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Length-weight Relationship, Condition Factor and Sex Ratio of Forty Six Important Fishes in a Tropical Flood River

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Abstract A study was conducted on the length-weight relationship, condition factor and the sex ratio of 14,466 fish representing 46 species belonging to 28 genera from 16 families of economically important freshwater fishes inhabiting the 200 km length of Cross River inlands wetlands, Nigeria. Fish samples were collected with artisanal gears (gillnets, cast nets, seine nets) during January 2006 and December, 2007. 87.5% of the species sampled had more males than females. The estimated b value (allometry coefficient) of the equation $W=aL^b$ ranged between 1.92 and 3.65 with mean and mode values of 2.6 ± 0.32 and 3 respectively. 65% of the samples had condition factor greater than the mean (0.77 ± 0.12). Fish Species of Cross River inland wetlands are therefore dominated by male populations, growth trend is mostly isometric (exhibit dimensional equality of the body parameters) and can be described as being in good condition.

Key words: Length-weight relationship, Condition factor, sex ratio, forty six fishes, tropical flood river.

INTRODUCTION

Human activities have fragmented and simplified the tropical wetland habitat. Resources enjoyed by the wetland communities are systematically being destroyed. Sustainable management and conservation of the wetland resources are urgently required. There is need to study some aspects of the biology of species of these water bodies which are the focus of this research. One of the most commonly used in the analysis of Fisheries data is length- weight relationship[21]. The length-weight relationship (LWR) is an important factor in the biological study of fishes and their stock assessments[15,30] It describes the functional regime in weight distribution per unit size of sub-population[16]. Hence, length-weight regressions have been used frequently for the estimation of weight from length because direct weight measurement can be time consuming in the field[29]. The relationship is also useful for assessing the relative wellbeing of the fish population Moreau *et al.*[22] and Bolger and Connolly[9] differentiating taxonomic units, setting yield equations and comparing populations of the same species in space and time[8] thus enhancing the knowledge of natural history of the fish in the inland water mass about which studies are scant in Nigeria. The length-weight values computed for various locations are useful for various ecological parameters of the water body which govern the dimensional variation exhibited by the fish as part of adaptations to freshwater habitat.

In fish length-weight relationship studies, fish body weight has an exponential relationship with its length. The power function; $W= aL^b$ is used to represent the length-weight relationship (When, W=total weight of fish; L=total length; a= constant of proportionality; b= allometry coefficient which most often fluctuates between 2 and 4).

Previous studies on fish length – weight relationship in Africa have been carried out on large rivers e.g. River Niger and Benue [6,33,3,12,35,23] and in all these studies only single species was used for biological assessment. The dearth of information on smaller but economically viable inland water bodies had been reported[23,5,35,17]. None of the studies had multi-species dimension. This study therefore reports on the length-weight relationship and condition factor of 46 economically important freshwater fish species in the Cross River.

MATERIAL AND METHODS

Monthly samples from artisanal fish catch along the 200km length of the Cross River inland wetlands, located at Latitude 4°.25-7° .00 N; Longitude7°.15-9°.30, Nigeria, were obtained during the period January 2004 to December 2006 (Figure 1). The fishing gears

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used in the area include; hand-lines, traps, gillnet, seine nets and cast nets. Total length (TL) of fish was measured to nearest 0.1cm from the tip of the snout (mouth closed) to the extended tip of the caudal fin. Body weight (BW) of individual fish was measured to the nearest O.lg with electronic balance after removing adhered water and other remains from the body surface. Length- weight relationship (LWR) was estimated from the equation; $W = aL^b$ [26] and was logarithmically transformed into logW =loga +blogL. W = weight of fish in grams, L = total length of fish in centimeters, a = constant of proportionality and b = allometry coefficient. The parameters a and b are estimated by method of least squares regression[36] for separate sexes using the log transformed data. The exponent (b) of the LWR was tested for departure from isometry (b=3) using t- statistics[26,11,32]. The comparison between obtained values of t-statistics and respective tabled critical values allowed for the determination of (statistical significance) the b-values, and their inclusion in the range (b=3) or allometric ranges (negative allometric: b<3 or positive allometric b b>3).

The condition factor was determined using the expression by Ricker[27] as K=W 100 / L.K = Condition factor, W= Total body weight, L =Total length.

For the genus and species identifications, the following sources were referred to: Kucuk and Ikiz (2004), Bogutskaya (1997a, b), Elvira (1987), Naseka *et al* (2006) for the Cyprinids; Erkakan *et al* (2007) for the Bagrids, Teugels (1982) for the Clariidae; Fisher et al (1987) for the Clupeidae and Mugilidae. Other samples of fish were identified using Olaosebikan and Raji (1988) and FAO identification sheet[13].

RESULTS AND DISCUSSION

Results: The parameters of the length- weight relationships (a and b values), the sample size, sex ratio and the coefficient of correlation (r) estimated for 46 species belonging to 28 genera and 16 families comprising 14,466 individuals are summerised in Table. 1. The sample size ranged from 16 individuals for *Polypterus senegalus* to 4007 for *Oreochromis niloticus.* Most of the data were based on large samples and thus may be considered reasonably representative and reliable. The smallest sample size corresponds to the infrequent species and the largest samples belong to those which are frequently encountered in huge numbers.

The estimated value of allometry coefficient (b) ranged between 1.92 *(Tilapia guinensis* and *Alestes nurse) and 3.65 (Calamoichthis calabaricus). The mean* b-value for all the species was 2.64 ±0.32 and the mode; 3. Apart from *Tilapia guinensis and Alestes nurse* (1.92); *Hepsetus odoe* (1.96), *Synodontis rabianus* (1.96) *Labeo coubie* (1.99), *Hydrocynus vittatus (2.11), Distichodus rostratus* (2.21) *and Sarotherodon galilaeus* (2.16) also indicated acute negative allometric growth (b < 3, P< 0.05) for overall samples, while *Tilapia mariae* (3.3), *Calamoichthys calabaricus* (3.7), *Alestes macrolepidotus* (3.3), *Clarias aboinensis* (3.4) and *Chrysichthys auratus* (3.4) were positively allometric (b > 3, P< 0.05) for overall samples. The distribution of b values for other species did not significantly deviate from the cube value (b = 3, P> 0.05) (Figure 2). The coefficient of correlation (r) of all species was very high.

87.5% of the overall species sampled had more males than females. Analysis of sex ratio showed that, with the exception of seven species; *Protopterus annectens* (1:2), *Calamoichthys calabaricus* (1:2), *Hepsetus odoe,* (1:1.8), *Distichodus rostratus* (1:3), *Synodontis obesus* (2:4), *Larbeo parvus* (1:1.5) and *Eutropius micropogon* (1:2.5) that indicated more females than males and *Oreochromis niloticus, Saratherodon galilaeus, Mormyrus rume, Mormyrus anguilloides, Clarias gariepinus, Synodontis rabbianus, and Eutropius niloticus* that has equal sexes in the catch, the rest thirty two species had more males than females.

The condition factor of the fish sampled varied from 0.53 for *Synodontis rabianus* and 0.97 for *Calamoichthys calabaricus* with mean of 0.772 ± 0.12 and mode; 0.91 and median; 0.72. Apart from few species like *Hemichromis fasciatus, Denticeps clupeoides, Pellonula vorax, Hepsetus odoe, Hemichromis vittatus, Alestes macrolepidotus, Denticep rostratus, Auchenoglanis occidentalis and Synodontis rabbianus* the distribution of CF values for all species showed that all other samples had condition factor greater than the median and about 65 % higher than the mean (Figure 3).

Discussion: Ranges of allometric coefficient for the 46 species investigated were all within the limits given for finfish[16,28,19]. However, when comparing LWRs available in this study, we found wide variability in parameter estimates for a single species. This may be due to the fact that the LWR is greatly affected by many factors related to population variability and nutritional conditions[27]. The parameters are therefore only useful for the population studies and the awareness of time of sampling is essential. Also it is a well known fact that the functional regression "b" value represents the body form, and it is directly related to the weight affected by ecological factors such as temperature, food supply, spawning conditions and other factors such as sex, age, fishing time and area and fishing vessels[17].

Table 1: Sex ratio and length-weight relationship parameters of forty six fin-fish species in Cross River inland wetlands (January 2006 to December, 2007).

Family/species	Sample Size	Sex Ratio	Mean TL ± SD	[2]a	[3]b	[4]r
Cichlidae:						
Oreochromis niloticus	2007	1:1	16.2 ±4.8	-1.6	2.7	0.95
Tilapia guineensis	214	1:0.5	18.6 ±6.4	-2.3	1.9	0.92
Tilapia mariae	720	2:1	21.3 ±3.3	-2.0	3.3	0.87
Talipiazilli	108	1:0.4	19.4 ±2.8	-2.1	2.2	0.79
Sarotherodon galilaeus	311	1:1	22.2 ±1.4	-2.2	2.2	0.92
Hem ichrom is fasciatus	211	0.5:1	15.5 ±2.4	-3.1	2.6	0.91
Hemichromis bimaculatus	44	1:0.3	14.3 ±1.8	-1.2	2.9	0.88
Protopteridae:						
Protopterus annectens	22	1:2	31.7±7.3	-2.0	2.8	0.86
Polypteridae:						
Polypterus senegalus	16	2:1	22.8 ±5.6	-2.7	2.9	0.89
Calamoichthys calabaricus	21	1:2	43 4 ± 6.8	-3.2	3.7	0.92
Denticeptidae:						
Denticeps clupeoides	216	2:0.7	10.5 ±1.2	-3.2	2.53	0.81
Clupeidae:						
Cynothrissa mento	384	2:1	6.8 ±1.8	0.2	3.4	0.76
Pellonula vorax	411	1:0.6	8.8 ±0.8	-2.7	2.6	0.96
Osteoglossidae:						
Heterotis niloticus	388	2:1	28.6 ± 6.9	-1.9	2.9	0.87
Mormyridae:						
Mormyrus rume	772	1:1	25.2 ±2.5	0.6	3.1	0.82
Mormyrus tapirus	301	1:0.2	22.1 ±3.0	-1.7	2.8	0.85
Mormyrop anguilloides	286	1:1	20.H6.6	-2.4	3.0	0.92
Petrocephalus ansorgii	102	1:0.5	6.8 ±2.2	-3.1	3.1	0.96
Petrocephalus bovei	56	1:0.2	7.1 ±1.5	-2.3	2.9	0.94
Hepsetidae:						
Hepsetus odae	28	11.8	22.6 ±2.1	-3.2	2.0	0.81
Characidae:						
Hydrocynus vittatus	272	1:0.6	18.1 ±4.5	-2.4	2.1	0.95
Alestes nurse	338	*1:1*	13.0 ±2.0	-1.8	1.9	0.92
Alestes macrocephalus	167	1:0.2	15.6 ±5.4	-3.3	0.9	0.54
Distichodontidae:						
Distichodus rostratus	38	1:3	24.1 ±2.6	0.3 2	.2.2	0.79
Clariidae:						
Clarias anguillaris	1500	1:0.6	30.4 ±1.6	-3.0	2.8	0.92
Clarias cameronensis	560	2:1	12.2 ±4.6	-3.1	2.4	0.9

Table 1: Continue

Clarias aboinensis	411	1:0.7	15.6 ±3.2	-2.2	3.4	0.93
Clarias gariepinus	74	1:1	20.4 ±3.2	-2.6	3.0	0.96
Clarias pachynema	158	2:1	13.2 ±2.2	-2.1	2.8	0.95
Heterobranchus longifilis	448	2:1	28.1 ±6.3	-2.3	2.7	0.89
Bagridae:						
Bagrus docmak	23	2:1	22.6 ± 6.3	-3.6	3.2	0.83
Chrysichthys nigrodigitatus	1950	1:0.5	34.6 ±6.9	-2,4	2.6	0.90
Chrysichthys auratus	810	1:0.8	31.2±15.3	-3.3	3.4	0.87
Chrysichthys filamentosus	814	2:1.5	28.6 ±9.4	-3.1	2.8	0.9
Auchenoglanis occidentalis	302	1:0.4	24.7 ± 5,5	-2.4	2.5	0.92
Parachenoglanis guttatus	155	1:5.1	14.6 ±7.5	-1.3	3.0	0.82
Mochokidae:						
Synodontis omias	62	1:0.2	11.7 ±1.9	-1.1	3.0	0.93
Synodontis schall	*355*	*2:1*	*12.6 ±0.2*	0.2	3.1	0.76
Synodontis obesus	102	2:4	10.4 ±1.2	-1.7	2.2	0.91
Synodontis rabbianus	87	1:1	11.1 ± 2.3	-2.8	1.9	0.94
Malapteruridae:						
Malapterurus electricus	58	2:1	108.1 ±4.1	-2.0	3.1	0.9
Cyprinidae:						
Labeo coubie	115	2:1	32.6 ±6.3	-4.5	3.1	0.90
Labeo senegalensis	71	1:0.3	28.1 ±7.8	-1.3	2.6	0.95
Labeo parvus	24	1:1.5	22.2 ±5.5	-2.7	2.0	0.89
Schilbeidae:						
Eutropius niloticus	127	1:1	15.1 ±2.2	1.38	2.8	0.93
Eutropius micropogon	97	1:2.5	13.6 ±1.7	-2.6	3.2	0.88

l=Total length, 2 ^Proportionality constant, 3 = allometry coefficient, 4= correlation coefficient.

For fishes which maintain dimensional equality, the isometric value will be 3. The b value less than 3 indicates that a fish becomes more slender as it increases in length. A value greater than 3 denotes stoutness or positive allometric growth[26]. 76% of the species presented in this study exhibited a trend of isometric growth depicting dimensional equality. This trend contrasts greatly from the deep-sea species where the pattern indicated an acute negative isometry[1,4]. This may be attributed to the ecological parameters at the freshwater environment in which these species have carved their ideal niche. The riverine environment is characterised mainly by high oxygen content, low salinity, high nutrient content and higher productivity in contrast to the permanently oligotrophic deep-sea condition[1]. To counter the scarcity of nutritional resources at deep-sea somatic growth is less important and energy is diverted to reproductive processes[19]. Thus, a drastic change in the maintenance of dimensional equality of the body parameters can be expected at deep sea when compared to riverine species that attain considerable growth before commencement of reproduction. The general trend of negative allometry exhibited by some few fish species and the positive allometry shown by yet a fewer species compared to the isometry observed in most of the species in the study area may be regarded as floodplain adaptations to survive in the different ecological zones of the flood river. Also the existence of fish species with differential growth patterns in the river implied that some species of the populations in the study area had heterogenous groups with body weights varying differently with the cube of total length. Therefore, the dynamics of populations of fish species in the study area cannot be analysed using the same conventional fish population dynamic models most of which assume isometry[26,31,11].

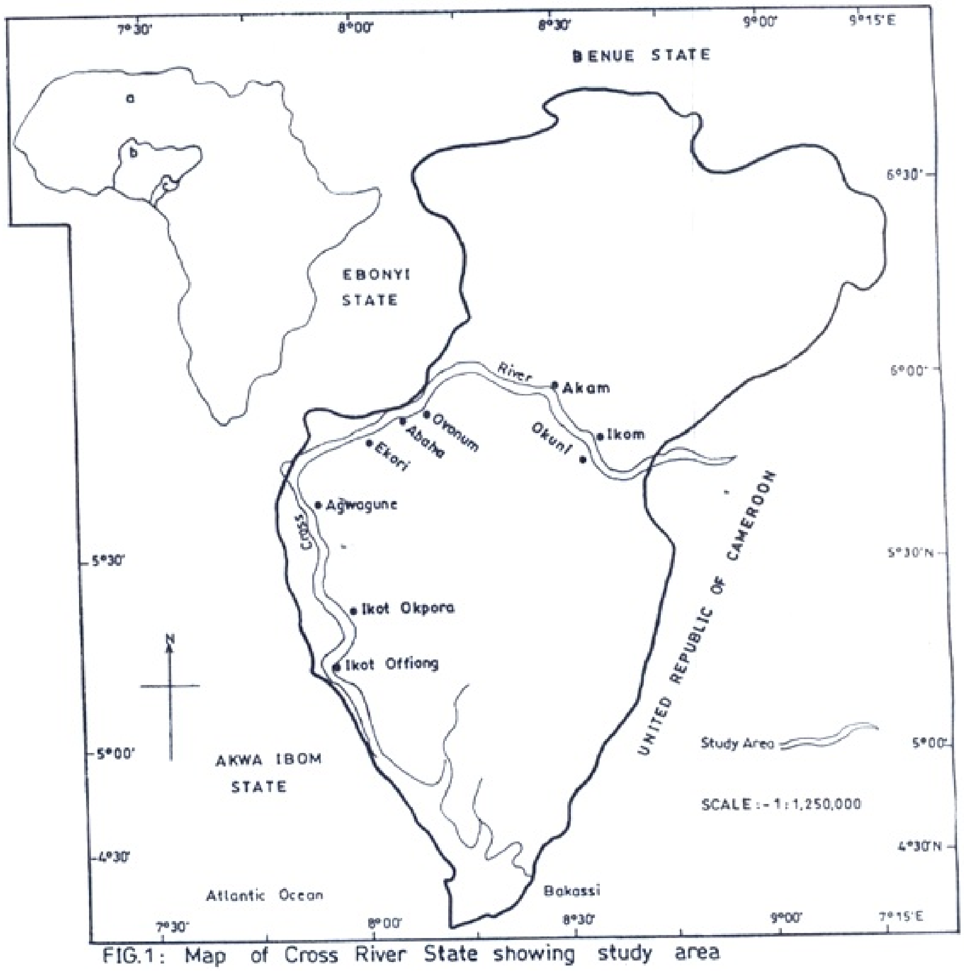

Fig. 1: Map of Cross State of Nigeria showing the study area

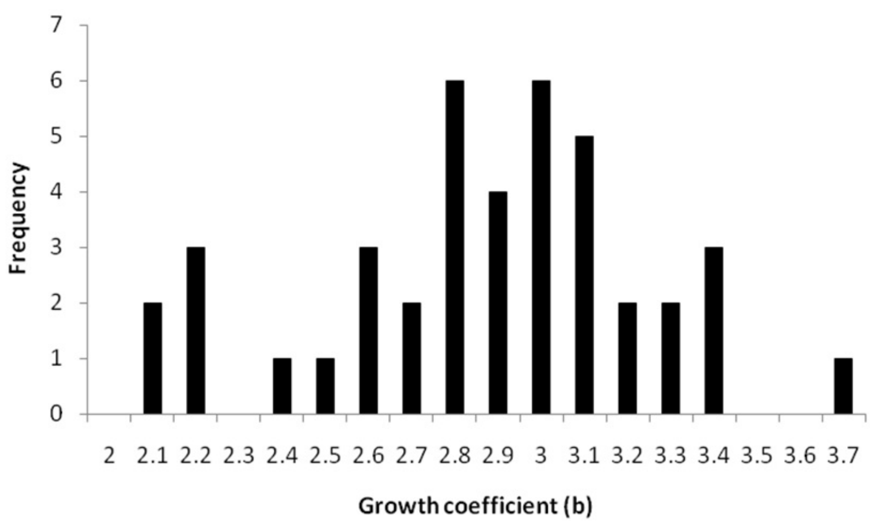

Fig. 2: Frequency distribution of growth coefficient for 46 fish species from inland wetlands, Cross River, Nigeria.

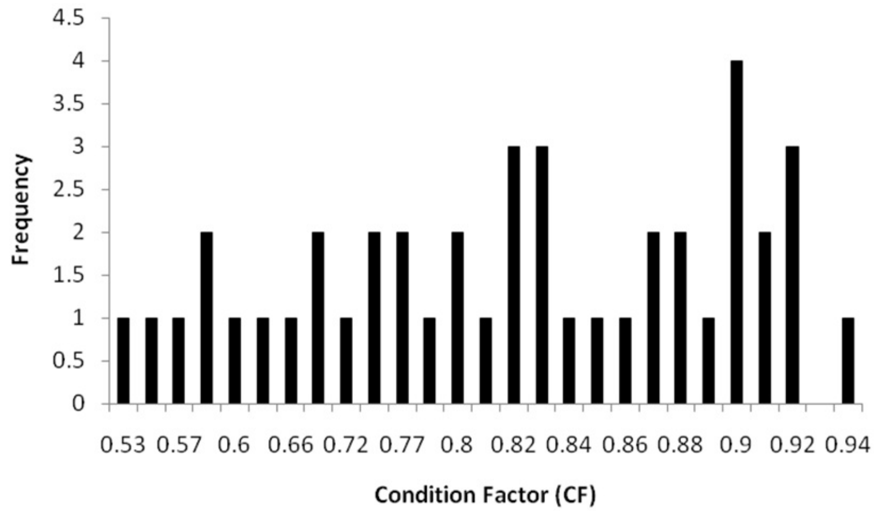

Fig. 3: Frequency distribution of Condition Factor for 46 fish species from inland wetlands of Cross River, Nigeria.

Higher variations in the proportionality constant (a) than in the exponents (b) in all zones of the study area agrees with findings by Bagenal and Tesh[7] who noted that the values of (a) vary with environmental factors where as (b) tends to remain unchanged during a given life phase. King and Udo[16], Akpan and Isangedihi[2] also observed that variability in (a) exceeded (b) in *Pseudotolithus barbarus* and *Pseudotolithus elongatus* respectively.

The fact that 65% of all the 46 species examined had condition above mean and that the overall mean condition factor did not significantly deviate from the value of 1.0, showed that the majority of the fish in the populations of Cross River inland wetlands were in good condition thus justifying the dimensional equality of their growth pattern. The high condition factor of the fish species in the river is an indication of abundant food. Condition factor is an index of physiological well being of fish Moreau *et al*[22] and following Bagenal's[7] explanation about condition factor habitat relationship, the populations of fish are to be considered as adapted to survive in the study area.

Length - weight relationship of fish in the inland water of Cross River depends on the condition of the fish and the fish species. According to Bolger and Connolly[9] the magnitude of the parameters in the length-weight relationship can be used to indicate the condition factor of a population or sub-population. Where growth is isometric (b=3) as in most of the species in the study area, the parameter (a) can be interpreted as the condition factor of the fish by multiplying it by 100, but if (b) is not equal to 3, the value (a) ceases to be an index of condition factor[26,11] and cannot be interpreted biologically. The length-weight parameters of species (male and female combined) in this study are in agreement with this principle. In analyzing population dynamics of the species in the study area different conventional population dynamic models could be useful since the population had heterogenous groups.

The observation in this study of more males (39 species) than females (7species) could be favourable to the fishery because it can serve as a regulatory mechanism for the sex ratio. This may be attributed to majority of the gears being set close to breeding grounds. Fryer and Iies[14] pointed out that in African water bodies it is common that the populations of male fish dominates because they generally present more growth than females without this representing a risk situation for the fishery.

Conclusion: The freshwater fish species in the Cross River inland wetlands are dominated by males. Most of the individual fish are in good condition and show dimensional equality in their growth pattern. The parameters as shown in this can be used in studying growth and population dynamics for any of the 46 species of fish exploited from this region.

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REFERENCES

1. Abhijit, M., 1998. Origin and evolution the deep-sea fauna. J. Indian Ocean St. 5: 251-253.pp.

2. Akpan, A.W. and I.A. Isangedihi, 2005. Dynamics in the length-weight relationship and condition factor of three species of *Pseudotolithus* in three tropical river estuaries. Liv. Sys. Dev. J. 2(5): 33-43.
3. Akpan, E.R., 1994. Dynamics in the length-weight relationship and condition index of three species of *Pseudotolithus* (Pisces :Sciaenidae) in three tropical river estuaries. Liv. Sus. Dev., 2(5): 33-44.
4. Allen, K.R., 1938. Some observations on the biology of trout in Windermere. J.Anim. Ecol., 7: 333-433.
5. Antai, E.S. and S. Holzlohner, 1986. bibliography of a decade (1975-1985) of coastal studies of the Cross River Estuaries and environs by the Institute of Oceanography, University of Calabar, Nigeria. Journal of Coastal Research, 15: 15-35.
6. Arawomo, G.A.O., 1987. The fish fauna of the rivers in the Federal Capital Territory, Abuja Nigeria. Ife Journal of Science, 2(1): 34-45.
7. Bagenal, T.B. and F.W. Tesch, 1978. Age and growth. In: Fish production in freshwater. Eds: T.B. Bagenal, Blackwell, Oxford, London , 120-128.
8. Beverton, R.J.H., And S.J. Holt, 1957. On the dynamics of the exploited fish population. Fish Invest. Minist. Agric. Fish Food, G.B. (2 Sea Fish). 19-533.
9. Bolger, T. and S.J. Connolly, 1989. The selection of suitable indices for measurement and analysis offish condition. J. of Fish biology, 34 (2): 171-182.
10. Carlander, K.,1969. Handbood of freshwater fisheries biology. Ames, lOwa., 10-37.
11. Enin, U.I., 1994. The artisanal shrimp fisheries of the Outer Cross River Estuary, Nigeria. Ph.D Thesis University of Calaber, 226.
12. Etim, L., 1993, Seasonal variation in tissue weight and biochemical composition of *Egeria radiate* (Tellinacea :Donacidae) from Cross River, Nigeria. Tropical Ecology, 34(2): 30.
13. Fischer, W. and G. Bianchi, 1984. FAO Species Identification Sheets for fishery area, 34: 47.
14. Fryer, G. and T.D. Iles., 1972. The Cichlid fishes of the Great Lakes of Africa. Their biology and evolution. Oliver and Boyd. Edinburgh.,641.
15. Gulland, J.A., 1983. Fish stock assessment: a manual of basic methods. FAO / Wiley series on Food and Agriculture. Rome.
16. King, R.P., 1996. Length- weight relationship of Nigerian Coastal water fishes. NAGA, ICLARM Quarterly, 19(4): 53-68.
17. King, R.P. and M. Udo, 1998. Dynamics the Length-weight relationship parameters of the mudskipper, *Periophthalmus babarus* (Gobidae), in Imo River Estuary, Nigeria.Hagolander meers, 52: 179-186.
18. LeCren, E.D., 1951. Length- weight relationship and seasonal cycle in gonad weight and condition in the perch. J. Ani. Ecol., 20: 234-342.
19. Large, P.A. Loranze, P. and J.G. Pope, 1999. Survey estimates of the overall size composition of the deep-sea fish species before and after exploitation. ICES, Center for Environment, Fisheries and Aquacultural Sciences. Lowesoft, U.K.
20. Largler, K.F., J.E. Bardach, R.R. Miller and D.R.M. Passion, 1977. Ichthyologia. Willey, New York,506-52.
21. Mendes, B., P. Fonseca and A. Campos, 2004. Weight -length relationships for 46 fish species of the Portuguese west coast. J. of Appl. Ichth., 20: 355-367.
22. Moreau, J., C. Bambino and D. Pauly, 1986. Indices of overall performance of 100 Tilapia (Cichlidae) population. In: The First Asian Fisheries Forum, Mandila, 201-221.
23. Moses, B.S., 1979. The Cross, Nigeria: its ecology and fisheries . In: Abstract of Intl. Conf. on Kainji Lake and Basin Development in Africa, 11: 335-375.
24. Moses, B.S., 1981. Prelimnary estimate of potential yield of Cross River water fisheries. In: B.S. Moses and G.O.Ilom (Ed). Abstract of the First Cross River State Fisheries conf. Min. of Natural Resouces, Calabar, 41-46.
25. Olaosebikan, B.D. and A. Raji, 1988. Field guide to the Nigerian fresh water fishes. FCFF, New Bussa Nigeria, 106.
26. Pauly, D., 1984. Fish population Dynamics in tropical water: a manual for use with programmable calculators. ICLARM studies and reviews, 8: 325.
27. Rlcker, W.W., 1975. Computations and interpretations of biological statistics of fish populations.Bull. Fish. Res .Bd. Can., 191: 201-210.
26. Royce, W.F., 1972. Introduction to fishery science. Academic Press, New York.
27. Slnovcic, G., M. Franicevic, B. Zorica, and V. Clles-Kee, 2004. Length- weight and length- length relationship of 10 pelagic fish species from Adriatic Sea (Croatia). J. of Appl. Ichth., 20: 156-167.

28. Sparre, P., E. Ursin and S.C. Venema, 1989. Introduction to Tropical fish assessment. Manual. FAO. Fisheries Technical Paper. No. 306. 1, Rome.
29. Sparre, P. and S.C. Venema, 1992. Introduction to tropical fish stock assessment. In: FAO Fish Tech Paper. Eds: I. Nabyak, 1: 1-37.
30. Sumbuloglu, K. and V. Sumbuloglu. 2000. Biyoistatistik.Hatipoglu Yayinlari, 53: 269, Ankara
31. Syndenham, D.H.J., 1979. The qualitative composition and longitudinal zonation of the fish fauna of Ogun River. Western Nigeria. Rev. Zool. Afric, 91(40): 976-996.
32. Tesch, W.F., 1968. Age and growth. In: W.E. Ricker (Eds). Methods for the assessment of fish production in fresh water. IPB Handbook, 3: 93-101.
33. Welcome, R.L., 1976. Extensive aquacultural practices in African floodplains. CIFA Tech. pap., 14(1): 248-255.
34. Zar, J.A., 1984. Biostatistical analysis. Prentice Hall, New Jersey.