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Morphometric Parameters of *Parailia pellucida* (Boulenger, 1901) from the Fresh Water Reaches of Lower Nun River, Niger Delta, Nigeria

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Abstract: Morphometric parameters of *Parailia pellucida* from the fresh Water reaches of lower Nun River in the Niger Delta area of Nigeria, was studied for a period of one year (Jan.-Dec. 2007), using five hundred specimens. The regression equation for the length weight relationship was Log W = 0.00001+3.23logL and correlation coefficient was 0.951 at $p<0.05$. The regression equation for length breadth relationship was Log M = 1.50LogT_L and correlation coefficient was 0.994 at $p<0.05$. The largest specimen measured 13.1 cm and weighed 99.6 g at age 3+. Growth increment in length (6.7 cm) was highest in 1-2 years; while growth in weight was highest (74.1g yr^{-1}) in 2-3 years. The Maximum length at age attained L_{max} was 12.5 cm weighing 99.9 g. The length attained at infinity ($L\infty$) was 13.2 cm. Growth exponent (b) was 3.23. Length performance index (θ^1) value was 2.73. Weight performance index value (Ø) was 1.87. Growth coefficient (K) value was 0.46. The hypothetical age at which length is zero (T_o) was –0.44; and the maximum age estimated was 3 years. There was no temporal variation in the condition of the fish through out the year with condition index value ranging from 0.91 – 1.00 and condition factor value of 0.96. Total mortality (Z) value was 1.4yr^{-1}. Natural Mortality (M) value was 0.55; fishing mortality (F) value was 0.87. Value for the rate of exploitation was 0.67 with corresponding percentage value of 67%. *Parailia pellucida* populations from the fresh water reaches of the lower nun river was higher than the optimal value for sustainable yield, for the exploitation of the fishery; therefore stands the risk of over exploitation if urgent measures are not taken to effectively manage the fishery.

Key words: *Parailia pellucida*, morphometric parameters, Nun River, Niger Delta and Nigeria

INTRODUCTION

The glass catfish *P. pellucid* a (Plate 1)are mid water swimmers belonging to the family schilbeidae and are known for their transparent bodies. They have high caloric value, rich in protein, lipid and essential minerals. Their products constitute one of the cheapest source of good quality animal proteins rich in certain amino acids notably methione, tryptophane and lysine needed for healthy growth. They contain more fat than any other fresh water fish. Schilbeidae are also known for their palatability. They are also of commercial importance both in Nigeria and many other countries.

P. pellucida can sometimes be confused with the Siluridae family but the Silurids do not possess an adipose fin and their dorsal are usually very small. Quite easy to keep in the aquarium as the vast majority will accept flake food.

The schilbids play an important role in the ecology and fisheries of West Africa and other inland waters. They constitute an important trophic web of this ecosystem and have been introduced into many artificial lakes and reservoirs such as kivu, Kariba and Tiga dam in parts of Africa (Coulter, 1970). Prior to their introduction into artificial lakes, they had colonized artificial lakes from natural riverside habitats.

Mophometric parameters form the basis for fishery management decisions (Sissenwine *et al.*, 1979). The fundamental tools are length-weight relationship, length breath relationship, growth at age, growth increment, mortality, exploitation and the condition factor (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 also facilitates the assessment of production, stock size, recruitment to adult stock and mortalities (Lowe-McConnel, 1987).

Fish mortality is caused by several factors, which include, age (King, 1991); fish predation (Otobo, 1993), environmental stress (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 contributions on growth studies have been made by Schaefer (1954), Beverton and Holt (1957), Ricker (1975) and Gulland (1969), among many other scientists, but the 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 difficulty of ageing tropical fish species, which from the ecological perspective inhabit 'steady-state environment'.

The length-weight relationship of fish is an important fishery management tool. Its importance is pronounced in estimating the average weight at a given length group (Beyer, 1987) and in assessing the relative well being of a fish population (Bolger and Connoly, 1989). Consequently length-weight studies on fish are extensive. Notable among these are the reports of Shenouda *et al.* (1994) for *Chrysichthys* spp. from the southern most part of the River Nile (Egypt); Alfred-Ockiya and Njoku (1995) for mullet in New Calabar River, Ahmed and Saha (1996) for carps in lake kapitel, Bangladash; King (1996) for Nigeria fresh water fishes; Hart (1997) for Mugil cephalus in Bonny Estuary and Diri (2002) for *Tilapia guinensis* in Elechi creek.

Following the adoption of Peterson length frequency distribution method for ageing 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-weight, Length-breadth, growth, mortality and exploitation rate data on many tropical fish species are still lacking.

Condition factor compares the wellbeing of a fish and is based on the hypothesis that heavier fish of a given length are in better condition (Bagenal and Tesch, (1978). Condition factors decreases with increase in length (Bakare, 1970; Fagade, 1979); and also influences the reproductive cycle in fish (Welcome, 1978). Condition factors of different species of cichlid fishes have been reported by Siddique (1977), Fagade (1978, 1979, 1983), Dadze and Wangila (1980), Arawomo (1982) and Oni *et al.* (1983). Condition factors reported for some other species include: Alfred-Ockiya (2000) for *Chana chana* in fresh water swamps of Niger Delta and Hart (1997) for *Mugil cephalus* in Bonny estuary.

Age studies of fishes form an important aspect of their biology and relationship with their environment. Lackey and Hubert (1981) observed, that it aids in the productivity, longevity, periods of maturity, recruitment of various year classes and determination of potential yield of fish stock. Information obtained on age could contribute to the optimal, or at least a rational exploitation of a fishery.

The Nun River is one of the most important river systems in the Niger Delta providing nursery and breeding grounds for a large variety of fish. Fishing in the river is intensified and catch per unit effort is low. Consequent upon speedy industrialization and other human activities, the river is fast becoming degraded. Fishing is carried out indiscriminately with various traditional and modern fishing gear (Sikoki *et al.*, 1998). In spite of the importance of this schilbeid and Nun River fishery, no attempt had been made to assess some morphometric parameters of *P. pellucida* from the Nun River.

Available data on similar or the same water body but different aspects are often scattered in unpublished reports, consultancy and related studies including the work of Ogbo (1982) (Otamiri River); Dokubo (1982) (Sombreiro River); Akari (1982) (Orashi River); Nwadiaro (1989) (Oguta Lake); Orji and Akobuche (1989) (Otamiri River); Chindah and Osuamkpa (1994) (Bonny River); Sikoki and Hart (1999) (Brass River); Abowei (2000) (Nun River) and Ezekiel *et al.* (2002) (Oduhioku Ekpeye flood plain). This informed this study to provide biological and statistical information on *P. pellucida* from the Nun River.

MATERIALS AND METHODS

Study Area: The study was carried out in the fresh water reaches of the lower Nun River for a period of one year (January-December 2007). 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 4º14′N and 5º35′N and longitude 5º26′E and 7º37′E. (Powell et al; 1985). It extends along the coast from the rivers basin in the West of Bonny River with characteristic extensive interconnection of creeks. It is the most important drainage feature of the 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 mm per year (Abowei, 2000). The dry season lasts for four months from November to February with occasional rainfall.

The lower Nun River is situated between latitude 5º01′ and 6º17′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 meters respectively. The river is subject to tidal influence in the dry season. Water flows rapidly in one direction during the flood (May to 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 hokeri, Nitrogena* sp.*, Costus afer, Bambosa vulgaris, Alchornia cordiffolla, Alstonia boonei, Antodesima* sp. and submerged macrophytes 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 forth nightly for one year (January-December, 2007), using gillnets, long lines, traps and stakes. Catches were isolated and conveyed in thermos cool boxes to the laboratory on each sampling day. *P. pellucida* (Plate 1) was identified using monographs, descriptions, checklist and keys (Daget, 1954; Boeseman, 1963; Reed *et al.*, 1967; Holden and Reed, 1972; Poll, 1974; Whyte, 1975; Jiri, 1976; Alfred-Ockya, 1983; Whitehead, 1984; Loveque *et al.*, 1991).

Plate 1: Lateral view of *Parailia pellucida*

Total length and weight of the fish specimens were measured to the nearest centimeter and gramme respectively, to obtain the required data. 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 six hundred fish specimens (600), following the integrated Peterson method (Pauly, 1983). The diagram was repeated six times along the time axis and a single continuous growth curve was flitted. The relative age (in years) and the corresponding modal lengths were determined from the plot. Total length and weight of fish specimens were measured to the nearest centimeter and grammes respectively, to obtain data on the length-weight relationship.

Length-weight and length-breadth relationship of fish specimens were determined using the exponential equation (Roff, 1986):

$$W = al^{b} \quad (1)$$

Where, b is an exponent with a value nearly always between 2 and 4, often close to 3. The value b=3 indicates that the fish grow symmetrically or isometrically (provided its specific gravity remains constant). Values other than 3 indicate allometric growth: If b>3, the fish becomes heavier for its length as it grows larger.

The methods used to obtain the growth parameters of the Von Bertalanffy's growth formula (VBGF) were:

Ford Walford plot: Lt + 1 was plotted against Lt where Lt+ 1 are lengths separated by a year interval. The value of Lt at the point of interception of the regression line with the 45° lines gave L_∞. Graphs of length and weight increment ▲L at age against the original length L_t and W_t.

The degree of association between the length and weight was expressed by a correlation coefficient "r". The correlation coefficient could take values ranging between – 1 and +1. When "r" is negative, it means that one variable tends to decrease as the other increases; there is a negative correlation (corresponding to a negative value of 'b' in regression analysis). When r is positive, on the other hand, it means that the one variable increases with the one (which corresponds to a positive value of b in regression analysis) (Pauly, 1983).

However, whether the correlation that was identified could have arisen by chance alone, the 'r' value was tested for 'significance'. That is, whether the (absolute) value of "r" was higher than or equal to a critical value of "r" as given in a statistical table.

Length-breadth relationship was determined using:

$$M = a\,(T_L)^{j}, \quad (2)$$

Where a = initial growth constant, J = growth rate exponent and T_L = total length of fish. Both coefficients were determined by least square regression analysis after logarithmically transforming all data into the from:

$$\text{Log } M = \text{Log } a + J \log T_L \quad (3)$$

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.

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

$$Ø = \text{Log } k + 2 \log l_\infty \quad (4)$$

Where k and l_∞ are parameters of VBGR.

Growth performance index $Ø^1$ was estimated from the equation (Pauly and Munro, 1984):

$$Ø^1 = \text{Log } k + 0.67 \log W_\infty \quad (5)$$

Where k is a parameter of VBGR and W_∞ is the mean weight of very old fish. The points at which the growth curve cuts the length axis on the sequentially arranged time scale gave the length at age counted from the origin. The estimation was derived from Pauly (1983).

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

$$z = \frac{nk}{(n+1)\left(L_\infty - 1^1 \big/ L_\infty - 1\right)} \quad (6)$$

Where n = number of fish in computing the mean length T, 1' = smallest of fish that is fully represented in the catch. K and L∞ are parameters of the VBGF.

An independent estimate of Z was obtained from the Hoeing formular in Ehrhardt et al 1975.

$$Z = 1.45 - 1.01\, T_{max} \quad (7)$$

Where T_{max} = Longevity (years)

Natural mortality coefficient (M) was estimated from Taylor's formula in Ehrhardt et al 1975.

$$M = 2.995T_o + 2.9975K \quad (8)$$

Fishing mortality coefficient (f) was estimated as:

$$E = Z - M \text{ (Gulland, 1971)} \quad (9)$$

The exploitation ratio was estimated using the formula:

$$E = F/Z \text{ (Gulland, 1971)} \quad (10)$$

The condition factor (CF) was calculated from the expression

$$CF = \frac{100W}{L^3} \quad (11)$$

Where, W = the fresh body weight in (g), L = total length in cm.

RESULTS

The length-weight regression equation, correlation coefficient (r) and significance of correlation of *P. pellucida* from the lower Nun River is shown in Table 1. The regression equation was LogW=0.0001+3.23logL and correlation coefficient of 0.951 at $p<0.05$.

The length-breath regression equation, correlation coefficient (r) and significance of correlation of *P. pellucida* from the lower Nun River is shown in Table 2. The regression equation was LogM = 1.50LogTL and correlation coefficient of 0.994at $p<0.05$.

Table 3 shows the length and weight at age of the fish species studied. The largest specimen *P. pellucida* measured 13.1 cm and weighed 99.6g at age 3+. The smallest specimen measured 9.8cm and weighed 37.2g at age 1+.

Table 1: Length-weight regression equation, correlation coefficient (r) and significance of correlation for *P. pellucida* species from the lower Nun River

Fish species	Regression equation	Correlation coefficient	Significance of correlation
P. pellucida	LogW=0.0001+3.23logL	0.951	P<0.05,t=21.3,df=910

Table 2: Length-breath relationship of *P. pellucida* from the Nun River

Fish species	Length-breath-equation	Correlation coefficient	Significance of correlation
P. pellucida	LogM = 1.50LogTL	0.994	P<0.05, t=213, df= 910

Table 4 shows the growth increment with age at length and weight for *P. pellucida*. Growth increment inlength was highest in 1-2 years (6.7 cm); while growth in weight was highest in 2-3 years (74.1g yr^{-1}).

Table 5 shows the growth parameters of ten fish species from the fresh water reaches of lower Nun River. The Maximum length at age attained L_{max} was 12.5 cm weighing 99.9g. The length attained at infinity (L∞) was 13.2 cm. Growth exponent (b) was 3.23. Length performance index (θ^1) values ranged was 2.73. Weight performance index values (Ø) ranged was 1.87. Growth coefficient (K) value was 0.46. The hypothetical age at which length is zero (T_o) was –0.44 and the maximum age estimated was 3 years.

The condition index values and factor of *P. pellucida* from the lower Nun River are shown in Table 6. There was no temporal variation in the condition of the fish through out the year with condition index value ranging from 0.91-1.00 and condition factor value of 0.96.

Table 7 shows the estimated mortality and exploitation value, of *P. pellucida*. Total mortality (Z) value was 1.4yr^{-1}. Natural Mortality (M) value was 0.55; fishing mortality (F) value was 0.87. Value for the rate of exploitation was 0.67 with corresponding percentage value of 67%.

Table 6: Condition index values and factors of *P. pellucida* from Nun River

Fish species	Condition index value	Condition factor
P. pellucida	0.91-1.00	0.96

Table 3: Length and weight at age of *P. pellucida* from the lower Nun River

Fish species	Length-at-age (cmyr^{-1})					Weight-at-age (g yr^{-1})				
	1+	2+	3+	4+	5+	1+	2+	3+	4+	5+
P. pellucida	9.8	11.5	13.1	-	-	37.2	78.2	99.6	-	-

Table 4: Growth increment with age at length and weight for *P. pellucida* in the lower Nun River

Fish species	Length-at-age (cm)				Weight-at-age (g yr^{-1})			
	1-2	2-3	3-4	4-5	1-2	2-3	3-4	4-5
P. pellucida	6.7	1.7	1.6	-	32.2	74.1	21.4	-

Table 5: Growth parameters of *P. pellucida* from the fresh water reaches of the lower Nun River

Fish species	Growth parameters								
	$L_{max\ cm}$	$W_{max\ (g)}$	L∞ (cm)	b	θ^1	Ø	K_{yr-1}	T_{oyr}-1	$T_{max\ yr}$
P. pellucida	12.5	99.9	13.2	3.23	2.73	1.87	0.46	-0.44	3

Table 7: Estimated mortality and exploitation values of *P. pellucida* from the lower Nun River

Fish species	Total mortality Zyr^{-1}	Natural mortality Myr^{-1}	Fishing mortality	Eyr^{-1}Exploitation rate	E%
P. pellucida	1.4	0.55	0.87	0.67	67

DISCUSSION

From the functional equation showing the relationship between length and weight, the length exponents "b" varied significantly other studies. *Parailia pellucida* exhibited isometric growth pattern. The "b" value for *P. pellucda* was 3.23. Several authors have reported both isometric and allometric growth for different fish species from various water bodies. King 1991, reported allometric growth patterns for Tilapia species from Umuoseriche lake. King (1996) reported isometric growth for *pseudotolithus elongatus* from Qua Iboe estuary. Ekeng (1990) also reported an isometric growth pattern for *Etmalosa fimbriata* from Cross River estuary in Cross River state. Marcus (1984), obtained an isometric growth patterns for *E. fimbriata* from coastal and brackish water of Akwa Ibom state. Sheneuda *et al.* (1994) also observed an isometric growth patterns for *Chysichthys auratus* from the southern most parts of River Nile and Egypt.

The transformed length fitted over weight gave linear growth indicating the three dimensional growth structures of most fish species (Lagler *et al*., 1977). Values of the length exponent in the length-weight relationship of *Parailia pellucida* being isometric implies that the fish species did not increase in weight faster than the cube of their total lengths. However, the weight of the rest species increased faster than the cube of their total lengths.

The length increment of the ten fish species studied was rapid. Rapid length increment was attained in the first two years, but dropped slightly from the third year. This was in agreement with the reports of Hart (1997) for *Mugil cephalus* in Bonny River, Nigeria and Alessio (1976) for Orbetello lake, Italy but different from the report by Marshall (1978) on the natural lakes, Tanganyika and Kivu. The difference could be attributed to the type of water, lake stability and differences in plankton population.

The mean condition factors ranging from 0.91-1.00 obtained in this study varied slightly with the results from other studies. Ajayi (1982), reported K = 0.77-0.81 for *Clarotes filamentosus* in lake Oguta; Nwadiaro and Okorie (1985) obtained K = 0.49-1.48 in Andoni river. The value obtained from the study showed that *P.pellucida* studied was in good condition. Gayando and Pauly (1997) reported that certain factors often affect the well being of a fish. These include: data pulling, sorting into classes, sex, stages of maturity and state of the stomach.

The length-breath relationship *P. pellucida* exhibited positive allometric growth (J<1.0). King (1991) also observed allometric length-breadth growth in *Illisha africana* in Qua Iboe estuary. Abowei and Davies (2009) also reported allometric length breath relationship for *Gnathonemus tamandua* from the fresh water reaches of the lower Nun River. 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 transformed 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, 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 Madahili (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 Madahili, 1997).

The L_{max} values of 12.5 cm, for *P. pellucida* varied for L_{max} values reported for the fish species studied by others. Reed *et al*. (1967) recorded L_{max} values of 20cm for *Clarotes laticeps*, 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 are 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 and Venema (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. The hypothetical age at which length is zero (T_o) values was negative. This result compared favorably 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 1.87 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) years estimated for this study compared favorably with the maximum age of 3 – 5 years estimate for some fish species in Nun river by Hart and Abowei (1997).

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). The result shows that *P. pellucida* with an exploitation rate of 0.67 is higher than 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 effectively manage the fishery.

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