LENGTH-WEIGHT RELATIONSHIP AND CONDITION FACTOR OF SOME COMMERCIAL FISH SPECIES IN OGUN STATE COASTAL ESTUARY, NIGERIA

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ABSTRACT

This study examined the length - weight relationships (LWRs) and condition factors of ten (10) commercially exploited fish species: Elops lacerta, Schilbe mystus, Sardienlla maderensis, Synodontis schall, Tilapia zillii, Mugil cephalus, Hepsetus odoe, Chrysichthys auratus, Chrysichthys nigrodigitatus and Sarotherodon galilaeus in Ogun State coastal estuary, Nigeria. A total of 5,609 fish specimens were collected from the commercial landings during the study. Parameters of LWR, a and b were estimated. Growth pattern, b, ranged between 2.462 ± 0.16 and 3.104±0.05 (r^2 = 0.8088 to 0.9976). T. zillii, E.lacerta, S.mystus, M. cephalus, S.schall,C. nigrodigitatus and S. galilaeus exhibited allometric growth pattern as b values were significantly (at 95% Cl) different from 3, while C. auratus, S. maderensis and H. odoe exhibited isometric growth pattern (b value not significantly at 95% Cl). On the average, the growth pattern of fish species sampled was significantly ($p<0.05$) different from 3. The condition factor, k, ranged from 0.63±0.01 (M.cephalus) to 3.86±0.09 (S. mystus) in the estuary. This indicated that the fish species were in good condition during the study as k values were >0.5. This study, therefore, called for close monitoring of LWR and condition factor of all these commercial fish species for effective stock management in the fishery.

Keywords: Length-weight relationship, condition factor, estuary, Nigeria, fish growth pattern

INTRODUCTION

Estuaries are the meeting place of freshwater from rivers and saltwater from the sea and, as such, are dynamic environments characterized by large fluctuations in environmental conditions (James *et al.*, 2007). This chemical property of water, coupled with other factors (e.g food availabiliy) may affect the fish growth rate and abundance.

The study of the biology of some fish species with preference to length-weight relationship (LWR) and condition factor (k) is an important aspect in fish biology. Bake and Sadiku (2004) described growth as the change in absolute weight (energy content) or length of fish over time, while Adedeji and Araoye (2005) summarized growth as a function of fish size. Busacker *et al*.(1990) also defined growth as any change in size or amount of body material, regardless of whether that change is positive or negative, temporary or long-lasting. The study of growth patterns in fish has been based principally on LWRs or relationships between sizes of scales or other calcified tissues and body length because of their

importance in age and growth analyses (Adeyemi *et al.*, 2009). Abowei and Hart (2009) reported that the LWR of fish also known as growth index is an important management tool used in estimating the average weight at a given length growth.

Length and weight data are useful as standard results of fish sampling programmes. These data are needed to estimate growth rates, length and age structures. LWRs allow fisheries scientists to convert growth in length equations to growth-in-weight in stock assessment models. Such applications are evident in the work of Egbal *et al*.(2011) among others.

The condition factor shows the degree of well-being of the fish in their habitat. It is expressed as 'coefficient of condition' also known as length – weight factor. The condition factor of fish can be affected by a number of factors such as stress, sex, season, availability of feeds, and other water quality parameters (Khallaf *et al*., 2003).The study of condition factor is important to understand the life cycle of fish histories and maintenance of the ecosystem equilibrium (Haruna and Bichi, 2005).

Various studies have been carried-out on the LWR and condition factors of fishes in Nigeria. Bolarinwa and Popoola (2013) worked on LWRs of some economic fishes of Ibeshe Waterside, Lagos Lagoon, Nigeria. Obasohan *et al.* (2012) also studied of the LWRs and condition factor of five fish species from Ibiekuma stream, Ekpoma, Edo State, Nigeria. Scanty or no information exists on the LWRs of different fish species in the Ogun State coastal estuary, hence this study. The study was carried out to assess the LWRs and condition factors of some fishes in the estuary condition in order to know their growth pattern and well-being. The results will be useful in decision making in the management and conservation of the fishes in the estuary.

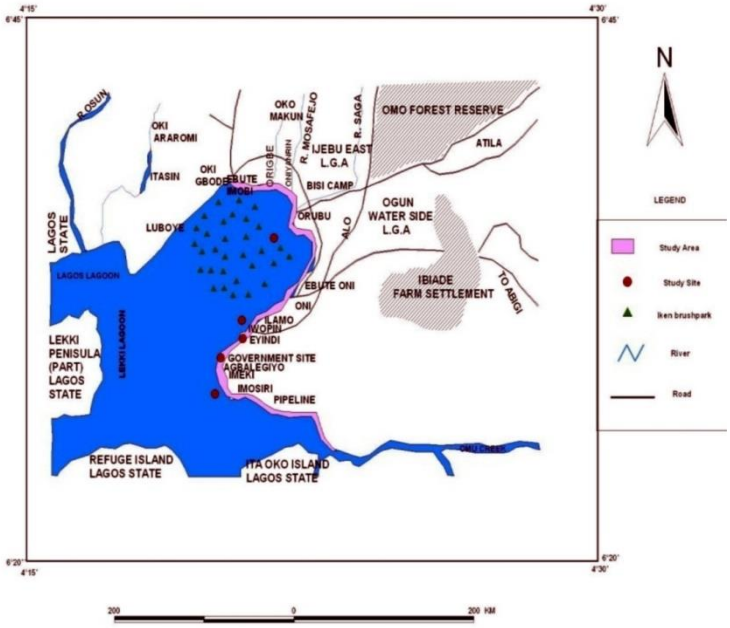

Figure 1: Map of Ogun State coastal estuary

Materials and methods

The study area

The study was carried-out in Ogun State coastal estuary, Ogun Waterside Local Government Area of Ogun State, Nigeria (Figure. 1).It is situated between $4^0 15^{'}$ E– $4^0 30^{'}$ E and $6^0 20^{'}$N$6^0 45^{'}$ N and bounded in the east by Lekki lagoon and south by Bight of Benin. The lack of direct access to the Atlantic Ocean coupled with the great influx of Rivers Osun, Mosafejo and Oni into the water makes it essentially freshwater (Abdul *et al.,* 2010). Fishing activities are carried-out with motorised and non- motorised canoes. The fishing gears include gillnet, seine net, cast net, non-return valve traps and brush park fish aggregator, bamboo trap, etc. According to Abdul (2009), several species of fish are present in the water and these include *Chrysichthys nigrodigitatus, Chrysichthys auratus, Tilapia zillii, Tilapia mariae, Sarotherodon galilaeus, Hepsetus odoe, Caranx hippo, Parachanna obscura, Polypterus senegalus, Gymnarchus niloticus, Mormyrus spp, Papyrocranus afer, Alestes spp, Sphyraena barracuda,* Clupeids, among others.

Samples collection

A total of 5,609 fish specimens were sampled from commercial catches of fishermen with fishing gears which included; gill net, seine net, castnet, Iken fish aggregating device and bamboo trap at all landing stations in the fishery. On each occasion, sampling was done between 06.45 and 14.00hour (GMT +1). Fish weights were measured to nearest 1g and total length (TL) to nearest 1cm. Fish identification was carried out following the field guide of Nigerian freshwater fishes by Olaosebikan and Raji (2013).

The Length – weight relationship

The Length – weight relationship (LWR) was estimated by using the equation (Froese, 2006):

$W = aL^b$

Where: W = weight of fish in (g), L = total length (TL) of fish in (cm), *a* = constant

b = the length exponent

The equation was linearised by a logarithmic transformation (Oliva-Paterna *et al*., 2009) to give:

$\text{Log } W = \text{Log } a + b \text{ Log } L$

The *a* and *b* values were obtained from a linear regression of the LWRs of fish. The squared correlation (r^2), which is the extent of reliability, was computed. Meanwhile, the value of *b* gives information on the kind of growth pattern of fish: the growth is isometric if $b=3$ and allometric if $b \neq 3$. The *b* value was estimated for each species of fish and tested for significant difference from 3 at 95% confidence limit.

To demonstrate significant difference of obtained mean *b*-value for all fish sampled from the isometric value 3, a t-test at p= 0.05 was used, expressed by the following equation (Sokal and Rohlf, 1987):

$$t_s = b - 3/s_b$$

Where, t_s is the t-test value, *b* the mean of all LWR exponents and s_b the standard error of *c*omparison between obtained t-test value and the respective tabular critical value allowed the determination of the statistical difference of *b* from 3. The fit of the model to the data was measured by the coefficient of Pearson r-squared (r^2).

Condition factor, "k"

The condition factor (k), which refers to the well-being of fish was estimated using the formula = $100W/L^b$ (Le Cren, 1957)

Where k = condition factor, W = body weight in (g) and L = total length (cm), *b* value used was obtained from the estimated LWR equation as suggested by Lima-Junior *et al*. (2002).

Table 1: LWR Parameters and Condition Factors

	Fish Species	Number	Length(cm)	Weight (g)	Condition Factor (k)	b	a	r^2	Growth pattern
1.	*Hepsetus odoe*	255	22.00±0.66 (18.0-27.0)	188.00±10.34 (60.0-209.0)	1.081±0.006	2.988±0.04	0.011	0.9962	I
2.	*Tilapia zillii*	720	14.89±0.25 (9.7-19.5)	79.01±3.49 (22.1-130.0)	1.941±0.005	3.058±0.02	0.019	0.9976	+A
3.	*Chrysichthys auratus*	315	17.03±0.29 (13.0-23.5)	50.71±2.29 (19.1-133.0)	0.913±0.020	3.021±0.09	0.009	0.8088	I
4.	*Elops lacerta*	85	18.82±0.45 (11.7-27.4)	40.39±3.12 (12.0-121.1)	1.35±0.060	2.698±0.14	0.013	0.8466	-A
5.	*Synodontis schall*	105	15.70±0.36 (11.0-23.0)	51.48±3.65 (18.0-135.0)	2.11±0.020	2.808±0.05	0.021	0.9829	-A
6.	*Schilbe mystus*	421	16.99±0.37 (11.7-22.4)	43.02±3.12 (17.0-87.0)	3.86±0.09	2.462±0.16	0.038	0.8397	-A
7.	*Mugil cephalus*	205	23.05±0.65 (15.0-40.0)	128.61±12.48 (28.0-561.0)	0.63±0.01	3.104±0.05	0.007	0.9799	+A
8.	*Sardinella maderensis*	307	14.51±0.25 (10.8-18.2)	25.94±1.26 (10.0-48.1)	1.03±0.003	2.90±0.24	0.011	0.9953	I
9.	*Chrysichthys nigrodigitatus*	1450	22.78±7.97 (11.0– 41.9)	119.0±34.77 (30.0-595.0)	0.970±0.06	2.747±0.09	0.019	0.9701	-A
10.	*Sarotherodon galilaeus*	1216	32.82±5.83 (18.0-40.9)	792.76±106.72 (134.0-1216.0)	0.978±0.05	2.898±0.144	0.031	0.9781	I

I: Isometric; $^-$A: Negative Allometric; $^+$A: Positive Allometric; b= exponent; a= intercept

Results

The LWR parameters and condition factors, k, of ten (10) fish species in Ogun State coastal estuary are presented in Table 1. For *Hepsetus odoe*, the length varied between 18.0-27.0 cm (22±0.66 cm) and the weight ranged between 60.0-209.0g (118.00±10.34g). The mean condition factor, k, was 1.081±0.006 and *b* value was 2.988±0.04. The length and weight of *Tilapia zillii* ranged between 9.7-19.5cm (14.89±0.25cm) and 22.1-130.0g (79.01±3.49) respectively. Its condition factor was 1.941±0.005 while *b* value was 3.058±0.02. For *Chrysichthys auratus*, respective ranges of length and weight were 13.0-23.5cm (17.03±0.29cm) and 19.1-133.0g (50.71±2.29g), while the condition factor, k, was 1.941±0.005 and *b* value was 3.021±0.12. *Elops lacerta* size varied from 11.7-27.4cm (18.82±0.45cm) and weighed between 12.0-121.1g (40.39±3.12g). The respective condition factor and exponent *b* were 1.35±0.006 and 2.698±0.14.The length and weight of *Synodontis schall* observed from the estuary ranged from 11.0-23.0cm (15.70±0.36cm) and 18.0-135.0g (51.48±3.65g) respectively. Its condition factor was 2.11±0.02 and *b* value was 2.808±0.05. *Schilbe mystus* length ranged from 11.7-22.4cm (16.99±0.31cm) and the weight was between 17.0-87.0g (43.02±2.52g). The condition factor (k) and *b* value were 3.86±0.09 and 2.462±0.16

respectively. *Mugil cephalus* had length and weight ranging from15.0-40.0cm and 28.0-561.0g with corresponding means of 23.05±0.65cm and 128.61±12.48g respectively. The mean condition factor was 0.63±0.01, and LWR exponent, *b,* was 3.104±0.07. The total length of *S. maderensis* ranged from 10.8-18.2cm with a mean size of 14.51±0.36cm and its weight ranged from 10.0-48.1g (mean=25.94±1.26g). The condition factor, k, and LWR exponent, *b*, were 1.03±0.003 and 2.90±0.24 respectively. *C. nigrodigitatus* and *S. galilaeus* respective ranges of length and weight were 11.0 – 41.9cm (22.78±7.97cm) and 18.0 -40.9cm (32.82±5.83cm), and 30.0-595.0g (119.0±34.77g) and 134.0-1216.0g (792.76±106.72g). Their condition factors, k, and exponent *b* of LWR were 0.9701 and 2.747±0.086, 0.9781 and 2.898±0.144 respectively. The values of exponent *b* for *T. zillii, E. lacerta, S. mystus, M. cephalus, S. schall, C. nigrodigitatus* and *S. galilaeus* were significantly different from 3 at 95% confidence limits, while those estimated for *C. auratus, S. maderensis* and *H. odoe* were not significantly different from 3 at 95% confidence limits. On the average, *b* value was significantly ($p<0.05$) different from 3.

Discussion

The LWR is widely recognized as an important tool in fisheries sciences, especially in fish biology, physiology, ecology, population dynamics, and stock assessment (Lagler *et al*., 1962; Osooz *et al*., 2005; Froese, 2006; Abdoli *et al*., 2008; Ferreira *et al*., 2008; Vaslet *et al*., 2008; Epler *et al*., 2009; Nowak *et al*., 2009). According to Froese (2006) and Vaslet *et al*. (2008), it is useful when rapid estimations of biomass are necessary. Also, if the aim is to transform the growth- in – length equations to growth- in- weight, the LWRs have successfully been used to estimate stock biomass from limited sample size, as indicators of fish condition and used for stock assessment models, also to compare the life histories of some species among regions and other aspects of fish population dynamics (Kolher *et al*.,1995; Petrakis and Stergiou, 1995; Goucalves *et al*., 1997; Moutopoulos and Stergiou, 2002; Adreu-Soler *et al*., 2006). Following the classification of Allen (1951), the values of *b* estimated from this study for *H. odoe, S. maderensis, C.auratus,* and *T. mariae* depict significant ($p< 0.05$) isometric growth pattern in the estuary. While those for *E. lacerta, S. mystus, S. schall* and *C.nigrodigitatus* had significant ($p<0.05$) negative growth pattern, and only *T. zillii* and *M. cephalus* exhibited significant ($p<0.05$) positive allometric growth pattern. The results of Adedokun *et al.* (2013) and Abowei *et al.* (2009) on *H. odoe* were contrary to the results of our study perhaps because of growth pattern of fish is ecosystem invariant. But that of Shenouda *et al*. (1994) on *C. auratus* from River Nile is in line with that reported in this study in Ogun State coastal estuary. Abdul (2009) had also earlier reported positive allometric growth pattern on the fish in the same habitat. Meanwhile, there is dearth of information on LWR of *E. lacerta* implying that the results might likely be the first in the region. Moreso, the fish is an offshore

spawner (McBride *et al*., 2012), with only the juveniles inhabiting the estuary. Negative allometric growth patterns have been reported for *S. mystus* (Adeyemi *et al*., 2009), *S. schall* (Midhat *et al*., 2012), and *C. nigrodigitatus* (Abdul *et al*., 2009) similar to those reported in this work. *T. zillii* had earlier been reported to have exhibited negative allometric growth pattern in Ogun State coastal estuary by Abdul (2009).

According to Froese (2006), when value of *b* =3, it indicates that small specimens have the same form and probably same condition as large specimens. The exponent *b* in this study varied between 2.462±0.16 (r^2= 0.8088) for *C. auratus* and 3.104±0.05 (r^2= 0.9976) for *T. zillii.* Froese and Pauly (2007) suggested that the exponent *b* should fall within 2.5 and 3.5, while Pauly and Gayanilo (1997) reported that the range should be between 2.5 and 4.0.

Variation in the *b* values of LWRs may be attributed to ecological conditions of the habitats or variation in the physiology of fish or both (Hossain *et al*., 2009), sex and season (Hossain *et al*., 2006), feeding rate, gonad development and growth phase (Hossain *et al.*, 2011). But according to Oliva-Paterna (2008), Wooten (1998), Sarkar *et al* (2013), LWR can be influenced by habitat, season, stomach fullness, gonad maturity, sex, health, preservation techniques and differences in the observed length ranges of the specimen caught. Meanwhile, LWR has been attributed to certain environmental factors such as overfishing, food competition trophic potential of the habitat. According to Tesch (1971), value of *a* varies mostly with environmental factors while *b* tends to remain unchanged during a given life phase but varies between populations of the same species. Allometric growth means that addition of length is more or less than addition in weight and the studied fish species grow lighter or heavier as it becomes longer. According to Gomez and Gomez (1984), high r^2 values inform that the LWRs models are reliable.

During periods when fish have high energy intake, the growth of tissues and the storage of energy in muscle and liver can cause an individual to have a greater- than-usual weight at a particular length. This excess is usually revealed by the condition factor, k (Busacker *et. al*., 1990). Condition factor measures the condition of fish, its nutritional state or physiological well-being. It is also a measure of the 'fitness' of the fish population as it is used to as rough estimate of the state of fish, whether healthy or unhealthy, starved or well-fed, spawning or spent (Busacker *et. al*., 1990). Bagenal and Tesch (1978) and Busacker *et al.* (1990) reported that any condition factor, $k \geq 0.5$ implies that the fish is in good condition (or high nutritional state). Therefore, 0.63±0.01 – 3.86±0.09 condition factors recorded showed that the fish were in good condition and high nutritional state in the habitat during this study. Le Cren (1951) reported that environmental factors, food supply, and parasitism have influence on the health of the fish. Low *k* value in certain times of the year might be due to low feeding intensity and degeneration of ovaries, while high *k* values could be attributed to high deposition of fats as preparation for spawning season. Condition factor is not constant for a species or population overtime interval and might be

influenced by both biotic and abiotic factors such as feeding regime and state of gonadal development (Oni *et al*., 1983; Saliu, 2001). Transfer of energy to the gonads in certain stage of life history of a fish might also bring about low condition factor, *k* (Lizama *et al*., 2002). Therefore, logically, condition factor, *k*, of fish is influenced by environmental factors such as season of year, availability of prey organisms, growth, maturity and stomach fullness.

Conclusion

This study on LWR and condition factor has provided information on the well-being of some commercially exploited fish species in Ogun State coastal estuary, Nigeria. Some of the fish species exhibited positive and negative allometric growth pattern, while some exhibited isometric growth pattern. All the sampled fish species were in good condition – responding well to the various ecological factors - as their condition factors were greater than 0.5. It is, therefore, recommended for effective sustainable fish stock management that the present ecological factors in the ecosystem be sustained maintained and more so monitored to support fish growth in the fishery.

References

Abdul, W. O. (2009). Stock Assessment of Tilapias in the Freshwater Ecotype of Ogun Estuary, Ogun State, Nigeria. PhD Thesis. University of Agriculture, Abeokuta, pp 50

Abdul, W. O., Omoniyi, I. T., Akegbejo-samsons, Y., Agbon, A. O., Idowu, A. A. (2010). Length-weight relationship and condition factor of cichlid tilapia, *Sarotherodon galilaeus* in the freshwater ecotype of Ogun estuary, Ogun State, Nigeria. International Journal of Biol. & Chemical Sciences,*4*(4): 1153-1162.

Abdoli, A., Rasooli, P., Mostafavi, H. (2008). Length-weight relationship of *Capoeta capoeta capoeta* (Guldenstaedt,1772) in the Gorganrud River, south Caspian Basin.J. Appl. Ichthyol., 24: 96-98.

Abowei, J.F.N. (2009). The Condition Factor, Length-Weight Relationship and Abundance of *Elops seneganensis* (Regan, 1909) from Nkoro River, Niger Delta, Nigeria. Advance Journal of Food Science and Technology,2(1): 16-21, 2010

Adedeji, R. A. and Araoye, P. A. (2005). Study and characterization in thegrowth of body parts of *Synodontis schall* (Pisces; Mochokidae) from Asa Dam, Ilorin, Nigeria. Nig. J. Fisheries ,(2 and 3): 219 – 244.

Adeyemi S O, Bankole N O, Adikwu I A, Akombo P .M. (2009). Age,Growth and Mortality of some commercially important Fish species in Gbadikere Lake, Kogi State, Nigeria. Int. J. of Lakes and Rivers Res.India Publications, 2 (1): 63 – 69

Allen, K. R. (1951). The Horokiwi Stream: A case study of a front population. New Zealand Marine Department Fisheries Bulletin, 10:238p

Andreu-Soler A., Oliva-Paterna F. J., Torralva M. (2006). A review of length–weightrelationships of fish from the

Segura River basin (SE Iberian Peninsula). J Appl Ichthyol , 22:295–296.

Bagenal, T.B. and Tesch,F.W. (1978). Age Growth in Method of Assessment of Fish Production in FreshWaters (Ed. T. Bagenal). Oxford Blackwell Scientific Publication, pp: 101-136.

Bake, G. G. and Sadiku, S .O E. (2004). Relationship between the Basic Morphometric measurements and Growth Pattern of *Heterotis niloticus* from River Kaduna flood plain. In: Proceedings of the Fisheries Society of Nigeria, Ilorin. 29th Nov. to 3rd Dec., 2004, pp: 515 – 519

Bolarinwa, J.B. and Popoola Q. (2013). Length-Weight Relationships of Some Economic Fishes of IbesheWaterside, Lagos Lagoon, Nigeria. J. Aquac. Res. Development, 5:1

Busacker, G.P., Adelman, I.R. and Goolish, E.M. (1990). Growth.Methods for fish biology (Eds. Schreck, C.B. and Moyle, P.B.). Ameriacan Fisheries Society, Bethesda, Maryland, USA- PCWA- L 446, pp: 363

Egbal, O.A., Mohammed E.A. and Afra A.A. (2011). Length-weight relationships andcondition factors of six species in Atbara River and khashin El-girba reservoir ,Sudan. International Journal of Agricultural Sciences, 3: 66-70

Epler, P., Nowak, M., Popek, W. (2009). Growth rate of the chub(*Squalius cephalus*) and the nase (*Chondrostoma nasus*) from Raba, Dunajec, and Poprad River. *AACL* Bioflux, 2:1-8.

Ferreira, S., Sousa, R., Delgado, J., Carvalho, D., Chada, T. (2008). Weight-length relationships for demersal fish speciescaught off the Madeira archipelago (eastern-central Atlantic). J. Appl. Ichthyol., 24: 93-95.

Froese, R. (2006). Cube law, condition factor and weight–lengthrelatioships: history, meta-analysis and recommendations. J. Appl. Ichthyol., 25: 241–253.

Froese, R. and Pauly, D. (Eds) (2007). Fishbase (Version 12 / 2007). WorldWide Web electronic publication. Available at: http://www.fishbase.org, version (accessed on 15 December 2007).

Gayanilo,F.C., Jr. and Pauly, D. (1987). Announcing the release of version 1.10 of the Compleat ELEFAN. ICLARM software 2: 65p.

Gomez, K.A. and Gomez, A.A. (1984). Statistical procedures for agricultural research. 2nd ed. John Wiley and Sons, Inc Canada.

Gonçalves, J. M. S., Bentes, L., Lino, P. G., Ribeiri, J., Canario, A. V. M., Erzini, K. (1997). Weight–length relationships for selected fish species ofsmall–scale demersal fisheries of the south and south–west coast of Portugal. Fish. Res., 30: 253–256.

Haruna, M. and Bichi, A.H. (2005). Studies on length-weight relationship and

condition factor of the cichlids of Tomas Lake, Kano, Nigeria. Biol. Environ. Sci. J. Trop., 2: 94-100.

Hossain, M.Y., Ahmed, Z. F., Leunda, P.M., Jasmine, S., Oscoz, J., Miranda, R., Ohtomi, (2006). Condition, length-weight and length-length relationships of the Asian stripedcatfish *Mystus vittatus* (Bloch, 1794) (Siluriformes: Bagridae) in the MathabhangaRiver, Southwestern Bangladesh. Appl Ichthyol,, 22(4):304-307.

Hossain, M.Y., Jasmine, S., Ibrahim, A.H.M., Ahmed, Z.F., Rahman, M.M., Ohtomi, J. (2009). Length- weight and length-length relationships of 10 small fish species fromthe Ganges, Bangladesh. Appl Ichthyol 25(1): 117-119.

Hossain, M.Y., Rahman, M. M., Fulanda, B., Jewel, M. A. S., Ahamed, F., Ohtomi, J. (2011). Length-weight and length-length relationships of five threatened fish species from theJamuna (Brahmaputra River tributary) River, northern Bangladesh. J. Appl Ichthyol.,363 p.

James, N.C., Cowley, P.D., Whitfield, A.K., Lamberth, S.J. (2007). Fish communities in temporarily open/closed estuaries from the warm- and cool-temperate regions of South Africa: a review. Reviews in Fish Biology and Fisheries, 17: 565–580.

Khallaf, E., Galal, M., Athuman, M. (2003). The biology of *Oreochromis niloticu*s in a polluted canal. Ecotoxicology, 12:405-416

Kolher, N., Casey, J., Turner, P. (1995). Length–weight relationships for 13species of sharks from the western North Atlantic. Fish. Bull., 93: 412–418.

Lagler, K.F., Bardach, J. E., Miller, R. R. (1962). Ichthyology –John Willey & Sons, Inc.: New York, 546 p.

Le Cren, E.D. (1951). The length-weight relationship and seasonal cycle in gonadal weight and condition in the perch *Perca fluviatilus*. J. Anim. Ecol**.,** 20: 201-219.

Lima-Junior, S. E., Cardne I. B., Goite, R (2002). Determination of a method for calculation of Allometric Condition Factor of fish. Acta scientiarum, 24:397-400.

Lizama, M., De Los, A.P., Ambrose, A.A. (2002). Condition factor in nine species of fish of the charachidae family in the upper Parana river floodplain, Brazil. Braz. J. Biol., 62 (1): 1213-1224

McBride, R.S., MacDonald, T.C., Matheson, R.E., Rydene, D.A., Hood, P.B. (2001). Nursery habitats for ladyfish, *Elops saurus*, along salinity gradients in two Florida estuaries. Fishery Bulletin, U.S. 99: 443–458

Moutopoulos, D. K.. and Stergiou, K. I. (2002). Length-weight and length-length relationship offish species from the Aegean Sea (Greece). J. Appl Ichthyol, 18:200–203.

Nowak, M., Popek, W., Jagusiak, W., Deptua, S., Popek, J., Tatoj, K., Klêczar, K., Epler, P. (2009). Weight-length relationships for three fishes (*Leuciscus leuciscus*, *Phoxinus phoxinus*, *Salmo trutta*) from the Strwi River (Dniester River drainage). Arch. Pol. Fish. 17: 313-316

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): 061-069

Olaosebikan, B.D. and A. Raji (1998). The field guide to Nigerian freshwater fishes. FCFFT, P.M.B.1500, New-Bussa Niger State, Nigeria. Decency Enterprises and Stationeries Ltd

Oliva-Paterna1,F. J., Torralva1, M.and Carvalho, E.D. (2009). Length–weight relationships for 20 species collected in the Jurumirim reservoir (Paranapanema Basin, Brazil). J. Appl. Ichthyol., 1–2

Oni, S.K.,Olayemi, J.Y., Adegboye, J.D. (1983). The comparative physiology of three ecologically(Rupel). *Synodonts schall.* Block and Schneider and *Tilapia zillii* (Gervais). J. Fish. Biol., 22: 105-109.

Oscoz, J., Campos, F., Escala, M. C. (2005). Weight–length relationships of some fish speciesof the Iberian Peninsula. J Appl Ichthyol, 21:73–74.

Petrakis, G., and Strergiou, K. I. (1995). Weight–length relationships for 33 fishspecies in Greek waters. Fish. Res., 21: 465–469.

Saliu, J.K. (2001). Observation on the condition factor of Brycinus nurse (Pisces: Cypriniformes, Characidae) from Asa Reservoir, Ilorin, Nigeria. Trop. Freshwater Biol., 10: 9-17

Shenouda, T.S., Faten, F.A., Mahmoud, M.R., Ray, M.M. (1994). A detail study on age and growth for*Chrysichthys auratus* and *Chrysichthys rueppelli*from the southern most part of the River Nile (Egypt). J. Egypt Ger. Soc., 200(1412): 73-101.

Sokal, R.R., Rolf, F.J. (1987). Introduction to Biostatistics. 2nd Edition. Freeman. New York,

Tesch, F.W. 1971. Age and growth. In: Ricker, W. E. ed., Methods for Assessment of Fish Production in Freshwaters, Blackwell Scientific Publications, Oxford, 98-100.

Vaslet, A., Bouchon-Navarro, Y., Louis, M., Bouchon, C. (2008). Weight–length relationships for 20 fish species collected in the mangroves of Guadeloupe (Lesser Antilles). J. Appl. Ichthyol., 24:99–100.