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Research Article

Length frequency distribution, length-weight relationship and condition factor of cichlid fishes (Teleostei: Cichlidae) from the New Calabar River, Nigeria

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Abstract: This research was conducted to study length frequency distribution, length-weight relationship (LWR) and condition factor of 10 cichlid fishes, viz. *Coptodon guineensis*, *Coptodon zillii*, *Coptodon dageti*, *Pelmatolapia mariae*, *Hemichromis fasciatus*, *Pelvicachromis taeniatus*, *Chomidotilapia guntheri*, *Tylochromis sudanensis, Sarotherodon galilaeus* and *Sarotherodon melanotheron* from New Calabar River. Samples were collected on monthly basis during February to July, 2017. A total of 1073 specimens ranging from 13.12±0.82 to 17.07±0.94cm in total length and 45.00±8.00 to 103.01±25.81g in total weight were collected. The LWR regressions showed that the exponent *b* value ranged from 2.38 (*Coptodon guineensis*) to 3.00 (*Sarotherodon galilaeus*). The coefficients of determination (r^2) of the LWR regressions ranged between 0.82 for *Coptodon guineensis* and 0.98 for *Sarotherodon galilaeus* indicating strong LWR relationships. The Fulton condition factor ranged from 1.95±0.06 (*Pelvicachromis taeniatus*) to 2.22±0.11 (*Pelmatolapia mariae*), indicating good conditions for the studied species.

Keywords: Africa, Allometry, Growth pattern, Isometry, Perciformes.

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Introduction

New Calabar River, a partially mixed estuary, is one of the major rivers in Niger Delta, Nigeria. It runs through the most densely populated areas in the hinterland and empty into the Atlantic Ocean at the southern tip of Bonny in the south. The river system is often a rich source of fish and other edible aquatic life. However, like other Nigerian inland waters, the fish yields are generally on the decline (Jamu & Ayinla 2003), largely due to overfishing, unethical fishing methods and pollution (Eyo & Ahmed 2005).

As a general rule, heavy fishing pressure is reflected by a decline in the mean size of fish caught and by a reorganization of the populations in favour of small-sized, fast-growing species (Regier & Loftus 1972; Rapport et al. 1985; Gulland & Garcia 1984; Murawski et al. 1991; Pauly et al. 1998; Faure 2000). Accumulating evidence suggests that selection pressure exerted through harvesting that is selective for size, age, sex, and maturity and for certain behavioural/genetic components have influenced the structure, plasticity, production, sustainability and recovery potential of a growing number of exploited stocks (Marteinsdottir & Pardoe 2008).

The length- weight relationship is very important for proper exploitation and management of the population of fish species (Pervin & Mortuza 2008; Keivany et al. 2015; Qamar et al. 2017). Relationship between length and weight is required for setting up

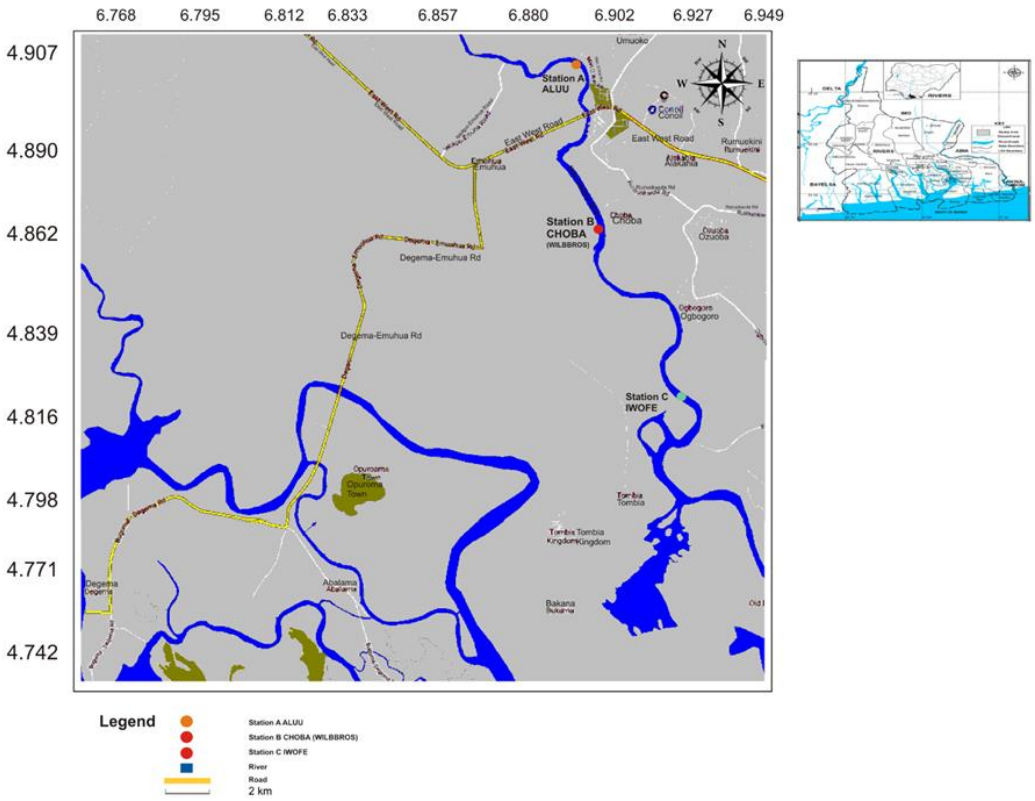

Fig.1. Map of Nigeria showing the location site.

yield equation (Beverton & Hold 1957; Ricker 1968). The isometric and allometric relationships based on regression analysis are still successful to estimate the body composition in fish and other animals in the production sector (Dumas et al. 2002).

In addition, condition factors of different population of the same species give some information about food supply, the timing and duration of breeding (Weatherly 1972). The condition factor can also be used in assessing the well-being of fish (Zamani-Faradonbe et al. 2015; Jafari et al. 2016). Fish in optimal physiological condition should grow and reproduce successfully thus ultimately ensuring sustainability of the population (Ross 1989). This study aims to give useful information on the growth pattern of cichlids species in New Calabar River for sustainable management of this cichlid fishery.

Materials and Methods

The study was carried out in the New Calabar River of Rivers State, Nigeria. It is a partially mixed estuary river lies between latitude 4°25′N and longitude 7°16′E. In order to determine the wider distribution of the cichlids in the New Calabar River, fish samples were collected from three identified fishing sites, viz. Aluu (Upper reaches), Iwofe (Middle reaches) and Choba/Aluu juncture (Lower reaches) (Fig. 1). Monthly fish samples were collected from the small-scale fishers using cast net, beach seine and gill net from February to July 2017.

Fish were identified using the keys and works of (Adesulu & Sydenham 2007) in the field to species level and preserved in ice, but not frozen, to keep them as fresh as possible. The taxonomy and nomenclature are in accordance with FishBase (Froese & Pauly 2017). Catches were immediately transported to the laboratory where total length (TL) was measured to the nearest cm. For each individual, total length (TL), standard length (SL) and total body weight (W) were taken using digital slide calipers and an electronic balance with 0.1cm and 0.1g

Table 1. Length-weight relationship and condition factor of ten cichlids from the New Calabar River.

Species	N	Total Length (cm)		Weight (g)		LW parameter			K	Growth pattern
		Mean	Range	Mean	Range	*a*	*b*	R^2		
C. guineensis (Sauvage, 1862)	357	16.11±1.54	5.90-31.20	103.01±25.81	5.00-748.00	-2.23	2.38	0.82	2.05±0.03	Negative allometry
S. melanotheron (Ruppell, 1852)	153	15.93±0.55	9.40-24.70	99.23±11.45	15.00-269.00	-3.57	2.86	0.93	2.20±0.79	Negative allometry
S. galilaeus (Linnaeus, 1758)	179	15.11±0.91	8.40-25.30	82.98±19.89	12.00-363.00	-3.91	3.00	0.98	2.09±0.05	Isometry
P. mariae (Boulenger, 1899)	25	13.74±0.53	8.30-21.60	70.39±12.54	14.00-236.00	-3.62	2.91	0.96	2.22±0.11	Negative allometry
C. dageti (Thysvanden udenaerde, 1971)	117	15.36±0.47	10.60-26.30	87.18±6.44	22.00-337.00	-3.55	2.88	0.95	2.10±0.05	Negative allometry
C. zillii (Gervais, 1848)	204	14.88±0.79	6.70-37.60	83.48±20.10	6.00-747.00	-3.69	2.94	0.97	2.12±0.03	Negative allometry
H. fasciatus (Guichenot, 1862)	6	13.12±0.82	12.30-14.90	45.00±8.00	37.00-61.00	-2.34	2.39	0.96	1.96±0.03	Negative allometry
P. taeniatus (Boulenger, 1901)	22	15.61±0.69	10.30-25.50	84.18±14.70	21.00-307.00	-3.84	2.96	0.94	1.95±0.06	Negative allometry

accuracy, accordingly. Among 10 cichlid species from 7 genera caught during the study, 8 species were selected for analysis of length-weight relationships because of their wide size ranges.

The length-weight relationships were expressed as: $W=aL^b$ and represented linearly by logarithms transformation: Log W= Log a+ bLog L. Parameters a and b were estimated by the least squares regression method. W and L were fish body weight and total length, respectively. The correlation (r^2) that is the degree of association between the length and weight was computed from the linear regression analysis. Condition factor of the fish was calculated using the formula: K= $W\times100/L^3$ Where K= condition factor, W= fish weight in grams, L= total length of fish in cm (Ricker 1973).

Results

A total of 1073 cichlid fishes belonging to 10 species and 7 genera were caught and examined but only 8 species were analysis for length-weight relationship (Table 1). The length frequency distribution in standard length of the cichlid species, means, standard deviation and total population are shown in Figure 2. The species with the highest modal class interval was *Coptodon guineensis* ranging from 0.0-12.5cm SL. The species with the lowest modal class interval was *Sarotherodon melanotheron* ranging from 11.5-12.0cm SL with total size range of 6.5-20.5cm SL and *Chomidotilapia guntheri* ranged from 10.25-10.75cm SL with total size range of 10.25-12.25cm SL.

The size composition of cichlids in the study area ranged from 13.12±0.82 recorded for *Hemichromis fasciatus* to 17.07±0.94cm recorded for *Tylochromis sudanensis* (Table 1). The exponent b ranged from 2.38 (*C. guineensis)* to 3.00 (*Sarotherodon galilaeus*). The coefficients of determination (r^2) of the LWR regressions varied between *C. guineensis* (0.82) and *S. galilaeus* (0.98) indicating strong length-weigh relationship. Condition factors of the studied fish species ranged from 1.95±0.06 (*Pelvicachromis taeniatus*) to 2.22±0.11 (*Pelmatolapia mariae*).

Discussion

The length frequency distribution of all the species were not all having equal interval due to the few numbers of some population such as *H. fasciatus*, *C. guntheri* and *T. sudanensis*, making it easier for interpretation. From the length frequency distribution graphs, the cichlids caught during this study where of different age groups with most of the population being juveniles and adults, although some species caught such as *H. fasciatus, C. guntheri* and *P. taeniatus* were all adults being naturally small in size (Pauly & Froese 2017). The size composition of

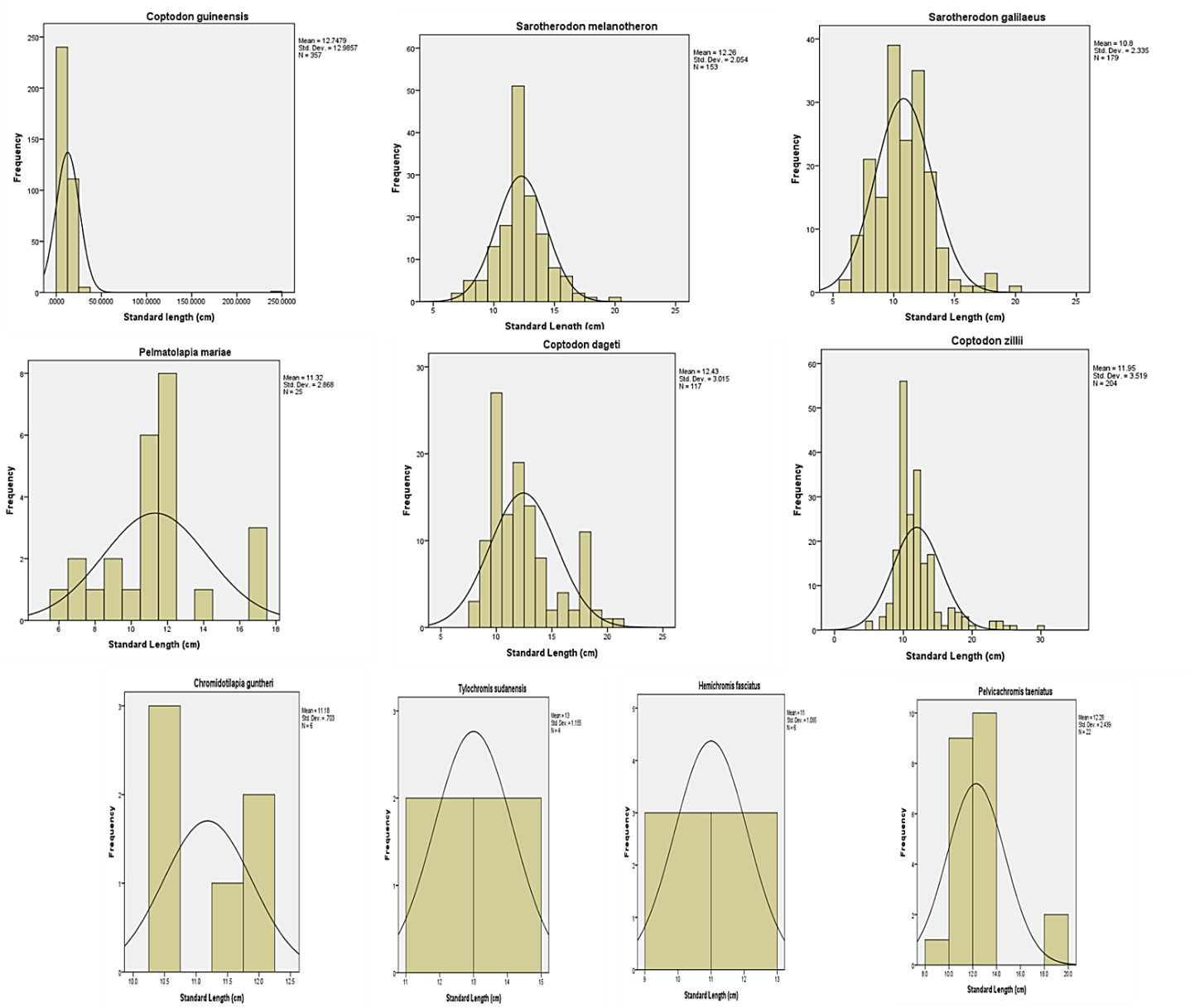

Fig.2. Length frequency distribution of 10 cichlids of the New Calabar River.

cichlids in the study area ranged from 13.12±0.82 recorded for *H. fasciatus* to 17.07±0.94cm recorded for *T. sudanensis.* (Table1). These results are similar to the findings of Olopade & Rufai (2014) who reported *H. fasciatus* as smallest captured fish among the five cichlid species in Oyan Dam, Nigeria.

In the present study, the correlation coefficient *r* between log length and log weight was found to be high in all the cichlids, indicating that the eight fish species were suggestive of a close relationship between length and weight of the species. Growth is considered isometric when *b* value is equal to 3 or allometric if otherwise (positive allometric if $b>3$ and negative allometric if $b<3$). In the present study, the values of *b* for the length-weight relationship were found to show negative allometry for seven fish species out of eight cichlids selected for analysis of length-weight relationship in the New Calabar River (Table 1). This indicates that the fish grows at different rate from the rest of the body. The allometric negative growth pattern has been observed in several freshwater fish species in Nigeria for

example; *H. fasciatus* from Badagry Creek (Agboola & Anetekhai 2008), *Oreochromis niloticus* from Wasai reservoir in Kano, (Imam et al. 2010), *Tilapia zillii* from reservoir in Abuja, Dan-Kishiya (2013) and *H. fasciatus* from Oyan Dam (Olopade & Rufai 2013). In this study the *b* values ranged from 2.38 (*C. guineensis*) to 3.00 (*S. galilaeus*). The values of b (growth exponent) for the eight species examined are within the limits (two and four) reported by Tesch (1971) for most fishes. The *b* value of LWRs for *P. mariae* was 3, indicative of isometric growth. Olopade & Rufai (2014) reported isometric growth patterns in *S. galilaeus, Oreochromis niloticus*, *Tilapia mariae* and *T. zillii* in Oyan Dam. Growth pattern and growth rates are highly species-specific and each species has growth characteristic of its own with respect to factors such as optimum temperature, adequate food and seasonal changes (Gupta & Gupta 2006). Several other factors could explain this variation in *b* values such as sexual dimorphism (Artigues et al. 2003), sampling procedure (sample size and length range) (Ecoutin & Abaret 2003). It is also inferred that higher *b* values imply relatively productive environmental conditions (Gopakumar et al. 1991).

Cichlids in New Calabar River in this study were observed to be in good condition, as the *K* values were greater than 1. The *K* values ranged from 1.95±0.06 to 2.22±0.11. However, the results of this study do not conform to those reported by Imam et al. (2010) in Wasai Reservoir in Kano who observed *K* values of 2.44, 3.4 and 2.73 in *O. niloticus, T. zillii* and *H. bimaculatus* respectively. It is also below that of Bagenal & Tesch (1978) which indicated a range of 2.9-4.8 as the ideal range of K value for the normal growth and utilization of nutrients by a normal fresh water fish. The differences in condition factor can be due to several reasons which include; stress, sex, season, availability of feeds, and other water quality parameters (Khallaf et al. 2003).

This study has provided baseline information on the length-weight and condition factor on the cichlids species which are relevant to stock assessment and sustainable fishery management in the New Calabar River. The pooled condition factors of the studied fish species ranged from 1.95±0.06 to 2.20±0.79 and eight out of ten cichlids showed negative allometric growth pattern. The negative allometric growth pattern recorded in almost all the species during the study could be attributed to intense fishing pressure and therefore there is a need for government to introduce fishery management techniques to regulate the fishing activities in the New Calabar River for sustainability of cichlids fishery.

Acknowledgments

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مقاله پژوهشی

توزیع فراوانی طولی، رابطه طول و وزن و ضریب وضعیت گردک‌ماهیان (ماهیان استخوانی عالی: گردک‌ماهیان) رودخانه نوکالابار نیجریه

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گروه شیلات دانشکده کشاورزی دانشگاه پورت هارکورت، نیجریه.

چکیده: این مطالعه به منظور بررسی توزیع فراوانی طولی، رابطه طول و وزن و ضریب وضعیت ۱۰ گونه گردک‌ماهی، یعنی *Coptodon guineensis*، *Coptodon zillii*، *Coptodon dageti*، *Pelmatolapia mariae*، *Hemichromis fasciatus*، *Pelvicachromis taeniatus*، *Chomidotilapia guntheri*، *Tylochromis sudanensis*، *Sarotherodon galilaeus* و *Sarotherodon melanotheron* در رودخانه نوکالابار صورت گرفت. نمونه‌ها به‌صورت ماهیانه از بهمن ۱۳۹۵ تا تیر ۱۳۹۶ صید گردیدند. در مجموع ۱۰۷۳ نمونه با میانگین طولی ۰/۸۲±۱۳/۱۲ تا ۰/۹۴±۱۷/۰۷و میانگین وزنی ۸/۰۰±۴۵/۰۰ تا ۲۵/۸۱±۱۰۳/۰۱ صید گردید. رگرسیون رابطه طول و وزن نشان داد که مقدار عدد نمایی b بین ۲/۳۸ (*C. guineensis*) تا ۳ (*S. galilaeus*) متغیر بود. ضریب همبستگی رگرسیون (r^2) رابطه طول و وزن بین ۰/۸۲ در *C. guineensis* و ۰/۹۸ در *Sa. galilaeus* بود که نشاندهنده ارتباط قوی بین طول و وزن بود. ضریب وضعیت بین ۰/۰۶±۱/۹۵ (*P. taeniatus*) تا ۰/۱۱±۲/۲۲ (*P. mariae*) متغیر بود که نشان‌دهنده وضعیت مناسب گونه‌های مورد مطالعه بود.

کلمات‌کلیدی: آفریقا، الگوهای رشد، رشد ناهمسان، رشد همسان، سوف‌ماهی‌شکلان.