Journal of Fisheries and Aquaculture
ISSN: 0976-9927 & E-ISSN: 0976-9935, Volume 4, Issue 2, 2013, pp.-82-86.
Available online at http://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000265

LENGTH-WEIGHT RELATIONSHIP AND CONDITION FACTOR OF SIX CICHLID (CICHILIDAE: PERCIFORMIS) SPECIES OF ANAMBRA RIVER, NIGERIA

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Received: June 10, 2013; Accepted: July 11, 2013

Abstract- The length-weight relationship and condition factor of six cichlid fish species inhabiting Anambra River were studied. The cichlid fish species were *Chromidotilapia guntheri* Sauvage 1882, *Hemichromis bimaculatus* Gill 1862, *Tilapia zillii* Gervais 1848, *Hemichromis fasciatus* Peters 1857, *Tilapia mariae* Boulenger 1899 and *Oreochromis niloticus* (Linnaeus 1758), obtained from fish landing sites of the river at Ogurugu, Nsugbe and Otuocha. *C. guntheri, H. bimaculatus* and *T. zillii* exhibited positive allometric growth with b = 3.452, 3.828 and 3.210, respectively, while *H. fasciatus, T. mariae* and *O. niloticus* exhibited negative allometric growth with b = 2.667, 2.272 and 2.792, respectively. There was difference in the condition factors for the combined fish species and the monthly factor for each fish species studied: *C. guntheri* was 3.44 ± 0.39, *H. fasciatus* (2.85 ± 0.30), *H. bimaculatus* (3.52 ± 0.20), *T. zillii* (3.77 ± 0.30), *T. mariae* (2.69 ± 0.28) and *O. niloticus* (2.91 ± 0.31). All species studied were in good condition. Relatively high condition factors of cichlid species estimated in the present study indicated that the physicochemical and biotic variables in the river were within acceptable limits for fish production freshwater ecosystem.

Keywords- Length-weight relationship, Condition factor, Cichlids, Anambra River

Citation: Atama C.I., et al. (2013) Length-Weight Relationship and Condition Factor of Six Cichlid (Cichilidae: Perciformis) Species of Anambra River, Nigeria. Journal of Fisheries and Aquaculture, ISSN: 0976-9927 & E-ISSN: 0976-9935, Volume 4, Issue 2, pp.-82-86.

Introduction

Inland open water fishery resources play a significant role in the economy, culture, tradition and food habits of the people of a nation. Fish can be a cheap source of highly nutritive protein, and they also contain other essential nutrients required by the body [1-3]. Hence studies about fish biology and ecology are important in order to improve fishery management and conservation. In this sense, studies about length-weight relationship (LWR) are of great importance in fishery assessments and management [4]. The LWR can give information on the stock composition, growth rate, life expectancy, mortality and production of fish species and it is an important tool in fish biology, stock composition, physiology, ecology and fisheries assessment [5-12]. Moreover it is useful in determining weight and biomass when only length measurements are available, as indicator of condition, to assess the relative well-being of a fish population and to allow for statistical comparisons of species growth between different populations. Consequently, LWR studies on fish are extensive [9,10,13-16].

On the other hand, the condition factor (K) is a parameter of the state of well-being of the fish based on the hypothesis that heavier fish of a particular length are in a better physiological condition [17]. The condition of a fish reflects recent physical and biological circumstances, as it is strongly influenced by both biotic and abiotic environmental variables, and fluctuates by interaction among feeding habits, parasitic burden and fish physiological conditions [5]. It can be used to compare the inter- and intra- specific "condition", "fatness" or wellbeing of fish from the same or contrasting habitats, it is a useful index for the monitoring of feeding intensity, age and growth rates in fish [18], and it can be used as an index to assess the status of the aquatic ecosystem in which fish live. In a similar way to LWR, studies about K on fish are extensive (e.g. condition factors of different tropical finfish species have been reported [9,10,19-30]. A lot of studies have been conducted on the length-weight relationship and condition factor of cichlids in Nigeria waters thus: *Chromidotilapia guntheri* of Anambra river [31], Eleiyele Lake, Southwestern Nigeria [32], Ntak Inyang stream, Akwa Ibom State [33] and Epe Lagoon, Lagos [16]; *Hemichromis bimaculatus of* Anambra river [30], Eleiyele Lake, Southwestern Nigeria [32] and Wasai reservoir, Kano [34]; *H. elongates of* Ntak Inyang stream, Akwa Ibom State [33]; *H. fasciatus of* Anambra river [30] and Ntak Inyang stream, Akwa Ibom State [33]; *H. niloticus of* Ntak Inyang stream, Akwa Ibom State [33]; *Oerochromis niloticus* of Anambra River [30], Sanni Luba Fish Farm, Ijebu-Ode, Ogun State [35], Gbedikere Lake, Bassa, Kogi State [36], Wasai reservoir, Kano [34] and *Sarotherodon melanotheron* of Eleiyele Lake, Southwestern Nigeria [32] and *Tilapia mariae* of Ethiope River, Nigeria [37] among many others. Reassessment of length-weight relationship and condition factor of Nigerian cichlids is needful for the sustainable management of the cichlid fishery resources in the face of the ever changing physico-chemical and adaphic conditions of our aquatic ecosystems. Thus this study reexamines the length-weight relationship and condition factor of six cichlid fishes of Anambra River, Nigeria. The studied cichlids were *C. guntheri, H. bimaculatus, H. fasciatus, O. niloticus, Tilapia mariae* and *T. zillii.*

Materials and Methods

The Anambra River is about 14,010 km^2 [38]. The Anambra River is the largest tributary of river Niger below Lokoja, and is often regarded as a component part of the lower Niger lowlands [38]. Essentially, the river has a southward course up to the Kogi/Enugu State boundary; it then meanders through Ogurugu to Otuocha and Nsugbe from where it flows down to form a confluence with the Niger River at Onitsha. The Anambra River basin lies between latitudes 6°10^1 and 7°20^{1}N and longitudes 6°35^1 and 7°40^{1}E [38]. Ichthyofaunally, the water bodies had 52 fish species belonging to 17 families. Two families, Characidae, 19.5%, and Mochokidae, 11.8%, constituted the dominant fish families in the river. The dominant fish species were *Citherinus citherius*, 9.02% and *Alestes nurse*, 7.1%. Other fish species with significant abundance were *Synodontis clarias* 6.9%, *Macrolepidotus curvier* 5.7%, *Labeo coubie* 5.4%, *Distichodus rostratus* 4.9% and *Schilbe mystus* 4.5%. The cichlids although recorded were not significantly abundant. The most abundant animal utilizing the basin was *Ardea cinerea* with 22.2% occurrence, *Caprini* sp. with 13.51% occurrence and *Varanus niloticus* with 10.04% occurrence. The least abundant animals utilizing basin were *Chephalophus rufilatus* and *Erythrocebus patas* with 0.58% occurrence, respectively [28]. The sampling areas were located around the major landing sites of the main river and the adjacent floodplain of Nsugbe, Otuocha & Ogurugu [Fig-1].

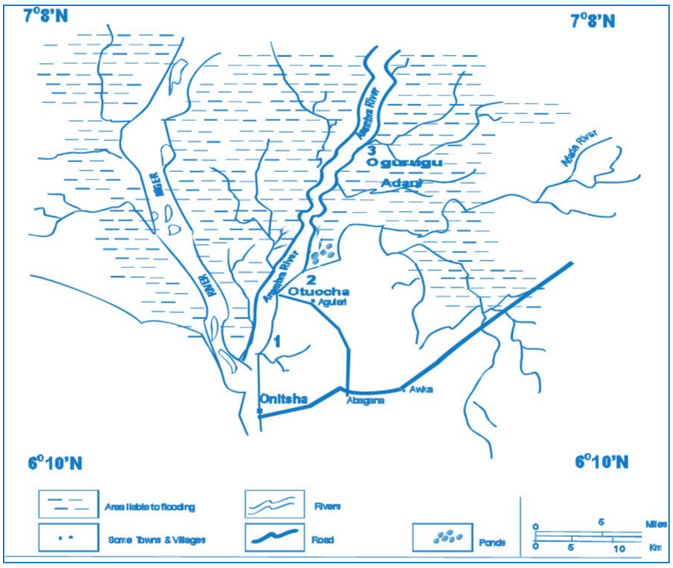

Fig. 1- Map of Anambra river basin showing the sampling locations 1, 2 and 3

All the major fish landing sites were sampled for cichlids. Sampling was done fortnightly from January to December 2010. Fish were purchased from local fishermen, by prior arrangement. The identified fishing gears used include, fish fences, hooks and line, set lines, lift nets, dragnets, beach seines and cast nets. Fish species were identified to species level [39], labeled and preserved in ice. Differences in the species size composition and abundance in the sampling locations were compensated for by sorting into length classes [40-42]. The total length (TL) of each freshly caught fish was measured to the nearest millimeter using a measuring board. A weighing balance was used to measure the fresh weight of the fish to the nearest gram. The sex (male or female) of each cichlid fish was determined after dissection to see the gonad. The parameters a (intercepts) and b (slopes) of the LWR estimated from: $W = aL^b$ where W = weight (g), L = standard length (cm), a = constant and b = growth exponent. The equation was linearised by a logarithmic transformation thus: $\text{Log } W = \text{Log } a + b \text{ Log } L$. In order to test if the obtained b values in the linear regression models were significantly different (allometric growth) from 3 (isometric growth), a t-test with confidence level of 95% was performed [43]. The value of the growth exponent was used to calculate the condition factor using the formula: $K = 100W / L^b$, where K = condition factor, W = total body weight (g), L = standard length (cm) and b = growth exponent.

Results and Discussion

A total of 7091 individuals belonging to six species of the cichlid family were used in the study. The most abundant species were the *Tilapia* species, while the least abundant was *H. bimaculatus*. The number of specimens, length ranges (minimum and maximum), parameters of length-weight relationships (a and b), the coefficient of relationship (r) and the condition factor (K) are given in [Table-1] and [Table-2]. Even though the change of b values depends primarily on the shape and fatness of the species, various factors may be responsible for differences in the observed b value for the length-weight relationships of Anambra River cichlids. These factors may include seasons, water temperature, salinity, food (quantity, quality and size), sex and stage of maturity [40,44-46]. The values obtained for the length-weight relationship showed that none of the cichlid species exhibited isometric growth. *C. guntheri, H. bimaculatus* and *T. zillii* exhibited positive allometric growth, whereas *H. fasciatus, T. mariae* and *O. niloticus* exhibited negative allometric growth [Table-1]. In line with the findings of this study, several authors [16,30,34,47-52] have reported negative allometric growth for different cichlid fish species from varied water bodies [Table-3]. This implies that the fish becomes less rotund as it grows in length [53].

The mean condition factors for the six cichlid species in Anambra River showed temporal (sex) variations. The condition factor for all the species in wet season was significantly ($p < 0.05$) higher than that in dry season. Seasonal variation in the condition factor of fish has been reported for *Leuciscus lepidus* and *Brycinus nurse* [20,54]. However, the results of this study do not conform to those published for *Tilapia guineensis*, *C. guntheri* and *T. mariae* [22,23] in which no seasonal changes were observed in condition factor. Afamdi [27] recorded a disparity in condition factor from his study, where K for *C. guntheri* and *T. mariae* for dry season were higher than that of wet season, but similar result for *T. zillii*. Despite these differences in observation, Oni, et al. [18] noted that condition factor was not constant for a species or population over a time interval and might be influenced by both biotic and abiotic factors such as feeding regime and state of gonadal development. In fish, the condition factor reflects information on the physiological state of the fish in relation to its welfare. From nutritional and reproductive points of view, condition factor reflects the accumulation of fat and gonadal development [5]. From a reproductive perspective, the highest K values were attained in some species during gonad maturation stages [55]. Condition factor also gives information when comparing two populations living in certain feeding, density, climate and other conditions; when determining the period of gonadal maturation and when following up the degree of feeding activity of a species to verify whether it is making good use of its feeding source [56]. Braga [57] showed that values of the condition factor may vary according to seasons as influenced by environmental conditions. Temporal variations in condition factor recorded this study was influenced by many biotic and abiotic factors such as phytoplankton abundance, predation, water temperature and dissolve oxygen concentrations among others which may of may not favour the survival of all the species in the ecosystem.

Table 1- Sexual dimorphism in length-weight relationship and condition factor (K) of six cichlid species in Anambra River, Nigeria between January and December 2010

Species	a	b	Number examined	r	Min. Length (cm)	Max. Length (cm)	K
Combine Sex							
C. guntheri	-1.907	3.341	1169	0.92	7.2	12.7	2.68 ± 0.02
H. bimaculatus	-0.221	1.266	890	0.16	7.6	7.9	1.75 ± 0.01
H. fasciatus	0.372	0.738	912	0.3	2.9	2.9	1.79 ± 0.25
O. niloticus	-0.826	2.059	1211	0.73	6.1	14.4	1.93 ± 0.06
T. mariae	-1.357	2.604	1340	0.93	6.9	16.3	1.76 ± 0.02
T. zillii	-1.66	3.038	1569	0.89	7	16.7	2.47 ± 0.03
Male							
C. guntheri	-1.878	3.317	671	0.955	7.2	12.7	2.69 ± 0.03
H. bimaculatus	-0.441	1.508	423	0.175	7.6	7.8	1.73 ± 0.01
H. fasciatus	0.766	0.32	405	0.262	2.9	40	1.84 ± 0.46
O. niloticus	-0.118	1.325	628	0.487	6	14	2.20 ± 0.14
T. mariae	-1.366	2.612	694	0.923	6.9	16.3	1.74 ± 0.03
T. zillii	-1.617	2.999	858	0.891	7.1	16.5	2.49 ± 0.04
Female							
C. guntheri	-1.942	3.373	498	0.88	7.2	12.1	2.67 ± 0.04
H. bimaculatus	0.093	0.913	467	0.121	7.6	7.9	1.77 ± 0.01
H. fasciatus	-0.525	1.682	507	0.651	3	19.7	1.75 ± 0.18
O. niloticus	-1.589	2.818	583	0.957	6.2	14.4	1.71 ± 0.02
T. mariae	-1.351	2.6	646	0.932	7.4	13.6	1.77 ± 0.02
T. zillii	-1.7	3.075	711	0.882	7.4	16.7	2.46 ± 0.04

Table 2- Seasonal variation in length-weight relationship and condition factor (K) of six cichlid species in Anambra River, Nigeria between January and December 2010

Species	a	b	Number examined	r	Min. Length (cm)	Max. Length (cm)	K
Dry Season							
C. guntheri	-1.999	3.441	783	0.938	7.2	12.7	2.70 ± 0.03
H. bimaculatus	-0.622	1.721	510	0.216	7.6	7.9	1.75 ± 0.01
H. fasciatus	0.548	0.549	602	0.344	7.1	40	2.02 ± 0.50
O. niloticus	-1.499	2.736	827	0.962	6.1	14.4	1.75 ± 0.02
T. mariae	-1.401	2.648	973	0.933	6.9	16.3	1.76 ± 0.02
T. zillii	-1.061	2.454	892	0.726	7.1	16.7	2.51 ± 0.08
Wet Season							
C. guntheri	-1.818	3.244	386	0.896	7.2	12.6	2.66 ± 0.03
H. bimaculatus	0.459	0.497	380	0.059	7.6	7.9	1.74 ± 0.01
H. fasciatus	0.893	0.233	310	0.159	2.9	34.2	1.51 ± 0.06
O. niloticus	-1.481	2.717	384	0.959	6.1	14.4	1.75 ± 0.02
T. mariae	-1.303	2.551	596	0.922	6.9	16.3	1.76 ± 0.03
T. zillii	-1.584	2.977	448	0.879	7.5	16.7	2.54 ± 0.04

Table 3- Variations in length-weight relationship and condition factor (K) of cichlid species in varied aquatic ecosystems between 2004 and 2012

Species	Length (cm) Range / mean	Weight (g)	a	b	r	K	Habitat	Source
C. guntheri	12.42	62.57	-0.44	2.046	0.64	-	Epe Lagoon Lagos, Nigeria	Soyinka and Ebigbo, 2012
C. guntheri	8.4 -10.1	-	0.0001	3.452	0.88	3.66 ± 0.22	Anambra River, Nigeria	This study
C. guntheri	10.38 ± 1.33	-	0.0252	2.895	0.939	-	Anambra River, Nigeria	Ezenwaji, 2004
C. guntheri	16.60 ± 4.10	125.60 ± 11.20	-	-	-	2.7	Ntak Inyang stream, Ikpa River Akwa Ibom State, Nigeria	Onuoha, et al. 2010
H. bimaculatus	7.85 ± 1.36	-	0.0577	2.481	0.979	-	Anambra River, Nigeria	Ezenwaji 2004
H. bimaculatus	-	-	0.6	2	-	-	Wasai Reservoir, Kano, Nigeria	Imam, et al. 2010
H. bimaculatus	7.6- 7.9	-	0.0032	3.828	0.771	3.70 ± 0.21	Anambra River, Nigeria	This study
H. elongatus	11.70 ± 3.40	30.00 ± 5.50	-	-	-	1.8	Ntak Inyang stream, Ikpa River Akwa Ibom State, Nigeria	Onuoha, et al. 2010
H. fasciatus	9.67 ± 2.08	-	0.0294	2.779	0.905	-	Anambra River, Nigeria	Ezenwaji 2004
H. fasciatus	10.10 ± 3.20	46.80 ± 6.80	-	-	-	1.2	Ntak Inyang stream, Ikpa River Akwa Ibom State, Nigeria	Onuoha, et al. 2010
H. fasciatus	7.4-14.8	-	0.0311	2.667	0.916	3.16 ± 0.18	Anambra River, Nigeria	This study
H. niloticus	6.60 ± 2.60	7.10 ± 2.70	-	-	-	2.5	Ntak Inyang stream, Ikpa River Akwa Ibom State, Nigeria	Onuoha, et al. 2010
O. niloticus	10.8 ± 3.42	58.63 ± 65.94	0.0267	3.1817	0.9797	3.64 ± 0.71	Gbedikere Lake, Bassa, Kogi State	Adeyemi, et al. 2009
O. niloticus	15.32 ± 2.90	-	0.0033	3.689	0.997	-	Anambra River, Nigeria	Ezenwaji, 2004
O. niloticus	-	-	1.34	1.4	-		Wasai Reservoir, Kano, Nigeria	Imam, et al. 2010
O. niloticus	-	-	-2	3.1	-	1.11	Sanni Luba Fish Farm Ijebu-Ode, Ogun State, Nigeria	Olurin and Aderibigbe, 2006
O. niloticus	6.2- 14.2	-	0.0307	2.792	0.952	3.12 ± 0.32	Anambra River, Nigeria	This study
P. guntheri	6.10 ± 2.50	11.30 ± 3.40	-	-	-	2.5	Ntak Inyang stream, Ikpa River Akwa Ibom State, Nigeria	Onuoha, et al. 2010
P. pulcher	9.40 ± 3.00	16.30 ± 4.00	-	-	-	1.9	Ntak Inyang stream, Ikpa River Akwa Ibom State, Nigeria	Onuoha, et al. 2010
S. macrocephala	9.70 ± 3.10	22.80 ± 4.80	-	-	-	1.9	Ntak Inyang stream, Ikpa River Akwa Ibom State, Nigeria	Onuoha, et al. 2010
S. melanotheron	16.14 + 2.43	127.37 ± 9.62	-	2.38	0.81	-	Ologe Lagoon, Lagos	Ndimele, et al. 2010
S. melanotheron	-	-	0.029	2.87	0.99	-	Ahémé Lake, Bénin	Niyonkuru and Laleye, 2012
S. melanotheron	-	-	0.029	2.86	0.99	-	Nokoué Lake, Bénin	Niyonkuru and Laleye, 2012
S. melanotheron	9.80 ± 3.10	20.30 ± 4.50	-	-	-	2.2	Ntak Inyang stream, Ikpa River Akwa Ibom State, Nigeria	Onuoha, et al. 2010
S. melanotheron	8.25 ± 4.22	15.60 ± 19.07	−1.8176	3.04	1.0503	-	Buguma Creek, Nigeria	Oribhabor, et al. 2009
T. dageti	13.80 ± 3.70	123.30 ± 11.10	-	-	-	1.9	Ntak Inyang stream, Ikpa River Akwa Ibom State, Nigeria	Onuoha, et al. 2010
T. guineensis	-	-	0.032	2.76	0.99	-	Ahémé Lake, Bénin	Niyonkuru and Laleye, 2012
T. guineensis	-	-	0.025	2.87	0.97	-	Nokoué Lake, Bénin	Niyonkuru and Laleye, 2012
T. guineensis	6.10 ± 2.50	16.90 ± 4.10	-	-	-	2.7	Ntak Inyang stream, Ikpa River Akwa Ibom State, Nigeria	Onuoha, et al. 2010
T. guineensis	10.10 ± 3.63	27.90 ± 49.86	-1.583	2.83	0.1417	-	Buguma Creek, Nigeria	Oribhabor, et al., 2009
T. mariae	9.41 ± 2.96	-	0.0192	3.066	0.986	-	Anambra River, Nigeria	Ezenwaji 2004
T. mariae	-	44.65 ± 18.36	-0.8088	2.209	0.7372	2.4	Badagry Lagoon, Nigeria	Soyinka and Ayo-Olalusi 2009
T. mariae	-	49.90 ± 19.17.	-1.4391	2. 757	0.9502	2.05	Ologe Lagoon, Nigeria	Soyinka and Ayo-Olalusi 2009
T. mariae	6.9-16.3	-	0.1041	2.272	0.901	2.85 ± 0.37	Anambra River, Nigeria	This study
T. zillii	-	-	1.37	2.5	-	-	Wasai Reservoir, Kano, Nigeria	Imam, et al. 2010
T. zillii	7.1-16.2	-	0.0125	3.21	0.947	4.05 ± 0.28	Anambra River, Nigeria	This study
T. zillii	15.25 ± 3.41	-	0.0383	2.788	0.994	-	Anambra River, Nigeria	Ezenwaji, 2004
T. zillii	6.80 ± 2.60	9.30 ± 3.0	-	-	-	2.8	Ntak Inyang stream	Onuoha, et al. 2010
T. zillii	7-15 cm	-	-	2.69	0.98	2.01 ± 0.28	Lake Qarun, Egypt	Shalloof, 2009

Acknowledgements

We are indebted to Department of Zoology and Environmental Biology, University of Nigeria, Nsukka for providing full laboratory facilities during the study periods. We are also thankful to Mr. Simon Ugwu and Mr. Sabestine Ali who assisted in fish collection. There is no conflict of interest among the authors for the publication of this research article.

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