………Equation 4

Where a = constant and b = regression coefficient both of which were determined by least square regression analysis by using double log (Base 10) transformed data pairs.

Each pair of ovaries was split longitudinally, turned inside out and then preserved in small vials containing modified Gilson's fluid for a period of two weeks before estimating fecundity (Bagenal, 1978). The vials were agitated periodically to ensure the separation of eggs from the ovarian connective tissue. The preserved ovaries were washed several times to get rid of the preservative. The ovaries were then weighed to the nearest 0.01g after removing the excess moisture with blotting paper. Eggs were then separated from the ovarian tissues and placed on a filter paper. The weight of a known number of eggs was used to estimate individual egg weight (IEW).

Absolute fecundity (total number of ripe eggs in the ovaries prior to spawning) was estimated by gravimetric method (Bagenal, 1978; Simpson, 1951) after drying the eggs at 27-29°C ambient temperature for 24 hours. The numbers of eggs in each sub-sample were counted with the help of a magnifying glass (Bhuiyan *et al*., 2006). Where possible, the relationship between absolute fecundity and the independent variables (total length, standard length, ovary length, body weight, somatic weight, ovary weight, total egg weight, individual egg weight, gonadosomatic index, condition actor and hepatosomatic index) were determined by least square regression analysis using logarithmic transformation. Different fecundity indices were also determined to confirm trend of increase or decrease with growth in length and weight of the fish:

The number of eggs produced per centimetre total length and standard length called standard fecundity (Şaşı, 2008).

The number of eggs produced per gram body weight, somatic weight, egg weight and individual eggs weight called relative fecundity (Kant *et al*., 2016).

The number of eggs produced per centimeters ovary length and per ovary weight.The ovary weight as percentage of fish body weight of the coefficient maturity (Udo *et al*., 2008)

Statistical Analysis

In addition to length-weight relationship and fecundity indices, and use of Chi-square for sex ratio as described above, measure of central tendency and dispersion were used to characterize the length, weight, condition factors and fecundity parameters.

Results

Morphometry, Sex Ratio and Fecundity

A total of 26 fish species belonging to 15 families were examined. The 221 individuals sampled comprised of 93 males and 128 females. Length-weight relationship, sex ratio and fecundity were determined for individual species based on sample size.

Species Based on Sample Size

The length-weight relationship was estimated for only 10 species of fishes due to the low abundance of other species (Table 1). The allometric coefficient (b value) for the 10 species ranged from 1.84 for *B. leuciscus* to 3.81 for *P. obscura*. The lowest regression was observed for *P. afer* (r = 0.60), while the highest was for *P. obscura* (r = 1.07). Analysis of variance (ANOVA) showed that there was highly significant regression for the 10 species.

Sex ratio was estimated for 202 individuals belonging to 11 species that had sample size range of 2 to 44 (Table 2). The ratio of males to females ranged from 1:0.6 for *A. spilopterus* to 1:4.8 for *T. mariae*. Chi-squared showed that there were no significant differences (p>0.05) from the expected 1:1 ratio for the species except for *P. obscura* and *T. mariae* which were highly significantly different (p<0.0.1), (Table 2).

A total of 26 fecund females comprising *P. afer* (1), *B. leuciscus* (4), *A. spilopterus* (3), *C. nigrodigitatus* (1), *P. obscura* (5), *T. mariae* (8), *T. guineensis* (3), and *C. kingsleyae* (1) were examined for the fecundity estimate and indices of fecundity of fecund fish species were calculated using mean number of eggs per cm (total length, standard length, ovary length, body weight, somatic weight, ovary weight, egg weight, individual egg weight, coefficient of maturity, gonadosomatic index, hepatosomatic index, fecundity and condition factor) (Table 3).

Highly significant regression was observed in the standard length and ovary weight of *A. spilopterus* with $F = 5.42\ SL^{-2.62}$ and $F = 2.54\ OW^{-0.24}$ as shown in Table 4. The variability of fecundity estimated within the population was examined using a co-efficient of variation. The lowest percentage coefficient variability was found in *T. guineensis* with 11.39% and the highest in *T. mariae* with 34.75% (Table 5).

Table 1: Summary Descriptive of Length-Weight Relationship Parameters and Condition Factor of Fish Morphometric Data, January – August 2009.

SN	Fish Species	N	Total length $\bar{x}$±S.D (cm) (min-max)	Standard length (cm) $\bar{x}$±S.D (min-max)	Weight (g) $\bar{x}$±S.D (min-max)	Condition Factor $\bar{x}$±S.D (min-max)	Length-Weight Relationship		
							a	b	r
1	*Erpetoichthys calabaricus*	1	- (26.5-26.5)	- (25.6-25.6)	- (20.15-20.15)	- (0.11-0.11)	-	-	-
2	*Cynothrissa mento*	1	- (8.2-8.2)	- (6.5-6.5)	- (5.05-5.05)	- (0.92-0.92)	-	-	-
3	*Papyrochranus afer*	6	43.65±11.87 (29.3-55.2)	41.58±11.36 (29.5-52.7)	587.28±432.18 (130.29-1100)	0.54±0.04 (0.52-0.65)	-3.24	3.71	0.60*
4	*Xenomystus nigri*	2	- (16.9-39.9)	- (16.2-38.0)	- (27.93-314.43	- (0.19-0.19)	-	-	-
5	*Gnathonemus petersii*	1	- (27.7-27.7)	- (24.2-24.2)	- (77.47-77.47)	- (0.36-0.36)	-	-	-
6	*Hepsetus odoe*	4	31.93±10.17 (17.6-41.5)	27.33±7.62 (17.2-35.5)	616.88±660.52 (175.22-1600)	1.79±1.15 (0.83-3.21)	-0.35	2	0.8
7	*Alestes baramose*	1	- (11.3-11.3)	- (9.2-9.2)	- (17.23-17.23)	- (1.19-1.19)	-	-	-
8	*Brycinus leuciscus*	37	9.34±1.93 (3.0-14.2)	7.42±1.39 (4.8-11.4)	10.66±6.72 (1.99-35.63)	1.95±3.78 (0.92-24.22)	-16.24	1.84	0.72*
9	*Anoldicthys spiloterus*	28	8.86±2.40 (5.4-15.2)	7.31±1.98 (4.6-11.8)	11.18±11.41 (1.78-52.51)	1.26±0.28 (0.75-1.89)	-1.97	3.06	0.90*
10	*Chrysichthys macropogon*	2	- (16.7-20.7)	- (14.2-17.0)	- (52.09-89.23)	- (0.27-0.27)	-	-	-
11	*Chrysichthys nigrodigitatus*	9	16.43±2.52 (12.9-20.7)	13.33±6.02 (10.1-17.0)	47.15±21.54 (21.70-89.23)	1.00±0.10 (0.88-1.15)	1.69	2.75	1*
12	*Clarias gariepinus*	1	- (18.8-18.8)	- (17.3-17.3)	- (46.44-46.44)	- (0.70-0.70)	-	-	-
13	*Clarias submarginatus*	1	- (28-28)	- (25.5-25.5)	- (96.1-96.1)	- (0.44-0.44)	-	-	-
14	*Malapterus miryiriya*	1	- (12.7-12.7)	- (10.8-10.8)	- (29.07-29.07)	- (1.42.1.42)	-	-	-
15	*Parachanna obscura*	25	27.52±5.13 (27.52-34.6)	23.46±20.53 (12.2-30.3)	199.30±9594.34 (24.20-357.18)	1.70±4.30 (0.72-22.33)	-3.22	3.81	1.07*
16	*Asatotilapia bloyeti*	4	9.35±3.29 (6.2-13.5)	7.63±2.51 (5.2-10.7)	18.06±18.70 (3.26-43.70)	1.57±0.26 (1.31-1.80)	-2.22	3.43	1*

International Journal of Basic Science and Technology ISSN 2488-8648
May, Volume 6, Number 1, Pages 35 - 49 http://www.ijbst.fuotuoke.edu.ng/ 41

Table 1 Continued

SN	Fish Species	N	Total length $\bar{x}$±S.D (cm) (min-max)	Standard length (cm) $\bar{x}$±S.D (min-max)	Weight (g) $\bar{x}$±S.D (min-max)	Condition Factor $\bar{x}$±S.D (min-max)	Length-Weight Relationship		
							a	b	r
17	*Pelvicachromis pulcher*	1	- (14.3-14.3)	- (12.0-12.0)	- (47.04-47.04)	- (1.61-1.61)	-	-	-
18	*Hemichromis fasciatus*	2	- (6.2-16.5)	- (5.2-13.5)	- (3.33-89.01)	- (0.79-0.79)	-	-	-
19	*Hemichromis bimaculatus*	1	- (9.8-9.8)	- (7.5-7.5)	- (13.83-13.83)	- (1.47-1.47)	-	-	-
20	*Tilapia mariae*	23	18.70±2.70 (11.1-24.2)	15±2.22 (9.0-20.0)	183.04±80.32 (76.96-391.03)	2.59±0.4 (1.70-3.19)	-2.24	3.5	0.97*
21	*Tilapia guineensis*	44	15.58±2.79 (10.8-25.1)	12.57±2.70 (8.5-21.4)	105.41±73.61 (23.11-397.12)	2.43±0.28 (1.10-2.88)	-2.68	3.28	0.99*
22	*Oreochromis niloticus*	1	- (27.2-27.2)	- (22.0-22.0)	- (999-999)	- (4.96-4.96)	-	-	-
23	*Ctenopoma kingsleyae*	22	1.10±2.06 (8.6-16.5)	10.3±1.7 (7.0-13.8)	46.42±21.60 (12.31-99.70)	2.00±0.14 (1.78-2.22)	-0.21	1.92	0.95*
24	*Liza falcipinnus*	1	- (12.8-12.8)	- (10.5-10.5)	- (23.11-23.11)	- (1.10-1.10)	-	-	-
25	*Lutjanus endecacanthus*	1	- (22.3-22.3)	- (18.0-18.0)	- (166.49-166.49)	- (1.50-1.50)	-	-	-
26	*Pomadasys jubelini*	1	- (20.4-20.4)	- (16.5-16.5)	- (102.02-102.02)	- (1.20-1.20)	-	-	-

ISSN 2488-8648
http://www.ijbst.fuotuoke.edu.ng/

Table 2: Sex ratio and Number of Fecund Individuals of Some Fish Species in Qua Iboe River, January – August, 2009

Fish Species	Sample Size	Male	Female	No of Fecund Individual	Ratio of Males and Females	Calculate x^2 on sex ratio	P Value
Papyrochranus afer	6	2	4	1	1:2	0.66	P > 0.05
Hepsetus odoe	4	1	3	-	1:3	1	P > 0.05
Brycinus leuciscus	37	20	17	4	1:0.9	0.24	P > 0.05
Arnoldichthys spilopterus	28	18	10	3	1:0.6	2.28	P > 0.05
Chrysichthys macropogon	2	1	1	-	1:1	1	P > 0.05
Chrysichthys nigrodigitatus	9	-	9	1	-	-	-
Parachanna obscura	25	6	19	5	1:3.2	6.76	P < 0.01
Hemichromis fasciatus	2	1	1	-	1:1	1	P > 0.05
Tilapia mariae	23	4	19	8	1:4.8	9.78	P < 0.01
Tilapia guineensis	44	19	25	3	1:1.3	0.82	P > 0.05
Ctenopoma kingsleyae	22	14	8	1	1:0.6	1.64	P > 0.05

Table 3: Indices of Fecundity of the Fecund Fish Species of Qua Iboe River, January – August 2009.

Fish Species	No. of eggs per Cm TL, $\bar{x}$±S.D (min-max)	No. of eggs per Cm SL, $\bar{x}$±S.D (min-max)	No. of eggs per Cm OL, $\bar{x}$±S.D (min-max)	No. of eggs per g BW, $\bar{x}$±S.D (min-max)	No. of eggs per g SW, $\bar{x}$±S.D (min-max)	No. of eggs per g OW, $\bar{x}$±S.D (min-max)	No. of eggs per g EW, $\bar{x}$±S.D (min-max)	No. of eggs per g IEW, $\bar{x}$±S.D (min-max)	Coefficient of maturity $\bar{x}$±SD (min-max)	GSI $\bar{x}$±S.D (min-max)	H51 $\bar{x}$±SD (min-max)	Fecundity $\bar{x}$±SD (min-max)	K $\bar{x}$±SD (min-max)
Payrochranus afer	- (8.13-8.13)	- (8.55-8.55)	- (136.45-136.45)	- (0.53-0.53)	- (237.64-237.64)	- (431.63-431.63)	- (183913.04-183913.04)	- (0.22.0.22)	- (0.22-0.22)	- (0.22-0.22)	- (0.13-0.13)	- (423-423)	- (0.57-0.57)
Brycinus leuciscus	104.55±19.27 (79.79-125.45)	129.55±23.86 (100-157.71)	8714.99± 16061.44 (150-32800)	108.46±33.86 (63.34-141)	115.36±36.33 (70.09-152.91)	92950± 11547.01 (75000-110400)	6274.39± 3736.06 (1875.10-933.33)	6057070.29± 3781534.08 (1415094.34-101813186.81)	0.40±0.57 (0.08-1.26)	0.12±0.0028 (0.09-0.15)	9.96±10.53 (0.21-19.97)	929.5±150.66 (750-1104)	1.26±0.75 (1.05-1.43)
Arnoldichthys spilopterus	90.82±27.11 (65-119.06)	108.77±38.87 (71.19-148.82)	807.74±209.09 (580.58-992.16)	82.13±43.40 (44.76-129.74)	90.46±47.00 (3.82-141.74)	46147.22± 48017.19 (7475-29766.67)	1795.07± 2100.23 (470.87-4216.67)	1994206.35± 26551836.09 (284761.90-5060000)	0.32±0.24 (0.13-0.60)	0.07±0.084 (0.007-0.16)	0.75±0.14 (0.65-0.91)	834.33± 213.14 (598-1012)	1.4±0.28 (1.21-1.72)
Chrysichthys nigrodigitatus	- (29.76-29.76)	- (36.39-36.69)	- (195.2-195.2)	- (12.28-12.28)	- (12.62-12.62)	- (24400-24400)	- (24400-24400)	- (1190243.90-1190243.90)	- (0.05-0.05)	- (0.16-0.16)	- (3.11-3.11)	- (4.88-4.88)	- 0.90-0.90)
Parachanna obscura	50.73±8.13 (40.10-61.32)	59.02±8.50 (47.96-70.4)	396.17±147.47 (270.77-636)	8.4±3.95 (4.73-14.85)	8.45±4.02 (4.73-15.03)	129110.27± 138924.44 (2089.81-33.4000)	36559.06± 21359.26 (2160.82 – 55666.67	48096533.33± 31622776.6 (3816000-88000000	0.06±0.12 (0.002-0.273)	3.32±7.02 (0.05-15.88)	0.56±0.15 (0.40-0.79)	1405±428.53 (870-1908)	0.90±0.087 (0.80-1.03)
Tilapia mariae	44.35±19.00 (26.14-81.88	55.45±23.73 (33.33-101.67)	153.15±65.58 (83.88-271.11)	5.55±4.41 (2.36-15.85)	5.73±4.6 (2.38-16.56)	36051.96± 42426.41 (218.98-116400)	5219.63± 12268.41 (267.03-3584.62)	2916491.99± 5707138.39 (130434.78-1648571.43)	0.54±0.95 (0.0060-2.21)	0.57±0.99 (0.0062-2.31)	0.26±0.15	805.25± 279.86 (460-1220)	2.53±0.38 (1.70-2.93)
Tilapia guineensis	32.37±4.33 (27.37-34.93)	45.46±15.20 (32.10-62)	112.75±16.47 (95.48-128.28)	2.92±1.36 (1.73-4.35)	2.99±1.41 (1.73-4.51)	29225.93± 34309.28 (6577.78-112400)	387.87± 295.68 (216.91-729.30)	206542.28± 253968.50 (216.91-490714.29)	0.030±0.032 (0.003-0.066)	0.031±0.050 (0.003-0.068)	0.09±0.052 (0.06-0.15)	674.33± 76.79 (592-744)	2.72±0.19 (2.51-2.88)
Ctenopoma kingsleyae	- (114.04-114.04)	- (144.44-144.44)	- (1625-1625)	- (47.79-47.79)	- (50.04-50.04)	- (65000-65000)	- (3170.73-3170.73)	- (4062500-4062500)	- (0.07-0.07)	- (0.08-0.08)	- (0.11-0.11)	- (1300-1300)	- 1.84-1.84)

Where n = Number of Samples, S.D=Standard Deviation, SW=Somatic Weight , IEW = Individual Egg Weight, TL = Total Length OL= Ovary Length, OW = Ovary Weight, GSI=Gonadosomatic Index, SL=Standard Length, BW=Body Weight EW=Egg Weight, HSI =Hepatosomatic Index, K=Condition Factor

Table 4: Functional Equations for the relationships between absolute fecundity and independent variables of some of the fecund fish species

	Variables and functional equations					
Fecund Fish Species	Total length	Standard length	Ovary length	Body length	Somatic weight	Ovary weight
Bryanus leuciscus	F=14.04 TL -11.667	F=18.72 SL-18.33	F=2.95OL -0.034	F=4.27 BW -0.33	F=1.94 SW 0.5	F=2.96 OW -0
Arnoldichthys spiloterus	F=2.91 TL 0.01	F=5.24 SL-2.62*	F=3.00 OL -6.90	F=3.43 BW -0.5025	F=1.94 SW 0.51	F=2.54 OW -0.24*
Parachanna-obscura	F=1.34 TL1.25	F=1.74 SL 1.02	F=2.91 OL 0.4	F=2.21 Bw 0.41	F=3.71n SW -0.65	F= -19.01 OW -13.84
Tilapia mariae	F=2.00 TL 0.7	F=3.27 SL-0.33	F=2.60 OL 0.38	F=3.25 BW -0.1667	F=2.80 SW 0.119	F=2.82 OW -0.0476
Tilapia guineensis	F=0.2 TL 2	F=1.59 SL 1	F=-4.97 OL 10	F=2.57 BW 0.11	F=2.97 SW -0.24	F=2.77 OW -0.0392

Contd….

Fecund Fish Species	Egg weight	Individual egg weight	GSI	Condition factor
Bryanus leuciscus	F=2.97 EW -0.014	F=2.16 IEW 0.12	F=2.85 GSI 0.067	F=3.01 Kf -0.5
Arnoldichthys spiloterus	F=2.88 EW -0.19	F=1.95 IEW 0.16	F=2.60 GSI -0.271	F=6.53 Kf-82.2
Parachanna obscura	F=55.64 EW 42.01	F=3.88 IEW -0.10	F=3.18 GSI 0.10	F=2.93 Kf -4.01
Tilapia mariae	F=2.88 EW 0.063	F=2.82 EW 0.01	F=2.90 GSI 0.179	F=2.98 Kf -0.25
Tilapia guineensis	F=2.85 EW -0.05	F=2.90 IEW -0.017	F=3.12 GSI -0.2	F=2.4 Kf 1

Table5. Coefficient of variability of some of the fecund fish species

Fish Species	Coefficient of variability (%)
Bryanus leuciscus	16.21
Arnoldichthys spiloterus	25.55
Parachanna obscura	30.50
Tilapia mariae	34.75
Tilapia guineensis	11.39

Discussion

Diversity studies based on morphometrics may prove essential in determining key areas for conservation and management (Jawad and Al-Janabi, 2016). Fisheries stock assessment estimate a fish population biomass, age structure and provide in-depth information on such things as the average number of eggs produced, the number of females versus males (sex ratio) and their feeding habit (Jega *et al*., 2017). Artificial reproduction and the estimation of fecundity are of fundamental importance for the culture of commercial fish and for the conservation of threatened species (Arantes *et al*., 2013).

The relationship between body length and weight is of great importance in fishery biology (Bhatt, 1983). When comparing length-weight relationship available in the literature, one might find wide variability in parameter estimated for a single species. This is due to the fact that the length-weight relationship is greatly affected by many factors related to population variability, sampling and estimation methods. Sampling related factors include sample size, length distribution in the sample and type of length measure, while nutritional conditions account for intrinsic biological variability (Ricker, 1997). In *P. obscura*, the values of a = -3.22, b = 3.81 and r = 1.07 obtained from this study was at vaiance in the values of a, b and r obtained from the regression equation for *P. obscura* from other river systems. For example, King (1996b) in his studies of *P. obscura* from Cross River recorded a, b, and r values 0.0059, 3.088 and 0.889 respectively. A work in Imo River reported the same values for a, b, and r, whereas from Ikpopa River for *P. obscura*, obtained a, b, and r values were 0.065, 3.41 and 0.957 respectively. This differences would be due to locational differences, size of fish studied and season of collection. More research is required for length weight relationship in fishes as there are few reports in this area. The physiological conditions and the well-being of a fish are influenced by meteorological, oceanographic and biometric parameters (Ama-Abasi, 2007). The mean condition factors for the fishes showed that they were in good condition. Fish can attain either isometric growth, negative or positive allometric growth (Ajah and Asuquo, 2017). Isometric growth reveal that there is no body change or shape as the organism grows, meanwhile a negative allometric growth implies that the fish becomes slimmer as it increases in length. A positive allometric growth means the fish becomes deeper-bodied as it grows (Reidel *et al*. 2007). The values of the exponent b provided information on the fish growth. When b = 3, increase in weight is isometric. When the value of b is other than 3, weight increase is allometric, (positive allometric if b>3, negative allometric if b<3) (Sangun *et al*., 2007). Out of the 10 species with b values in the present study, only the value of *Arnoldichthys spiloterus* was isometric, while others were either positively or negatively allometric.

Research on sex ratio of *Parailia pellucida* in River Niger, Delta, Nigeria reported significantly higher occurrences of males to females (Allison *et al*., 2008). In this present study, out of 221 fin species investigated, females' ratio was higher than the males. Studies on sex ratio off the coast of Lagos, Nigeria indicated that the ratio of males was significantly higher than that of females (Anyanwu, 1990). There is a correspondence in the results of Anyanwu, 1990 and Allison et al., 2008, but in this present study, the result is the reverse. This might be due to water current, low spawning intensity, food availability and differences in size of the species in the different sampling sites. The low proportion of gravid females obtained (26 out of 221) is quite similar with observed 53 gravid females of *C. nigrodigitatus* out of 502.

Study of reproductive aspects of *C. nigrodigitatus* from Cross River, Nigeria indicatedted absolute fecundity of 28086 eggs found in 64 cm fish as the highest so far reported for *C. nigrodigitatus* (Fagade and Adebisi, 1979), but in the present study, total number of 488 eggs was found in a 29.76 cm fish. 3200 eggs were recorded for *C. auratus* of Niger River which superseded that of *C. nigrodigitatus* (Imevbore, 1970). Fecundity of *Sarotherodon galilaeus* in Opa Reservoir, Ile-Ife, Nigeria, indicated that the average number of eggs obtained per females is 1048 while the number of eggs in each mature ovary varied from 604 to 2173 (Fawole and Arawomo, 1999)and the result is lower than that observed by other workers for *S. galilaeus*. Fecundity of 1452 was obtained for a female specimen with total length of 28.4 cm (Adebisi, 1987). In this study, some specimens harbor low fecundity and some with a higher fecundity. The lowest fecundity was found in *Tilapia mariae* ranging from 913 to 1220. In this study, fish specimens of the same length or weight had variable fecundities, exhibit fluctuations in fecundity among fish of the same species, size and age. Fagade *et al*. (1984), suggested that Variation in fecundity may be due to differential abundance of food

Conclusion

In fisheries biology, absolute fecundity is defined as the number of ripe eggs in the ovaries prior to spawning of an individual female fish. Sex ratio determines the sexes of male to female This study reported an unbalanced sex ratio of males and females. The relationship between body length and weight is of great importance in fishery biology, it also has important applications in fish stock assessment in fisheries science, the condition factor is used to appraise the fatness or wellbeing of fish. Since few reports are recorded about the reproductive biology of fishes in freshwater bodies, and this report being the first in this study area, more research should be carried out and recorded for future use in fisheries conservation and management.

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