DOI: 10.2478/cjf-2019-0011

CODEN RIBAEG ISSN 1330-061X (print)
1848-0586 (online)

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LENGTH-WEIGHT RELATIONSHIP, CONDITION FACTOR AND FECUNDITY OF AFRICAN SNAKEHEAD *Parachanna obscura* FROM THE ANAMBRA RIVER, SOUTH EAST NIGERIA

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ARTICLE INFO

Received: 29 July 2017
Accepted: 10 March 2019

Keywords:
Allometric growth
Gonad weight
Hepatosomatic index
Gonadosomatic index

ABSTRACT

The length-weight relationship, condition factor, fecundity, gonadosomatic and hepatosomatic indices of *Parachanna obscura* from the Anambra River were determined between December 2015 and June 2016. Eighty-three live samples of *P. obscura* were obtained from fishermen. Descriptive statistics, correlation and regression analysis were used to analyze the obtained data. The length-weight relationship had R values of 0.933, 0.843 and 0.896 for male, female and combined sexes, respectively. The b value of 3.133 for male and 2.674 for female were not significantly different (P>0.05). Mean condition factors of 0.89±0.33 and 0.80±0.21 were obtained for female and male, respectively. The largest number of eggs (10,965) was found in a female with the body weight of 154 g, gonad weight of 9.1 g and egg size of 1.3 mm, while the least fecund female with 1820 eggs weighed (94 g) and had a gonad weight 2.1 g with egg size of 1.0 mm. The hepatosomatic indices ranged between 0.55±0.20 and 0.64±0.29 in both male and female, respectively, while female gonadosomatic index average was 2.05±1.44. There was a positive correlation between fecundity and gonad weight.

How to Cite

Osho, F. E., Usman, R. A. (2019): Length-weight relationship, condition factor and fecundity of African snakehead *Parachanna obscura* from the Anambra River, South East Nigeria. Croatian Journal of Fisheries, 77, 99-105. DOI: 10.2478/cjf-2019-0011.

INTRODUCTION

Parachanna obscura is an important food and aquarium fish that is widely loved in Africa for its gastronomic qualities (Whenu and Fagade, 2012). However, this fish has been documented by IUCN (2016) as an endangered species. A better understanding of the natural populations of this fish is needed for proper conservation and exploitation. For ages, studies on the length-weight relationship, condition factor and fecundity are imperative for proper management decisions and conservation of aquatic resources. They are important prerequisites to a more detailed study on their breeding and production. Condition factor is essential in understanding the life cycle of fish species and contributes to adequate management of these species (Imam et al., 2010). The length-weight relationship is a useful tool in fish growth pattern (Pepple and Ofor, 2011) and for the estimation of mortality, recruitment and other parameters of population. Such information is also important for fish stock assessment

and understanding the population dynamics, which could serve as a valuable and useful tool in the management of the species. The Anambra River is a major source of *P. obscura* and other wild caught fishes all year round in South East Nigeria (Eyo and Mgbenka, 1992). Jamu and Ayinla (2003) reported that the fish yields of most Nigeria's inland waters were generally on the decline. However, Anyanwu *et al.* (2009) reported the fisheries economy of this river was profitable and suggested that scientific measures be taken to sustain this. An understanding of the fisheries of this river will contribute to the goal of its sustainable exploitation and utilization of its resources. Therefore, this study investigated the length-weight relationship, condition factor and fecundity of *P. obscura* in Anambra State.

MATERIALS AND METHODS

Experimental site

This study was carried out in the River Anambra, South East Nigeria. The River basin lies between latitudes 6°10′ and 7°20′N and longitudes 6°35′ and 7°40′E in the Southeast of Nigeria.

Collection of specimens

Eighty three *P. obscura* samples were obtained from the fishermen's catch at Otuocha landing site of the Anambra River, Nigeria between December 2015 and June 2016. The fish were transported in a 50-litre keg to the Fisheries Laboratory of Department of Fisheries and Aquaculture Management, Nnamdi Azikiwe University, Awka, Nigeria.
Morphometric analysis
Body weight was measured to the nearest 0.1 g, total length and standard length were measured to the nearest 0.1 cm. The length-weight relationships were determined by linear regression techniques for both sexes, as well as length and weight of the fish, using the following equation $W= aL^b$ (Ricker, 1971).

Taking the logarithm: Log W= Log a+b Log SL

Where

W = Weight of the fish (g)
SL = Standard length of the fish (cm)
a =the regression constant which is also the intercept
b = the regression of coefficient

Condition factor (K)

The condition factor which measures the relative wellbeing of the fish was calculated for both sexes using $K = 100W/L^3$ by Tesch (1978):

K = Condition factor; W = Weight (g); L = Length (cm)

Gonadosomatic index (GSI)

The fish were dissected and the ovaries were exposed and were taken out carefully. Weight of gonads was taken with weighing balance and finally the GSI value of the specimen was calculated. This was expressed as percentage of the gonad weight (GW) in terms of body weight (BW) of the fish (Afonso-Dias *et al.,* 2005).

GSI = Gonad weight (g)/Body weight (g) x 100

Hepatosomatic index (HSI)

The fish liver were carefully removed and weighed on electronic scale to the nearest 0.01 g. The hepatosomatic index (HSI) was calculated as a percentage of the liver to the body weight using HSI = Liver weight (g)/Body weight (g) x 100

Fecundity determination

Samples of a known weight were taken from the anterior, middle and posterior regions of each ovary and kept in a bottle containing 10% formalin solution for preservation. The subsamples were preserved in 10% formalin solution. After 24 hrs eggs became larger and separated from each other. The eggs in the subsamples were counted under a magnifying glass and weighed. Thereafter, the mean values of eggs were computed. Then the fecundity of the collected specimens was calculated according to Yeldan and Avsar (2000).
Using:

F = Ovary weight × number of eggs in the subsamples/ subsample weight

Diameter of randomly selected eggs was measured with digital micrometer to the nearest 0.01 mm.

Data analysis

The condition of the fish was expressed by Fulton's condition factor (K), calculated using the formula: $K= 100W/L^3$. Descriptive statistics and regression analysis were used to analyze the morphometric parameters. Relationships between variables (length vs. weight, fecundity vs. body weight/length) were analyzed using correlation analyses.

RESULTS

Length-weight relationship

A total of 83 samples of *P. obscura* were examined in this study, of which 36 were females and 47 were males. The samples ranged in total length from 18.70 to 34.50 cm with the mean of 26.16±4.41 cm, and from 17.20 to 34.70 cm with the mean of 25.76±3.58 cm for male and female, respectively. The total weight ranged from 47.00 to 320.00 g with the mean of 156.11±82.66 g, and from 40.00 to 355.00 g with the mean of 157.97±74.18 g for male and female, respectively, as presented in Table 1. The regression model indicating the relationship between length-weight of male, female and combined sexes of *P. obcura* had R^2 values of 0.870, 0.709 and 0.803, respectively, at significant level of $P<0.05$. Coefficients of length (b) of male (with value of 3.133) were positive while those of the female and combined sexes (with values of 2.674 and 2.956, respectively) were negative.

Table 1. Mean values of weight (W), total (TL) and standard length (SL) of different sexes of *Parachanna obscura* collected from the Anambra River (p<0.05)

	Male		Female		P-value	Combined sexes	
	Mean±SD	Min.-Max.	Mean±SD	Min.-Max.		Mean±SD	Min.-Max.
W (g)	156.11±82.66	47.00-320.00	157.97±74.18	40.00-355.00	0.915	156.92±78.63	40.00-35.500
TL (cm)	26.16±4.41	18.70-34.50	25.76±3.58	17.20-34.70	0.656	25.99±4.05	17.20-34.70
SL (cm)	21.83±3.77	15.40-29.30	21.40±3.15	14.20-28.90	0.581	21.64±3.50	14.20-29.30

Condition factor (K)

Table 2 indicates the mean values of the condition factors of both sexes of *P. obscura*. The condition factor of both sexes of *P. obscura* ranged between 0.59 and 2.34, while the female and male samples had mean values of 0.89±0.33 and 0.80±0.21, respectively. The statistical analysis indicated that there was no significant difference (P>0.05) in the condition factors of both sexes of fish samples collected.

Table 2. Condition factor (K) and hepatosomatic index (HSI) of different sexes of *Parachanna obscura* collected from the Anambra River

Parameter	Sex	N	Mean ±SD	Min-Max	P-value
K	Female	36	0.89±0.33	0.59-2.34	0.116
	Male	47	0.80±0.21	0.44-1.68	
HSI	Female	36	0.55±0.20	0.22-1.06	0.09
	Male	47	0.64±0.29	0.31-1.56	

Hepatosomatic index (HSI) and gonadosomatic index (GSI)

Presented in Table 2 are the mean and range values of HSI and female GSI of *P. obscura*. The hepatosomatic index ranged between 0.31 and 1.56 with the mean of 0.64±0.29, and between 0.22 to 1.06 with the mean of 0.55±0.20 for both female and male, respectively. The statistical analysis indicated that there was no significant difference (P>0.05) in the mean HSI for both sexes. However, the GSI ranged between 0.50 and 5.84 with the mean of 2.05±1.44.

Fecundity

Fifty per cent of the female *P. obscura* studied was found to be fecund (Table 3). The highest number of eggs (10,965) was found in a female with the total length of 26.2 cm, body weight of 154 g, gonad weight of 9.1 g and egg size recorded was 1.3 mm. Meanwhile, the smallest fecund female had 1820 eggs which measured 22.1 cm in total length, 94 g in body weight, with gonad weight of 2.1 g and egg size of 1.0 mm.

Table 3. Mean Fecundity, egg size, gonad weight, and gonadosomatic index of female *Parachanna obscura* samples collected from the Anambra River

Parameter	Mean±SD	Min-Max
Fecundity (F)	5263.00±3343.73	1820.00-10965.00
Egg size (ES) (mm)	1.10±0.50	0.90-1.30
Gonad weight(g)	3.30±2.76	0.80-10.00
Gonadosomatic Index	2.05±1.44	0.50-5.84

Fecundity, egg size and some growth and reproductive parameters

The relationships of fecundity with gonad weight and egg size were significant (P<0.05), as shown in Table 4. There were strong correlations between total length and standard length. Fecundity was weakly correlated with total length and standard length. However, there were negative correlations between fecundity and condition factor, egg size and condition factor, total length and condition factor with the values of -0.113, -0.030 and -0.270, respectively. Among all correlated variables, fecundity and gonad weight were the highest. This was closely followed by total length and standard length.

DISCUSSION

The results of the present study revealed that *P. obscura* exhibited negative and positive allometric growth pattern with regression analysis exponent b values less than and greater than 3 in females and males, respectively. The 'b' values in length-weight relationships determine the growth pattern of the fish species. Though the b values for both sexes were not significantly different, the result conforms to the observations of Osho et al. (2014) that the males of many tropical species grow faster and have more standard sizes than females, probably due to beneficial anabolism enhancing androgens. This result also corroborated the findings of Obasohan et al. (2012) who reported negative allometric growth pattern in five different fish species including *P. obscura* from Ibiekuma stream, Ekpoma, Edo state, Nigeria. Imam et al. (2010)

Table 4. Pearson Correlation Matrix for *Parachanna obscura* from the Anambra River

	Weight (g)	Total Length (cm)	Standard Length (cm)	Fecundity 'F'	Condition Factor 'K'	Egg Size (mm)	Gonad Weight (g)
Weight	1						
Total Length	0.771*	1					
Standard Length	0.785*	0.990*	1				
Fecundity	0.398	0.479*	0.442*	1			
Condition Factor	0.380	-0.270	-0.247	-0.113	1		
Egg Size	0.318	0.322	0.287	0.822*	-0.030	1	
Gonad Weight	0.423*	0.506*	0.467*	0.992*	-0.122	0.818*	1

*Correlation is significant at the 0.05 level

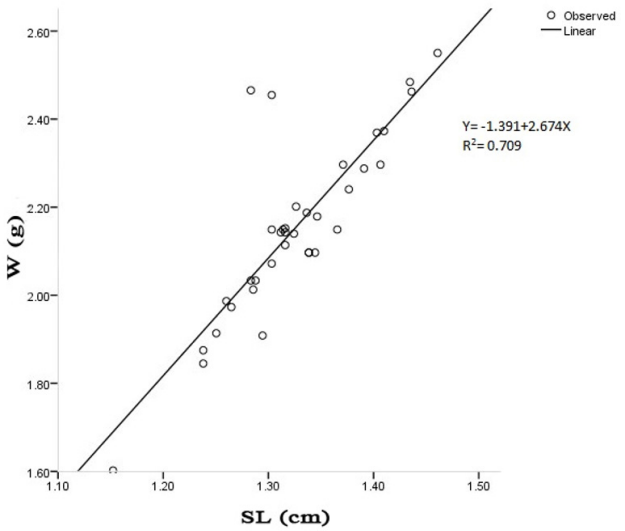

Fig 1. Length-weight relationship of *Parachanna obscura* (females) collected from the Anambra River

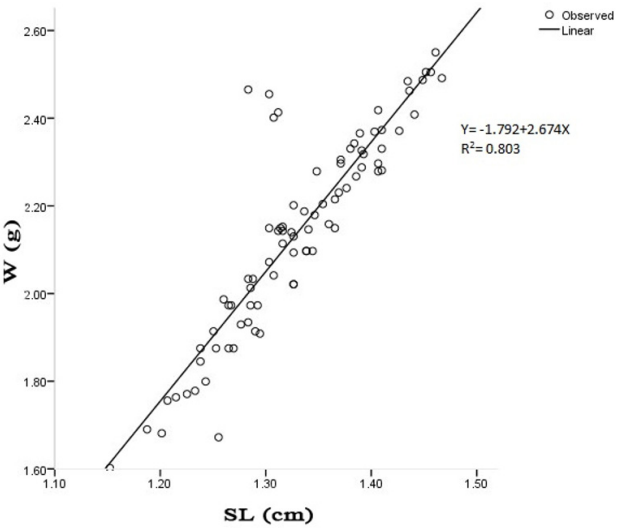

Fig 3. Length-weight relationship of *Parachanna obscura* (combined sexes) from the Anambra River

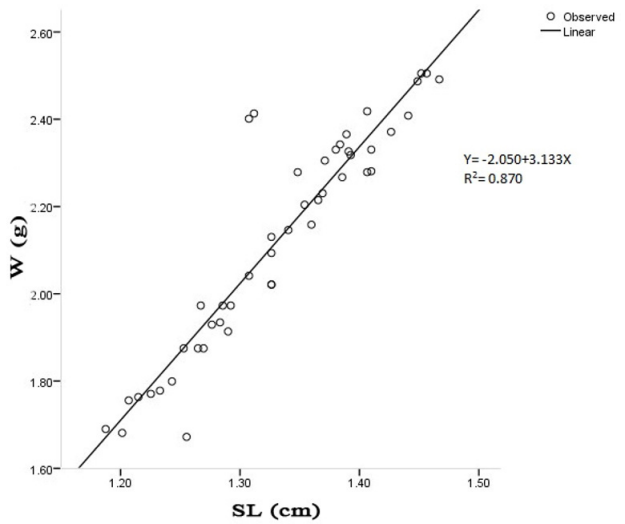

Fig 2. Length-weight relationship of *Parachanna obscura* (males) collected from the Anambra River

also reported a negative pattern of allometric growth in the research conducted on four fish species including *Tilapia zilli*, *Oreochromis niloticus* and others from Wassai Reservoir in Kano. However, Garba and Arome (2006) reported isometric growth pattern for *Malapterurus electricus* from the lower Benue River and as well as similar findings on *Ethmalosa frimbiata* and *Ilisha africana* from the Nkoro River (Abowei et al., 2009). The present results may be attributed to age, sex, sampling methods, sample size, as well as the prevailing ecological conditions in the water (Obasohan et al., 2012).

The study showed the condition factor of *P. obscura* from the Anambra River ranged between 0.89 and 0.80 for males and females, respectively. Condition factor is an index used for monitoring feeding intensity, age and growth rate in fish. It is strongly influenced by both abiotic and biotic environment conditions and can be used to assess the status of the aquatic ecosystem in which fish live (Anene, 2005). It was reported by Odo (2007) that

some of the water quality parameters were unsuitable for aquatic biota and fish production in the Anambra River. Oil exploration and exploitation in the Niger Delta of Nigeria have been seen as the major sources of threats to environmental management and sustainability of this river (Obiakor et al., 2014). The results of condition factor were less than 1 and are in tandem with the findings of Obasohan et al. (2012) who recorded values less than 0.5 and 0.9 for *Papyrocranus afer* and *P. obscura*, respectively. These results may be attributed to different factors such as sex, age, state of maturity, size, state of stomach fullness and environmental factors affecting fish in water bodies (Ama-Abasi, 2007; Yem et al., 2007; Adeyemi et al., 2009). The sampled fish exhibited wide variations in the number of eggs, with larger samples producing more eggs than the smaller ones. However, the highest number of eggs was not found in the largest fish and the lowest number of eggs was not found in the smallest fish. Different fish species present a lot of differences in their reproductive potential (Murua et al., 2003). Fecundity of fishes varies, depending on the reproductive characteristics of a species, changes in environmental conditions such as temperature, food availability, habitat and predation intensity (Murua et al., 2003). Similarly, Mekkawy and Hassan (2011) associated changes in fecundity with age, sex, size weight, gonad weight and locality. Olurin and Savage (2011) reported a range of 1711 to 4000 for *P. obscura* weighing between 161.94 and 380.78 g from the Oshun River, Southwest Nigeria. There was a high correlation coefficient between the Fecundity (F) and Gonad Weight (GW), which is r = 0.992. This result corroborated with the findings of Rheman et al. (2002) reported for *Liza parsia*. Similar findings were also reported by Shinkafi and Ipinjolu (2012). There was a moderate correlation between fecundity and body weight. This result is in line with the findings of Shaheena (2012) from Dal Lake Kashmir for *Carassius carasssius*. Fecundity also correlated to length and weight in *P. obscura* (Victor and Akpocha, 1992).

According to Hulata et al. (1974), large egg size enhances fry and larval viability due to its higher yolk content, and hence food supply to the larva. In this present study, the egg size ranged between 0.90 and 1.30 mm, which were fairly large. Olurin and Savage (2011) reported egg size which ranged between 0.88 and 1.11 mm for snake head fish from the River Oshun. There was strong correlation coefficient between fecundity and egg size, which is r = 0.822. The result indicated that the number of eggs will increase by 82% as the weight of gonad increases. The result also revealed that gonad weight will increase as the body weight increases.

In this study, the GSI in the females ranged between 0.50 and 5.84. Olurin and Savage (2011) observed a range between 1.10 and 2.80 for *P. africana* from the River Oshun. The hepatosomatic index of this present study ranged from 0.31 to 1.56, and between 0.22 to 1.06 for male and female *P. obscura*, respectively. This result showed that hepatosomatic indices of male were higher than those of female *P. obsura*. Kareem et al. (2016) reported that a fish living in favourable environment in terms of food availability and good environmental conditions grow faster with K ≥ 1. However, most of the documented condition factor results of *P. obscura* from Nigeria's freshwater environment have reported values less than 1. Obasohan et al. (2012) recorded values less than 0.5 and 0.9 for *Papyrocranus afer* and *P. obscura*, respectively, from the Ibiekuma stream, Ekpoma, Edo state, Nigeria. Bassey and Ajah (2010) also documented condition factors ranging between 0.63 and 0.79 for pond cultured *P. obscura* given different feed types in Calabar, Nigeria, while Oyelese (2006) recorded a value of 0.80 for *P. obscura* from Ibadan, Southwest Nigeria. Results from the present work are, therefore, within the ranges that have been documented for captured and cultured *P. obscura* in Nigeria. These patterns of obtained results might be owed to the fact that the species is highly streamlined and not a robust fish or round. Freose (2006) and Treer et al. (2009) concluded that different body forms of fish such as elongated, fusiform and short or deep body types have significant effect on condition factors.

SAŽETAK

DUŽINSKO-MASENI ODNOS, FAKTOR KONDICIJE I PLODNOST AFRIČKE ZMIJOGLAVE RIBE *Parachanna obscura* IZ RIJEKE ANAMBRA, JUGOISTOČNA NIGERIJA

Utvrđen je dužinsko-maseni odnos, faktor kondicije, plodnost te gonadosomatski i hepatosomatski indeksi za *Parachanna obscura* iz rijeke Anambre. Od ribara je dobiveno 83 živih jedinki *P. obscura*. Za analizu dobivenih podataka korištena je deskriptivna statistika, korelacijska i regresijska analiza. Odnos dužine i mase imao je R vrijednosti 0,933, 0,843 i 0,896 za muške, ženske i kombinirane spolove. Vrijednost b je varirala od 3,133 za mužjake i 2,667 za ženke i nije se značajno razlikovala. Faktor kondicije je iznosio 0,89 ± 0,33 i 0,80 ± 0,21 za ženke odnosno mužjake. Najveći broj jaja (10.965) nađen je u ženki tjelesne mase 154 g, mase gonada 9,1 g i veličine jaja 1,3 mm. Najmanje plodna ženka je bila s 1820 jaja, mase (94 g), masom gonada 2,1 g s veličinom jaja 1,0 mm. Hepatosomatski indeksi bili su u rasponu od 0,55 ± 0,20 do 0,64 ± 0,29 u mužjaka odnosno ženki, dok je prosjek gonadosomatskog indeksa ženki iznosio 2,05 ± 1,44. Utvrđena je pozitivna korelacija između plodnosti i mase gonada.

Ključne riječi: Alometrijski rast, masa gonada, hepatosomatski indeks, gonadosomatski indeks.

REFERENCES

Abowei, F. N., Hart, A. I. (2009): Some morphometric parameters of 10 finfish species from the lower Nun River, Niger Delta, Nigeria. Research Journal of Biological Sciences.4, 3, 282-288.

Adeyemi, S.O., Bankole N.O., Adikwu I. A., Akombo P. M. (2009): Age, growth mortality of some commercially important fish species in Gbadikere Lake, Kogi State, Nigeria. International Journal of Lakes and Rivers Resources, 2, 1, 63 – 69.

Afonso-Dias, I., Reis C., Andrade P. (2005): Reproductive Aspects of *Microchiru sazevia* (Risso, 1810) (Pisces: Soleidae) from the south coast of Portugal. African Journal of Applied Zoology, 9, 13-19.

Ama-Abasi, D., Affia I. N. (2010): Aspects of the biology of Snakeshead, *Parachanna obscura* (Gunther 1861) in the Cross River Nigeria. Global Journal of Agricultural Sciences, 9, 2, 7-13.

Anene, A. (2005): Condition Factors of Cichlid Species of Man-made Lake in Imo State, Southeast, Nigeria. Journal of Fish and Aquatic Science, 5, 43-47.

Anyanwu, D. C. Mkpado M., Ohaka C.C (2009): Economic Analysis of Artisanal Fishing at River Niger Onitsha, Anambra State, Nigeria. Agro-Science Journal of Tropical Agriculture, Food, Environment and Extension, 8, 3,: 175 – 179.

Bagenal, T.B., Tesch, F.W. (1978): Age and growth. In T.B. Bagenal (eds). Methods for the assessment of fish production in freshwater. IBP Handbook No. 3. Blackwell Scientific Publications, Oxford., 101-136pp.

Bassey, A. U., Ajah, P. O. (2010): Effect of three feeding regimes on growth, condition factor and food conversion tate of pond cultured *Parachanna obscura* (Gunther, 1861) (Channidae) in Calabar, Nigeria. Turkish Journal of Fisheries and Aquatic Sciences 10, 195-202.

Bolaji, B. B., Mfon, T. U., Utibe, D. I. (2011): Preliminary study on the aspects of the biology of Snakehead fish, *Prachanna obscura* in a Nigerian wetland. African Journal of Food and Agriculture, 1, 1-4.

Eyo, J. E., Mgbenka, B. O. (1992): Aspects of the biology of *Clarias gariepinus* in Anambra River Basin. 1. Oocyte diameter, fecundity and sex ratio. Journal of Agricultural Science Technology 2, 1, 47 – 51.

Froese, R. (2006): Cube law, condition factor and weight–length relationships: history, meta-analysis and recommendations. Journal of Applied Ichthyology, 22, 241–253

Garba, O. F., Arome, A. G. (2006): Growth, reproduction and feeding biology of *Malapterurus electricus* (Gmelin, 1789) in Lower Benue River, Nigeria. In: Proceedings of the 21st Annual Conference of the Fisheries Society of Nigeria, Calabar, 117 – 128.

Hulata, G., Moav, R., Wohlfarth, G. (1974): The relationship of gonad and egg size to weight and age in the European and Chinese races of common carp, *Cyprinus carpio* L. Journal of Fish Biology, 6, 745-758.

Imam, T. S., Bala, U., Balarabe, M. L., Oyeyi, T.I. (2010). Length-weight relationship and condition factor of four fish species from Wasai Reservoir in Kano, Nigeria. African Journal of General Agriculture, 6, 3, 101-136.

IUCN, (2016): IUCN red list of threatened species. Version 2016.1 IUCN 2016. IUCN red list of threatened species. Downloaded 15 July, 2016

Jamu, D. M., Ayinla, A. O. (2003): Potential for the development of agriculture in Africa. NAGA, 26, 3, 9-13.

Kareem, O. K., Olanrewaju, A. N., Osho, E. F., Orisasona, O., Akintunde, M. A. (2016): Growth patterns and condition factor of Hepsetus odoe (Bloch, 1794) captured in Eleyele Lake, Southwest Nigeria. Fisheries and Aquaculture Journal 7: 178 – 185.

Kpogue, D. N. S., Mensah, G. A., Fiogbe, E. D. (2013): A review of biology, ecology and prospects for aquaculture of *Parachanna obscura*. Reviews in Fish Biology and Fisheries, 23, 1, 41–50.

Mekkawy, I. A. A., Hassan, A. A. (2011): Some reproductive parameters of *Synodontis Schall* (Bloch and Schneider, 1801) from the River Nile, Egypt. Journal Fisheries and Aquatic Science, 6, 456-471.

Murua, H., Kraus, G., Saborido-Rey F., Witthames P. R., Thorsen A., Junquera S. (2003): Procedures to estimate fecundity of marine fish species in relation to their reproductive strategy. Journal of Northwest Atlantic Fish. Sci., 33, 33-54.

Obasohan, E. E., Obasohan, E. E., Imasuen, J. A., Isidahome, C. E. (2012): Preliminary studies of the length-weight relationships and condition factor of five fish species from Ibiekuma Stream, Ekpoma, Edo State, Nigeria. Journal of Agricultural Research and Development, 2, 3, 61-69.

Obiakor, M. O., Okonkwo, J. C., Ezeonyejiaku, C. D., Okonkwo, C. N. (2014): Polycyclic Aromatic Hydrocarbons (PAHs) in freshwater media: Factorial effects and human dietary exposure risk. Assessment Resources and Environment, 4, 6, 247-259.

Odo, G. E., Nwani, C. D., Ngwu, G. I., Eyo, J. E. (2007): Harnessing aquatic physicochemical parameters influencing macroinvertebrate fauna in Anambra River Basin for sustainable fish productivity. Animal Research International, 4, 2, 705– 712.

Olurin, K. B., Savage, O. D. (2011): Reproductive biology, length–weight relationship and condition factor of *Parachanna obscura*, from River Oshun, South-west Nigeria. International Journal of Fisheries and Aquaculture, 3, 8, 146 - 150.

Osho, E. F., Ajani, E. K., Omitoyin. B. O., Aniebo, V. (2014): Physical masculinization and growth performance of *Oreochromis niloticus* placed on 17α-methyltestosterone treated diet. Journal of Environmental Extension, 12, 41-45.

Oyelese, O. A. (2006): Implications of carcass quality and condition factor to the processing of some selected freshwater fish families. Journal of Fisheries International, 1, 132-138.

Pepple, P. C., Ofor, C. O. (2011): Length–Weight relationship of *Heleterobranchus longifilis* reared in earthen ponds, Nigerian Journal of Fisheries, 8, 2, 315-321.

Rheman, S., Islam, M. L., Shah, M. M. R., Mondal, S., Alam, M. J. (2002): Observation on the fecundity and gonadosomatic index (GSI) of Grey Mullet, *Liza parsia* (Ham.). Journal of Biological Sciences, 2, 10, 690-693.

Ricker, W. E. (Ed.) (1971): Methods for assessment of fish reproduction in freshwaters. IBP Handbook No. 3, Blackwell Scientific Publications, Oxford. 98-130pp.

Shaheena, S. (2012): Study on fecundity and GSI of *Carassius carassius* (Linneaus, 1758 introduced) from Dal Lake Kashmir. Journal of Biology, Agriculture and Healthcare. 2, 68-75.

Shinkafi, B. A., Ipinjolu, J. K. (2012): Gonadosomatic index, fecundity and egg size of *Auchenoglanis occidentalis* (Cuvier and Valenciennes) in River Rima, North-western Nigeria. Nigerian Journal of Basic and Applied Science, 20, 3, 217-224.

Tesch, F. W. (1978): Age and growth. In: Ricker, W. E. (Ed.) (1971) Methods for assessment of fish reproduction in freshwaters. IBP Handbook No. 3, Blackwell Scientific Publications, Oxford. 98-130.

Treer, T., Piria, M., Šprem, N. 2009: The relationship between condition and form factors of freshwater fishes of Croatia. Journal of Applied Ichthyology, 25, 608–610

Victor, R., Akpocha, B. O. (1992): The biology of snakehead, *Parachanna obscure* (Gunther), in a Nigerian pond under monoculture: Aquaculture, 101, 17-24

Whenu, O. O., Fagade, S. O. (2012): Dietary pattern of the population of *Parachanna obscura*, in River Owo, Southwest, Nigeria. Journal of Fisheries and Aquatic Science 7, 49-56.

Yeldan, H., Avsar, D. (2000): A preliminary study on the reproduction of the Rabbit fish *Siganus rivulatus* (Forsskal. 1775) in the North-eastern Mediterranean. Journal of Zoololgy. 24, 173-182.

Yem, I. Y., Sani, O. A., Mshelia, M. B, Onimisi, H. U. (2007): The length-weight relationship and condition factor of the Banded Jewel fish (*Hemichromis fasciatus*) from Kainji Lake, Nigeria. In: Proceedings of the 22nd Annual Conference of the Fisheries Society of Nigeria, 4, 15–23.