Full Length Research Paper

Aspects of the biology of trap caught *Chrysichthys nigrodigitatus* (Lacepede: 1803) from the New Calabar River, Nigeria

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Length and weight measurements of a population of 513 specimens of trap-caught *Chrysichthys nigrodigitatus* harvested between January and July (excluding May), 2010 were analyzed using the following softwares; FiSAT (Fish Stock Assessment Tool) and Popdyn JFB.xls. Results of the sampled population gave a total length range of 18 to 95 cm, L_{max} (113.8 cm), L_∞ (116.8 cm), L_m (60 cm), L_{opt} (75.9 cm), and weight; 100 to 12,000 g indicating the promising nature of this trap fishery to make significant contribution to food security and socio-economic development if effective management of the fishery can be developed and enforced. The high percentage of occurrence (76%) of length at first maturity L_m is suggestive of the need for more confirmatory research that can lead to the enactment of a limited access fishery law in the form of closed season and closed area along this river system. The negligible occurrence of small sized individuals from catches indicated the appropriateness of this cylindrical metal trap as gear for the sustainable exploitation of *C. nigrodigitatus* fishery.

**Key words:** *Chrysichthys*, trap, population parameter.

INTRODUCTION

The Nigerian coastline is 853 km (Mondjanagini et al., 1998) and rich in fishery resources. The world has been witnessing decries on the unsustainable exploitation of the fisheries resource. The vision for sustainability in the exploitation of the fishery resource has culminated into researchers investigating the potential yield of water bodies in terms of fish production (Abdul and Omoniyi, 2007), and the eventual management of such resources. The fishery resource in the New Calabar River is exploited in a subsistent artisanal manner, being characterized by the use of different types of traditional fishing gear such as pipe and drum traps (elongated cylindrical metal that is completely sealed at one end with a valve-like cap at the other end), gill and cast nets, while the craft in use is an unmotorized dugout canoe and paddle.

Many fish species belonging to the families Lutjanidae, Clupeidae, Cichlidae and the Claroteidae comprise catches from the river, but the most abundant are the Claroteidae (silver catfish) and Cichlidae (tilapias). Changes in fish population and structure are due to reproduction, recruitment, growth, mortality, as well as, environmental factors. The pattern of fish population can be predicted from year to year but the type of gear employed for harvest can eliminate certain sizes and ages from a fish assemblage. Over the years, several factors have been identified as causes of fish mortality and these include fish predation, parasitism and other diseases, age, environmental stress and the fishing activity itself. There are increased anthropogenic activities along this river channel hence, the need to have data of its fisheries for future comparative studies.

Chrysichthys nigrodigitatus, of the family Claroteidae plays a pivotal role in the ecology and fisheries of Nigeria in particular, and West Africa at large. They occupy a significant trophic level in the ecosystem and have been

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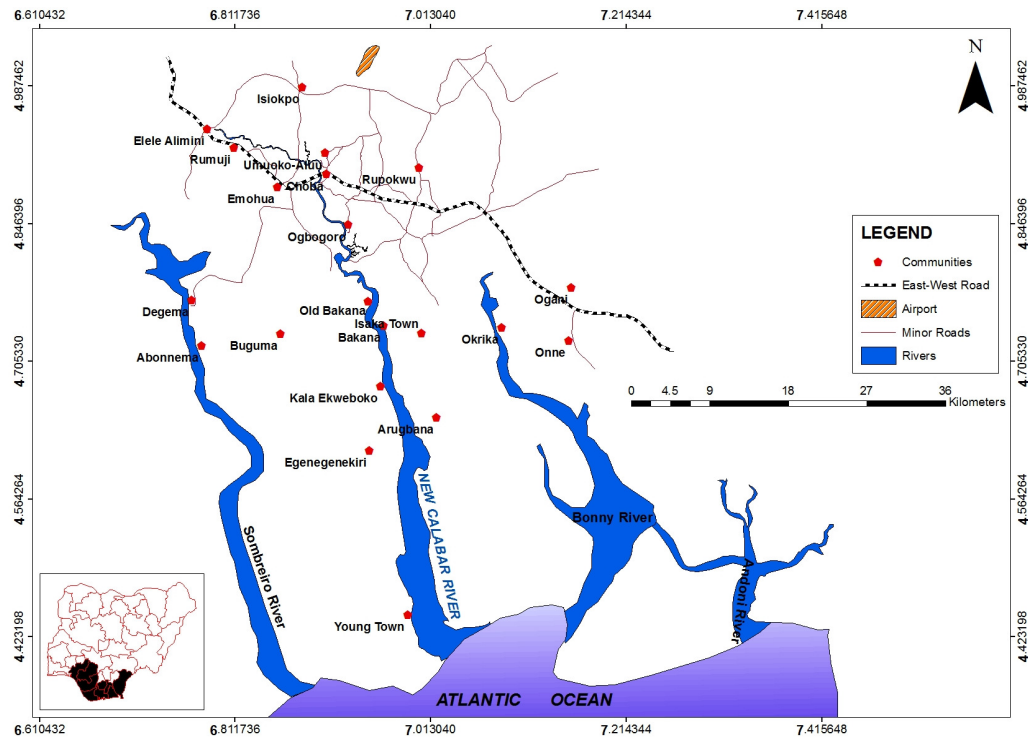
Figure 1. Map of lower Niger Delta showing the New Calabar River drainage system and study area. Inset is map of Nigeria showing position of the lower Niger Delta.

introduced into many artificial lakes and reservoirs such as Kivu, Kariba and Tiga dam in Africa (Coulter, 1970). Introduction of *C. nigrodigitatus* was a fisheries management measure to forestall the problem of fish depletion. Before management measures can be proffered, the status of the fishery needs to be known. Many tools have been developed to determine the state of fish stocks in order to proffer management measures that can either hinder the collapse of the fishery or aid the development of a recovery plan.

Some documented studies on various aspects of *C. nigrodigitatus* in Nigeria and worldwide are works done by Emmanuel and Chukwu (2010); Francis and Erondu (2010); Abowei et al. (2009); Dada and Araoye (2008), Offem et al. (2008), Francis and Sikoki (2007a, b, c), Fafioye and Oluojo (2005), Taiwo and Aransiola (2003), Hart (1997) for *Mugil cephalus* in bonny estuary, Nigeria; Alfred-Ockiya and Njoku (1995) for mullet in New Calabar River, king (1996) for Nigerian coastal waters and Shenouda et al. (1994) for *Chrysichthys* spp. from the Southernmost part of the river Nile, Egypt. Previous studies did not address certain aspects of the biology of *C. nigrodigitatus*. This present work has been carried out to determine length-weight relationship, Fulton condition factor (K), maximum length (L_{max}), length at optimum yield (L_{opt}), length at first maturity (L_m) and asymptotic length, of trap-caught *C. nigrodigitatus* from the New Calabar River. The result from this study will contribute to the knowledge by providing information on the aspects of

the population dynamics of *C. nigrodigitatus* in the New Calabar River that hitherto had not been estimated and form a baseline for comparative purposes with future studies since a lot of anthropogenic activities are on-going within the study area.

METHODOLOGY

Study area

The study was carried out at the New Calabar River. The river, which is located in the coastal area of Niger Delta empties into the Atlantic Ocean (Figure 1). It is one of the important water resources in the Niger Delta in Southern Nigeria and is situated by the crude oil city of Port Harcourt in Rivers State. The river is located between latitude 4°25' N and longitude 7°1'60'' E with the Delta itself having a bearing of 5°45'N and 6°35'N in latitude and 4°50'E and 5°15'E in longitude. Covering a land mass of some 70,000 Km^2, the Niger Delta accounts for about 8% of Nigerian land mass (NDES, 2003). Nwadiaro and Ayodele (1992) described the river as being black in colour and tidal. The river contains fresh water at its upper and middle reaches but brackish towards the mouth. The University of Port Harcourt is located within the middle reaches of the river. The annual rainfall of the region is between 2,000 and 3,000 mm (Abowei, 2000), while the dry season lasts from around March to October and occasional rainfall experienced even during the dry season months of about November to March.

Fish sampling

Samples for the study were gotten from artisanal fishers who land

their catches at the Onumiriahia landing site just before the Choba Bridge (Figure 1). Sampling of landed catch to collect data of length and weight measurements was done twice a week from the month of February to July, once in the month of January, and no sampling in the month of May, 2010. All the catch landed by a randomly selected fisher that used trap was measured. The species was identified using the key (Sikoki and Francis, 2007). The total length (TL) in centimeters of the fish was the measurement from the tip of the anterior most part of the snout to the tip of the caudal fin using a meter rule calibrated in centimeters. Fish specimens were measured to the nearest centimeter and the weight taken after blot - drying with a piece of clean hand towel. Weighing was done with 20 kg table top weighing balance. The length measurements were converted into length frequencies with constant class interval of 1 cm and fed into the Powell-Whetherall plot in FiSAT to obtain $L\infty$ as the output (Gayanilo and Pauly, 1997).

Metal trap fishing operation

The fishers on this river system use wide range of fishing gear such as cast nets, gill nets, and traps (cylindrical metal measuring 1m long and 1.8 m in circumference). Metal traps are among the most important traditional fishing gear on this river. One end of the metal trap was completely sealed while the other end was covered in a valve-like fashion to prevent escape. The valve hinders escape of fish that enters into the trap. Dropped at the bottom of the river at the fishing ground, the trap can be set at any part of the river and at anytime, but it is usually set and left overnight. Fishers engage in trap fishery for about twice a week, but more often for other types of fishery. By means of rope, the position of the trap can be detected and the catch hauled into the canoe.

Data analysis

The Fulton condition factor (K) was calculated by the formula:

$$k = 100 \, W/L^3 \tag{1}$$

Where K = Fulton condition factor, W = weight of the sampled fish (g) and L = Total length of fish (cm).

The length-weight relationship (LWR) was estimated by the regression routine in FISAT. The underlying principle for this estimation is the formula:

$$W = aL^b \text{ (Pauly, 1983)} \tag{2}$$

Where W = weight of fish (g); L =Total length of fish in centimeters; a = Y-axis intercept (a constant); b = length growth coefficient. Equation 2 was transformed into logarithm form:

$$\log W = \log a + b \log L \tag{3}$$

The essence of Equation 3 was to transform it from the curvilinear to the linear length-weight relationship.
The maximum Length L_{max} in the sampled catch was determined using the L_{max} routine in FiSAT.
As $L\infty$ was fed into Popdyn JFB.xls, Lm and Lopt automatically popped up as output.

RESULTS

The results for the Fulton condition factor k, length-weight relationship and length metrics for the *C. nigrodigitatus*

population in the New Calabar River are presented in Table 1, while the percentages and cumulative percentage occurrence of length classes are in Table 2. Fish with the least length (L_m) of 18 cm weighed 100 g, and that with the observed L_{max} of 95 cm weighed 12,000 g. There was monthly variation in the condition factor and the correlation analysis showed negative allometric growth. The values for $L\infty$, L_m and L_{opt} are also reported in Table 1. While L_m fell within the length class having the highest cumulative percentage of occurrence (76%), L_{opt} occurred within the length class where low incidence of cumulative percentage occurrence of 16% was recorded. The result also indicated that most of the landed catches were within the range for L_m which is 44.5 cm – 80.4 cm; all the high values of cumulative percentage occurrence among the length classes hovered around L_m (Table 2).

DISCUSSION

The mean and range of condition factor obtained for *C. nigrodigitatus* in this study can be compared to result of other authors. Condition factor k of 1.31 (mean); range = 0.40 to 1.93 for this present study seems to fluctuate more widely than the values of 0.75 and 0.74 with ranges of 0.49 to 1.45 and 0.69 to 1.48 reported by Francis and Sikoki (2007c) for two consecutive years for fishes from the Andoni river brackish water system. The values of mean K = 1.07 with a range of range 1.02 to 1.19 by Nwadiaro and Okereke (1993) in Otamiri River, South eastern Nigerian also falls within the above ranges though, the *C. nigrodigitatus* from the Otamiri River seems to be in better condition than that of the New Calabar river considering the minimum condition factor of 0.40 obtained in New Calabar river. Various factors that affect the condition of a fish species include environmental factors such as aquatic vegetation Offem *et al*. (2008); food Nwadiaro and Ayodele (1992); stage of maturity, state of stomach fullness, season, and lack of grading into size classes Gayanilo and Pauly (1997) and genetic factors. Offem et al. (2008) however, observed no significant seasonal and inter-sexual differences. Fish samples in the present study were neither sorted by size nor stage of stomach fullness and this could therefore, have been responsible for wide fluctuation in the values of the condition factor. In addition, since the Fulton condition factor reveals the well being of fish species, the New Calabar River appears to be well suited to the growth of *C. nigrodigitatus* when the high value of mean K is considered.

The length-weight relationship of *C. nigrodigitatus*, from the New Calabar river exhibited negative allometric growth of the fish, but isometric in that from the Andoni River brackish water system in two consecutive years (Francis, 2003); such differences can point to a stable and more fitted nature of the brackish water environment for the development of *C. nigrodigitatus* some 10 years

Table 1. Estimates of some biological parameters of trap-caught *C. nigrodigitatus* from the New Calabar River, Niger Delta, Nigeria.

Parameter	Month					
	January	**February**	**March**	**April**	**June**	**July**
Population size	15	100	37	45	110	206
Length range (cm)	36 - 65	31 - 87	44 - 95	44 - 90	30 - 75	18 - 92
Weight range (g)		300 -11,200	1300 -12000	1300 -12000	400 - 4900	100 -10,000
Correlation constant (a)		-0.28	0.01	0.02	0.31	
Length exponent/slope b		2.09	1.93	1.94	2.03	
Correlation coefficient (r)		0.97	0.94	0.93	0.94	
Type of growth		Negative	Allometry			
Range of Fulton K		0.86 -1.93	0.86 -1.81	0.84 -1.88	0.40 -1.88	0.61-1.88
Mean K		1.25	1.28	1.30	1.37	1.34

$L\infty$ 116.8cm + s.e range =   98.5-138.5
L_m 60cm + s.e range   =   44.8-80.4cm
L_{max} 113.8cm + S.E range =   101.34-126.27
L_{opt} 75.9cm + s.e range =   64.2-89.8
$L_m/L\infty$ 0.51
$L_{max}/L\infty$ 0.97

Table 2. Cumulative percentage occurrence of length classes of trap- caught *Chrysichthys nigrodigitatus* from the New Calabar River, Niger Delta, Nigeria.

Length class (cm)	Month sampled/ Frequency of occurrence (% in parenthesis)						
	January	**February**	**March**	**April**	**June**	**July**	**Cumulative % occurrence**
16-20						1(1)	1
21-25						6(3)	3
26-30					3(3)	37(18)	21
31-35		5(4)				29(14)	21
36-40	2	4(4)			8(8)	20(10)	24
41-45	2	5(5)	3(9)	2(5)	11(10)	21(11)	40
46-50	6	14(14)	2(6)	4(9)	27(25)	32(16)	70
51-55		8(8)	4(11)	6(14)	21(19)	23(12)	64
[a] 56-60	2	16(16)	5(14)	7(16)	22(20)	20(10)	76
61-65	2	12(12)	8(22)	6(14)	6(6)	10(5)	59
66-70	1	12(12)	6(17)	6(14)	10(9)	3(2)	55
71-75		7(7)	4(11)	5(12)	1(1)	1(1)	32
76-80		9(9)	1(3)	1(3)		1(1)	16
[b]81-85		6(6)	2(6)	4(9)		1(1)	22
86-90		1(1)	1(3)	3(7)		1(1)	22
91-95		1(1)	1(3)				4
Population size	15	100	37	45	110	206	513

[a] - length class where L_m occurred; [b] - length class where L_{opt} occurred.

back. Besides, if the *C. nigrodigitatus* from the Andoni and New Calabar rivers are of different stocks, it can account for observed differences in growth (Gayanilo and Pauly, 1997). Furthermore, climatic change and temporal effects can show up in the growth of the fish stocks since there is a gap of 10 years between the periods of collection of the two sets of data from the two rivers.

Ecoutin et al. (2005) reported isomeric growth for *C. nigrodigitatus* with b value of 3.127 ± 0.34 in the Gambia while Offem et al. (2008) noted isometric and allometric growths at the upper and lower reaches of the Cross River estuary, Nigeria and these two reaches had vegetation cover of grass, and mixture of grass and forest respectively indicating that the type of vegetation cover

along the river can affect fish growth, especially for herbivorous ones.

High values of length indicators of *C. nigrodigitatus* population in this study, L_m, L_{opt} and $L\infty$ reveal that this trap fishery in New Calabar River is still a viable one when compared to previously reported values (Emmanuel and Chukwu, 2010; Francis and Erondu, 2010; Offem et al., 2008; Ofori-Danson et al., 2002; Nawa, 1987). As has been noted earlier, the species occurring in these two coastal ecosystems of the Cross river estuary and Andoni river are all in the Niger Delta and may be of different stocks. The identification of Lopt around the length class having the highest cumulative percentage occurrence in the catches could be revealing a thriving fishery whose management should commence in order to avoid growth overfishing or serious depletion issues since rapid urbanization, especially, sand dredging is on-going along this river.

Already, the cumulative percentage occurrence of the length class containing L_{opt} is low (16%), as such, it can be interpreted as lower incidence of fishing at high biomass. The fishery is efficient when fished at high biomass. In addition, the seemingly low incidence of cumulative occurrence of L_{opt} in the catch is suggestive of the need to establish and enforce fisheries management measures to avert unsustainable exploitation of this fishery. Though other population parameters such as T_{max} (maximum age of fish), K (growth curvature), t_o (age at length zero) and mortalities were not determined in this study since the sampling duration was six months, *C. nigrodigitatus* in this ecosystem seems to grow to longer lengths and bigger sizes compared to results from Lake Volta, Ghana (Ofori-Danson et al., 2002).

Conclusions

The observed variations in the condition factor and parameters of the length-weight of *C. nigrodigitatus* is not out of place since the samples were pooled in spite of differences of stage of maturity, sex, state of stomach fullness; differences in stock populations, different growth rates at different stages of development and seasonal variations. In addition, it can be safely deduced that the hydrographic conditions of the New Calabar river was very suitable for the growth of *C. nigrodigitatus* in the light of the high values of observed length metrics (Lm, Lmax, Lopt and L∞) that characterized its population compared to values from previous studies.

The fishers are encouraged to engage in this fishery for now, since fish migration has begun to set in due to the sand dredging activities as confirmed through personal interaction with the fishers. The management of this catfish trap fishery in terms of enacting laws to establish area and season closure is also advocated. Besides, the on-going sand dredging and other urbanization activities along this river should be executed according to

international standards, and not to the detriment of this seemingly thriving fishery. The low incidence of L_{opt} as evident in the low cumulative percentage of its occurrence points to the need to speed up action for its management programme. This metal trap as a gear is recommended for the sustainable exploitation of *C. nigrodigitatus* fishery since the occurrence of its small sized fishes was negligible among the sampled population.

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