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Reproductive and Phenotypic Indices among the Haplotypes of *Clarias gariepinus* (Buchell, 1822) From Rivers Benue and Donga, Nigeria

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ABSTRACT: The study on reproductive and phenotypic indices of *Clarias gariepinus* (Burchell, 1822) haplotype from Rivers Benue and Donga, Nigeria was carried out from February - May 2021, to evaluate phenotypic and production indices among the genetic groups of African catfish (*C. gariepinus*). Sixty (60) matured samples of *C. gariepinus* of different sizes were bought from artisanal fisherfolks. Fish samples were utilised for the molecular analysis and also were assessed for reproductive and phenotypic indices in the genotypes. The phenotypic identity and production indices of the male specimens of the haplotype 1 and 3 from river Benue. Significant differences ($p< 0.05$) occurred in mean weight, standard length and dorsal ray counts, while head length and number of anal fin ray counts of the haplotype 1 and haplotype 3 phenotypes were similar. The male specimens of the haplotype 1 and 3 from river Donga. Significant differences ($p< 0.05$) occurred in all the body morphology. On the gonadal morphological traits, gonads weight is significant while gonads length and number of gonadal teeth are not significant. The female specimens of the haplotype 1 and 3 from river Benue significant differences ($p< 0.05$) occurred in all body morphology. Among the egg production indices are significantly different, while latency period, weight of stripped eggs, number of egg/1g weight and incubation period are similar among the haplotypes while the female specimens of the haplotype 1 and 3 from river Donga. Significant differences ($p<0.05$) occurred in all the body morphology. All gonadal morphological traits are significant. Among the egg production indices are significantly different, while latency period, number of egg/1g weight and incubation period are similar among the haplotypes. Compared haplotypes among *C. gariepinus* genetic group have potential for more egg production at similar body weights and is important for the hatchery production of the catfish, as the observed variation would influence breeding programming and subsequent level of success.

Keywords: Genetic, Haplotypes, Morphology, Phenotypic, Reproduction indices

Introduction

The use of high-quality gametes from fish brood stock is of great importance for ensuring the production of viable larvae for aquaculture (Saeed *et al*., 2010). *Clarias* is a genus of catfishes (order Siluriformes) of the family Clariidae, the air-breathing catfishes. They are of a wide variety of body shapes but all of them possess well-developed barbells, the whiskers, which gives them the common name catfish (Huisman and Richter, 1987). They live in freshwater environments and are bottom dwellers and as such bottom feeders. They are also obligate air breathers, which mean they do spend some time on the surface. This species can live in very poorly oxygenated waters and is one of the last species to live in such an uninhabitable place (Bart and Dunham, 1990). They are also able to secrete mucus to prevent drying and are able to burrow in the muddy substrate of a drying body of water with pH range from 6.5 to 8.0 (Skelton, 1993; Teugels, 1986).
The anatomical organization of the production indices in catfish is variable among the families of catfish, but the majority of them present fringed testis. In the testes of some species of Siluriformes, organs and structures

such as a spermatogenic cranial region and a secretory caudal region are observed, in addition to the presence of seminal vesicles in the caudal region. The total number of fringes and their length are different in the caudal and cranial portions between species. Fringes of the caudal region may present tubules, in which the lumen is filled by secretion and spermatozoa. Spermatocytes are formed from cytoplasmic extensions of Sertoli cells; the release of spermatozoa is allowed by breaking of the cyst walls (Urbanyi *et al*., 1999). Seminal vesicles are typically paired, multi chambered, and connected with the sperm duct, and have been reported to play a glandular and a storage function (Owoyemi *et al*., 2015).

Milt quality is a measure of the ability of sperm to successfully fertilize an egg and such ability mostly depends on qualitative parameters of milt i.e. composition of seminal fluid, milt volume, sperm density and sperm motility (Rurangwa *et al*., 2004). Fish seminal fluid has a unique composition regarding the presence of the organic and inorganic components which support the viability of spermatozoa (Hajirezaee and Rafiee, 2010).

Sperm motility and sperm density determine the fertilization capability of spermatozoa and often are used to estimate milt because of chemical properties of seminal fluid, fish spermatozoa are immotile in seminal fluid. After activation of motility, spermatozoa move towards micropyles in the surface of eggs and then fertilization is done. When a dense milt (i.e. containing more counts of sperm cells) sample is used for fertilization, it is obvious that the chance of collision of a sperm with an egg is higher than a milt sample containing a lower density of spermatozoa (Saeed *et al*., 2010).

Knowledge on all biological aspects of these species especially reproduction properties may help to understand their appropriate management and conservation in the nature. In this regard, many studies have investigated the reproduction properties of fishes especially gamete quality, the studies which followed the aquaculture and conservational goals. Sperm motility and sperm density determine the fertilization capability of spermatozoa and are considered as the qualitative parameters of fish spermatozoa (Billard *et al*., 1993; Linhart *et al*., 1994; Krol *et al*., 2006). Seminal plasma has a special composition composed of organic and inorganic (ions) components which support the viability of spermatozoa (Ciereszko *et al*., 2000).

Understanding the reproduction properties of *Clarias gariepinus* can help to understand their management and conservation in the nature and also to carry out artificial reproduction in hatchery condition. This study aims to evaluate phenotypic and production indices among the haplotype's African catfish (*C. gariepinus).*

Materials and methods

Description of sampling site: The samples were collected from River Benue and River Donga, River Benue which lies between latitude 8º10'58.3″N and longitude 9º44'42.32″E in DMS (Degrees Minutes Seconds) or 8.18122 and 9.74431 (in decimal degrees) and it has an area of 3,121 km² while River Donga lies between latitude 7°43′00″N and longitude 10°03′00″E. The Rivers exists year-round, the water volume fluctuates with seasons. The rivers overflow its bank during the rainy season (May-October) but decreases drastically in volume leaving tiny island in the middle of the Rivers during the dry season (November-April). Figure 1 shows the rivers and sampling locations. The rivers contain several species of fish which are of economic importance to the people of Taraba State and Nigeria at large.

Fish collection and sampling: A total of sixty (60) fish samples of *Clarias gariepinus* caught with various fishing gear at River Benue and Donga were bought from artisanal fishermen at the landing site from February to May 2021. Physical examination of the external features of the samples was carried out and observed for abnormalities at the main landing site and samples were thereafter transported in a 25 liters' plastic container to Kahzu Integrated Farm Gindin Waya, for identification and examination.

Experimental fish: The experimental fish were obtained from an ongoing research at the experimental site. The fish specimens were produced from brooders of the Benue and Donga Haplotype of *Clarias gariepinus*

Genetic Distance of the Haplotypes

	Haplotype_1	**Haplotype_2**	**Haplotype_3**
Haplotype_1			
Haplotype_2	0.000211		
Haplotype_3	0.001797	0.001843	

Note: Haplotypes were genetically distant at 0.000211 (hap 1-2), 0.001797 (hap 1-3) and 0.001843 (hap 2-3)

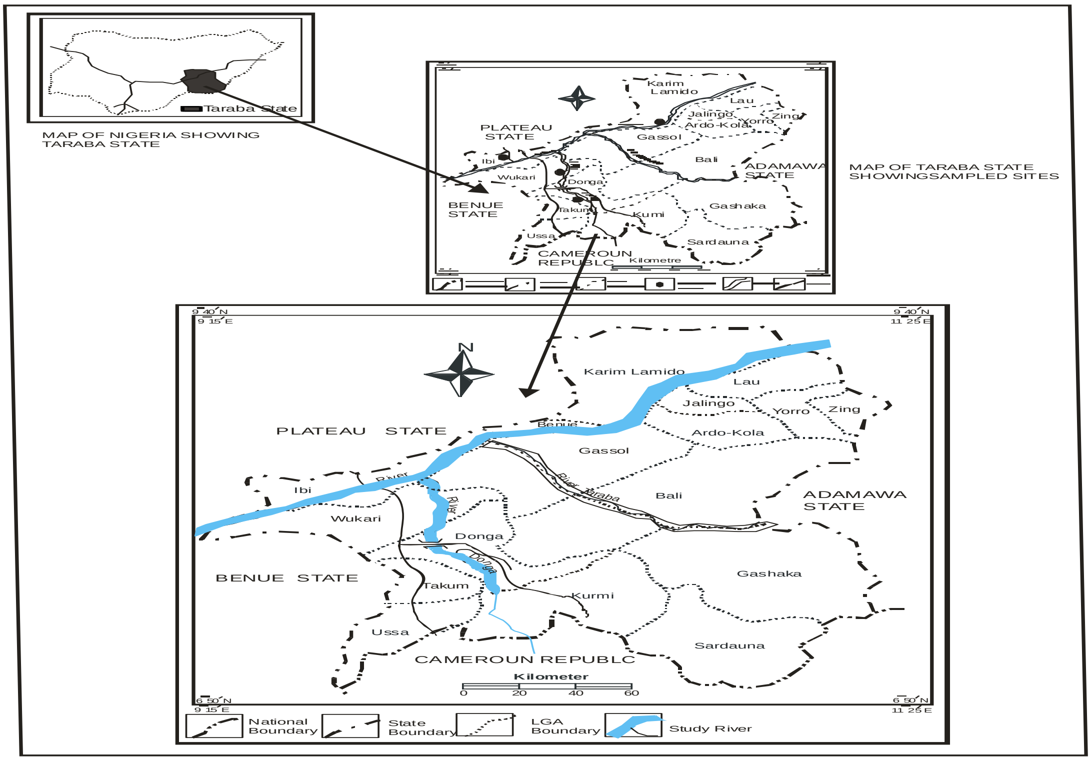

Fig. 1: Geographical locations of sampling site and Rivers

*Identification of fish sample***:** The experimental fish were identified as described by Teugels, (1986).
*Sexing of fish***:** Sex of fish sample were determined as described by Imam and Dewu, (2010).
Preparation of fishes for milt collection: All the procured brooders of *C. gariepinus* were subjected to length and weight measurement, afterwards, the live male brooders were dissected to expose the milt sac. Milt sac were cleaned and dried with cotton towel/tissue paper before examination.
Phenotypic assessment and tissue sample collection: Following stunning, the live weight and length of the fishes were measured as well as the length (cm) of the genital papillae. The fish were sacrificed using American Veterinary Medical Association AVMA, (2013) method and then a ventral midline incision was made into the body cavity, and the testes were resected (cut off). The weights (g) of the left and right testes were taken. These data were utilized to calculate the allometric indices for each fish according to Owoyemi *et al*., 2015 while egg from each of the female specimens under each genotype category was collected and each of the female were assessed for weight of female, volume of stripped eggs from which fecundity and gonadosomatic index was derived using the formula for determination of reproductive success.
Evaluation and characterization of milt: The milt samples were evaluated and characterized in terms of the following parameters-

- *Milt volume***:** Milt volume from each haplotype of *Clarias gariepinus* were measured directly by collecting the milt in 4.5 ml graduated cryovials. The milt volume was recorded by reading the level of milt in cryovials.
- *Colour:* Colour of each milt sample was observed visually just after milt collection.
- *Hydrogen ion concentration (pH):* A pocket-sized (pen type) digital pH meter (Hanna made) was used in the General hospital Wukari medical laboratory. After calibration of the pH meter, its tip was placed in the milt sample and the reading was taken.
- *Sperm motility and cell count:* For calculation of sperm cells, 0.05 ml fresh milt were mixed with 1.95 ml Neutral Buffered Formalin (NBF) with a bit of methyl green (stain). It is 40-times dilution of the sperms. After mixing well, this mixture was kept for 10 minutes. Number of sperms cells were counted for each sample by employing a Haemocytometer. The sperm cell count was estimated by using the following formula as described by Rurangwa *et al*., 2004.

Sperm cell count (sperms/ml) = X x 40 x 200 x 1000
where: X = Mean value of number of sperm cells
40 = First step dilution of fresh milt with NBF
200 = Haemocytometer dilution
1000 = Conversion factor from mm3 to cc3 or ml

The following formulae were utilized for evaluation of reproductive production indices

- Gonad/body weight ratio was calculated as: = $\frac{\text{Gonad weight (g)}}{\text{Mean weight (g)}} \times 100$ (1)
- Gonad/body length ratio was calculated as: = $\frac{\text{Gonad length (cm)}}{\text{Standard length (cm)}} \times 100$ (2)
- Gonadosomatic index (GSI) in male was calculated as: = $\frac{\text{Testes weight (g)}}{\text{Body weight (g)}} \times 100$ (3)
- Gonadosomatic index (GSI) in female was calculated as: = $\frac{\text{Ovary}}{\text{Body weight (g)}} \times 100$ (4)
- Pseudo-gonadosomatic index (GSI) in female was calculated as: =

$$\frac{\text{Weight of egg mass (g)}}{\text{Body weight before inducement(g)} - \text{Weight of stripped eggs (g)}} \times 100 \quad (5)$$

Statistical analysis: The SPSS software version 20 was used to analyze data. All correlations were tested using the bivariate correlation coefficients of Pearson. Then, linear and non-linear regression models was investigated using regression fits.

Results

Phenotypic characterization and reproductive indices among the haplotypes of Clarias gariepinus from Benue and Donga Rivers: The phenotypic identity and production indices of the male specimens of the haplotype 1 and 3 from river Benue are presented in Table 1. Significant differences ($p < 0.05$) occurred in mean weight, standard length and dorsal ray counts, while head length and number of anal fin ray counts of the haplotype 1 and haplotype 3 phenotypes were similar. On the gonadal morphological traits: gonads length, weight and number of teeth, gonad length and weight are significant while number of gonad teeth are similar. Only gonad/body length ratio is significant among the gonads production indices. For milt quality, significant difference occurred in only seminal plasma, while colour, milt volume, viscosity and liquefaction are similar. Active spermatozoa and motility duration are significantly different, while sluggish, dead spermatozoa and semen cell count are similar. In percentage morphology, coiled tail spermatozoa are significant, while normal and swollen spermatozoa are similar.

Table 1 Phenotypical characteristics and production indices of male *C. gariepinus* from River Benue

Phenotypical/production indices	Haplotype 1	Haplotype 3	P-value
Body morphology			
Mean weight (kg)	1.07±0.12	1.20±0.20	P<0.05
Standard length (cm)	45.30±1.18	46.33±1.53	P<0.05
Head length (cm)	14.17±1.04	9.73±8.43	
Dorsal fin rays count (DFR)	73.33±0.58	69.33±0.58	P<0.05
Anal fin rays count (AFR)	33.67±0.58	54.33±0.58	
Gonads morphology			
Gonad length (cm)	4.00±0.10	4.27±0.15	P<0.05
Gonad weight (g)	4.33±0.21	5.03±0.25	P<0.05
Numbers of gonad teeth	15.33±4.16	15.33±2.52	
Gonads production indices			
Gonad/body weight ratio	0.43±0.01	0.52±0.01	
Gonad/body length ratio	9.11±0.00	8.81±0.23	P<0.05
Gonadosomatic index	0.42±0.02	0.51±0.02	
Milt quality			
Colour	Straw	Straw	
Milt volume (ml)	4.50±5.63	1.03±0.06	
Seminal plasma pH	7.37±0.06	7.07±0.12	P<0.05
Viscosity	Low	Low	
Liquefaction	Low	Low	
Sperm motility (%)			
Active Spermatozoa	17.67±0.58	15.33±0.58	P<0.05
Sluggish Spermatozoa	26.67±1.53	32.67±3.21	
Dead Spermatozoa	10.33±8.50	1.00±1.00	

Motility duration(s)	121.67±3.79	136.33±1.53	P<0.05
Semen cell count (6/m6)	10.00±0.00	10.30±0.00	
Morphology (%)			
Normal Spermatozoa	9.00±7.94	6.33±5.69	
Swollen Spermatozoa	11.00±9.54	13.33±11.72	
Coiled Tail Spermatozoa	13.67±11.85	12.33±10.79	P<0.05

P<0.05 indicate significant difference

The phenotypic identity and production indices of the female specimens of the haplotype 1 and 3 from river Benue are presented in Table 2. Significant differences ($p < 0.05$) occurred in all body morphology mean weight, standard length, head length, dorsal rays count and anal fin rays count. All gonadal morphological traits: ovary length and weight are significant. Among the egg production indices, stripping percentage, gonadosomatic index and pseudo-gonadosomatic index are significantly different, while latency period, weight of stripped eggs, number of egg/1g weight and incubation period are similar among the haplotypes.

Table 2: Phenotypical characteristics and production indices of female *C. gariepinus* from River Benue

Phenotypical/Production indices	Haplotype 1	Haplotype 3	P-value
Body morphology			
Mean weight (kg)	1.10±0.10	1.13±0.12	P<0.05
Standard length (cm)	50.23±1.21	48.00±1.00	P<0.05
Head length (cm)	15.67±1.53	14.13±0.15	P<0.05
Dorsal fin rays count (DFR)	63.00±1.00	73.67±2.52	P<0.05
Anal fin rays count (AFR)	52.00±2.00	54.33±2.08	P<0.05
Gonads morphology			
Ovary length (cm)	5.2.7±0.32	6.10±0.10	P<0.05
Ovary weight (g)	81.33±7.09	75.33±3.21	P<0.05
Egg production indices			
Latency period (hour)	10:05	10:15	
Weight of stripped eggs (g)	81.93±9.61	66.23±2.40	
Number of egg/1g weight	600.00±0.00	600.00±0.00	
Stripping percentage	5.94±0.01	5.39±0.01	P<0.05
Gonadosomatic index	6.23±0.02	5.91±0.01	P<0.05
Pseudo-Gonadosomatic index	6.31±0.01	5.67±0.02	P<0.05
Incubation period (hours)	19-28	19-28	19-28

P<0.05 indicate significant difference

The phenotypic identity and production indices of the male specimens of the haplotype 1 and 3 from river Donga are presented in Table 3. Significant differences ($p < 0.05$) occurred in all the body morphology (Mean weight, standard length, head length and dorsal ray counts and anal fin rays count. On the gonadal morphological traits, gonads weight is significant while gonads length and number of gonadal teeth are not significant. Among the gonad production indices, gonad/body length ratio is significant while gonad/body weight ratio and gonadosomatic index is similar. Milt volume and seminal plasma are significant, while colour, viscosity and liquefaction are similar. Furthermore, sluggish spermatozoa and semen cell count are significant, while active, dead spermatozoa, motility duration are similar. No significant occurred among the percentage morphology index (normal, swollen and coiled tail spermatozoa).

Table 3: Phenotypical characteristics and production indices of male *C. gariepinus* from River Donga

Phenotypical/production indices	Haplotype 1	Haplotype 3	P-value
Body morphology			
Mean weight (kg)	1.08±0.08	1.17±0.20	P<0.05
Standard length (cm)	41.00±2.00	40.33±0.58	P<0.05
Head length (cm)	12.93±0.93	11.77±0.25	P<0.05
Dorsal fin rays count (DFR)	68.67±1.53	73.67±0.58	P<0.05
Anal fin rays count (AFR)	54.00±1.00	53.33±1.15	P<0.05
Gonads morphology			
Gonad length (cm)	3.80±0.10	4.50±0.10	

Gonad weight (g)	4.17±0.06	4.73±0.12	P<0.05
Numbers of gonad teeth	13.33±2.52	23.00±2.00	
Gonads production indices			
Gonad/body weight ratio	0.36±0.02	0.43±0.02	
Gonad/body length ratio	9.45±0.07	10.80±0.61	P<0.05
Gonadosomatic index	0.55±0.39	0.43±0.02	
Milt quality			
Colour	Straw	Straw	
Milt volume (ml)	1.43±0.06	1.67±0.15	P<0.05
Seminal plasma pH	8.03±0.06	8.10±0.10	P<0.05
Viscosity	Moderate	High	
Liquefaction	Moderate	Moderate	
Sperm motility (%)			
Active Spermatozoa	35.00±2.00	49.33±1.53	
Sluggish Spermatozoa	24.33±1.15	22.67±3.51	P<0.05
Dead Spermatozoa	39.00±2.65	20.00±1.73	
Motility duration(s)	107.67±4.04	137.67±16.17	
Semen cell count (5/m6)	46.30±0.00	89.80±0.00	P<0.05
Morphology (%)			
Normal Spermatozoa	18.33±16.07	29.00±25.16	
Swollen Spermatozoa	20.00±2.00	11.67±6.66	
Coiled Tail Spermatozoa	7.00±2.00	21.33±2.08	

P<0.05 indicate significant difference

The phenotypic identity and production indices of the female specimens of the haplotype 1 and 3 from river Donga are presented in Table 4. Significant differences (p< 0.05) occurred in all the body morphology (mean weight, standard length, head length, dorsal rays count and anal fin rays count). All gonadal morphological traits: ovary length and weight are significant.

Among the egg production indices, weight of stripped eggs, stripping percentage, gonadosomatic index and pseudo-gonadosomatic index are significantly different, while latency period, number of egg/1g weight and incubation period are similar among the haplotypes.

Table 4: Phenotypical characteristics and production indices of female *C. gariepinus* from River Donga

Phenotypical/production indices	Haplotype 1	Haplotype 3	P-value
Body morphology			
Mean weight (kg)	1.03±0.06	1.10±0.10	P<0.05
Standard length (cm)	43.67±0.58	41.00±2.00	P<0.05
Head length (cm)	11.77±0.25	10.60±0.36	P<0.05
Dorsal fin rays count (DFR)	75.67±0.58	69.33±0.58	P<0.05
Anal fin rays count (AFR)	51.67±1.53	48.00±2.00	P<0.05
Gonads morphology			
Ovary length (cm)	4.67±0.15	5.67±0.15	
Ovary weight (g)	69.00±1.00	82.33±1.53	
Egg production indices			
Latency period (hour)	10:25	10:35	
Weight of stripped eggs (g)	65.14±0.24	72.24±2.28	P<0.05
Number of egg/1g weight	600.00±0.00	600.00±0.00	
Stripping percentage	6.54±0.01	6.40±0.14	P<0.05
Gonadosomatic index	6.87±0.06	6.65±0.17	P<0.05
Pseudo-Gonadosomatic index	6.92±0.06	6.61±0.05	P<0.05
Incubation period (hours)	19-28	19-28	19-28

P<0.05 indicate significant difference

Discussion

Phenotypic characterization and reproductive indices of Benue and Donga haplotypes: Knowledge on biological aspects of fish especially reproductive properties is essential to their management and conservation in the nature. In this regard, giving attentions to endemic fish species are very important since these species are of the most important part of local ecosystem. In the milt, sperm is only the haploid cells that are responsible for transfer of male characters to the egg for the development of new individual.

Phenotypic characterization of Benue and Donga rivers C. gariepinus haplotypes: The phenotypic identity and production indices of the male specimens of the Benue and Donga rivers haplotype 1 and 3 respectively are presented in Table 1 and 3. Male of river Benue haplotype shows a significant difference ($p<0.05$) in mean body weight, standard length and dorsal ray counts while, head length and number of anal fin ray counts of the haplotype 1 and 3 were similar. While in river Donga haplotype significant difference ($p<0.05$) occurred in mean body weight, standard length, dorsal fin ray counts, head length and number of anal fin ray counts of both haplotype 1 and 3. The dorsal ray count is an important taxonomic trait in *C. gariepinus* (Holden and Reeds, 1978). The number of dorsal rays count in both haplotypes were within the values reported by Teugels (1986b), indicating that the analyzed specimens were the *C. gariepinus* species. However, the significantly higher dorsal ray count observed in both Benue and Donga rivers haplotype was in agreement with Oyebola *et al*., (2013) and Oyebola *et al*., (2016) who reported significantly different morphotypes of *C. gariepinus*, in which dorsal ray count was higher compared to Standard length indicating that pectoral spine possibly co-varies with standard length. Meanwhile, standard body length is an important aquaculture production trait in fish. Similarly, significant differences occurred in all the assessed gonadal morphological traits: gonads length, weight and number of teeth; gonads production indices: gonad/body weight and gonad/body length ratios; as well as milt qualities: sperm motility and %live/dead sperm.

The phenotypic identity and production indices of the female specimens of the Benue and Donga rivers haplotype 1 and 3 respectively are presented in Table 2 and 4. The body morphology of the female specimens of Benue and Donga rivers haplotype which showed significant difference was observed at mean body weight, standard length dorsal fin ray counts, head length and number of anal fin ray counts of both haplotype 1 and 3. While only river Benue haplotype 1 and 3 showed significant deference in gonad morphology (ovary length and ovary weight), the river Donga female haplotype 1 and 3 showed no difference. This result showed corroboration on the pattern of significance in the assessed phenotypes in the males. This result indicates that, although, significant differences consistently occurred between standard lengths of the haplotypes that would have superior values may vary with sex, with male having longer body than the female (Oyebola *et al*., 2016).

With respect to egg production, Benue and Donga rivers haplotype had significantly higher values in weight of stripped eggs, number of eggs in one (1) gram of egg, and stripping percentage.

Reproductive indices of Benue and Donga rivers C. gariepinus haplotypes: Milt is stored in genital tract/posterior portion of the testes before it is released from the body. Viable fish sperm is currently considered the most useful parameter for assessing sperm quality in fish (Rurangwa *et al*., 2004). The quality of fish sperm is as important as quality of female eggs for viable off-springs, various studies have been carried out on induced spawning in female fish with lesser attention on the male counterpart. Sperm morphology, density, volume, motility and fertilizing capacity, as well as composition and osmolality of the seminal plasma are parameters commonly measured to assess sperm quality in fish (Alavi *et al*., 2004).

However, present study revealed that milt volume was not significantly increased with the increase of brooder length. Raghuvanshi, (2007) could not establish any relationship between milt volume and size of brooder in Mahaseer and other snow trout. Variation in sperm quality may be due to sex ratio, stocking density, age, size, nutrition and feeding regime; (Tahoun *et al*., 2008). Studies have shown that qualitative parameters of the milt (sperm motility, sperm lobe length, milt volume and count) can be influenced by several factors such as feeding regime, the quality of the feed (Cerovsky *et al*., 2009), environmental factors, variations between individual, age, weight, length of the fish Ochokwu *et al*., (2015), season of the year (Hajirazaee *et al*., (2010), stress, uptake of nutritive and genetic materials, physiochemical properties of water (pH, salinity and temperature and dissolve oxygen) (Brooks *et al*., 1997).

Sperm motility in teleost fish, is so far considered the best biomarker of milt quality (Lahnsteiner *et al*., 2004). Duration of motility was 121.67±3.79 Hap1 and 136.33±1.53 sec Hap3 for river Benue while river Donga 107.67±4.04 Hap1 and 137.67±16.17 sec. Hap3, results that are not consistent with *Ictalurus punctatus*, Jaspers *et al*., (1978). While reviewing the literature it appears that the sperm motility duration in *S. progastus* and other cold- 45 water species is very short in comparison to other fresh water and marine fish species. Similar view has also been expressed by Rurangwa *et al*., (2004). According to Effer *et al*., (2013) the duration of sperm motility in fish depends on the temperature of the activation medium and have great influence on successful fertilization.

pH of milt in the fish species is generally alkaline and characteristic feature of the species. In the milt of fresh water fish species it was reported slightly alkaline as it is 7.31 + 0.07 in *S. richardsonii* (Raghuvanshi, 2007). Present study also reveals that pH of *C. gariepinus* milt is slightly alkaline river Benue haplotype (Hap1. 7.37 ± 0.06 and Hap3. 7.07 ± 0.12) while river Donga haplotype (Hap1. 8.03 ± 0.06 and Hap3. 8.10 ± 0.10) which showed very little variation, with the individual brooders. Thus, the present finding further strengthen the concept that milt of fresh water species is slightly alkaline. pH is an important seminal plasma characteristic

influencing the potential for motility of fish spermatozoa. The pH of an activating solution also affects motility. Alkaline conditions similar to or greater than those of seminal plasma apparently enhance the motility and fertility of salmonid spermatozoa (Stoss, 1983). According to Duplinsky, (1982) low pH has a determinate effect on the activity of Northern pike sperm. Variation in pH value may be due to the addition of the seminal plasma portion and reduction in the viscosity of milt samples in large sized brooders.
The variation in sperm motility duration in different species depends largely on the endogenous energy reserve in form of ATP and mitochondrial occurrence and ability of sperm to utilize energy from exogenous sources (Mansour *et al*., 2002). The long sperm motility duration is advantageous for maximum chances of fertilization and considered good in terms of the milt quality. The short sperm motility duration in fishes has a critical influence on the successful fertilization, since the spermatozoa must find and enter the micropyle during this limited period. In nature, the species with short motility duration select such a mating strategy, which maximize the chances of sperm-egg contact, for example, they exhibit sexual display and gametes of both the sexes are released in close proximity. This also seems to be true in cases of *C. gariepinus* on the fertilization success, motility duration, intensity of sperm activity (beat frequency) is an important bearing as it effects on the velocity of sperm and thereby total displacement in an environment towards egg and composition of the fish species semen and its physical characteristics have been found to varied with the fish species.

Conclusion

In the present study, some phenotypic and production indices of *C. gariepinus* spermatozoa were investigated. The morphological properties of sperm may be related with systematics and phylogenetic features and therefore interesting under taxonomical aspects of fish. These finding indicates that compared haplotypes among *C. gariepinus* genetic group have potential for more egg production at similar body weights and is important for the hatchery production of the catfish, as the observed variation would influence breeding programming and subsequent level of success.

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References

Alavi SMH, Cosson J, Karami M, Mojazi AB, Akhoundzadeh MA: Spermatozoa motility in the persian surgeon, *Acipenser persicus*. Effects of pH, dilution rate, ions and osmolality. Reproduction, 128, 819-828. 2004.

AVMA: American Veterinary Medical Association (AVMA) Guidelines for the Euthanasia of Animals: 2013 Edition, American Veterinary Medical Association. 1931 N. Meacham Road Schaumburg, IL 60173. BART. 2013.

Bart AN, Dunham RA: Factors affecting survival of channel catfish after surgical removal of testes. Prog Fis. Cult, 52; 241-246. 1990.

Billard R., Cosson J, Crime L: Motility of fresh and aged halibut sperm. Aquat Living Resour, 6: 67-75. 1993. DOI: http://dx.doi.org/10.1051/alr:1993008

Brooks S, Tyler CR, Sumpter JP: Department of Biology and Biochemistry, Brunel University, Uxbridge, Middlesex Ub83PH, United Kingdom, Reviewed in Fish Biology and Fisheries, 7, 387-416. 1997.

Cerovsky J, Frydrychova S, Lustykova A, Lipensky J, Rozkot M: Semen characteristics of boars receiving control diet and control diet supplemented with L-carnitine. Czech J Anim. Sci, 54, 417-425. 2009.

Ciereszko A, Glogowski J, Dabrowski K: Biochemical characteristics of seminal plasma and spermatozoa of freshwater fihes. In: Tiersch T.R., Mazik P.M. (eds.): World Aquaculture Society. Cryopreservation of Aquatic Species. Baton Rouge, LA, USA, 20 – 48. 2000.

Duplinsky PD: Sperm motility of northern pike and chain pickerel at various pH values. Trans. Am Fish Soc, 111(6), 768-771. 1982.

Effer B, Figueroa E, Augsburger A: Sperm biology of *Merluccius australis*: Sperm structure, semen characteristics and effects of pH, temperature and osmolality on sperm motility. Aquaculture, 408-409;147-151. 2013.

Hajirezaee S, Rafiee GR: Stress responses of Persian sturgeon, *Acipenser persicus* to repetition of a management stressor (hand stripping of milt). JABS, J Appl Biol Sci, 4: 9 - 12. 2010.

Hajirezaee S, Mojaziamizi B, Mirvaghefi A, Sheikh A: Evaluation of semen quality of endangered Caspian brown trout (*Salmo trutta caspius*) in different times of spermiation during the spawning season. Czech J Anim Sci,. *55*,445-455. 2010.

Holden M, Reeds W: *West African fresh water fish*: West African nature and book. London: Longman Publishing limited, 61p. 1978.

Huisman EA, Richter CJJ: Reproduction, growth, health control and aquacultural potential of the African catfish, *Clarias garieninus*. Aquaculture, 63: 1-14. 1987.

Imam TS, Dewu RA: Survey of Piscine ecto and intestinal parasites of Clarias sp. sold at Galadima road fish market, Kano metropolis, Nigeria. Biosci Biotechnol Res Commun, 22(4):209. 2010.

Jaspers EJ, Avault JE, Roussel JD: Testicular and spermatozoal characteristics of channel catfish, *Ictalurus punctatus*, outside the spawning season. Trans Am Fish Soc, 107(2), 309-315. 1978.

Krol J, Glogowski J, Demska-Zakes K, Hliwa P: Quality of semen and histological analysis of testes in Eurasian perch *Perca luviatilis L*. during a spawning period. Czech J Anim Sci, 51: 220 – 226. 2006.

Lahnsteiner F, Mansour N, Berger B: The effect of inorganic and organic pollutants on sperm motility of some freshwater teleosts. J Fish Biol, 65, 1283-1297. 2004.

Linhart O, Billard R, Proteau JP: Cryopreservation of European catfih (*Silurus glanis L*.) spermatozoa. Aquaculture. 115: 340–359. 1994. doi:10.1016/0044-8486(93)90148-R

Mansour N, Lahnsteiner F, Patzner RA: The spermatozoon of the African catfish: fine structure, motility, viability and its behaviour in seminal vesicle secretion. J Fish Biol, 60, 545-560. 2002.

Ochokwu IJ, Apollos TG, Oshoke JO: Effect of egg and sperm quality in successful fish breeding. IOSR-J Agric Vet SCI. 8(8), 48-57. 2015

Owoyemi AO, Oyeyemi MO, Adeyemo AK, Aina OO: Reproductive potential of male catfish treated with gel extract of *Aloe vera* plant. Nig Vet J, 36(4):1341-1350. 2015.

Oyebola OO, Jacob JM, Omorodion BA, Akinsola YY, Samuel A: Molecular marker (allozyme) assisted selection of latent production traits and fingerprints of novel strains of fish (*Clarias gariepinus*). Aquaculture, 1-5. 2016.

Oyebola OO, Omitoyin BO, Salako AE, Ajani EK, Awodiran MO: Genetic and biochemical differentiation of pectoral spine variants in *Clarias gariepinus*. Int J Modern Biol Res, 1:8-14. 2013.

Piironen J, Hyvarinen H: Composition of the milt of some teleost fishes. J Fish Biol, 22, 351-361. 1983.

Raghuvanshi SK, Agarwal NK, Thapliyal BL: Induced breeding and artificial fertilization of Snow trout through the application of ovaprim. J Inland fish SOC India, 39(1), 12-19. 2007.

Rurangwa E, Kime DE, Ollevier F, Nash JP: The measurement of sperm motility and factors affecting sperm quality in cultured fish. Aquaculture, 234: 1-28. 2004.

Saeed H, Bagher MA, Alireza M: Fish milt quality and major factors influencing the milt quality parameters: A review. Afr J Biotechnol, 9 (54), 9148-9154. 2010.

Skelton P: A Complete Guide to the Freshwater Fishes of Southern Africa. Halfway House: Southern Book Publishers Ltd.Alabama, USA. 388p. 1993.

Stoss J: Fish gamete preservation and spermatozoan 9154 *African Journal of Biotechnology Physiology*. In: Hoar W.S., Randall, D.J., Donaldson, E.M., eds. Fish physiol. New York: Academic Press, 305-350. 1983.

Tahoun AM, Ibrahim MAR, Hammoudi YF, Eid MS, Zaki El-Din MMA, Magouz FI: Effect of age and stocking density on spawning performance of Nile Tilapia (*Oreochromis niloticus*) broodstock reared in hapas. *8th International Symposium on Tilapia in Aquaculture*, 329-343. 2008.

Teugels G: A systematic revision of the African species of the genus *Clarias* (Pisces: Clariidae). *Annales Musee Royal de l'Afrique Centrale*, 247: 1-199. 1986.

Teugels GG: Morphology data of *Clarias gariepinus*: Identification Keys. http:// fishbase.sinica.edu.tw/physiology/MorphDataSummary. 1986b.

Urbanyi B, Horvath A, Varga Z, Horvath L: Effect of extenders on sperm cryopreservation of African catfish, *Clarias gariepinus*. Aquac Res, 30: 145-151**.** 1999.