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# Some Morphormetric Parameters of Ten Finfish Species from the Lower Nun River, Niger Delta, Nigeria

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**Abstract:** The morphormetric parameters: Length-breadth relationship, growth, mortality and exploitation rate of 10 fish species from the fresh water reaches of the lower Nun river was studied for a period of 2 years, using different fishing gear. All species exhibited positive allometric growth (J>1) with growth rate values (J) ranging from 1.06 (*Parailia pellucida*) to 1.67 (*Synodontis membranaceus*) except *Sphyraena barracuda*, which exhibited negative allometry (J<1) with growth rate values of J = 0.73. The correlation coefficient (r) values ranged from 0.957 (*S. membranaceus*) to 0.994. (*P. pellucida*). "r" values were positive for all species studied. The length attained at age ($L_{max}$) ranged from 12.5 cm (*P. Pellucida*) $t_o$ 59.1 cm (*Clarotes laticeps*) weighting 99.5 and 491.0 g, respectively. The length attained at infinity L∞ ranged from 13.2 cm (*P. Pellucida*) to 60.0 cm (*C. laticeps*). Growth exponent ranged from 2.63 *(S. membranaceus)* to 3.23 (*P. Pellucida*). Length performance index ($ø^1$) ranged from 2.34 (brycinus baremose) to 3.23 (*Synodontis clarias*). Weight performance index (ø) values ranged from 1.48 (*Distichodus rostratus*) to 2.97 (*S. clarias*). Growth coefificent (k) values ranged from 0.26 (*Brycinus dentex* and *Brycinus baremose*) to 0.64 (*Synodontis schall*). The hypothetical age at which length is zero ($T_o$) values ranged from-0.2$yr^{-1}$ (*B. dentex*) to-1.05 (*S. clarias*). The maximum age estimated ($T_{max}$) ranged from 3 (*P. pelluada*) to 6 years (*D. rostratus*). Total mortality (Z) values ranged from 1.1$yr^{-1}$ (*B. baremose*) to 2.1$yr^{-1}$ (*S schall*). Natural mortality (m values ranged from 0.55 $year^{-1}$ (*P. pellucida*) to 1.82$yr^{-1}$ (*S. schall*). Fishing mortality (F) values ranged from 0.17$yr^{-1}$ (*B. baremose)* to 0.87 $year^{-1}$ (*P. pelluada*) values for the Exploitation rate (E) ranged from 0.11$yr^{-1}$ (B. baremise) to 0.67 $year^{-1}$ (*P. pellecida*) with corresponding percentage values of 11 and 45. The study revealed that *S. clarias*, *S. barracuda* and *P. Pellucida* with exploitation rates of 0.54, 0.54 and 0.67, respectively exceed the optimal value for sustainable yield for the exploitation of the fishery. Therefore, these populations stand the risk of over exploitation in the lower Nun River, if urgent measures are not taking to protect their fisheries.

**Key words:** Growth and mortality, length-breadth relationships and exploitation rates, finfish, Niger Delta, Nigeria

## INTRODUCTION

Fish plays an important role in the development of a nation. Apart from being a cheap source of highly nutritive protein, it also contains other essential nutrients required by the body (Sikoki and Otobotekere, 1999). The length-breadth relationship of fish is an important fishery management tool. It is used in evaluating the growth in morphometric parameters relative to total length (King, 1996) and the design of fishing gear (Sikoki *et al*., 1998). The relationship between mean body breadth of fish and mesh selectivity is linear (Ita and Maelahili, 1997).

Fish stock assessment evaluates the effect of fishing on a fishery as a basis for fishery management decisions (Sissenwine *et al*., 1979). The fundamental models used are based on four parameters: Growth, recruitment, natural and fishing mortality (Ricker, 1975). Age and growth are particularly important for describing the status of a fish population and for predicting the potential yield of the fishery. It is essential for the estimation of growth rate, age at maturity, longevity and spawning (Anonymous, 1981). It also facilitates the assessment of production, stock size, recruitment to adult stock and mortalities (Lowe-McConnel, 1987).

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Fish mortality is caused by several factors, which include, age (King, 1991) fish predation (Otobo, 1993), environmental store (Chapman and Van Well, 1978); parasites and diseases (Landau, 1979) and fishing activity (King, 1991). The exploitation rate is an index, which estimates the level of utilization of a fishery. The value of exploitation rate is based on the fact that sustainable yield is optimized when the fishing mortality coefficient is equal to natural mortality (Pauly, 1983). Significant contribution on growth studies have been made by Schaefer (1954), Beverton and Holt (1957), Ricker (1975) and Gulland (1969), among many other scientists, but their studies were concerned primarily with temperate stocks. On the other hand, studies on the population dynamics of tropical fish stock have been limited by the difficult of ageing tropical fish species, which from the ecological perspective inhabit ‘steady-state environment.

Following the adoption of Peterson length frequency distribution method for the ageing of tropical fishes. There have been notable contributions by Longhurst (1964), Gulland (1969) and Pauly (1980) in this area of fisheries research. In spite of these efforts, Length-breadth, growth, mortality and exploitation rate data on many tropical fish species are still lacking.

The Nun river is one of the most important river systems is the Niger delta providing nursery and breeding grounds for a large variety of fish. Fishing in the river is intensified and the catch per unit effort is low. Consequent upon speedy industrialization and other human activities, the river is fast becoming degraded; fishing is carried out indiscrimately with various traditional and modern fishing gears (Sikoki *et al.*, 1998). In spite of the importance of fish and the Nun river fishery, no attempt has been made to assess the length breadth, growth, mortality and exploitation rate of the fish species studied.

Available data on similar or the same water body, but different aspects are often scattered in unpublished reports, consultancy and related studies including the research of Ogbo (1982) (Otamiri river); Dokubo (1982) (Sombreiro river), Akari (1982) (Orashi river); Nwandiaro (1989) (Oguta Lake), Orji and Akobuche (1989) (Otamiri river), Chidah and Osuamkpe (1994) (Bonny river); Sikoki and Hart (1999) (Brass river); Abowei (2000) (Nun River), Ezekiel *et al.* (2002) (Odioku Ekpeye flood plan), Abowei and Hart (2007) (Nun River) and Hart and Abowei (2007) (Nun River). This study provides biological and statistical information on fish species. This is significant to management decisions for the sustainable exploitation of the fishery.

## MATERIALS AND METHODS

The study was carried out in the fresh water reaches of the lower Nun River. The Nun River is one of the numerous low land rivers in the Niger Delta. The Niger Delta Basin covers all the land between latitude 4°14'N and 5°35'N and longitude 5°28'E and 7°37'E (Powell *et al.*, 1985). It extends along the coast from the river basin in the west of Bonny River with characteristic extensive interconnection of creeks. It is the most important rain age feature of he Niger Basin river system with about 2% of the surface area of Nigeria. The annual rainfall of the Niger Delta is between 2,000-3000 mn year$^{-1}$ (Abowei, 2000). The dry season lasts for 4 months from November to February with occasional rainfall.

The lower Nun River is situated between latitude 5°01'E. The stretch of the river is a long and wide meander whose outer concave bank is relatively shallow with sandy point bars (Otobo, 1993). The depth and width of the river varies slightly at different points (Sikoki *et al.*, 1998). The minimum and maximum widths are 200 and 250 m, respectively. The river is subject to tidal influence in the dry season. Water flows rapidly in one direction during the flood (May-October). At the peak of the dry season, the direction is slightly, reversed by the rising tide. At full tide the flow is almost stagnant.

The riparian vegetation is composed of a tree canopy made up of *Raphia hookeri*, *Nitrogena* sp. *Costus*, *Afar*, *Bambosa vulgaris*, *Alchornia cordiholla*, *Alstonia boonei*, *Antodesima* sp. and submerged macrohytes which include: *Utricularia* sp., *Nymphea lotus*, *Lemna erecta*, *Cyclosorus* sp., *Commelia* sp. and *Hyponea* sp. (Sikoki *et al.*, 1998).

**Fish sampling:** Sampling was carried out 4th nightly, between September 1997 and August 1999, using gill nets, long lines traps and stakes. Catches were isolated and conveyed in thermos cool boxes to the laboratory on each sampling day. Fish specimens were identified using monographs, descriptions, checklist and keys (Daget, 1954; Boeseman, 1963; Reed *et al.*, 1967; Holden and Reed, 1972; Poll, 1974; Whyte, 1975; Jiri, 1975; Alfred-Ockiya, 1983; Whitehead, 1984; Loveque *et al.*, 1991).

Total length, weight and breadth of the fish specimens were measured to the nearest centimeter and gramme respectively, to obtain data on length-weight, length-breadth relationships in estimating growth, mortality and exploitation rates of the species studied. The weight of each fish was obtained after draining from the buccal cavity and blot drying samples.

Age was estimated from the length frequency distribution plot using 1900 fish specimens, following the integrated Peterson method (Pauly, 1983). The diagram was repeated 6 times along the time axis and a single continuous growth curve was fitted. The relative lengths were determined from the plot. Length-breadth relationship was determined from the power function by Roff (1986):

$$M = a\,(T_L)^j \tag{1}$$

where:

a = Initial growth constant
J = Growth rate exponent
$T_L$ = Total length of fish

Both coefficients were determined by least square regression analysis after logarithmically transforming all data into the from:

$$\text{Log } M = \text{Log } a + J \log T_L \tag{2}$$

If J = 1.0 then M growth rate is constant and equal to the initial growth consistent (isometric growth), otherwise there is a negative (J<1.0) or positive (J>1.0) allometric growth. The methods used, to obtain the growth parameters of the Von Beta lanffy's growth formula (VBGR) were:

- Ford walford plot $L_t + 1$ was plotted against $L_t$ where + 1 are lengths separated by a year interval. The value of $L_t$ at the point of interception of the regression line with the 45° line gives $L_{oo}$
- Graph of length and weight increments ($\Delta L$) at age against the original length $L_t$ and $W_t$ for the purpose of obtaining $L_{oo}$ and $W_{oo}$
- Graph of $\text{Log}_e\, L_N - L_t/L_N$ to obtain the intercept of the regression line on the time axis

Length performance index Ø was estimated from the equation (Pauly and Munro, 1984):

$$Ø = \text{Log}k + 2 \text{ long } L\infty \tag{3}$$

where, K and L∞ are parameters of VBGR growth performance index.

$$Ø^1 = \text{Log } k + 0.67 \log W\infty \tag{4}$$

where:

k = A parameter of VBGR
W∞ = The mean weight of very old fish

The points at which the growth curve cuts the axis on the sequentially arranged time scale gave the length at age counted from the origin.

From the length at age, the growth parameters: maximum length at age ($L_{max}$), maximum weight attained ($W_{max}$), length attained at finity (L∞), length-breadth exponent (b), growth coefficient (K), hypothetical age at which length is zero. ($T_o$) and maximum time attained for the various species was estimated.

The total mortality coefficient (Z) was estimated from the formula given by Ssentengo and Larkin in Pauly (1983):

$$Z = \frac{nk}{(n+1)\,(L\infty - 1^1/L\infty - 1)} \tag{5}$$

where:

n = Number of fish used in computing the mean length T
$1^1$ = Smallest fish that is fully represented in the catch
K and L∞ = Parameters of the VBGP

An independent estimate of Z was obtained from Hoeing formular in Ehrhardt *et al*. (1983):

$$Z = 1.45\text{-}1.01\ T_{max} \tag{6}$$

where, $T_{max}$ = Longevity (years), Natural mortality coefficient (M) was estimated from Taylor's formula in Ehrhart *et al*. (1983):

$$M = 2.9957T_0 + 2.9975k \tag{7}$$

Fishing mortality coefficient (F) was estimated as:

$$F = Z\text{-}M \text{ (Gulland, 1971)} \tag{8}$$

The exploitation ratio was estimated using the formula:

$$E = F/Z \text{ (Gulland, 1971)} \tag{9}$$

## RESULTS

The length exponents, correlation coefficient and significance of correlation of the length-breadth relationships of 10 fish species from the Nun river fishery are presented in Table 1. All fish species exhibited positive allometric growth (J>1) with growth rate values (J) ranging from 1.6 (*Parailia pellucida*) to 1.67 (*Synodontis membranaceus*) except *Sphyraena barracuda* which exhibited negative allometric growth (J<I) with a growth rate value (J) = 0.73 (*Synodontis membranaceus*) to 0.994 (*Parailia pellucida*. "r" values were positive for all fish species studied.

Table 2 shows the growth parameters of 10 fish species from the fresh water reaches of lower Nun River. The maximum length at age attained $L_{max}$ ranged ($L_{max}$)

Table 1: Length-breath relationship of selected fish species from the Nun River

| Fish species | Growth rate exponent | Correlation coefficient | Significance of correlation |
|---|---|---|---|
| Parailia pellucida | LogM = 1.5 log $T_L$ | 0.994 | $p<0.05$, t = 213, df = 910 |
| *Clarotes laticeps* | LogM =1.18 log $T_L$ | 0.961 | $p<0.05$, t =131. df = 555 |
| *Brycinus baremose* | LogM =1.18 log $T_L$ | 0.990 | $p<0.05$, t =38.2 df = 535 |
| *Brycinus dentex* | LogM =1.09 log $T_L$ | 0.974 | $p<0.05$, t =29.1 df = 512 |
| *Distichodus rostratus* | LogM =1.60 log $T_L$ | 0.968 | $p<0.05$, t =43.5 df = 507 |
| *Synodontis schall* | LogM =1.25 log $T_L$ | 0.977 | $p<0.05$, t =37.6 df = 508 |
| *Synodontis clarias* | LogM =1.33 log $T_L$ | 0.964 | $p<0.05$, t =33.4 df = 556 |
| *Synodontis membranaceus* | LogM =1.67 log $T_L$ | 0.957 | $p<0.05$,, t =29.6 df = 512 |
| *Gnathonemus tamandua* | LogM =1.23 log $T_L$ | 0.983 | $p<0.05$, t =34.1 df = 506 |
| *Sphyraena barracuda* | LogM =0.73 log $T_L$ | 0.962 | $p<0.05$, t =31.5 df = 549 |

Table 2: Growth parameters of ten fish species from the fresh water reaches of the lower Nun River

| | Growth parameters | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Fish species | $L_{max\,cm}$ | $W_{max\,(g)}$ | $L_\infty$ (cm) | b | $\theta^1$ | Ø | $K_{yr\text{-}1}$ | $T_{oyr}$-1 | $T_{max\,yr}$ |
| *Parailia pellucida* | 12.5 | 99.9 | 13.2 | 3.23 | 2.73 | 1.87 | 0.46 | -0.44 | 3 |
| *Clarotes laticeps* | 59.1 | 491.0 | 60.0 | 2.88 | 2.78 | 2.32 | 0.36 | -0.62 | 5 |
| *Brycinus baremose* | 27.9 | 216.3 | 27.5 | 2.93 | 2.34 | 2.61 | 0.26 | -0.33 | 4 |
| *Bruycinus dentex* | 25.5 | 199.6 | 26.5 | 2.74 | 2.83 | 2.78 | 0.26 | -0.20 | 4 |
| *Distichodus rostratus* | 54.0 | 420.8 | 55.0 | 2.76 | 2.87 | 1.48 | 0.27 | -0.46 | 6 |
| *Synodontis schall* | 38.7 | 296.3 | 39.0 | 2.73 | 2.71 | 2.86 | 0.64 | -0.51 | 4 |
| *Synodontis clarias* | 35.6 | 289.8 | 26.0 | 2.79 | 3.23 | 2.97 | 0.43 | -1.05 | 5 |
| *Synodontis membranaceus* | 43.8 | 340.2 | 41.2 | 2.86 | 2.63 | 2.84 | 0.38 | -0.35 | 5 |
| *Gnatheonemus tamandua* | 38.2 | 305.2 | 37.0 | 2.74 | 2.31 | 1.96 | 0.32 | -0.44 | 5 |
| *Sphyraena barracuda* | 34.1 | 249.3 | 30.4 | 2.84 | 3.17 | 2.26 | 0.55 | -0.25 | 5 |

Table 3: Estimated mortality and exploitation values of ten fish species from the lower Nun river

| Fish species | Total mortality (2 $year^{-1}$) | Natural mortality ($Myr^{-1}$) | Fishing mortality ($Eyr^{-1}$) | Exploitation rate | E (%) |
|---|---|---|---|---|---|
| *Parailia pellucida* | 1.4 | 0.55 | 0.87 | 0.67 | 67 |
| *Clarotes laticeps* | 1.2 | 0.87 | 0.33 | 0.27 | 27 |
| *Brycinus baremose* | 1.6 | 1.43 | 0.17 | 0.1 | 11 |
| *Brycinus dentex* | 1.1 | 0.63 | 0.49 | 0.43 | 43 |
| *Distichodus rostratus* | 1.5 | 0.97 | 0.52 | 0.35 | 35 |
| *Synodontis schall* | 2.1 | 1.82 | 0.30 | 0.14 | 14 |
| *Synodontis clarias* | 2.1 | 0.57 | 0.67 | 0.54 | 54 |
| *Synodontis membranaceus* | 1.5 | 1.28 | 0.22 | 0.75 | 15 |
| *Gnatheonemus tamandua* | 1.3 | 0.93 | 0.40 | 0.30 | 30 |
| *Sphyraena barracuda* | 1.6 | 0.79 | 0.81 | 0.54 | 54 |

from 12.5 cm (*Paralia pellucida*) to 59.1cm (*Clarotes laticps*) weighing 99.5 and 491.0 g, respectively. The length attained at infinity ($L\infty$) ranged from 13.2 cm (*Parailia pelucida*) to 60.0 cm (*Clarotes laticeps*). Growth exponent (b) ranged from 2.63 (*Synodontis membranaceans*) to 3.23 (*Parailia pelucida*). Length performance index ($\theta^1$) values ranged from 2.34 (*Brycinus baremose*) to 3.23 (*Synodotis clarias*). Weight performance index values (Ø) ranged from 1.48 (*Distichodus rostratus*) to 2.97 (*Synodontis clarias*). Growth coefficient (K) values ranged from 0.26 (*Brycinus dentex* and *Brycinus baremose*) to 0.64 (*Synodontis schall*). The hypothetical age at which length is zero ($T_o$) range from -0.20 $year^{-1}$ (*Brycinus dentex*) to -1.05 $year^1$ (*Synodontis clarias*) and the maximum age estimated ranged from 3 years (*Parailia*) *pellucida*) to 6 years (*Distichodus rostratus*).

Table 3 Shows the estimated mortality and exploitation value, of the fish species studied. Total mortality (Z) values ranges from 1.1 $year^{-1}$ (*Brycinus* baramose) to 2.1 $year^{-1}$ (*Synadontis schall*). Natural Mortality (M) values ranged from 0.55 $year^{-1}$ (*Parailia pellucida*) to 1.82 $year^{-1}$ (*Synadontis schall*) Fishing mortality (F) values ranged from 0.17 (*Brycinus baremose*) to 0.87 (*Parailia pellucida*). Values for the rate of exploitation ranged from 0.11$year^{-1}$ (*Brycinus dentex*) to 0.67 (*Parailia pellucida*) with corresponding percentage values of 11 and 54.

## DISCUSSION

The length-breath relationship of all species studied exhibited positive allometric growth ($J<1.0$). King (1991) also observed allometric length-breadth growth in lllisha africana in Qua Iboe estuary. The length breadth relationship being alometric means that growth rate was neither constant nor equal to the initial growth constant ($J<1.0$). However, the transform length fitted over breath resulted to a three dimensional growth structure of most fish species (Lagler *et al*., 1977). Values of the length exponent in the length-breadth relationship of the species being allometric implied that studied the breadth of the fish species increased faster than the cube of their total length.

There is linear relationship between the fish body breadth and gill net mesh size selectivity. Ita and Maelahili (1997) reported a linear relationship between body breath and gill net mesh size selectivity. Fish species with larger body-breadth were caught more in larger mesh sizes, while fish with small body breadth swim across nets with larger mesh size because of its small size (Ita and Maelahili, 1997).

The $L_{max}$ values of 12.5, 59.1, 27.9, 25.5, 54.0, 38.7, 35.5, 43.8, 38.2 and 34.1 cm for *Parailia pellucida*, *Clarotes laticeps*, *brycinus baremose*, *Brycinus dentex*, *Distichodus rostratus*, *Synodontis schall*, *Synodontis clarias*, *Synodontis membranacens*, *Gnathonemus tamandua* and *Sphyraena barracuda* respectively, varied for $L_{max}$ values reported for the fish species studied. Reed *et al.* (1967) recorded $L_{max}$ values of 30, 100, 30, 60, 40, 26, 35 and 40 cm, respectively all species studied except *Sphyraena barracuda*, from Northern Nigeria. It has however been shown that the maximum size attainable in fishes is generally location specific (King, 1991). King (1996) attributed the differences in maximum size attained by fish in different water bodies to noise from out board engines and industrial activities. Abowei and Hart (2007) attributed the differences in maximum size of *Chysichthys nigrodigitatus* in the lower river to high fishing pressure, environmental pollution and degradation. The fresh water reaches of the Nun river is often subjected to outboard engine operation. The SPDC Nun river flow station is also located along the river (Abowei and Hart, 2007).

Generally the estimated growth parameters in this study varied from those estimated for some fish species from some water bodies. Spare *et al.* (1992) had already reported that growth parameters differ from species to species and also stock to stock even within the same species as a result of different environmental conditions. In all species studied, the hypothetical age at which length is zero ($T_o$) values were negative. This result compared favourably with the general observation made by Pauly (1983). King (1996) also estimated a negative $T_o$ value for Tilapia marie from Cross river Niger. However, the results from this study varied from the report by Arawomo (1982), who reported positive "$T_o$" values for *Sarotherodon niloticus* in Opa reservoir. Valentine (1995) and Abowei and Hart (2007) also reported positive "$T_o$" values for major cichlids and *Chryschthys nigrogiditatus* from Umuoserche Lake and Nun, river respectively.

The growth performance index of 2.34-3.23 was relatively high. Growth performance index Ø compares the growth performance of different population of fish species. Faster growth rates are defensive mechanism against predators. The maximum age (3-6) years estimated for this study compared favourably with the maximum age of 3-5 years estimate for some fish species in Nun river by Hart and Abowei (2007).

The exploitation rate assesses if a stock is over fished or not, on the assumption that optimal value E ($E_{opt}$) is equal to 0.5. The use of E or 0.5 as optimal value for the exploitation rate is based on the assumption that the sustainable yield is optimized when F = M (Gulland, 1971).

## CONCLUSION

The result shows that *Synodonatis clarias* (0.54), *Sphyraena barracuda* (0.54) and *Parailia pellucida* (0.67) exceed the optimal value for sustainable yield, for the exploitation of the fishery. These populations therefore, stand the risk of over exploitation if urgent measures are not taken to protect the fishery.

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