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ARTICLE

The Growth Parameters and Mortalities of Five Species of *Synodonits* in the Lower River Benue at Makurdi

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ABSTRACT

The growth parameters and mortalities of five species of *Synodontis* in the lower river Benue at Makurdi, Benue State were studied from January, 2016 to December, 2018. The asymptotic length (L∞) calculated for the five species ranged from 18.80cm in *S.clarias* females to 37.04cm in *S.membranaceus* females. The t*0* values were all negative in the combined sexes of *S.clarias*, *S.omias*, *S.gambiensis* and *S.membranaceus*. In both combined sexes of *S.membranaceus* and *S.schall*, the t*0* values were positive. The growth rate (K) was low in *S.clarias* and *S.omias* (0.301 - 0.497, 0.171 - 0.310) respectively and higher in *S.membranaceus* (0.310 - 0.640), *S.schall* females (0.430 - 0.580); *S.schall* males (0.573), *S.gambiensis* (0.500 - 0.571). Growth performance index (Ø') was 2.212 in *S.gambiensis* and 2.946 in *S.schall* combined. Natural Mortality (M) ranged from 0.5422 in *S.omias* females to 1.3340 in *S.membranaceus* males. Fishing Mortality (F) was 0.8214 in *S.omias* combined and 3.0934 in *S.membranaceus* females. Total mortality (Z) ranged from 1.52 in *S. omias* combined to 4.078 in *S.membranaceus* combined. Mean Exploitation (E) ratios was 0.61 in *S.clarias*, 0.64 in *S.omias*, 0.53 in *S.gambiences*, 0.70 in *S.membranaceus*, and 0.66 in *S.schall*. The rate at which these species survived in the River was low (from 0.147, in *S.omias* combined, to 1.482 in *S.membranaceus* combined).

1. Introduction

The growth of a fish like any other organism results from its food consumption and assimilation [1]. The growth of fishes can be affected by many factors which include food availability (amount and quality), population density, food consumption, genetic composition, photoperiods, and length of growing periods. Temperature affects the rate of metabolism of fishes as they are ectothermic. Changes in temperature from season to season affect the growth rate [2,1]. Other factors include salinity, amount of dissolved oxygen, the physiological condition of the fish, parasitism, competition, predation and presence of adequate anions and cations in the water body [3-5].

Age determination and growth are important aspects of fisheries management [6,7]. The study of factors influencing fish growth which include maturation, migration, food and feeding habits, spawning frequency, stock responses to changes in habitats are essential to the fishery biologist [8].

Fish growth can be used to describe the status of a given fish population as well as for predicting the potential yield of the fishery. It also facilitates the assessment of production, stock size and recruitment to adult stock [9]. According to [10], fish growth can be used to measure

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characteristics of fish stocks, species and is fundamental to the understanding of the life histories of demographics, ecosystem dynamics and sustainability of fisheries. The Walford plot analysis for fish is used to determine the Von Bertalanffy growth parameters for different sexes of fishery stock in a given body of water. However, [10] observed that information on growth parameters of many tropical fishes were either scarce, few or no records were available at all in Fishbase. There are no published works on the determination of true asymptotic length (L_∞) of *Synodontis* species in this River. This research therefore, focus on the determination of the true asymptotic length (L_∞) and length- at-age (L_t) of five *Synodontis* species in River Benue at Makurdi.

2. Materials and Methods

2.1 The Study Area

The study area was the Lower Benue River at Makurdi. The Lower Benue River is part of the Benue River contained within Benue state of Nigeria to the confluence at Lokoja [11].

Benue state is located in the middle belt area of Nigeria. It is located between Latitudes 6° 25'N and 8° 8'N and Longitudes 7° 47'E and 10°E. (http://www.absoluteastronomy.com).

River Benue is an inland water body which originates in the Adamawa Plateau of Northern Cameroun as the Benoue and flows to the west across east-central Nigeria as the Benue. It extends from the Adamawa mountains of Cameroun some 500 km beyond the Nigerian territory where it flows west through the town of Garoua and Lagdo Reservoir into Nigeria south of the Mandara mountains, and through Jimeta, Ibi and Makurdi before it joins with River Niger at Lokoja, about 1400 km long [11].

Makurdi town, the capital of Benue state and the headquaters of Makurdi Local Government Area are situated on both banks of this River within the flood plain. The town is between Latitudes 7° 38'N and 7° 50'N and Longitudes 8° 24'E and 8° 38'E. Its mean elevation is 92 meters above sea level [11].

The flood plain stretches for as much as 187 km with a width ranging between 3-10 km [12]. The flood plain is flooded mainly along the south bank. The large area of flood plain is flooded every year in the rainy season when it rises extending to long distances along the shores [12]. The flooded plain forms breeding grounds for fish species.

At bankfull, the flooded plain can cover 129,000 ha, but when flooded, the area can rise to 310,000 ha. [11] observed that the highest water levels of the River were in August-September and the lowest were in March and April.

2.2 Length at Age

The length at age of the five species of *Synodontis* was calculated using the [13] growth model of in the LSA/FiSAT computer programmes using the formula below:

$$\mathbf{L(t) = L_\infty(1-e^{-k(t-to)})}$$

Where L(t) = length at age t

L_∞ = the asymptotic or maximum attainable length, assuming fish growth is indefinite.

k = the rate at which the asymptotic length is approached.

t_o = the time in the growth history of fish at which the fish would be zero sized

e = exponential and

t = age in years.

Growth curves were fitted to the Von-Bertalanffy model and tested with Walford plots to obtained L∞ trials [7].

The gradient Log_e L∞ + Kt_0, is the intercept, then $t_0 = \frac{\text{Y-intercept} - \text{Loge L}\infty}{K}$.

K is the gradient of the line of best fit from the trial plots of Log_e (L∞ - Lt) against age.

2.3 Mortality

2.3.1 Natural Mortality (M)

Natural mortality (M) for the five species of *Synodontis* was estimated using empirical formula below:

$$\mathbf{Log_{10}M = -0.0066 - 0.279\ Log_{10}L_\infty + 0.6543LogK + 0.463Log_{10}T}$$ **[17].**

Where,

L_∞ = the asymptotic length of the fish species in cm

K = the Von Bertalanffy parameters,

T = the mean environmental temperature which was 27.6 in this study.

2.3.2 Total Mortality (Z)

Total Mortality (Z) was calculated on FiSAT II from the lengths of fish samples using the formula below:

$$\mathbf{Z = K\ [L\infty - L_{mean}]/[L_{mean} - L']}$$

where

Z= Beverton and Holt function, K = curvature parameter of the VBGF, L∞ = asymptotic length of fish, L_{mean} = mean length of fish samples and L' = cut off or lower limit of the smallest length class.

2.3.3 Growth Performance Index

The growth performance index Ø' was calculated using the formula below:

$$\mathbf{Ø' = LogK + 2LogL\infty}$$ **[14].**

Where, K and L∞ are parameters of VBGF.

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3. Results

The growth parameters and mortalities of the five species of *Synodontis* as obtained from the Walford and Ricker plots and estimations were shown in Table 1.

The growth rates (K) of the five species was generally low in *S.clarias* and *S.omias* in male and female sexes. Growth rate of 0.640 was the highest in *S.membranaceus* males, followed by 0.580 in *S.schall* females, then 0.573 in *S.schall* males and 0.571 in *S.gambiensis* males.

The growth performance index (Ø) of all the species ranged between 2.212 in *S.gambiensis* females to 2.946 in *S. schall* males and females. In *S. clarias,* the growth performance index (Ø') in length was 2.453, 2.321 and 2.693 in females and males sexes respectively. In *S.omias*, the values were 2.440 and 2.321 in the females and males sexes respectively. *S.gambiensis* had the growth performance index of 2.212 and 2.374 for females and males respectively. The growth performance index was 2.562 in *S.membranaceus* females and 2.689 for the males. The growth performance of 2.756 was observed in *S.schall* females and 2.64 for the males. The growth performance was highest in *S.schall* followed by *S.membranaceus* and lowest in *S.gambiensis*.

The asymptotic lengths (L_∞) for the five species ranged between 18.80cm in *S.clarias* females to 37.04cm in *S.membranaceus* females. In *S.clarias*, the L_∞ ranged between 18.80cm -28.50cm. *S.omias* had the range of 28.0cm - 28.50cm, *S.gambiensis* 23.0cm - 23.70cm, *S.membranaceus* 28.05cm-37.04cm and *S.schall* 28.05cm - 30.05cm (Table 1).

The hypothetical age at which length is zero (t_0) was negative in *S.clarias, S.omias, S.gambiensis* and *S.membrnaceus* and positive in both sexes of *S.membranaceus* and *S.schall*.

The natural mortality (M) was 0.5422 in *S.omias* females and 1.3340 in *S. membranaceus* males. Natural mortalities were higher in *S.schall* and *S.gambiensis* than all the other species (Table 1).

The total mortality (Z) of the five species ranged between 1.5120 in *S.omias* combined to 4.078 in *S.membranaceus* females. The total mortality of the five species was generally high (Table 1).

The fishing mortality (F) for the five species ranged between 0.8214 in *S.omias* combined to 3.0934 in *S.membranaceus* females. The Fishing mortality for the species was higher than natural mortality (Table 1).

Table 1. Growth Parameters and Mortalities of the Five Species of Synodontis in the Lower River Benue.

Species	Sex	Growth Parameters						Mortality Coefficients				
		L_∞ (cm)	K (1/yr)	t_o (cm)	L_t - L_{to} (cm)	Back-calculated	Ø	S	M (1/yr)	F (1/yr)	Z (1/yr)	E(F/Z)
S.clarias	♀	18.80	0.385	-0.723	7.85	7.46	2.453	1.232	0.7403	1.1427	1.883	0.76
	♂	28.50	0.301	-0.440	5.50	8.55	2.331	0.961	0.8242	1.2238	2.048	0.60
	Comb.	23.00	0.497	-0.090	6.55	8.18	2.693	0.659	1.2036	1.0844	2.288	0.47
S.omias	♀	28.05	0.171	-0.706	4.43	9.16	2.440	0.287	0.5422	1.6518	2.194	0.75
	♂	28.00	0.310	-0.419	8.50	8.66	2.321	0.375	0.8188	1.3882	2.207	0.63
	Comb.	28.50	0.240	-0.542	10.90	9.82	2.649	0.147	0.6906	0.8214	1.512	0.54
S.gambiensis	♀	23.50	0.500	-0.714	9.84	6.38	2.212	0.389	1.1774	1.0096	2.187	0.46
	♂	23.70	0.571	-0.464	9.84	6.43	2.374	0.279	1.3070	2.1540	3.461	0.62
	Comb.	23.00	0.523	-0.641	9.53	8.61	2.445	0.556	1.2444	1.3376	2.582	0.52
S.membranaceus	♀	37.04	0.320	0.344	8.90	9.86	2.562	0.945	0.9846	3.0934	4.078	0.77
	♂	28.25	0.640	0.890	12.65	9.53	2.689	1.466	1.3340	1.9850	3.319	0.60
	Comb.	35.10	0.310	-0.032	6.70	8.46	2.869	1.482	0.8312	2.2108	3.042	0.73
S.schall	♀	30.05	0.580	0.830	9.10	7.78	2.756	0.431	1.2351	2.2029	3.438	0.64
	♂	30.00	0.570	0.332	9.50	7.55	2.645	0.327	1.2267	2.3553	3.582	0.66
	Comb.	28.50	0.430	0.000	7.70	7.71	2.946	0.614	1.0453	2.3597	3.405	0.69

L_∞ = Asymptotic Length, K = Growth curvature, t_o = length at time 0, L_t - L_{to} = Change in length, Ø = Growth Performance Index, S=Survival Rate, M = Natural Mortality, F = Fishing Mortality, Z = Total Mortality, E= Exploitation Ratio

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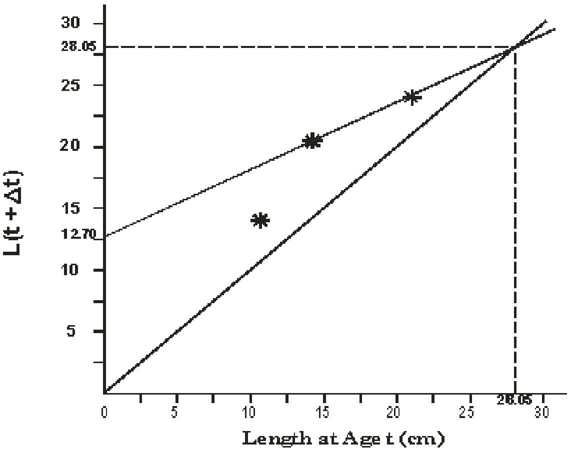

Figure 1a. WALFORD PLOT FOR DETERMINATION OF L∞ FOR *S.membanaceus* (MALES)

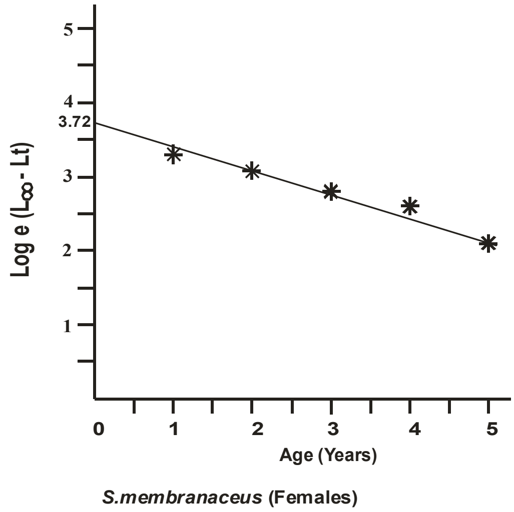

Figure 2b. RICKER PLOT FOR DETERMINATION OF TRUE L∞

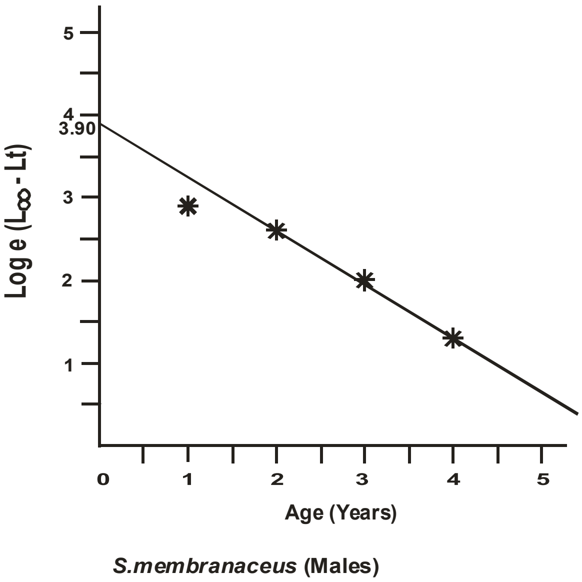

Figure 1b. RICKER PLOT FOR DETERMINATION OF TRUE L_∞

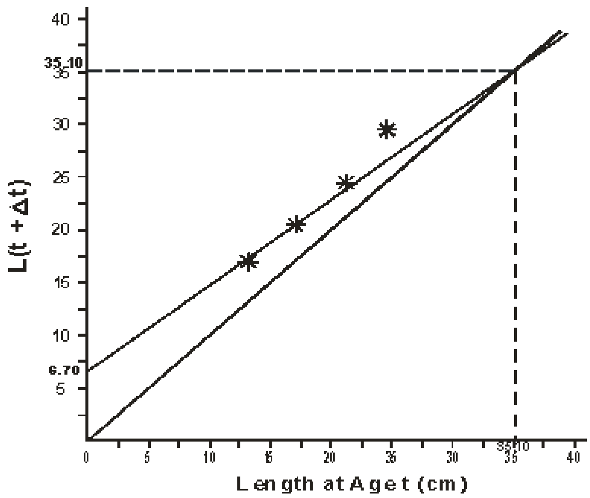

Figure 3a. WALFORD PLOT FOR DETERMINATION OF L_∞ FOR *S.membranaceus* COMBINED

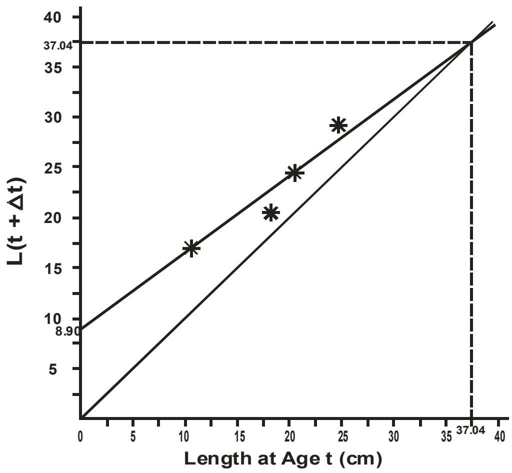

Figure 2a. WALFORD PLOT FOR DETERMINATION OF L_∞ *S.membranaceus* (FEMALES)

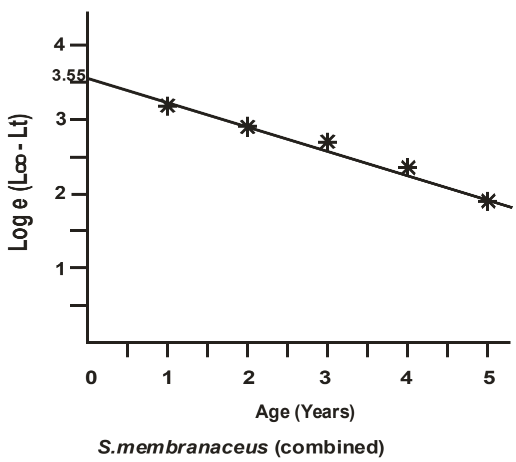

Figure 3b. RICKER PLOT FOR DETERMINATION OF TRUE L∞

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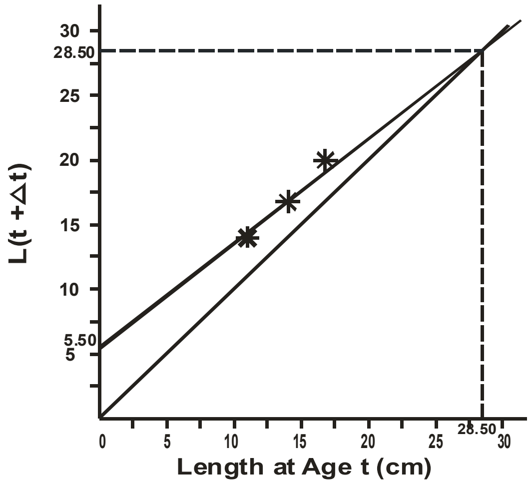

Figure 4a. WALFORD PLOT FOR DETERMINATION OF L∞ FOR *S.clarias* (MALES)

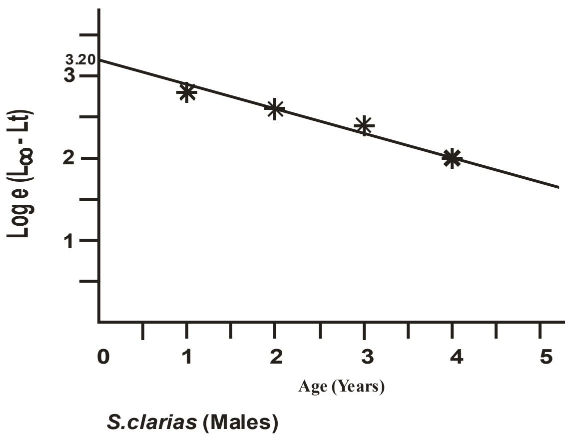

Figure 4b. RICKER PLOT FOR DETERMINATION OF TRUE L∞

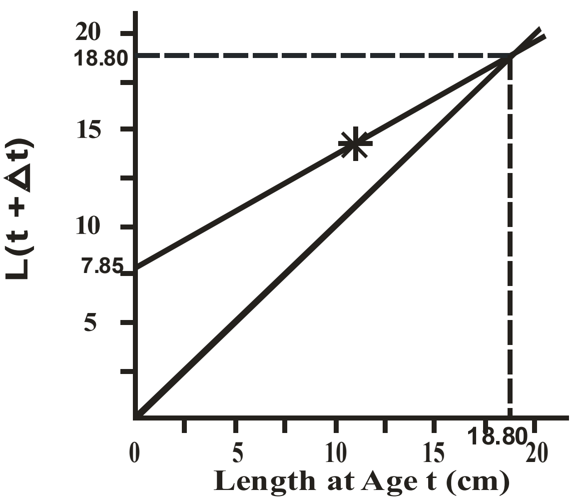

Figure 5a. WALFORD PLOT FOR DETERMINATION OF L∞ FOR *S.clarias* (FEMALES)

Figure 5b. RICKER PLOT FOR DETERMINATION OF TRUE L∞

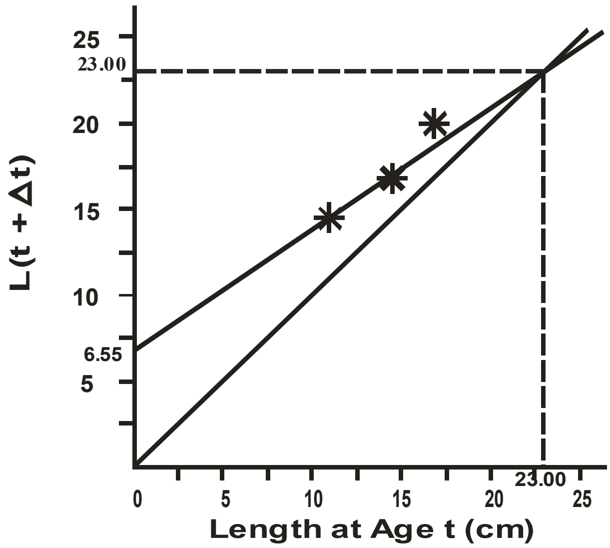

Figure 6a. WALFORD PLOT FOR DETERMINATION OF L∞ FOR *S.clarias* combined

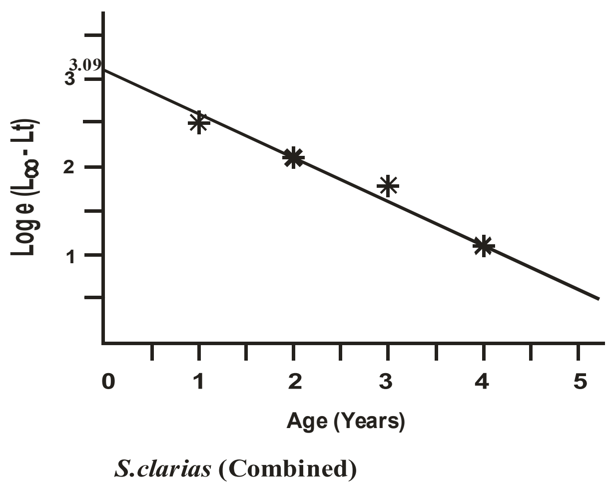

Figure 6b. RICKER PLOT FOR DETERMINATION OF TRUE L∞

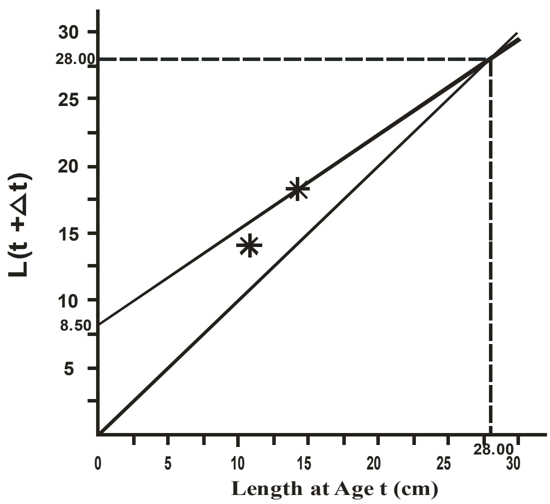

Figure 7a. WALFORD PLOT DETERMINATION OF L∞ FOR *S.omias* (MALES)

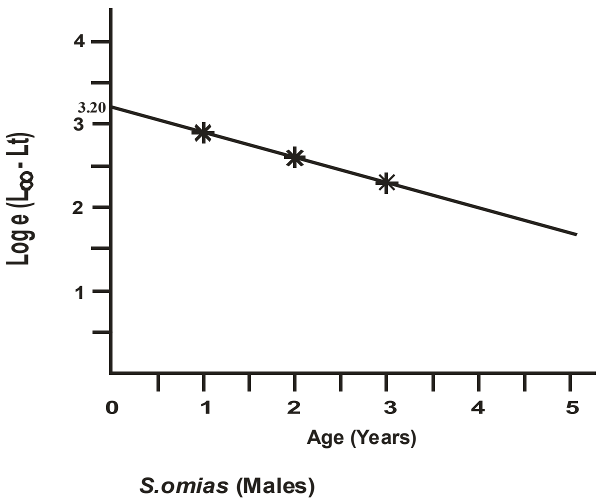

Figure 7b. RICKER PLOT FOR DETERMINATION OF TRUE L∞

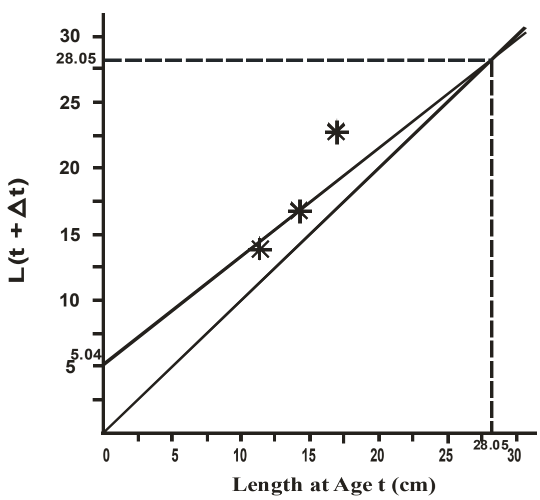

Figure 8a. WALFORD PLOT FOR DETERMINATION OF L∞ FOR *S.omias* (FEMALES)

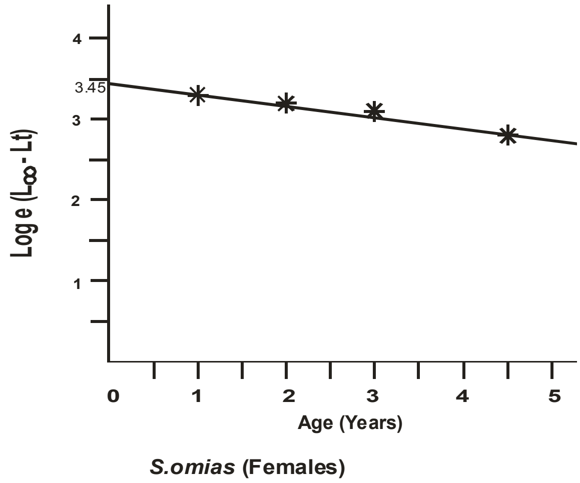

Figure 8b. RICKER PLOT FOR DETERMINATION OF TRUE L∞

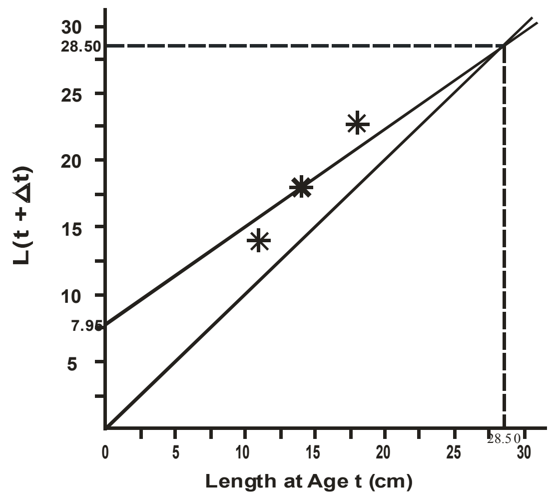

Figure 9a. WALFORD PLOT FOR DETERMINATION OF L∞ FOR *S.omias* COMBINED

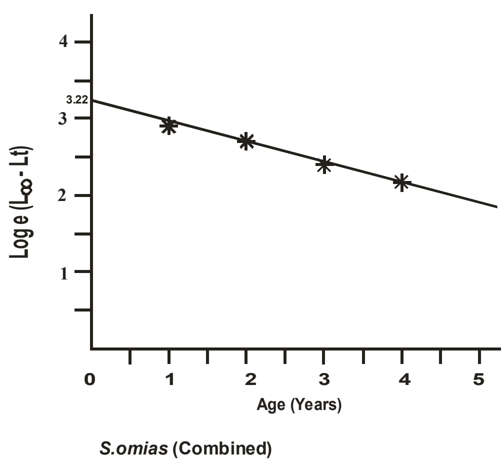

Figure 9b. RICKER PLOT FOR DETERMINATION OF TRUE L∞

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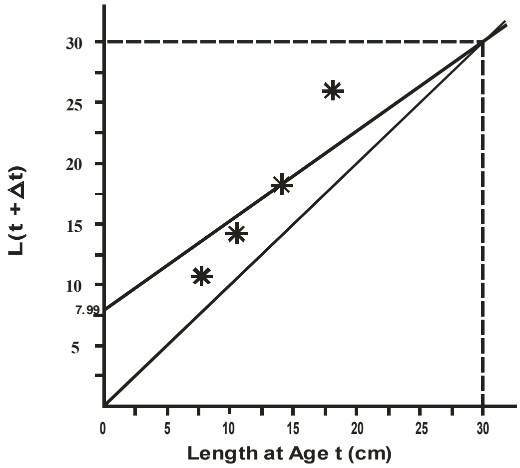

Figure 10a: WALFORD PLOT FOR DETERMINATION OF L∞ FOR *S.schall* (MALES)

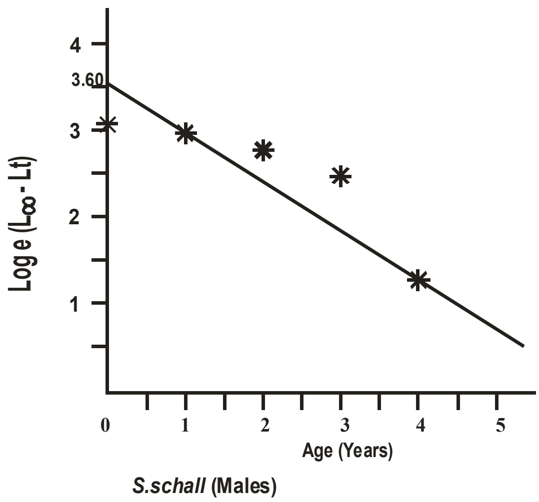

Figure 10b. RICKER PLOT FOR DETERMINATION OF TRUE L∞

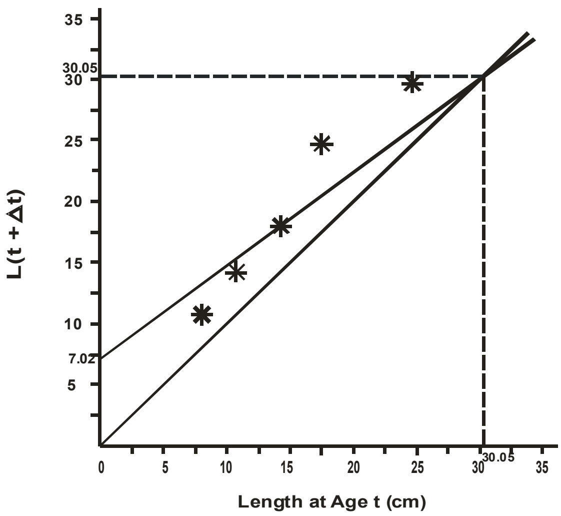

Figure 11a. WALFORD PLOT FOR DETERMINATION OF L∞ FOR *S.schall* (FEMALES)

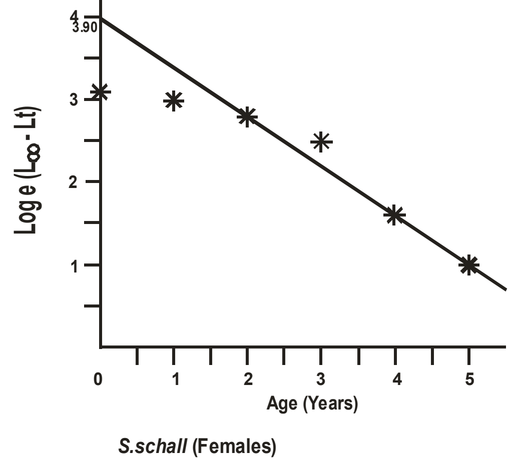

Figure 11b. RICKER PLOT FOR DETERMINATION OF TRUE L∞

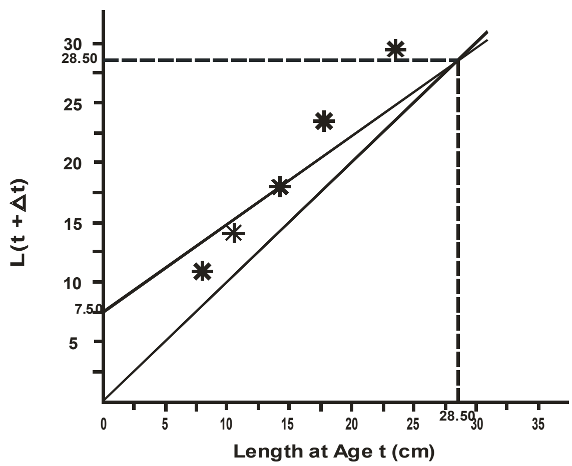

Figure 12a. WALFORD PLOT FOR DETERMINATION OF L∞ FOR *S.schall* COMBINED

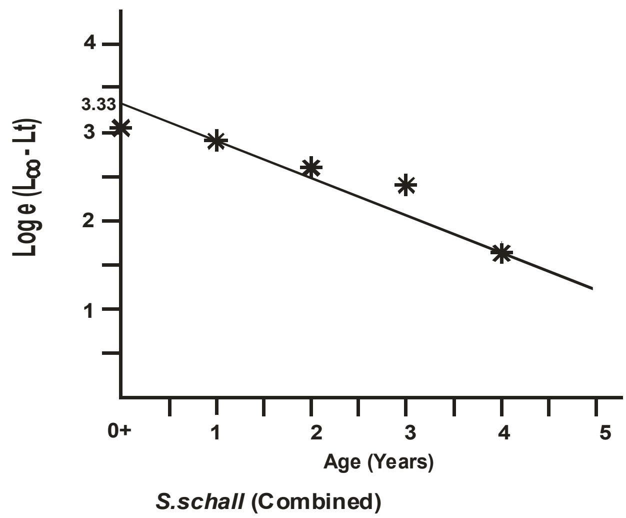

Figure 12b. RICKER PLOT FOR DETERMINATION OF TRUE L∞

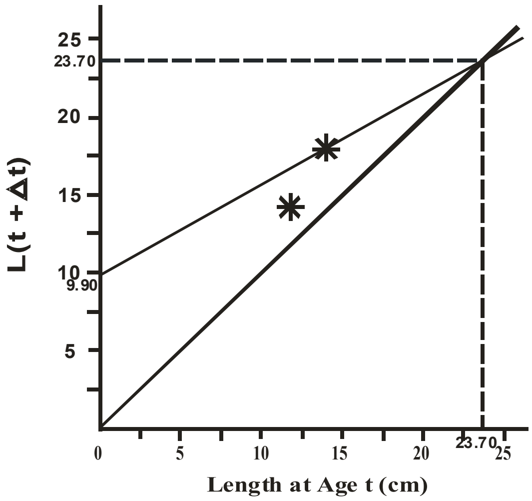

Figure 13a. WALFORD PLOT FOR DETERMINATION OF L∞ FOR *S.gambiensis* (MALES)

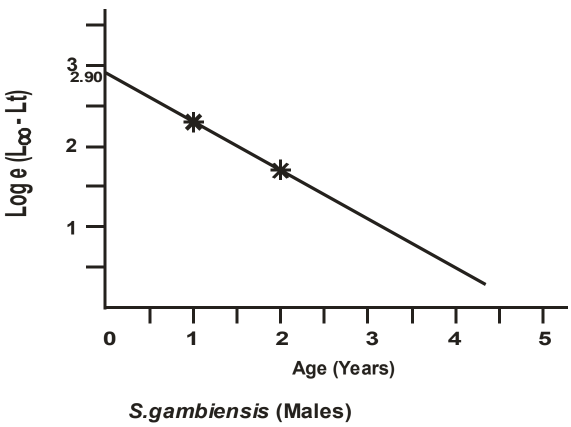

Figure 13b. RICKER PLOT FOR DETERMINATION OF TRUE L∞

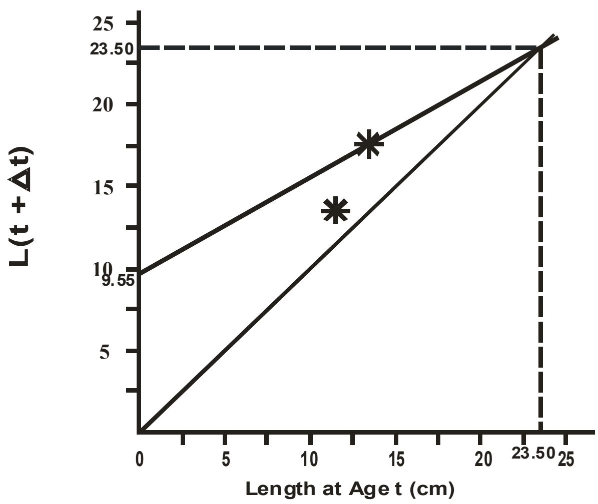

Figure 14a. WALFORD PLOT FOR DETERMINATION OF L∞ FOR *S.gambiensis* (FEMALES)

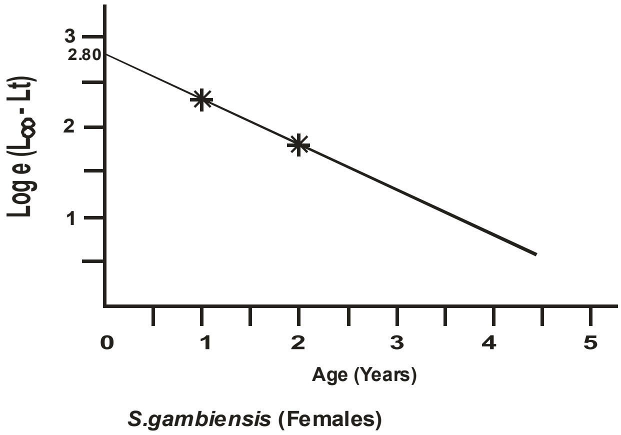

Figure 14b. RICKER PLOT FOR DETERMINATION OF TRUE L∞

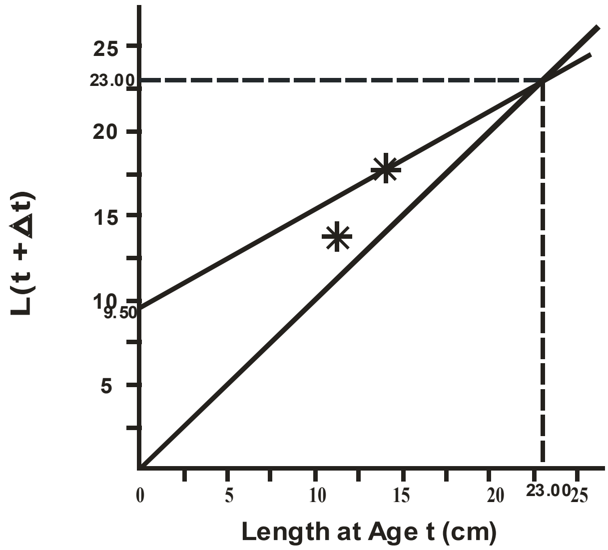

Figure 15a. WALFORD PLOT FOR DETERMINATION OF L∞ FOR *S.gambiensis* COMBINED

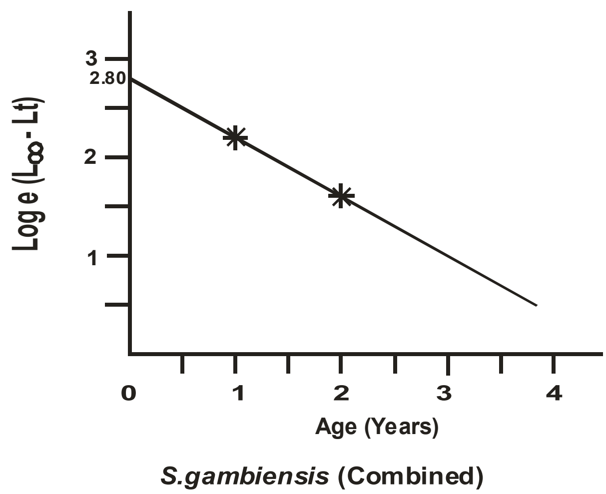

Figure 15b. RICKER PLOT FOR DETERMINATION OF TRUE L∞

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4. Discussion

The asymptotic lengths (L_∞) calculated for the five species ranged from 18.80 cm in *S.clarias* females to 37.04 cm in *S.membranaceus* females. The highest L_∞ of 28.50 cm was observed in *S.clarias* males, while the maximum length of fish of this species was 30.0cm also a male. In *S.omias* the highest L_∞ of 28.50 cm was observed in the combined, the maximum length of 22.8 cm was found in female. The highest L_∞ of *S.gambiensis* was 23.70 cm in the males and the maximum length of 18.1cm was still in male. The L_∞ of *S.membranaceus* was 37.04 cm in the females where as the maximum length was 28.8 cm in female. The highest *L∞* of female *S.schall* was 30.05 cm with the maximum length of 30.40 cm. The L_∞ in *S.omias*, *S.gambiensis* and *S. membranaceus* were higher than the maximum length of other species of Synodontis under this research. This means that *S.omias*, *S.gambiensis* and *S. membranaceus* had a tendency to live long and grow bigger if the physico-chemical parameters of River Benue are favourable.

The results of this study were different from [15] which computed the $L_{\infty,}$ back calculated, and integrated methods in *S.schall* as 50.4 cm, 49.5 cm and 50.0 cm respectively. Again, the results of this study is different from [16] who observed the L_∞ of 62.74cm, 64.24cm and 63.45 cm for males, females and combined sexes of *S.schall* respectively in Egypt at Gizza. Further, this study is similar to [17] who reported the L_∞ of *S.schall* to be 38.7 cm, *S.clarias* 35.56 cm and *S.membranaceus* 43.8 cm from the Lower Nun River, Niger Delta.

According to [18], growth of fishes differed from species to species and from stock to stock even within the same species as a result of different environmental conditions. [19] posited that the maximum size attained in fishes was generally location specific. A study conducted by [20] revealed that the differences in the maximum size of *Chrysichthys nigrodigitatus* in the Lower Nun River was due to high fishing pressure, environmental pollution and degradation. [10] observed that the variations in the growth parameters of some of the species sampled in the central Amazon appeared to accord with the high degree of environmental variations in the ecosystem. The smaller sizes obtained in this river could also be attributed to fishing pressure and environmental pollution and degradation.

In this study, *S.clarias, S.omias, S.gambiensis* and *S.membrnaceus* had negative hypothetical age at which length was zero (t_0) and positive in *S.membranaceus* male and female and *S.schall* male and female. The results of this study was different from the work of [21] who observed a negative t_0 of -1.543 in *O.niloticus* from a tropical shallow Lake in Mexico. Similarly the result of this study was different from [22] who obtained a negative t_0 of -3.93 for *Pellnula leonensis*. The results of this study was similar to the work of [23] who reported positive t_0 values of 0.12 for *O.niloticus* males, 0.66 for females; 0.30 for *S.galilalaeus* males, 0.86 for females and 0.50 for *B.bayad* males, 0.85 for females.

The growth rates (K) of the five species was generally low in *S.clarias* and *S.omias* in male and female sexes. The results of this study showed that the rate at which the males and females of *S.schall* approach L_∞ is similar. Whereas in *S.membranaceus, S.gambiensis* and *S.clarias,* the males had a faster growth rate than the females. The findings of this study was similar with that of [21] and [24].

Growth performance indices of the studied species were very good (Table 1). The results of this work on Growth performance index (Ø') was in conformity with [9] who reported the length performance index (Ø') of 2.63 in *Hemisynodontis membranaceus*. More so, the results was similar to [24] who observed the length performance indices of 2.71 in *S.schall*, 2.63 in *S.membranaceus*, and 3.23 in *S.clarias.* Further, the result was similar to [19] who reported the growth performance indices in length of *S.schall* as 2.689, 2.692 and 2.709 in the males, females and combined sexes respectively. In addition, this research was similar to [28] who observed the performance index of 2.62 and 2.51 in *Schilbe mystus* in Asejire and Oyan Lakes respectively. [30] stated that L∞, K and t_0 were highly related or correlated as K depended on the values of L∞ and $t_{0.}$ With all else held constant, K would be larger for smaller values of L∞.

The results of this study showed high mortality for all the species. Their Natural mortality (M) ranged from 0.5422 in *S.omias* females to 1.3240 in *S.membranaceus* males. Fishing mortality (F) ranged from 0.8214 in S.omias combined to 3.094 in *S.membranaceus* females. Total mortality (Z) of the studied fish was low. The results of this study were similar to that of [20] who observed the total mortality (Z) for *S.schall* and *S.clarias* as 2.1, 1.5 in *S.membranaceus*. In addition, this study was similar to [25] who observed the Z of 2.54, M of 0.88 and F of 1.66 in *Clarias gariepinus* and [23] who obtained low values of mortalities in *S.schall*. This study is different from [28] who obtained the total mortality (Z) of 0.61-1.25 for some fish species in River Katsin-Ala. Again, this work is different from [28] who reported Z, M and F as 4.03, 2.77 and 1.26 respectivly in *Pellonula leonensis*. Fish mortality in this study could be attributed to factors such as fish age, fish predation, environmental stress, parasites, diseases and fishing activities by man [22,30,9].

5. Conclusions

The studied species had potentials to grow more if the existing conditions in the river were favourable. However, among the studied speciesm the growth of *S.gambiensis* was very poor while that of *S.schall* and *S.membranaceus* was good.

The values of the asymptotic lengths obtained in this study from the Walford plots were appropriate for these species in the River Benue.

In the species studied, the hypothetical age at which length is zero (t_0) were all negative in *S.clarias, S.omias, S.gambiensis* and *S.membrnaceus* combined and positive in *S.membranaceus* male and female and *S.schall* male, female and combined.

Recommendation

Based on the findings of this research which showed that growth performance of *S.gambiensis, S.clarias* and *S.omias* in the river was very poor, I recommend that a minimum mesh size of 7.5cm should be enforced to allow these species to reproduce at least once before they are captured.

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References

[1] Nikolsky, G. V. (1963). The Ecology of Fishes. *Academic press*, New York, 35-41.

[2] Lagler, K. F., Bardach, J. E., Litter, R. R. and Passimo, D. R. M. (1977). Ichthyology. *John Wiley and Sons Inc*., 506.

[3] Bagenal, T.B. (1978). Aspects of fish fecundity, pp 75-95. In:S.D.Gerking (ed) Ecology of Freshwater Fish Production, Blackwell Scientific.Oxford England.

[4] Adeyemi, S. O. (2011). Study of some physico-chemical parameters and their effect on Potential Fish Yield in Gbadikere Lake. Bassa, Kogi State, Nigeria. *Pakistan Journal of Nutrition,* 10 (5): 475-479.

[5] Deekae, S.N. & Abowei, J.F.N (2010)a. The mortality, exploitation rate and longevity of Macrobrachium macrobrachion (Herklots, 1851) in Luubara Creek, Ogoni land, Niger Delta, Nigeria. *Journal of Biological Sciences*, 2 (5):323-327.

[6] Ricker, W. E. (1975). Computation and Interpretation of biological statistics of fish populations. *Bull. Fish. Rep. Bill Can. Bull,* 191: 1 - 382.

[7] Pauly, D. (1983). Some Simple Methods for the Assessment of Tropical Fish Stock. *Food and Agricultural Organisation of the United Nations*. FAO Technical Paper 234: 2-41.

[8] Ekelemu K. Jerimoth and Samuel A.A. Zelibe , 2007. Age Determination in *Citharinus citharus* (Pisces: Citharinidae) and *Synodontis nigrita* (Pisces: Mochokidae) in Lake Ona, Southern Nigeria. *Journal of Fisheries International, 2: 4-11.*

[9] Abowei, J. F. N. (2009). Aspects of *Hemisynodontis membanaceus* (Geoffrey- St, Hilare, 1809) Population Dynamics from the Fresh Water Reaches of Lower Nun River, Niger Delta, Nigeria. *Advance Journal of Food and Technology,* 1 (1): 27-34.

[10] Guerreiro A., Amadio S., Fabré N., Batista V. (2018). Estimation of growth parameters of five fish species (Actinopterygii) caught in the central Amazon. *Acta Ichthyol. Piscat*. 48 (3): 303-313.

[11] Reid, M. G. and Sydenhan, H. L. (1979). A check-list of Lower Benue River fishes. Icthyo - geographical review of the Benue River, West-Africa. *Journal of Natural History,* 13: 14-67.

[12] Reed, W., Burchark, J., Hopson, A. J., Jennes, J and Yaro, I. (1967). Fish and Fisheries of Northern Nigeria. *Gaskiya Corporation, Zaria, Northern-Nigeria*, 85-101.

[13] Von. B. (1957). The Endocrinology of Growth, Development, and Metabolism in Vertebrates.

[14] Pauly, D. (1980). On the interrelations between natural mortality, growth parameters and mean environmental temperature in 175 fish stock. *J. Cons. Perm. Int. Explor. Mer*., 39 (2): 175 - 192.

[15] Pauly, D. and Munro, J. L. (1984). Once more on growth comparison in fishes and vertebrates. *Fishbyte*, 2 (1): 21-25.

[16] Araoye, P. A. (1997). Bio-Ecology of a Mochokid *Synodontis Schall* (Bloch and Schneider, 1801) in Asa Lake, Ilorin, Nigeria. Ph. D. Thesis, University of Ibadan, 201.

[17] Abowei, J. F. N. and Hart, A. I. (2009). Some Morphometric Parameters of Ten Finfish species from the Lower Nun River, Delta, Nigeria. *Research Journal of Biological sciences,* 4 (3): 282-288.

[18] Midhat, A. E. K., Mohammed, M. N., A. and Seham, A. I. (2012). Environmental studies on *Synodontis*

DOI: https://doi.org/10.30564/jzr.v3i3.3408

schall (Bloch and Schneider, 1801), (Pisces: Mochokidae) in The River Nile at Gizza Sector, Egypt: Biological aspects of Population Dynamics. *Journal of Fisheries and Aquatic ,* 7: 104 - 133.

[19] Sparre, P., Ursin, E., Venema, S. C. (1992). Introduction to Fish Stock Assessment Part 1, manual FAO. *Fisheries Technical Paper* No. 306/1 Revision 1. Rome FAO, 396.

[20] King, R. P. (1991). The biology of *Tilapia mariae* (Boulenger, 1899), (Pisces: Cichlidae) in a Nigerian Rainforest Stream. Ph.D Thesis. University of Portharcourt, Nigeria, 386.

[21] Abowei, J. F. N., Hart, A. I. (2007). Size, composition, age, growth, mortality and exploitation rate of *Chrysichthys nigrodigitatus* from Num River, Niger Delta, Nigeria. *Afr. J. Applied Zool. Environ. Biol*., (9): 44 - 50.

[22] Gomez-Marquez, J. L., Perila-Mendoza, B. Salgado-Ugarte, I.H., and Arredondo-Figueroa, J. L. (2008). Age and growth of tilapia, *Oreochromis niloticus* (Perciformes: Cichlidae) from a Tropical shallow lake in Mexico. *Revista de Biologia Tropical,* 56 (2). www.Scielo.Sa.Cr/Scielo.php.

[23] Okechukwu, I. O. (2011). Age, Growth and Mortality of *Clarias gariepinus* (Siluriformes: Clariidae) in the Mid-Cross River Flood plain ecosystem, Nigeria. *Revista Biologia Tropical,* 59 (4): 121-127.

[24] Sambo, F. and Haruna M. (2012). Some Aspects of the growth parameters of the fishes of Ibrahim Adamu Lake, Kazaure, Jigawa state, Nigeria. *Bayero Journal of Pure and Applied Science*, 5 (1): 175 - 181.

[25] Lebo, P. E., King, R. P., Etim, L., Akpan, B. E. and Jonathan, G. E. (2010). Breeding Seasonality and population dynamics of the catfish *Schilbe mystus* (Schilbeidae) in the Cross River, Nigeria. *African Journal on Line*, www.:ajol.info/index.

[26] Adedolapo, A. (2007). Age and growth of the African butter catfish, *Schilbe mystus* (Linnaeus, 1758) in Asajire and Oyan Lakes, South-Western Nigeria. *Journal of Fisheries and Aquatic Sciences*, 2: 110-119.

[27] Ogle, D. H. (2018). Growth (Von Bertalanffy) Ogle's Notes. Derekogle.com/NCNRS349/Theme by beautiful-jekyll.

[28] Ogueri, C., Adaka, G. S., Nlewadim, A. A. and Ben-Chendo, G. N. (2009). Comparative analysis of growth parameters and ages of fish species in River Katsin-Ala, Nigeria. *Nigerian Journal of Fisheries*, 6 (1&2): 35-43.

[29] Uneke, B. I., Nwani, C. D., Okogwu, O. and Okoh, F. (2010). Growth, Mortality, Recruitment and Yield of *Pellonula leonensis* Boulenger, 1917 (Osteitchtyes: Clupeidae) in a Tropical Flood River System. *Journal of Fisheries International,* (1): 19 - 26.

[30] Otobo, A. J. T. (1993). The Ecology and fishery of the Pygmy Herring *Sierrthensa leonensis* (Thysvan Den Audenaerde, 1969) in the Nun River and Taylor Creek of the Niger Delta. Ph.D. Thesis University of Port Harcourt, 298.

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