Current Research Journal of Biological Sciences 1 (1): 28-34, 2009
ISSN: 2041-0778

Age, Growth, Mortality and Condition Factor Study of *Gnathonemus Tamandua* (Gunther, 1862) from the Fresh Water Reaches of Lower Nun River, Niger Delta, Nigeria

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Abstract: Age, growth and mortality of *Gnathonemus tamandua* from the fresh water reaches of lower Nun River Niger Delta Nigeria was studied for one year, using five hundred specimens. The maximum length at age attained L_{max} was 38.2 cm weighing 305.2 g. The length attained at infinity ($L\ \infty$) was 37.0 cm. Growth exponent (b) was 2.74. Length performance index (θ^1) value was 2.31. Weight performance index value (Ø) was 1.96. The growth coefficient (K) value was 0.32. The hypothetical age at which length is zero (T_o) was –0.44 and the maximum age estimated was 4 years. There was no temporal variation in the condition of the fish throughout the year with condition index value ranging from 0.83 – 1.00 and condition factor value of 0.92. Total mortality (Z) value was $1.2 yr^{-1}$. Natural Mortality (M) value was 0.1.3; fishing mortality (F) value was 0.40; value for the rate of exploitation was 0.30 with corresponding percentage value of 30. *G. tamandua* population from the fresh water reaches of the lower Nun River was below the optimal value for sustainable yield, for the exploitation of the fishery. It is therefore stands the risk of under exploitation if urgent measures are not taken to develop the fishery.

Key words: *Gnathonemus tamandua*, length, weight, mortality, condition factor, performance index, Nun River

INTRODUCTION

The blunt-jawed elephantnose, *Gnathonemus tamandua*, is an elephantfish in the genus Gnathonemus and family mormyridae. Other names in English include worm-jawed mormyrid. It is found in murky waters in West Africa. The fish is brown or black with a long elephant-like snout and the mouth is located near the end of this probiscus. Its diet consists of worms, small fish, and insects. In captivity are fairly hard to take care for because they need a narrow range of water temperatures, a large tank, and special food

They 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 riverine habitats.

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 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), Boverton 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.

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Notable among these are the reports of Shenouda *et al.* (1994) for *Chrysichthys sp.* 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, 1979). 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 (1978) 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 mormyrid and Nun River fishery, no attempt had been made to assess the population parameters of *Gnathonemus tamandua* 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); Nwandiaro (1989), (Oguta Lake); Orji and Akobuche (1989), (Otamiri River); Chindah and Osuamkpe (1994), (Bonny River); Sikoki and Hart (1999), (Brass River); Abowei (2000), (Nun River); Ezekiel *et al.*, 2002; (Oduhioku Ekpeye flood plain). This informed this study to provide biological and statistical information on *Clarotes lateceps* from the Nun River.

MATERIALS AND METHODS

Study Area : 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 4º14¹N and 5º35¹N and longitude 5º26¹E and 7º37¹E. (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 5º01¹ and 6º17¹E. 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 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, Costus afer, Bambosa vulgaris, Alchornia cordiffolla, Alstonia boonei, Antodesima sp.* and submerged macrophytes which include: *Utricularia, Nymphea lotus, Lemna erecta, Cyclosorus, Commelia* and *Hyponea sp.* (Sikoki *et al.*, 1998).

Fish Sampling: Sampling was carried out forth nightly for one year, using gillnets, 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; Bosseman, 1963; Reed *et al.*, 1967; Holden and Reed, 1972; Poll, 1974; Whyte, 1975; Jiri, 1976; Alfred-Ockya, 1983; Whitehead, 1984; Loveque *et al.*, 1991). Total length and weight of the fish specimens were measured to the nearest centimeter and gram, 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 grams, 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 Walfored 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 45^0 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).

$$Z = \frac{nk}{(n+1)(L_\infty - 1^1/L_\infty - I)} \quad (6)$$

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 formula 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.

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

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 *Gnathonemus tamandua* from the lower Nun River is presented in Table 1. The regression equation was Log W = 0.0137+2.74logL and correlation coefficient of 0.959 at P<0.05. The length-breath regression equation, correlation coefficient (r) and significance of correlation

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

Fish species	Regression equation	Correlation coefficient	Significance of correlation
Gnathonemus tamandua	LogW=0.0137+2.74logL	0.959	P<0.05,t=29.6,df=512

Table 2: Length-breath relationship of *Gnathonemus tamandua* from the Nun River

Fish species	Length-breath-equation	Correlation-coefficient	Significance of correlation
Gnathonemus tamandua	LogM =1.23 Log T_L	0.983	p<0.05 t =34.1, df = 506

Table 3: Length and weight at age of *Gnathonemus tamandua* from the lower Nun River

Fish species	Length-at-age (cm yr)				Weight-at-age (g yr)			
	1+	2 +	3+	4+	1+	2+	3+	4+
Gnathonemus tamandua	26.8	30.8	34.1	37.1	101.1	209.5	258.2	304.1

Table 4: Growth increment with age at length and weight for *Gnathonemus tamandua* in the lower Nun River

Fish species	Length-at-age (cm)				Weight-at-age (g yr)			
	1-2	2-3	3-4	4-5	1-2	2-3	3-4	4-5
Gnathonemus tamandua	9.3	4.0	3.3	3.0	73.5	107.7	48.7	45.9

Table 5: Growth parameters of *Gnathonemus tamandua* 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_{oyz}-1	$T_{max\ yr}$
Gnathonemus tamandua	38.2	305.2	37.0	2.74	2.31	1.96	0.32	-0.44	5

Table 6: Condition index values and factors of *Gnathonemus tamandua* from Nun River

Fish species	Condition index value	Condition factor
Gnathonemus tamandua	0.83-1.00	0.92

Table 7: Estimated mortality and exploitation values of *Gnathonemus tamandua* from the lower Nun River

Fish species	Total mortality Zyr^{-1}	Natural mortality Myr^{-1}	Fishing mortality Eyr-1	Exploitation rate	E%
Gnathonemus tamandua	1.3	0.93	0.40	0.30	30

of Gnathonemus tamandua from the lower Nun River is presented in Table 2. The regression equation was LogM =1.23 Log T_L and correlation coefficient of 0.983 at P<0.05. Table 3 shows the length and weight at age of the fish species studied. The largest specimen *Gnathonemus tamandua* measured 37.1 cm and weighed 304.1g at age 4^+. Table 4 shows the growth increment with age at length and weight for *Gnathonemus tamandua*. Growth increment in length was highest in 1-2 years; while growth in weight was highest in 2-3 years.

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 38.2 cm weighing 305.2 g. The length attained at infinity (L∞) was 37.0 cm. Growth exponent (b) was 2.74. Length performance index (θ^1) values ranged was 2.31. Weight performance index values (Ø) ranged was 1.96. Growth coefficient (K) value was 0.32. The hypothetical age at which length is zero, (T_o) was –0.44 and the maximum age estimated was 4 years. The condition index values and factor of *Gnathonemus tamandua* 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 0.83-1.00 and condition factor value of 0.92. Table 7 shows the estimated mortality and exploitation value, of *Gnathonemus tamandua*. Total mortality (Z) value was $1.3yr^{-1}$. Natural Mortality (M) value was 0.93; fishing mortality (F) value was 0.40. Value for the rate of exploitation was 0.30 with corresponding percentage value of 30.

DISCUSSION

The length-breath relationship *Gnathonemus tamandua* exhibited positive allometric growth (J<1.0). King (1991) also observed allometric length – breadth growth in *Illisha 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 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 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 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 59.1cm, for *Gnathonemus tamandua* varied for L_{max} values reported for the fish species studied by others. Reed *et al.*, 1967 recorded L_{max} values of 100cm 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 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), Abowei and Hart (2007) also reported positive "T_o" values for major cichlids and *Chrysichthys nigrogiditatus* from Umuoserche Lake and Nun river, respectively.

The growth performance index of 2.32 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, (4) 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 (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 *Gnathonemus tamandua* with an exploitation rate of 0.30 is below the optimal value for sustainable yield, for the exploitation of the fishery. These populations therefore stand the risk of under exploitation if urgent measures are not taken to develop the fishery.

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