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RECRUITMENT PATTERN AND LENGTH-AT-FIRST-CAPTURE OF THE SILVERCATFISH CHRYSICHTHYS NIGRODIGITATUS LACÉPÈDE (1803): CLAROTEIDAE IN LOWER CROSS RIVER, SOUTHEAST NIGERIA

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ABSTRACT

The recruitment pattern and length-at-first-capture of ***Chrysichthys nigrodigitatus*** *from lower Cross River, Nigeria, were derived from 12 consecutive month length - frequency samples (October 2011 to November 2012) using FAO – ICLARM Stock Assessment Tools (FiSAT II) software. Recruitment was continuous all year-around with two peaks of unequal pulses: the major in March-April (15.19-15.32%) and minor in July-August (11.10-13.16%), apparently occurring during rainy and early dry seasons, respectively. No recruitment was observed in October. The recruitment pattern observed was consistent with the general spawning pattern of the species (April - August) reported by earlier researchers. The probability of capture routine estimated the mean length-at-first-capture,* L_c *= 36.24 cm. The mean ratio of length-at-first-capture* (L_c) *to asymptotic* (L_∞) *was 0.309 indicating the length at-first-capture was quite low for the population indicating higher fishing pressure on the stock, thereby endangering the health status of the resource.*

Key words: Artisanal fishery, fishing season, logit transformation, resource sustainability, running average.

INTRODUCTION

Recruitment is the entrance of young fish into the exploited fishing area where they become liable to capture by the fishing gear (Gulland, 1971). It also refers to the addition of new fish to the vulnerable population by growth from among smaller-sized individuals (Gayanilo & Pauly, 1997); or Recruitment is the movement of young fishes from nursery area into the main fishing ground (Pauly, 1984). Thus, recruitment is a major source of variability in fish populations.

The mean age at recruitment (Abowei *et al.*, 2008) and recruitment pattern of fish generally depend on the type of gear used in fishing. The recruitment pattern affords the identification of the number of recruitment pulses per year and their relative importance to each other. Generally, a recruitment curve is derived from a proper knowledge of the biology of the species concerned and estimation of the recruitment pattern based on size composition of actual catches with known selectivity of gear. Recruitment is also a very crucial phenomenon in fisheries as it determines the magnitude of catch that can be taken year to year from a fish stock (Pauly, 1984; Biswass, 1993).

Changes in length-at-first-capture (L_c) predict the response of relative yield-per-recruit of the species. Hence, it is an important input in the computation of the potential yield of a fishery (relative yield -per- recruit or relative biomass-per-recruit) and the exploitation level that produces the maximum yield-per-recruit (E_{max}). In addition, the L_c is a very vital parameter when used along with length-at-first-maturity as an indication of the health status of the resource.

Chrysichthys nigrodigitatus (Lacépède, 1803) is of great economic importance and drives ecological structure in the Lower Cross River ecosystem. It is a valuable commodity in rural communities of Nigeria and it forms the bulk of economic rent of the rural households. The livelihood of the artisanal fishers therefore depends on the harvest capacity of this resource. Atobatele & Ugwumba (2011) reported that intensive fishing activity has impacted on fish size as they are not allowed to grow to maximum size. The species belongs to the family Claroteidae and has been described by Reed *et al.* (1967) in Northern part of Nigeria. The population dynamics (growth, mortality and exploitation rate) of the species has been reported for Lake Volta, Ghana; Nun River and Andoni River in the Niger Delta, Nigeria by Ofori–Danson *et al.* (2002), Abowei & Hart (2007) and Francis and Samuel (2010), respectively. Other aspects of its biology studied include age and growth in the Cross River (Ezenwa & Ikusemiju, 1981); condition factor, diet and reproductive biology in the Cross River estuary (Offem *et al.* 2008) and diseases (Obiekezie *et al.* 1988). Zafar *et al.* (1997) reported of two recruitment peaks per year (highest in September and lowest in June) in a coastal shrimp fishery in Bangladesh. The two major recruitment events suggest that two cohorts are possibly produced in a year in Bangladeshi water system. This study will add to the body of data in providing vital scientific information on recruitment pattern and length-at-first-capture of *C. nigrodigitatus* to aid its sustainable management in the Lower Cross River, Nigeria.

DESCRIPTION OF THE STUDY AREA

The study was conducted within the Itu bridge head axis (4°25′ – 7°01′ N; 7°15′ – 9°3′ E; Fig. 1), along the course of the Lower Cross River in southeast Nigeria. The area lies within the rain forest belt with an annual rainfall of up to 2500 mm; wet season spans April to mid-November (Ekanem, 2000); average water depth is 4m (dry season) to 14m (rainy season); mean annual temperature is about 27°C, approximately 30°C maximum April or May, and 22°C minimum in January, giving a narrow range of about 8°C (Etim & Enyenihi,1991; Etim & Brey,1994;

Etim *et al*., 1994). The river annually overflows its banks into the floodplains from July to October (Moses, 1987).

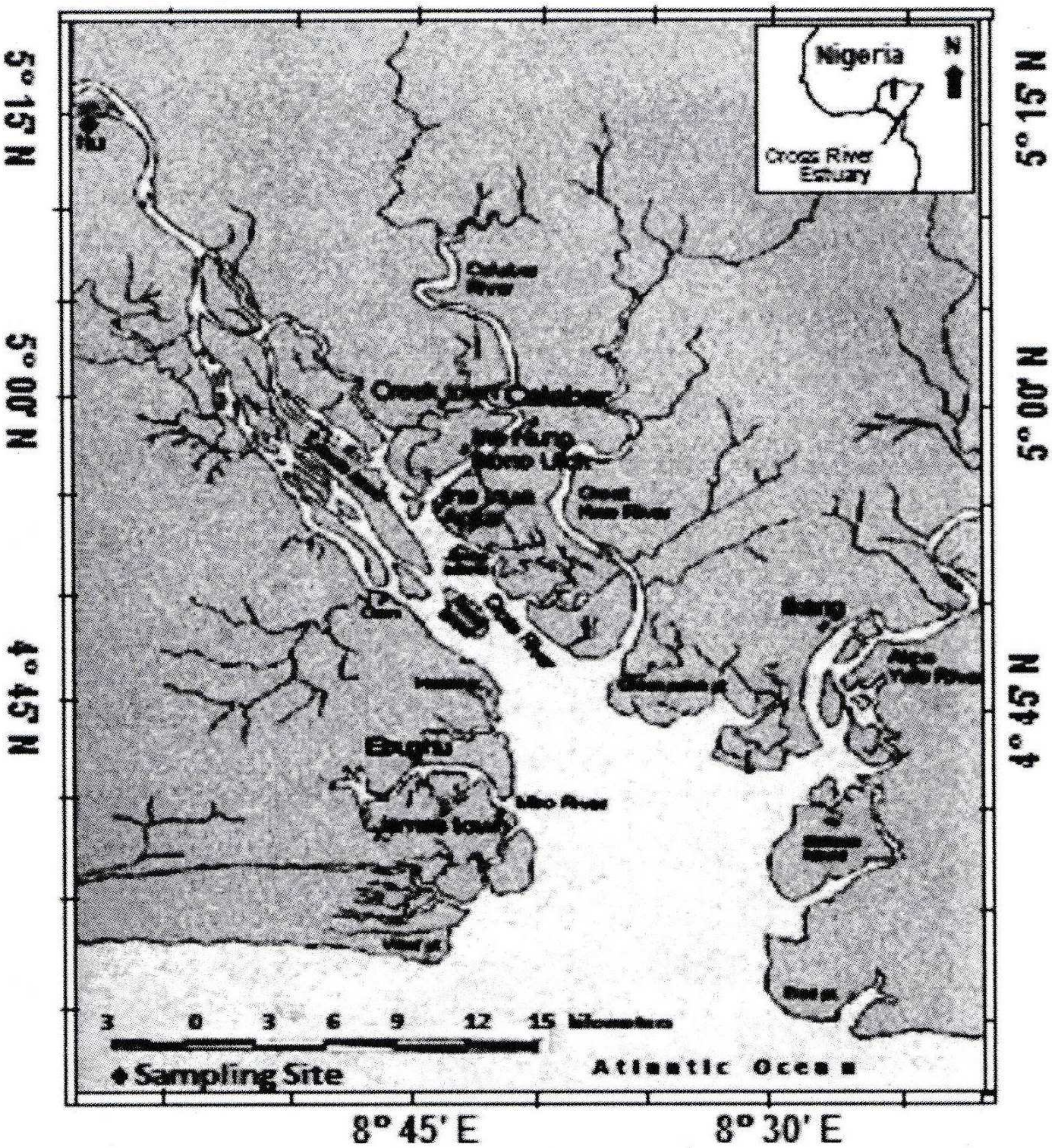

Fig. 1: Map of the Cross River, Southeastern Nigeria showing Itu (Sampling area)

MATERIALS AND METHODS

Field Sampling

A total of 6,846 specimens of *C. nigrodigitatus* caught by artisanal fishers were randomly sampled for 12 consecutive months (November 2011 to October 2012). The fishers employed bottom-set gillnets (22-76 mm stretched mesh) and bottom set traps mounted on wooden canoes November 2011 to October 2012 and landed the catch at Itu beach/bridgehead. The identification and measurement of total length (TL) of each sampled fish, to the nearest 0.01 cm, was recorded according to Fischer & Bianchi (1982) and Olaosebikan & Raji (1988), irrespective of sex. The monthly length data were pooled together in 10 cm length-classes, not above 10 class intervals (Gayanilo *et al.*, 2002) to represent one theoretical annual cycle and analyzed accordingly.

Estimation of the parameters of Von Bertalanffy Growth Function (VBGF)

The parameters of the von Bertalanffy growth function (VBGF): asymptotic length ($L\infty$) and growth coefficient (K) were estimated using ELEFAN-1 routine (Pauly & David, 1981) incorporated in the FiSAT II software. The index of goodness-of-fi (Rn) was calculated as

Rn= 10(ESP/ASP)/10..(1)

Here ASP (available sum of peaks) is the sum of all values of available peaks while ESP (expected sums of peaks) is the sum of all peaks and troughs which the growth curves pass through. The residual of the Gulland and Holt plot from the length-at-age derived from the linking of cohort means, gave the value of the amplitude of growth oscillation and the winter point, WP (the point at which growth was slowest).

Growth Performance Index (Ø')

The estimated L_∞ and K were used to calculate the growth performance index (Ø') of *C. nigrodigitatus* using the equation of Pauly & Munro (1984):

(Ø') $= 2 \log L_\infty + \log K$... (2)

Where L_∞ is the asymptotic length in (cm) and K is the growth coefficient expressed in (yr^{-1}).The growth performance index assessed the reliability of L_∞ and K.

Probability of capture

The probability of capture *P* of each size class *i* was estimated from the ascending left arm of the length-converted catch curve procedure (Pauly, 1987). The method involves dividing the numbers actually sampled by the expected numbers obtained by backward extrapolation of the straight portion or the right descending part of the catch curve in each length class of the ascending part of the catch curve. The plot of the cumulative probability of capture against mid length, a resultant curve was obtained; and smoothed using the logit transformation. From this curve, the length-at-first-capture (L_c) was taken as corresponding to the cumulative probability at 50%.

Seasonal recruitment pattern

The seasonal recruitment pattern of the stock was obtained by back projecting the trajectory defined by the VBGF along the pooled length-frequency data onto a one-year time scale (Pauly, 1987). Thereafter, using the maximum likelihood approach, a Gaussian distribution was fitted to the back projected data to separate them into their constituent time scale following the normal separation (NORMSEP) procedure of Pauly and David (1981) with asymptotic length (L_∞) and growth coefficient (K) as inputs. This resulted in a graph indicating the pattern, number and relative strength of recruitment pulses per year.

RESULTS

Length-frequency distribution and Von Bertalanffy parameters

The monthly length-frequency distribution showed that the 44.5 cm mid length class was the dominant size group and constituted 23.11% of the population, while the least value of 0.12% was observed at 104.5 mid length class (Fig. 2). The estimated parameters of the VBGF are: K= 1.5yr^{-1}, L_∞ = 120.23 cm, C= 0.75, WP= 0.50; the response surface (Rn) = 0.234 and Ø' = 4.045.

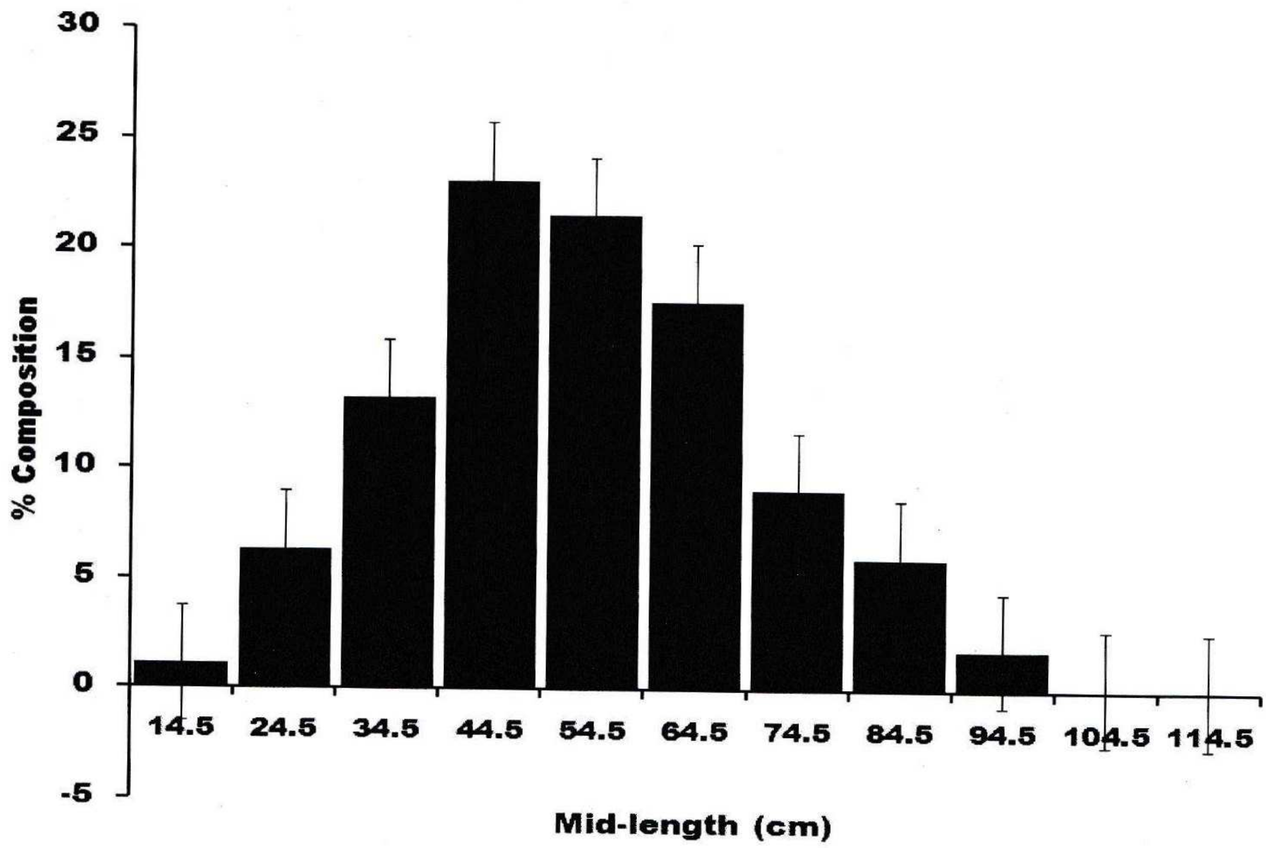

Fig. 2: The length-frequency of *C. nigrodigitatus*from artisanal landings of the Lower Cross River at Itu, Nigeria

Recruitment pattern

The recruitment pattern (Fig. 3a, b) of *C. nigrodigitatus* indicated continuous recruitment with many micro cohorts and two unequal peaks/pulses; the major in March-April (15.19-15.32%) and minor in July-August (11.10-13.16%); while no recruitment were observed in the 12th month of sampling - October (Table 1).

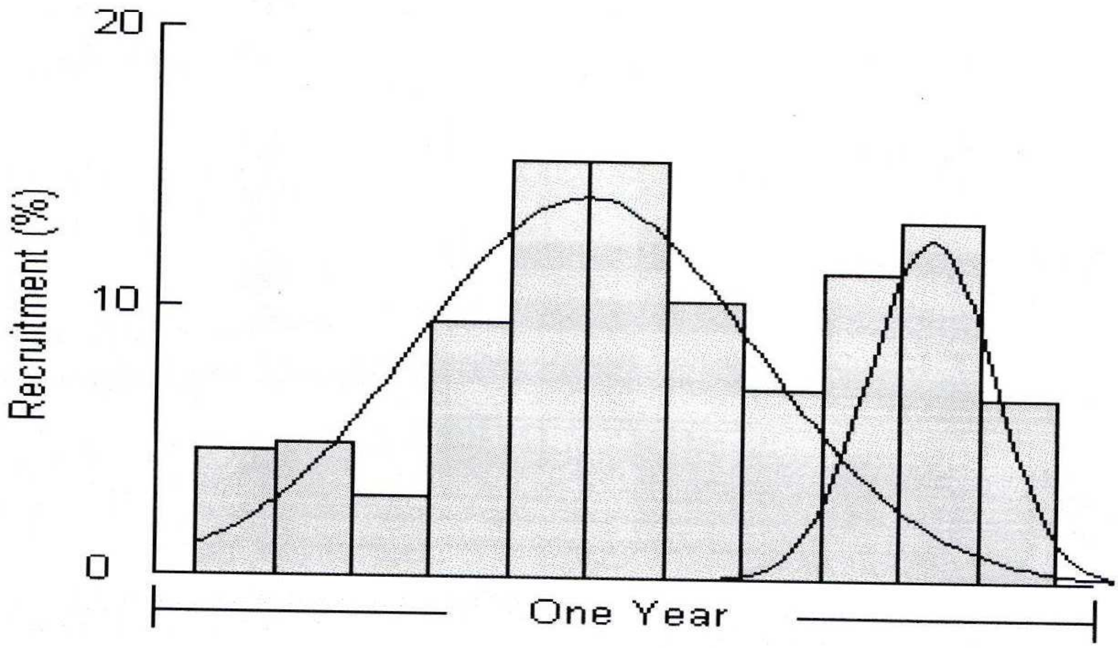

Fig. 3: Backward projection of the restructured VBGF length frequency data of *C. nigrodigitatus* onto an arbitrary one-year time scale with the superimposed recruitment pattern decomposed into pulses exhibiting two peaks of unequal pulse strength

TABLE 1

Recruitment Pattern for *C. nigrodigitatus*

Cohorts*	Relative	%	Cohorts	Relative	%
1	Nov,	4.63	7	May,	10.11
2	Dec,	4.68	8	Jun,	6.99
3	Jan,	2.80	9	Jul,	11.10
4	Feb,	9.41	10	Aug,	13.16
5	Mar,	15.19	11	Sep,	6.60
6	Apr,	15.32	12	Oct,	0.00

*Relative Months

Probability of capture (length- at- first capture)

The probability of capture (Fig. 4a,b) estimated the length-at-first-capture of *C. nigrodigitatus* L_{50}, L_{25} and L_{75} as 37.22, 30.56 and 43.37 cm by Logit transformation and 34.54, 26.88 and 43.24 cm by Running average routines; with , respectively. The mean length-at-first-capture, L_c = 36.24 cm (Table 2).

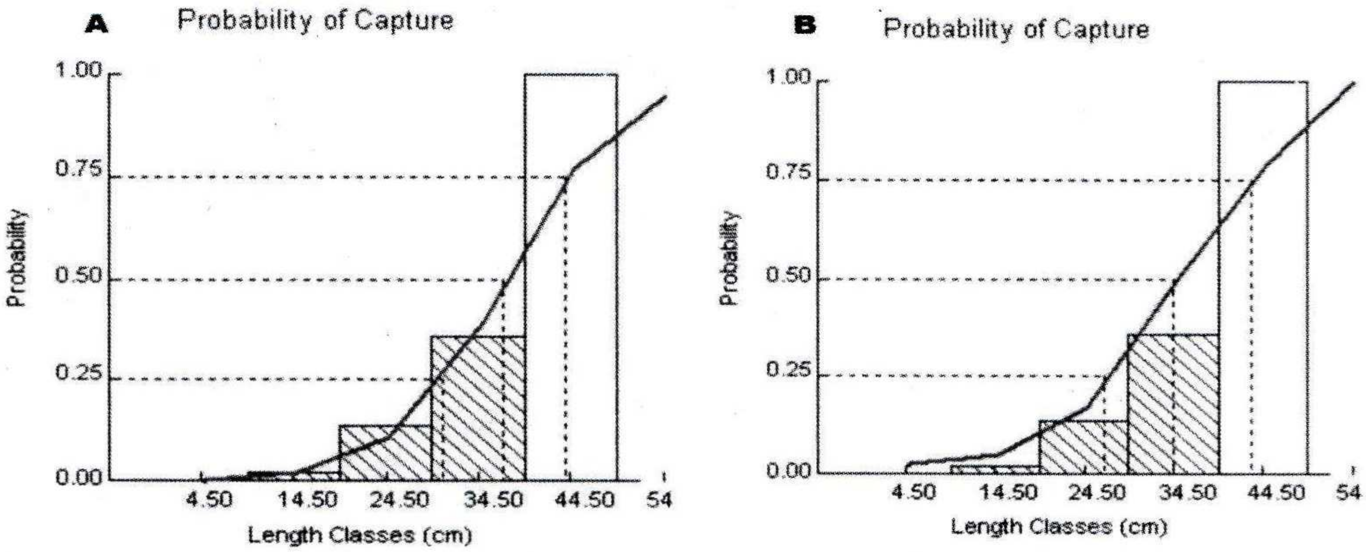

Fig. 4: Probability of capture by length class of *C. nigrodigitatus* estimated from the ascending arm of the catch curve showing the length at first capture L_{50} = 37.22, L_{25} = 30.56, L_{75} = 43.37 by Logistic transformation (a); and L_{50} = 34.54, L_{25} = 26.88, L_{75} = 43.24 by Running average routine (b)estimated from the dotted lines at the middle. It is one of the inputs in computing the relative yield- per-recruit, relative biomass- per – recruit and plotting of the yield isopleths

TABLE 2

Estimate of Length-At-Fist-Capture for *C. Nigrodigitatus* Using Both the Logits and Running Average Routines

Routine	L_{25} (cm)	L_{50} or L_c (cm)	L_{75} (cm)
Logits Transformation	30.56	37.22	43.87
Running Average	26.88	34.54	43.24
Mean	28.72	35.88	43.555

DISCUSSION

Recruitment pattern

Major peak in recruitment in the current study is similar to the observation of Offem *et al.* (2008) which reported peak recruitment during wet season months (April - August) coinciding with breeding period when the rainfall in the area remains above average. This observation agrees with the assertion of Moses (2001) that juvenile abundance and fish population structure relates linearly with flood regime. He asserted especially as it concerns some coastal and estuarine fishes like *C. nigrodigitatus* of the Lower Cross River, Nigeria. The major recruitment peak observed in this study is also in close agreement with the findings of Pauly and Navaluna (1983) for tropical species. In addition, the year-round recruitment observed in this study, has been described to be a normal phenomenon for tropical fish (Qasim, 1973; Weber, 1976; Pauly, 1984) and for short-lived species (Pauly and Navalua, 1983) while the double peaks observed could be adduced to influence of environmental factors (such as temperature, nutrient availability, and others) prevailing in the study area. Mueter *et al.* (2007) assert that the abundance and productivity of commercial fish stocks vary on inter-annual and inter-decadal time scale as a result of environmental variations, species interactions and fishing. The recruitment pattern (Fig. 2) indicates the peaks of the smaller sized fish between April and August; corresponding closely to the spawning pattern of the species.

Moses analysed empirical data and demonstrated the influence of flood regime on the catch and biology of fish species (Moses, 1987) and on *C. nigrodigitatus* (Moses, 2001) in the Cross River flood-plain ecosystem. The recruitment pattern of the *C. nigrodigitatus* in this study corroborates that observations indicating that the flooding of the river system is influenced by rainfall during the wet season months. During these months, rainfall and river discharge (runoff) bring into the system nutrients (organic detritus) which may stimulate the rapid growth of microorganisms and hence of invertebrates which may be fed upon directly by the fish. Also, as the water expands into the forest of the flood plain, it engulfs animals (insects, insect larvae, earthworms, snails, etc.), as well as plant materials and planktonic organisms, which can provide increased food for the fish during the wet season. High tropic flexibility enables the switching from one diet to another according to availability and this is good for the transfer of fuel in the ecosystem (Moses, 2001).

Besides the leaves, branches and stems of the macrophyte provide sufficient cover for eggs, larvae and juvenile of *C. nigrodigitatus,* thereby reducing the amount of predation and natural mortality. Thus, the wet season appears to be the main growth and fattening season for this species and this season influences the reproductive successes and recruitment strength of the bagrid catfish in the Lower Cross River, Nigeria (Offem *et al.,* 2008). Therefore, food availability, spawning pattern, nature of breeding grounds and breeding habits coupled with shelter, hydrological regime, vegetation cover and migration pattern are major influencing factors affecting the distribution and abundance of *C. nigrodigitatus* of the Lower Cross River, Nigeria (Moses, 2001; Offem *et al.,* 2008).

Length-at-first-capture (l_c)

The L_c for *C. nigrodigitatus* were 37.22 cm and 34.54 cm using the logits transformation and running average methods, respectively (Table 3); implying that the smallest size susceptible to the exploitation method is juvenile. The mean ratio of length-at- first-capture (L_c) to asymptotic (L_∞) was 0.309 indicating the fish were caught at 31% of growth, which is quite low for the population. From the management point of view, this is not a healthy trend for the resource and as such calls for a management strategy that will allow the escape of such sizes from the gear used in the resource exploitation. Probability of capture analysis by extrapolation of the length-converted catch curve provides reasonable estimates of mesh size at first capture. The logistic curves assume selection is symmetrical or nearly so, while the running averages smoothen the data sets by interpolating the selection parameters. The L_c serves as a biological index and vital parameter that indicates the health status of the resource and should be considered along with length at first maturity in the management of fisheries resource.

In conclusion, *C. nigrodigitatus* in the Lower Cross River exhibit two recruitment peaks of un-equal strengths, the major in March-April and minor in July-August. The length-at- first-capture is quite low for the population; which may be attributed to higher fishing pressure on the stock. For sustainability of this resource, exploitation should be avoided in the months of June-August, the major breeding season of the stock; to allow young recruits to grow and reproduce thereby ensuring resource sustainability.

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