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Aspects of *Hemisynodontis membranaceus* (Greffroy-st Hilare, 1809) Population Dynamics from the Fresh Water Reaches of Lower Nun River, Niger Delta, Nigeria

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Abstract: Age and growth and mortality study of *Hemisynodontis membranaceus* 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. 2008), using five hundred specimens. The regression equation for the length weight relationship was Log W = 0.0157+2.86logL and correlation coefficient was 0.966 at $P<0.05$. The regression equation for length breadth relationship was Log M =1.67 Log T_L and correlation coefficient was 0.957 at $P<0.05$. The largest specimen measured 41.7cm and weighed 341.5g at age 4^+. Growth increment in length (12.0cm) was highest in 1-2 years; while growth in weight was highest (102.7g) in 2-3 years. The Maximum length at age attained L_{max} was 43.8cm weighing 340.2g. The length attained at infinity (L ∞) was 41.2cm. Growth exponent (b) was 2.86. Length performance index (θ^1) value was 2.63. Weight performance index value (Ø) was 2.84. Growth coefficient (K) value was 0.38. The hypothetical age at which length is zero (T_o) was –0.35; and the maximum age estimated was 5 years. 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 0.94. Total mortality (Z) value was $1.5yr^{-1}$. Natural Mortality (M) value was 1.28; fishing mortality (F) value was 0.22. Value for the rate of exploitation was 0.30 with corresponding percentage value of 75. *Hemisynodontis membranaceus* 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: *Hemisynodontis membranaceus*, age and growth, mortality, condition factor, Nun River and Nigeria

INTRODUCTION

The moustache catfish, *Hemisynodontis membranaceus* is the only representative of the family mochokidae. Many authors consider H. membranaceus to be a synonym of the genus Synodontis, while others believe it to be a separate genus. A cephalo nuchal shield is present (Burgess, 1989) and is granular in appearance. A membrane covers the maxillary barbels and the mandibular barbels are branched. A large adipose fin is present, which extends from the relatively small dorsal fin to the forked caudal fin (Burgess, 1989). The color is a uniform blue/black.

The gill operculum contains gill rakers, which form a unique palatine organ. This enables the catfish to filter plankton/zooplankton. H. membranaceus is found in the river Volta and its four tributaries. Bugress, 1989 completed another survey of the river Volta in 2001, in which he discovered an alarming decline in the population (2001), due to several factors including over fishing and habitat destruction. He concluded that the species requires immediate assistance by implementing conservation measures. As very small fish (less than 30mm) these fish are patterned with a few large spots on their body. These fade quickly with growth. Can be confused with Brachysynodontis but quick look at the barbells will sort them out. In Brachysynodontis only the maxilarry are membranous and to a lesser degree than in Hemisynodontis.

H. membranaceus inhabits Tropical Africa – Nile basin, Chad, Niger, Senegal, Gambia and Volta River. Its optimum pH and temperature range is 6.5-7.5 and 22.0ºC–25.0ºC respectively. In nature the fish feeds mainly on plankton but this is well substituted in the aquarium by frozen brine shrimp and daphnia, which are eaten in large quantities. A solitary cave is all that is required for this fish. Peaceful and not too antisocial with other catfish excepting other members of its own family. Youngsters appear sociable to each other but become quarrelsome with age. Although, able to be kept with more sedate fish, boisterous central America cichlids are an ideal mix for this fish as their messy eating habits provide plenty of food for the catfish.

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.

Population dynamics (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), 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 mochokidae and Nun River fishery, no attempt had been made to assess the population parameters of *Hemisynodontis membranaceus* 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), Ezekiel *et al*; 2002; (Oduhioku Ekpeye flood plain), This informed this study to provide biological and statistical information on *Hemisynodontis membranaceus* from the Nun River.

MATERIALS AND METHODS

Study Area: The study was carried out in the fresh water reaches of the lower Nun River from January-December 2008. 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 2,000-3000mm 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 5º 01′ 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, 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, 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). 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 45º 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):

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

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).

$$Z = \frac{nk}{(n+1)\,(L\text{-}1\ 1/L\text{-}1)} \quad (6)$$

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

Fish species	Regression equation	Correlation coefficient	Significance of correlation
Hemisynodontis membranaceus	LogW=0.0157+2.86logL	0.966	P<0.05,t=33.4,df=556

Table 2: Length-breath relationship of *Hemisynodontis membranaceus* from the Nun River

Fish species	Length-breath-equation	Correlation-coefficient	Significance of correlation
H. membranaceus	LogM = 1.67Log	TL 0.975	P<0.05 t=29.6 df = 512

Table 3: Length and weight at age of *Hemisynodontis membranaceus* from the lower Nun River

Fish species	Length-at-age (cmyr)					Weight-at-age (g yr)				
	1+	2+	3+	4+	5+	1+	2+	3+	4+	5+
Hemisynodontis membranaceus	29.0	35.0	39.0	41.7	-	110.1	238.0	296.5	341.5	-

Table 4: Growth increment with age at length and weight for *Hemisynodontis membranaceus* 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
Hemisynodontis membranaceus	12.0	6.0	4.0	2.9	90.1	102.7	53.3	43.1

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

Fish species	Growth parameters								
	L_{max}	W_{max}	L∞	b	θ^{1}	Ø	K_{yr-1}	T_{oyr}-1	$T_{max\ yr}$
Hemisynodontis membranaceus	43.8	340.2	41.2	2.86	2.63	2.84	0.38	-0.35	5

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 *Hemisynodontis membranaceus* from the lower Nun River is presented in Table 1. The regression equation was Log W = 0.0157+2.86logL and correlation coefficient of 0.966 at P<0.05.

The length – breath regression equation, correlation coefficient (r) and significance of correlation of *Hemisynodontis membranaceus* from the lower Nun River is presented in Table 2. The regression equation was LogM =1.67 Log T_L and correlation coefficient of 0.975 at P<0.05.

Table 3 shows the length and weight at age of the fish species studied. The largest specimen *Hemisynodontis membranaceus* measured 41.7cm and weighed 341.5g at age 4^+. The smallest specimen measured 29cm and weighed 110.1 at age 1+.

Table 4 shows the growth increment with age at length and weight for *Hemisynodontis membranaceus*. Growth increment in length was highest in 1-2 years(12cm); while growth in weight was highest in 2-3 years(102g 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 43.8 cm

Table 6: Condition index values and factors of *Hemisynodontis membranaceus* from Nun River

Fish species	Condition index value	Condition factor
Hemisynodontis membranaceus	0.87-1.00	0.94

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

Fish species	Total mortality Zyr-1	Natural mortality Myr^{-1}	Fishing mortality Eyr^{-1}	Exploitation rate	E%
Hemisynodontis membranaceus	1.5	1.28	0.22	0.75	75

weighing 340.2g. The length attained at infinity (L ∞) was 41.2 cm. Growth exponent (b) was 2.86. Length performance index (θ^1) values ranged was 2.63. Weight performance index values (Ø) ranged was 2.84. Growth coefficient (K) value was 0.38. The hypothetical age at which length is zero (T_o) was –0.35 and the maximum age estimated was 5 years.

The condition index values and factor of *Hemisynodontis membranaceus* 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 0.87 – 1.00 and condition factor value of 0.94.

Table 7 Shows the estimated mortality and exploitation value, of *Hemisynodontis membranaceus*. Total mortality (Z) value was $1.5yr^{-1}$. Natural Mortality (M) value was 1.28; fishing mortality (F) value was 0.22. Value for the rate of exploitation was 0.75 with corresponding percentage value of 75.

DISCUSSION

The length-breath relationship *Hemisynodontis membranaceus* exhibited positive allometric growth (J<1.0). King (1991) also observed allometric length – breadth growth in *lllisha 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 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 43.8cm, for *Hemisynodontis membranaceus* 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 Davies 2009,).

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) 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 2.84 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, (5) 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 *Hemisynodontis membranaceus* with an exploitation rate of 0.75 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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