LENGTH AT AGE AND LENGTH-WEIGHT RELATIONSHIP OF *Parailia pellucida* OF THE NUN RIVER, NIGER DELTA, NIGERIA

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ABSTRACT
The length at age and length-weight relationship of Parailia pellucida of the lower Nun River was investigated. The modal Total Lengths (TL) (cm) for the males of age 1+ to 4+ were 6.6, 8.5, 9.8, and 11.0 with an absolute increment of 1.9, 1.3, 1.2 respectively. L_t *+1 was 8.5, 9.8 and 11.0 for ages 1+ to 3+ males respectively. The modal lengths, absolute increment and* L_t *+ 1 for the females of age 1+ to 3+ were as follows: Age 1+ was 7.4, 2.3, 9.7; Age 2+ was 9.7, 1.7, 11.4; Age 3+, had modal length only of 11.4 cm. There was increase in weight with increase in size such that while the smallest male and female specimens of 4.8 cm and 4.6 cm weighed 0.169 g and 0.452 g respectively, the largest male of 11.5 cm and female of 11.2 cm weighed 7.242 g and 5.760 g respectively. The length – weight regression trends indicated variation in the growth pattern of Parailia pellucida in the Nun River. It was negative allometry in both male (b = 2.491) and female (b =2.788).*
Keywords: Length - frequency, maximum length, absolute increment, relative increment

INTRODUCTION

Length at age is a function of growth which is the change of size of a living organism with age (Nawa and Allison, 1995) and unlike mammals and birds, fish tends to have a continuous growth throughout the whole of their lives. In other words, fish growth can be measured for an individual by length or weight and can be related to age (Yilmaz *et al*., 2010). Growth rate is most rapid in young fish and diminishes progressively with age (Cushing and Walsh, 1976, Nawa and Allison, 1995).

Body proportions like the length-weight relationship vary seasonally and throughout the year leading to seasonal variations in the shape of the fish. Length-weight relationship (LWR) and its parameters ‘a’ and ‘b’ are of great importance in fishery biology and fisheries research (Stergiou and Moutopoulos, 2001) and are used for practical assessment of stocks of aquatic species in situations which include; conversion of length of individual fish to weight; estimating the mean weight of fish of a given length amongst others. Studies on fisheries biology, fish population and management, according to Mortuzan and Rahman (2006), require information on length-weight relationship of the species. LWR can as well be used to convert growth-in-length equations to growth-in-weight in stock assessment studies (Ozaydin & Taskavak, 2007). It can also be useful in studies of gonad development, rate of feeding, metamorphosis, maturity and condition of the fish (Le Cren, 1951). In addition, LWR is useful for between-region comparisons of life histories of certain species (Goncalves *et al.*, 1996; Moutopoulos & Stergiou, 2000). Length–weight relationships are also important components of FishBase (Froese and Pauly, 1998) and are important in modeling aquatic ecosystems (Kulbicki *et a*l., 2005). Weight can be estimated from length-weight regression analysis instead of being measured directly which can be time consuming in the field (Sinovcic *et al*., 2004).

Bagenal & Tesch, (1978), observed a range of values from 2 to 5 as the growth exponent ‘b’ in LWR. A characteristic of LWR in fishes and invertebrates is that when the exponent b is 3, it indicates isometric growth (without changing body shape) but when below or above 3, growth is allometric (fish changes shape as it grows larger) i.e. the fish becomes less rotund as it grows in length (Anderson and Gutreuter, 1983). Wootton (1992) opined that $b<3$ indicates that the fish gets relatively thinner as it grows larger while $b>3$, it gets plumpier as it grows larger. Thus the LWR equation provides some clue on the condition of fish in a population. Pauly (1984) provided another characteristics of LWR where if weight growth is isometric (b=3), then the intercept ‘a’ can be interpreted as the condition factor (CF) of the fish by multiplying it by 100, that is, CF = a x 100, but where $b\neq3$, the value of ‘a’ ceases to be an index of condition and cannot be interpreted biologically.

This study was carried out because data on Length and weight are very useful in fish sampling programs more so, LWR and Length-at-age data provides information on mortality, age at maturity, growth and production, stock composition and live span (King, 1996a,b. and Soomro *et al*., 2007).

THE STUDY AREA

An area of about 2,180 km^2 around Anyama community was sampled in the lower Nun River in Southern Ijaw Local Government Area, Lat. 4^o 51' N and 4^o 54' N; Long 6^o 11' E, and 6^o 13' E, in Bayelsa State, Niger Delta, Nigeria. The study area consists of a moderately steep sloping concave bank with loamy bottom and a relatively shallow sandy convex bank. The depth across the river was 2.7 m, (convex), 5.4 m (central) and 7.8 m in the concave area in the dry season. In the rainy season, it was 6.0 m, 8.75 m and 11.20 m respectively.

In the dry season, a very mild tidal influence was observed. At the peak of the dry season, a slightly reversed flow occurred during the high tides. The river flow is one directional during the flood period. At about the end of May, flood sets in and recedes from about the end of October to early November recording a flood height of 2.7m – 4.0m and a mean of 3.35m.

MATERIALS AND METHODS

Specimens were collected at the study area and measured for length and weight and pooled to provide monthly data. Measurement for total length (TL) of the fish (cm) was done with plastic ruler from the tip of the anterior- most part of the snout to the tip of the caudal fin (cm).

Measurements of the weight of fishes were done with a table top weighing balance, to the nearest 0.05g, after blotting them dry with a piece of clean cotton cloth. The length measurements were converted into length frequencies with constant class interval of 1cm. The monthly total length frequencies were plotted and fitted with a growth curve drawn with free-hand over the modal lengths to provide estimates of length-at- age, relative age and the von Bertalanffy growth parameters

Age Determination

The integrated length- frequency method (Pauly, 1983; Sparre,1987) was employed to estimate age by analyzing the polymodal length frequency distribution plots that resulted from the fish sample data grouped into1cm length classes. The length data for the whole year was then pooled into one length-frequency plot, which was assumed to roughly represent a steady- state population. The cumulative length-frequency diagram was repeated six times along the time axis for convenience. The ages were obtained by fitting a free-hand growth curve directly upon the plots of the length frequency distributions arranged in time. The point where the curve meets the length axis gives the mean length of the species and the age read from the time axis (Pauly, 1983). The single growth curve was fitted by eye. Each discrete mode in the distribution was presumed to be a year class.

Length–At–Age

The points at which the growth curve cuts the length axis on the sequentially arranged time scale, gives the length-at-age from which the absolute and relative growth rates were estimated following Everhart *et al.* (1975).

Absolute growth refers to the mean fish size at each age and is estimated as:

Absolute growth = $TL_{n+1} - TL_{n.}$

Where: TL_{n+1} and TL_n are two succeeding lengths separated by time interval (1yr).

Relative growth refers to the rate of increment between two time intervals and was calculated as the increment between two age groups divided by the length at the younger age.

$$\text{Relative growth} = \frac{Ln+1-Ln}{Ln}$$

The coefficient of growth or instantaneous rate of growth was calculated as the difference between the natural log (Ln) of length for consecutive ages (Ricker, 1975):

$$G = LnL_2 - LnL_1$$

Where L_2 and L_1 are succeeding lengths separated at 1-year interval.

Length-Weight Relationship

The length- weight relationship of *P. pellucida* was directly determined following Le Cren (1951) equation: $W = aL^b$

Where: W = Weight

L = Length,

a = regression constant (intercept)

b = regression coefficient (slope)

Calculations were made after a log-log transformation of the data thus:

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

The pattern of growth (allometric or isometric) in *P. pellucida* was verified from the value of 'b' in the equation $W = aL^b$. The linear regression routine option 3 in FiSAT software (Gayanilo *et al.*1995) using PIII 950 MHz computer was used for the analysis. Only the mid-lengths and mean weights of the classes were employed in data analysis since this was the format accepted by FiSAT (Gayanilo and Pauly, 1997).

RESULTS

Length – at – Age

The relative ages and modal lengths (i.e. length-at-age) of *Parailia pellucida* obtained through Pauly's integrated distribution plots are presented in Table 1. The males attained ages that ranged from 1+yr to 4+ yrs while the females truncated at age 3+ yrs. The absolute and relative increments as well as the instantaneous rate of increase are shown in Table 2.

Table 1: Length -at-age and absolute increment in male and female *Parailia pellucida* of the lower Nun River, Niger Delta (2001)

Sex / Age (Yrs.)		Modal length TL (cm)	Absolute increment	$L_t + 1$
Male	1+	6.6	1.9	8.5
	2+	8.5	1.3	9.8
	3+	9.8	1.2	11.0
	4+	11.0	-	-
Female	1+	7.4	2.3	9.7
	2+	9.7	1.7	11.4
	3+	11.4	-	-
	4+	-	-	-

Table 2: Absolute and relative increments and instantaneous rates of increase in length and age of *Paralia pellucida* in the lower Nun River, Niger Delta (2001)

CHARACTERISTICS	SEX	YEAR CLASS			
		1 – 2	2 – 3	3 – 4	**Annual**
Absolute	Male	1.9	1.3	1.2	2.0
Increment (cm)	Female	2.3	1.7	-	2.7
	Combined sexes	2.3	1.7	0.7	2.2
Relative	Male	28.8	15.3	12.2	18.8
Increment (%)	Female	31.1	17.5	-	24.3
	Combined sexes	33.8	18.7	6.5	19.7
Instantaneous	Male	0.253	0.142	0.115	0.170
rate of increase	Female	0.271	0.161	-	0.216
	Combine sexes	0.291	0.171	0.063	0.175

It was observed from the calculated absolute and relative increments that the rate of growth in length was faster in the younger ages and in the females than the males. Absolute and relative increments as well as the instantaneous rate of increase decreased with age.

Length – Weight Relationship (LWR)

Parailia pellucida of the lower Nun River system showed increases in weight with increase in body length. The smallest male examined measured 4.8 cm total length (TL) and weighed 0.619 g while the largest male was 11.5 cm and weighed 7.242 g. The smallest female had a total length of 4.6 cm and weighed 0.452 g while the largest female was 11.2 cm TL and weighed 5.760 g. The LWR was determined following a log-log transformation. The statistics of regression are shown in Table 3. The linear relationships of log weight and log length are shown in Figs. 1A – 3C. The regression trends indicated variation in the growth pattern of *P. pellucida* in the Nun River. Growth exhibited a negative allometry in both male (b=2.491) and female (b=2.788) in 2000 and in male (b=2.634) and female (b=2.740) 2002. It also exhibited a near isometric growth in the male (b=2.967) and negative allometry in the female (b =2.859) in 2001.

Table 3: Exponential equations, coefficient of determination (r^2) and significance of correlation of the length–weight relationship in *Parailia pellucida* of lower Nun River, Niger Delta

YEAR	SEX	REGRESSION EQUATION	r^2	SIGNIFICANCE OF CORRELATION
2000	Male	$W = -1.946L^{2.491}$	0.865	$P < 0.001$, $t = 3.725$, $df = 97$
	Female	$W = -2.242\ L^{2.788}$	0.722	$P < 0.05$, $t = 2.288$, $df = 43$
2001	Male	$W = -2.286\ L^{2.967}$	0.884	$P < 0.001$, $t = 4.062$,$df = 99$
	Female	$W = -2.216\ L^{2.859}$	0.722	$P < 0.05$, $t = 2.288$, $df = 43$
2002	Male	$W = -1.984\ L^{2.634}$	0.884	$P < 0.01$, $t = 4.062$, $df = 99$
	Female	$W = -2.088\ L^{2.740}$	0.884	$P < 0.01$, $t = 4.105$, $df = 99$

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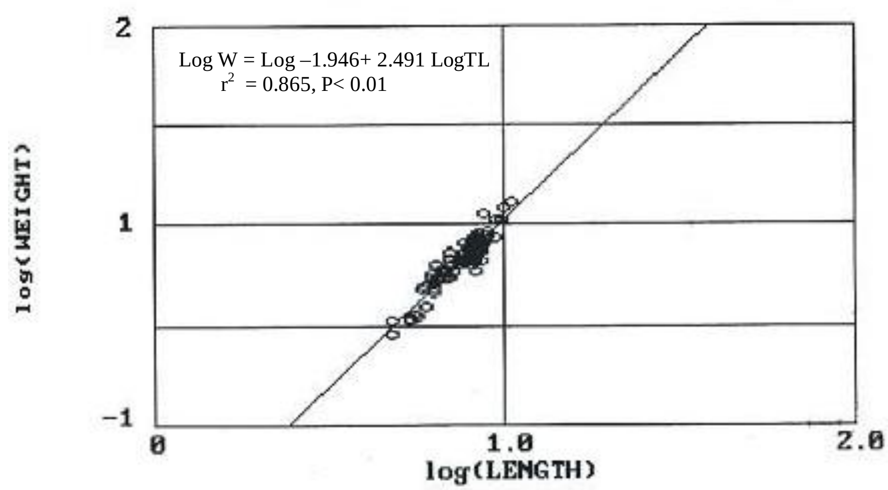

Fig. 1A: Length–weight relationship of female *Parailia pellucida* in the lower Nun River, Niger Delta (2000)

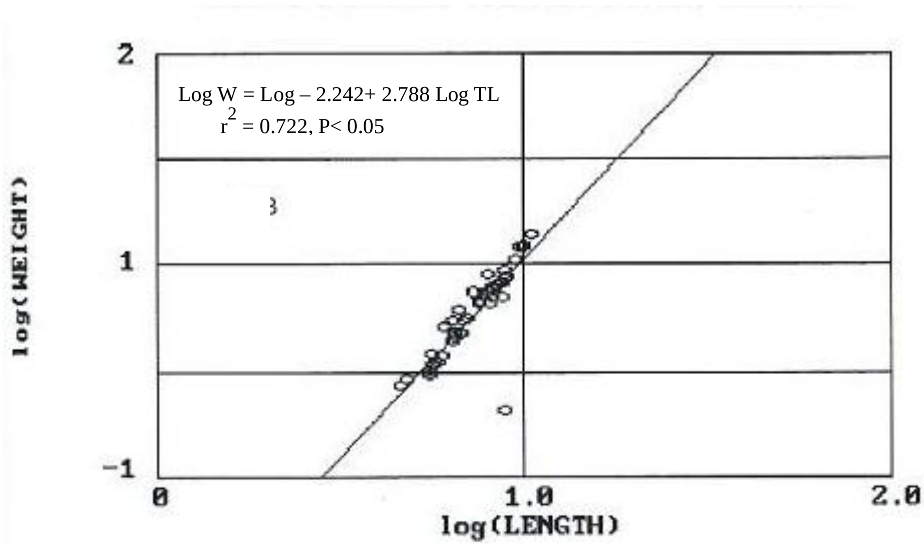

Fig. 1B: Length–weight relationship of female *Parailia pellucida* in the lower Nun River, Niger Delta (2000)

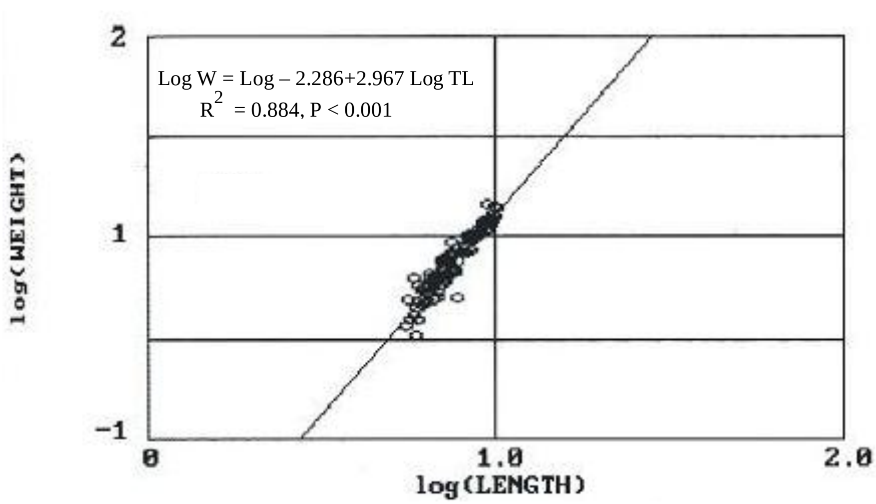

Fig.2A: Length–weight relationship of male *Parailia pellucida* in the lower Nun River, Niger Delta (2001)

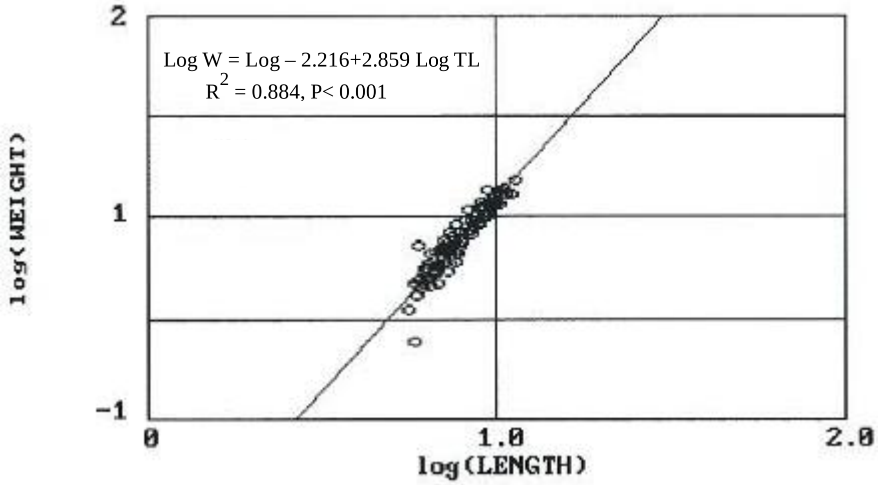

Fig.2B: Length–weight relationship of female *Parailia pellucida* in the lower Nun River, Niger Delta (2001)

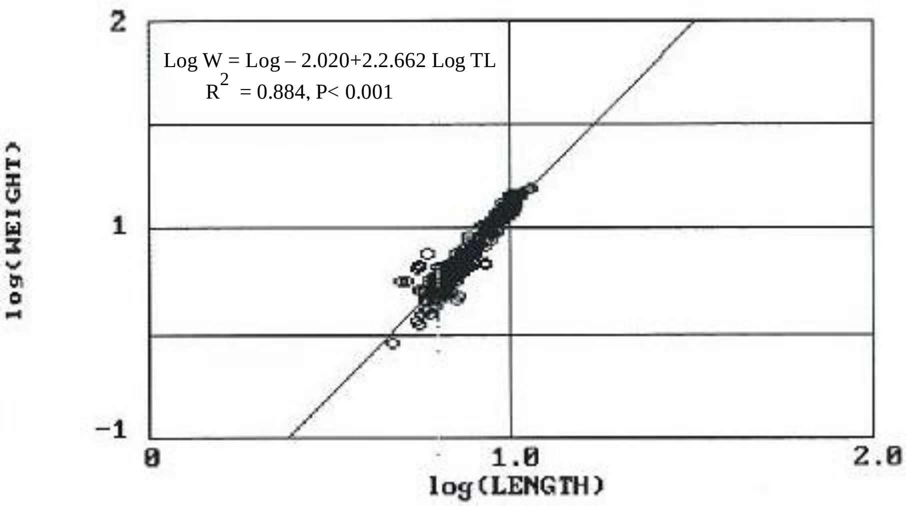

Fig. 2C: Length–weight relationship of combined sexes of *Parailia pellucida* in the lower Nun River, Niger Delta (2001)

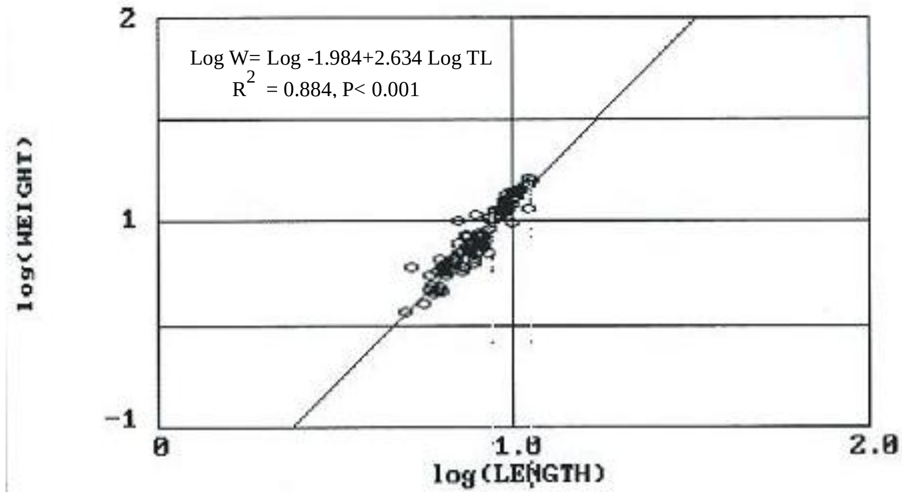

Fig. 3A: Length–weight relationship of male *Parailia pellucida* in the lower Nun River, Niger Delta (2002)

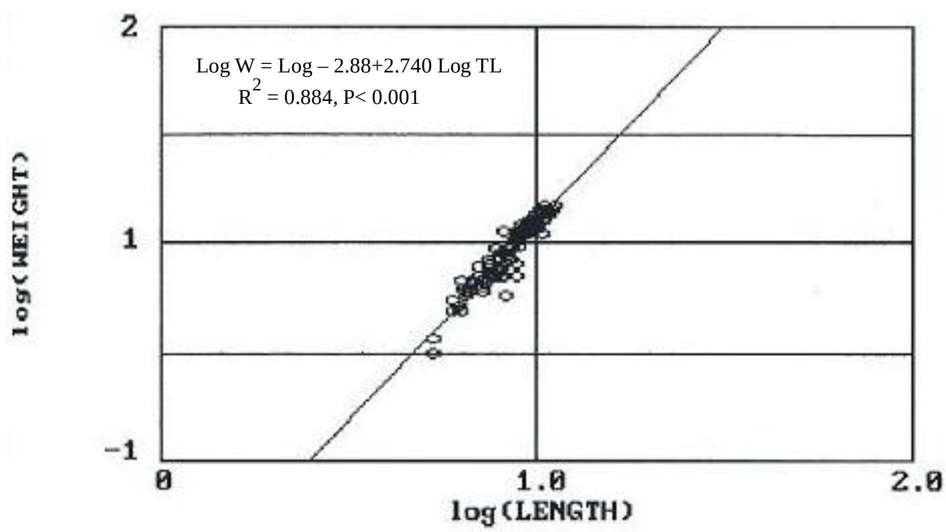

Fig. 3B: Length–weight Relationship of female *Parailia pellucida* in the lower Nun River, Niger Delta(2002)

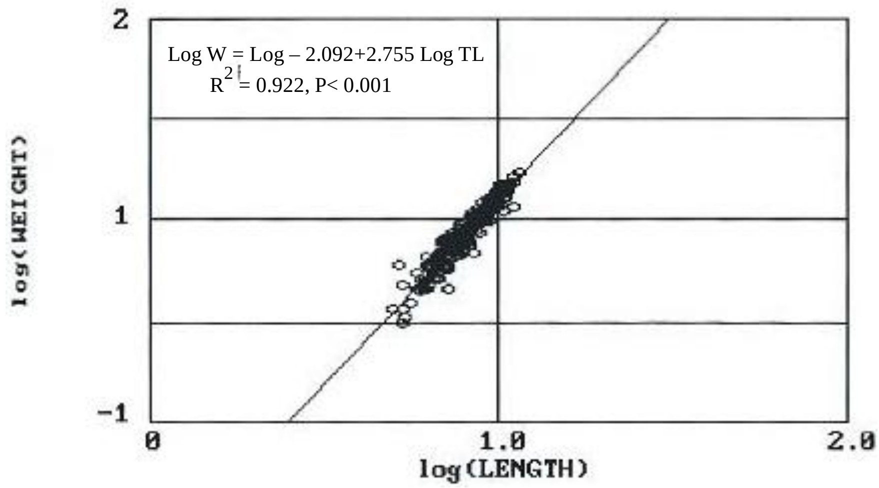

Fig. 3C: Length – weight relationship of combined sexes of *Parailia pellucida* in the lower Nun River Niger Delta (2002)

DISCUSSION

The higher growth increments in early life (age 1+& 2+ yrs) and the entire steady decrease of the instantaneous rate of increase agreed with the assertion of Everhart *et al.* (1975). A similar trend was reported in *Cynoglossus canariensis and C. goriensis* off South East Nigeria (Nawa and Allison, 1995).

The absence of age 4+yrs female specimens in spite of their larger size indicated faster growth in the females than males (Imevbore, 1970). The poor catch of very small specimens (0.6%) indicated that *P. pellucida* reasonably recruits to the fishable stock in the Lower Nun River at sizes above 4.5 – 5.5cm TL range. The assertion may be substantiated by the reasonable abundance (12.1%) of the succeeding size class of 5.5 – 6.5cm. The mean length-at-age of 2.6cm at 0+ years may be the size at spawning of *P.pellucida* in the Lower Nun River system.

The exponent b obtained for *P.pellucida* is less than 3 generally and is in agreement with Abowei (2000) indicating negative allometric growth in this fish, that is, the fish gets relatively thinner as it grows larger (Wootton, 1992). According to Yankova *et al.* (2010), allometric growth may be influenced in fishes by factors such as food availability, changes in body shape, growth fluctuations, environmental factors and physiology. Other similar results include Soomro *et al.* (2007) with b = 2.958 for female and b = 3.157 for male; Simon and Mazlan. (2008) with b = 2.99 in puffer fish *I. sceleratus* and Aura *et al.* (2011) with values ranging from b = 2.96 ± 0.027 to b = 3.41 ± 0.043 for *Squalis asper* and *Peristedion adeni* respectively; Ahmed *et al.* (2011) b value ranged between 2.278 in *Clarias lazera* and 3.680 for *Bargrus bayad.* Sexual dimorphism in growth occurred in 2001 with the males being near isometric (b=2.967) and the females negative allometric (b =2.859). Ikomi and Sikoki (2003) observed sexual dimorphism in the growth of *Brycinus longipinus* with the females showing isometric (b=3.035) and the males allometric growth (b= 3.484). Variation of b values, according to Welcomme (1969) and Gayanillo and Pauly (1997) could occur in a particular fish species due to sex differences, stage of maturity, change in habitat, time of year and stomach content as these also account for variation in the condition factor (K) of the fish species.

The b values observed in the LWR of *P. pellucida* fell within recorded values typical for most fishes which include Carlander (1969) b = 2.5 – 3.5; Royce (1972) b = 2.0– 3.5; Lagler *et al.* (1977) b = 2.5 – 4.0; King (1996a) b = 2.158 – 3.376; King (1996b) b=2.880 –3.114; Kumolu-Johnson and Ndimele (2011) b = 2.5 – 3.2. According to Frosta *et al.* (2004) the exponent b indicates the rate of weight gain relative to growth in length and varies among different populations of the same species or within the same species.

CONCLUSION

The study showed that female *P. pellucida* of the study area exhibited faster growth pattern than the males that was negative allometry. The information provided through this study could be very useful for the fact that LWR parameters are commonly used in fisheries management and fisheries biology applications.

REFERENCES

Abowei, J.F.N (2000). Aspects of the fisheries of the lower Nun River. *Ph. D Dissertation*, Dept. of Animal and Environmental Biology, University of Port Harcourt. 180pp.

Ahmed, E.O., Ali, M.E. & A.A. Aziz (2011). Length-weight relationships and condition factors of six fish species in Atbara River and Khashm El-Girba Reservoir, Sudan. *Int. J. Agric. Sci.* 3 (1): 65 – 70.

Anderson, R.O. and S.J Gutreuter (1983). Length-weight and associated structural indices in fisheries techniques (Nielsen, L. A., D. L. Johnson (eds.). *Amer. Fish Soc*., Bethesda: 215- 237.

Aura, C.M., Mungo, C.N., Kimani, E., Manyala, J.O. and Musa, S. (2011). Length-weight relationship for nine Deep Sea fish species off the Kenyan coast. *Pan American J. Aqua. Sci.* Vol. 6(2):188 - 192.

Bagenal, T.B. and F.W. Tesch (1978). Age and growth. *In*: Bagenal, T.B. (Ed). Methods of assessment of fish production in freshwater. Blackwell Scientific Publications. Oxford. pp101 – 136.

Carlander, K. (1969). Handbook of Freshwater Fishery Biology. Vol. 1 Iowa State University Press, Ames. Iowa 98pp.

Cushing, D.H. and Walsh, J.J. (1976). The Ecology of the Seas. *Blackwell Scientific Publications* 467pp.

Everhart, W.H., Alfred, W.E.and Young, W.D. (1975). Principles of Fishery Science. Cornell University Press Ithaca and London 288p.

Froese, R. and D. Pauly (1998). FishBase 1998: Concept, design and data source. *Manila, ICLARM.* 293p.

Frosta, L.O. Costa, P.A.S. and Braga, A.C. (2004). Length – weight relationships of marine fishes from the Central Brazilian Coast *NAGA, World Fish Centre Quarterly* Vol. 27 No. 182 (Jan.-June 2004) p.20-26.

Gayanilo, F. C. Jr., Sparre, P. and Pauly, D. (1995). FAO–ICLARM Stock Assessment Tools (FISAT) Users Manual. *FAO Compl. Info. Ser. (Fisheries)* 8. 126 p.

Gayanilo, F.C. Jr. and Pauly, D. (1997) eds. FAO-ICLARM Stock Assessment Tools (FiSAT) Reference manual *FAO Computerized Information Series* (Fisheries) No. 8 Rome, FAO, 262pp.

Goncalves, J.M.S., L. Bentes, P.G. Lino, J. Ribeiro, A.V.M. Canario, and K. Erzini (1996). Length-weight relationship for selected fish species of the small-scale demersal fisheries of the South and S. W. Coast of Portugal. *Fish. Res*. 30: 253-256.

Ikomi, R. B. and Sikoki, F. D (2003). Studies on the biology of the African Longfin Tetra, *Brycnus longipinnis* (Gunther, 1964) in the Jamieson River (Niger Delta, Nigeria). *Acta Ichthyologica et Piscatoria* Vol. XXXIII, Fasc.1 17 – 36.

Imevbore, A.M.A. (1970). Some general features of the Kainji Reservoir basin. *In*: Visser S.A. (Ed). Kainji Lake studies. Volume 1, Ecology. Ibadan University Press. pp 87 – 98.

King, R.P. (1996a). Length-weight relationships of Nigerian freshwater fishes. Naga The ICLARM Quarterly 19(3):49-52.

King, R.P. (1996b): Length-weight relationships of Nigerian coastal water fishes. Naga The ICLARM Quarterly 19(4):53-58.

Kulbicki, M., Guillemot, N., Amand, M. (2005). A general approach to length- weight relationships for New Caledonian Lagoon fishes. *Cybium*, 29: 235-252.

Kumolu-Johnson, CA. and Ndimele, P.E. (2011). Length-weight relationships of nine fish species from Olege lagoon, Lagos Nigeria. *Afr. J. Biotech.* 10(2): 241 - 243.

Lagler, K. F., Bardach, J. E., Milter, R.R. and Passimo, D. R. M. (1977). Ichthyology. John Wiley and Sons Inc. 506 pp.

Le Cren, C.P. (1951). Length.-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). *Journal of Animal Ecology* 20 (2): 201-219.

Mortuzan, M.G and Rahman, T. (2006). Length-weigth relationship, condition factor and sex-ratio of freshwater fish *Rhinomugil corsula* (Hamiltton) (Mugiliformes:Mugilidae) from Rajshahi, *Bangladesh. J. Bio. Sci*, 14:139-141.

Moutopoulos, D.K. and K.I. Stergiou (2000). Weight-length and length–weight relationships for 40 fish species of the Aegean Sea (Hellas). *Journal of Applied Ichthology* (In press)

Nawa, I.G. and Allison, M E (1995). The food of *Cynoglossus canariensis* (STEIND,1882) and *Cynoglossus goreensis* (STEND,1882) occurring off the S.E. Coast of Nigeria. *J. Aqua. Sci.* 10: 19-23.

Ozaydin, O. & Taskavak, E. (2007). Length-weight relationship for 47 fish species from Izmir Bay

(Eastern Agean Sea, Turkey). *Acta Adriatica*, 47(2): 211-216.

Pauly, D. (1983). Some simple methods for the assessment of tropical fish stocks. *FAO Fisheries Technical Paper.* No. 234 FAO. Rome.

Pauly, D. (1984). Length converted Catch Curve. A Powerful tool for fisheries research in the tropics (Part 3*): Fishbyte* 2, 9 -10

Ricker, W.E. (1975). Computation and interpretation of biological statistics of fish populations. *Bull. Fish. Res. Bd. Can* 191:209-210

Royce, W. F. (1972). Introduction of Fishery Science. Academic Press Inc.; London 112pp.

Simon, K.D. and A.G. Mazlan (2008). Length-weight and Length-length relationships of Archer and Puffer fish species. Open Fish Sci. J. Vol. 1: 19 – 22.

Soomro, A.N., W.A. Baloch, S.I.H. Jafri, and H. Suzuki (2007). Studies on Length-weight and Length –length relationships of a catfish *Eutropichthyes vacha* (Hamilton) (Schilbeidae: Siluriformes) from Indus River, Pakistan. Caspian J.Env. Sci. Vol. 5(2):143-145.

Sinovcic G., Franicevic M., Zorica B.and Cileskec V (2004). Length-weight relationships and condition factor for 10 pelagic fish species from the Adriatic Sea (Crotia). *J. Applied Ichthyol.* 20:156-158

Sparre, P. (1987). Computer Programmes for Fish Stock Assessment. Length – based Fish Stock assessment for Apple II Computers. *FAO Fish Tech. Pap*. (101): Suppl. 2:218P.

Stergiou, K.I. and D.K. Moutopoulos (2001). A review of Length-weight relationships of Fishes from Greek Marine Waters. *NAGA, The ICLARM Quarterly* (Vol. 24 Nov.182) Jan- June 2001.

Wootton, R.J. (1992). Fish Ecology: Tertiary Level Biology Blackie Lond, 212p

Welcomme, R.L (1969). The biology and ecology of the fishes of a small tropical stream. *J. Zool.* Lond. 158: 485-529.

Yankova, M.H., Raykov, V.S. and Gerdzhikov, D.B. (2010). Growth and Length-weight relationships of the horse mackerel, *Trachurus mediterraneaneus panticus* (Aleev, 1956) off the Bulgarian Black Sea coast. Turkey J. Zool. 34: 85 – 92.

Yilmaz, E,, Ismet, B., Cetin, S., Oskay, D.A., Yesilcimen, H.O. (2010). Age, growth, length-weight relationship and reproduction of the striped seabream (*Lithognathus mormyrus* L., 1758) (Sparidae) in the Beymelek Lagoon (Antalya, Turkey). *Turk. J. Zool.* 34: 93 -100.