



Revista de Biología Tropical

ISSN: 0034-7744

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Revista de Biología Tropical, vol. 55, núm. 3-4, septiembre-diciembre, 2007, pp. 969-977

Universidad de Costa Rica
San Pedro de Montes de Oca, Costa Rica

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Length weight relationship, condition factor and stomach contents of *Hemichromis bimaculatus*, *Sarotherodon melanotheron* and *Chromidotilapia guentheri* (Perciformes: Cichlidae) in Eleiyele Lake, Southwestern Nigeria

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Received 30-VI-2004. Corrected 01-XI-2006. Accepted 11-IV-2007.

Abstract: Length-weight relationship (LWR), condition factor (K) and stomach content of three cichlid fishes (*Hemichromis bimaculatus*, *Sarotherodon melanotheron*, and *Chromidotilapia guentheri*) were calculated at Eleiyele reservoir, Nigeria, Africa. The fish were collected monthly from fishermen during the dry season (January-March 2001) and the rainy season (April, May, June 2001). Gill nets of mesh sizes 50-55 mm were used. The LWR had a significant correlation for the three species and the growth exponent (b) for *H. bimaculatus* indicates a negative allometric growth (*S. melanotheron* and *C. guentheri* had isometric growth). Condition factor values were higher than one in the three species, and varied with size and season. Stomach contents revealed that the three species are omnivorous and that diet composition varies seasonally. Rev. Biol. Trop. 55 (3-4): 969-977. Epub 2007 December, 28.

Key words: length-weight relationship, condition factor, diet, *Hemichromis bimaculatus*, *Sarotherodon melanotheron*, *Chromidotilapia guentheri*.

Cichlids are important resources in the aquatic systems of tropical Africa (Fryer and Iles 1974). In many man made lakes they dominate the fisheries and in Eleiyele Lake, they constitute more than 50 % by number of the total annual landings of artisanal fishermen. There is little published work on the biology of fish fauna of Eleiyele Lake and is mainly on juvenile cichlids (Zelibe *et al.* 1990a,b), who reported five cichlid species in the lake. From personal observation in 2001 based on monitoring catch by fishermen in Eleiyele Lake, we found that there are seven species of cichlids including *H. bimaculatus* (Gill 1862) and *S. melanotheron* (Ruppell 1852) which were not reported earlier. Thus, this work try to investigate and report on aspects of biology of these species in Eleiyele Lake for the first time. Length weight relationship (LWR) of fishes are important in fisheries biology because

they allow the estimation of the average weight of the fish of a given length group by establishing a mathematical relation between the two (Beyer 1987). They are also useful for assessing the relative well being of the fish population. LWR has a number of important applications in fish stock assessment. Among these applications are estimating the standing stock biomass, and comparing the ontogeny of fish population from different regions (Patrakis and Stergiou 1995). Length-weight data are often used as an indication of fatness, general well being (Le Cren 1951) or of gonad development of fish and are useful for between region comparisons of like histories of a specific species (Wootton 1990). The food of fish varies for individual species with age, locality where found and with season.

This paper aims to provide data on LWR, condition factor and stomach contents of these

three cichlid species for the first time in Eleiyele lake and this information will enhance management, conservation and culture of these species. It will also allow for future comparisons between populations of the same species.

MATERIALS AND METHODS

Specimens of *H. bimaculatus*, *C. guentheri* (Sauvage 1882) and *S. melanotheron* were collected monthly from fishermen in Eleiyele lake during the dry season (January, February, March 2001) and rainy season (April, May, June 2001). Gill nets of mesh sizes 50-55 mm were the fishing gear used. Specimens collected were kept chilled in an ice chest to reduce post humous digestion of the stomach contents to the minimum while in transit to the laboratory. Total length (TL) was measured from the tip of the snout (mouth closed) to the extended tip of the caudal fin. Standard length (SL) was measured from the tip of the snout to the caudal peduncle. The lengths were taken with measuring board to the nearest 0.1 cm. Body weight of individual fish was measured to the nearest 0.1 g with an electric balance after removing the adhered water and other particles from the surface of body.

The length-weight relationship (LWR) was estimated by using the equation: $W = aL^b$ where W = weight (g), L = total length (cm), a = constant, b = growth exponent. A logarithmic transformation was used to make the relationship linear $\log W = \log a + b \log L$.

The values of the compiled growth exponent were used for the calculation of condition factor, K .

$$K = \frac{100 W}{L^b}$$

where K = condition factor, W = total body weight (g), L = total length (cm), b = growth exponent. For each species, the slopes of length-weight regressions were compared to 3 using student's t-test (Sokal and Rohlf 1987) to determine whether species grew isometrically.

Student's t-test was used to ascertain whether seasonal changes in condition factor for the species were statistically significant.

The specimens were cut open and the stomachs were removed and immersed in 4 % formalin. Each stomach was slit open, and the contents poured into a petri dish. The food were observed with unaided eye. Then, random samples of the stomach contents were taken and dropped on slides with the aid of a dropping pipette and observed under a light microscope. The stomach contents were identified and analyzed using the frequency of occurrence and numerical methods (Bagenal 1978).

In the frequency of occurrence method, the number of stomachs containing each food item is expressed as a percentage of all non-empty stomachs, though this method is quick and requires minimal apparatus, it gives little indication of the relative quantities of each food category present in the stomach (Hynes 1950).

In the numerical method, the number of individuals in each food category is expressed as a percentage of the total individuals in all food categories. This method has the limitation in that it overemphasizes the importance of small prey items found in a large number in fish. This method is not suitable for dealing with food items such as fragments and detritus that do not occur in discrete units, also it is difficult to identify the numbers in each food category because of mastication of the food. The food items were not identified to the species level due to the fact that most of the food items were observed crushed and under varying stages of digestion.

RESULTS

The results of the length-weight analyses are presented in table 1. All length-weight relationships were highly significant ($p < 0.05$) with r values greater than 0.60 slopes (b values) of the length weight relationship ranged from 2.14 for *H. bimaculatus* to 3.34 for *C. guentheri*. The regression coefficient (b) of *H. bimaculatus* is significantly different from 3.

TABLE 1
Estimated parameters of the length-weight relationships for three cichlid species in Eleiyele lake, Southwestern Nigeria

Species	n	Length range (cm)	a	b	r	S.E (b)
<i>H. bimaculatus</i>	120	7.4 – 10.4	-1.0789	*2.14	0.6201	0.3041
<i>C. guentheri</i>	120	8.9 – 11.5	-2.0365	3.34	0.8304	0.1732
<i>S. melanothon</i>	36	15.0 – 27.6	-1.4926	2.80	0.9193	0.2051

n: sample size

a and b: parameters of the relationship

SE (b) is the standard error of the slope b.

r = Correlation co-efficient.

*b = significantly different from 3.

Condition factor: the condition factor (k) calculated for *H. bimaculatus* varied from $1.14\text{--}3.13 \pm 1.79$, for *S. melanothon*. K varied from $1.40\text{--}3.60 \pm 2.79$, while it was $1.13\text{--}2.24 \pm 1.67$ for *C. guentheri*. The temporal changes for the three species are shown in Fig. 1. This shows that seasonal variation occurred in k factor of the three cichlid species and the highest mean k factor were recorded during the rainy season for *S. melanothon* (3.21) and *C. guentheri* (1.76), while for *H.*

bimaculatus highest mean k factor (1.92) was recorded during dry season. However only the dry season mean condition factor of *H. bimaculatus* was statistically different from rainy season K factor. Variations in condition factor with size for *H. bimaculatus*, *S. melanothon* and *C. guentheri* were shown in tables 2, 3 and 4 respectively. It can be seen that smaller sizes of *H. bimaculatus* (7.7–9 cm) are in better condition than others, while *S. melanothon* (24.1–30 cm) and *C. guentheri* (10–11.9 cm)

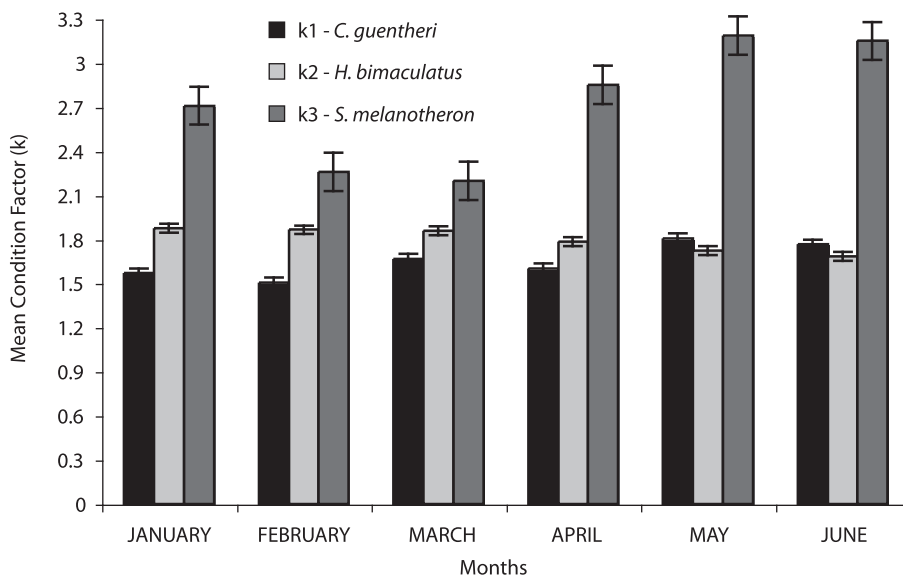


Fig. 1. Seasonal variation in condition factor of *Chromidotilapia guentheri*, *Hemichromis bimaculatus* and *Sarotherodon melanothon*.

larger size fishes had higher K factor. For the three species, there is no statistical difference between the k factor of the smaller and larger sized fishes.

The composition of the diet

Table 5 shows a summary of the percentage frequency of occurrence and total number of various categories of food organisms in the stomachs of each cichlid examined.

H. bimaculatus

Out of the 120 specimens of *H. bimaculatus* examined, 89 (74.2 %) had food in their stomachs. The table 5 shows that food from plant sources dominates the diet and formed 71.94 % of the diet by numerical abundance method and all of them also occurred frequently in stomachs being encountered in more than 50 % of stomach examined. Algae that occurred in the diet include blue green algae represented by *Oscillatoria*, *Phormidium*,

TABLE 2
Mean condition factor (K) in relation to size for H. bimaculatus

Length group (cm)	Number of specimens	Range of K-factor	Mean	t - statistics
7 – 8	9	1.60 – 3.13	2.05 ± 0.64	1.8
8.1 – 9.1	99	1.22 – 2.27	1.87 ± 0.9	
9.2 – 10.2	9	1.14 – 1.92	1.47 ± 0.43	
10.3 – 11.3	3	1.78	1.78	

TABLE 3
Mean condition factor (K) in relation to size for S. melanotheron

Length group (cm)	Number of specimens	Range of K-factor	Mean	t - statistics
15 – 18	30	1.4 – 3.6	2 ± 1.24	-2.683
18.1 – 21	9	1.4 – 2.8	2.6 ± 0.14	
21.1 – 24	3	1.7 – 3.2	2.6 ± 0.82	
24.1 – 27	3	1.92 – 3.8	2.9 ± 0.63	
27.1 – 30	1	3.1	3.1	

TABLE 4
Mean condition factor (K) in relation to size for C. guentheri

Length group (cm)	Number of specimens	Range of K-factor	Mean	t - statistics
8 – 8.9	2	1.63 – 1.65	1.64 ± 0.1	-1.1367
9 – 9.9	27	1.26 – 2.24	1.62 ± 0.82	
10 – 10.9	73	1.13 – 1.98	1.68 ± 0.34	
11 – 11.9	16	1.55 – 1.88	1.95 ± 0.21	

TABLE 5
Frequency of occurrence and numerical values of various food categories in the stomachs
of three cichlids from Eleiyele reservoir

Food items	<i>H. bimaculatus</i>		<i>S. melanotheron</i>		<i>C. guentheri</i>	
	% F	% N	% F	% N	% F	% N
Blue-green algae	76.4	19.29	89.3	34.48	71.84	16.79
Green algae	80.9	22.61	92.9	29.80	65.05	15.94
Desmids	58.4	7.76	57.1	1.94	60.19	8.82
Diatoms	62.9	10.79	82.1	11.01	78.64	16.62
Plant parts	85.4	11.49	85.7	4.86	77.67	8.82
Protozoa	-	-	42.9	0.68	-	-
Insect parts	69.7	9.67	67.9	0.08	91.26	8.33
Crustacean	51.6	0.66	71.4	0.01	64.08	0.42
Rotifers	52.8	4.65	53.6	2.21	58.25	6.47
Fish eggs	55.1	2.68	71.4	0.07	0.97	0.01
Snail	32.6	0.16	-	-	46.60	0.08
Organic detritus	-	-	89.3	7.41	-	-
Unidentified organisms	100	10.24	85.7	2.60	78.64	7.43
Sand grains	-	-	71.4	4.76	83.5	10.77

Anabaena, *Coelospharium* species. Green algae present in the diet include *Mougeotia*, *Zygnema*, *Microspora* and *Cladophora*. Desmid is represented by *Gonatozygon* and *Closterium*, *Docidium* and *Netrium* also occurred in the diet but in lesser quantity.

Some invertebrates animals are found in the diet mixed with the plant materials. These animals include appendages of arthropods, crustacean, and Mollusc which is represented only by *Melanoides tuberculata*. Species of *Gastropus*, *Trichocerca*, and *Trichotria* are the rotifers round in the diet. These animal component of the diet formed only 17.82 % of the diet by numerical abundance method.

S. melanotheron

A total of 36 specimens were examined, out of which 28 (78.8 %) had food in their stomachs. Plant food organisms constituted the most important food items of *S. melanotheron* by the numerical method (82.09 %) and they were also

encountered frequently in the stomach content. Blue green algae (*Oscillatoria*, *Phormidium*, *Anabaena* and *Coelospharium*), green algae (*Mougeotia*, *Zygnema*, *Oedogonium*) and diatoms made up 34.48 %, 29.8 % and 11.01 % of the food ingested by this cichlid respectively. These were followed by organic detritus (7.41 %), and sand grains (4.76 %). Animal food organisms such as rotifers (*Gastropus*, *Synchaeta*, *Trichotria*), insect parts, crustaceans, copepods, Protozoans, (*Chilodonella*, *Loxodes*), and fish eggs represented only 3.05 % of the total number of food organism. Organic detritus, unidentified materials and sand grains formed 7.41 %, 2.60 % and 4.76 % of the food item ingested respectively. The occurrence method of stomach content analysis also indicated that food of plant source (origin) were more important than animal food organisms for this species, all of them occurred in more than 80 % of stomachs examined except desmids that occurred in 57.1 %. Food of animal origin also occurred frequently in

stomachs examined with most of them encountered in more than 50 % of stomachs examined except protozoan which occurred in 42.9 %. Unidentified materials and sand grains also occurred frequently, seen in 85.7 % and 71.4 % of stomachs examined respectively.

C. guentheri

A total of 120 specimens of *C. guentheri* were examined, 103 (85.8 %) had food in them. Food encountered included blue green algae (*Spirulina*, *Nostoc*) green algae (*Mougeotia*, *Oedogonium*), desmids (*Gonatozygon*, *Closterium*, *Spirotaemaia*), diatoms (*Navicula*, *Nitschia*); rotifers (*Gastropus*, *Trichocerca*), Crustacea, plant parts, insect appendages, sand grains, and snail (*Melanoides tuberculata*). Food of plant origin also dominated the diet and formed 66.99 % of food encountered in the stomach by numerical analysis while food from animal source formed just 15.31 % of food encountered in the stomach by numerical analysis. Both food of animal and plant origin were encountered frequently in the stomach occurring in over 50 % of stomachs examined, except snail (46.6 %) and fish eggs (0.97 %).

Seasonal variation in the diet

H. bimaculatus

The food items selected were found to vary seasonally Fig. 2. Mollusc (*Melanoids tuberculata*) occurred in the stomach only during the raining season months (April to June) and did not form up to 1 % of the diet. Desmids are more predominant in the diet during the dry season months of January to March, where they constitute 13.26 % of the diet, while they formed just 2.85 % of diet on raining season. Insect parts and rotifers are also more in the diet during dry season months.

In contrast blue green algae and plant part occurred in larger number during the rainy season. Crustacea, green algae, diatoms, eggs

and unidentified food do not show any distinct seasonal variation in abundance.

S. melanotheron

Fig. 2 illustrates the seasonal variation in the composition of the diet of *S. melanotheron*. Numerical abundance of blue green algae, desmids, rotifers, eggs, and unidentified materials were higher during the dry season while plant parts, crustacean, insect parts, diatoms, organic detritus, sand grains and protozoa were higher during raining season.

C. guentheri

The seasonal variation in the composition of the diet of *C. guentheri* is illustrated in Fig. 2. numerical abundance of blue green algae, desmids, rotifers and unidentified materials were higher during dry season while plant parts, crustacean, insect parts and diatoms, were numerically more abundant during rainy season. *Melanoides tuberculata* occurred in the diet only during rainy months.

DISCUSSION

The correlation coefficients (r) for LWR is high for *H. bimaculatus*, *C. guentheri* and *S. melanotheron*, which indicate/increase in length with increase in weight. These agreed with earlier studies involving fish species from different water bodies Fagade and Olaniyan (1972), Fagade (1983), Merella *et al.* (1997), Ruiz-Ramirez (1997), Laléyé (2006). The values of b (growth exponent) for the three species examined are within the limits (two and four) reported by Tesch (1971) for most fishes. Only b value of *H. bimaculatus* is significantly different from 3 and this indicate negative allometric growth (Tesch 1971) while the remaining two species grow isometrically. Laléyé (2006) also reported the b value of *H. bimaculatus* in Ouémé River is significantly different from 3, while *S. melanotheron* and

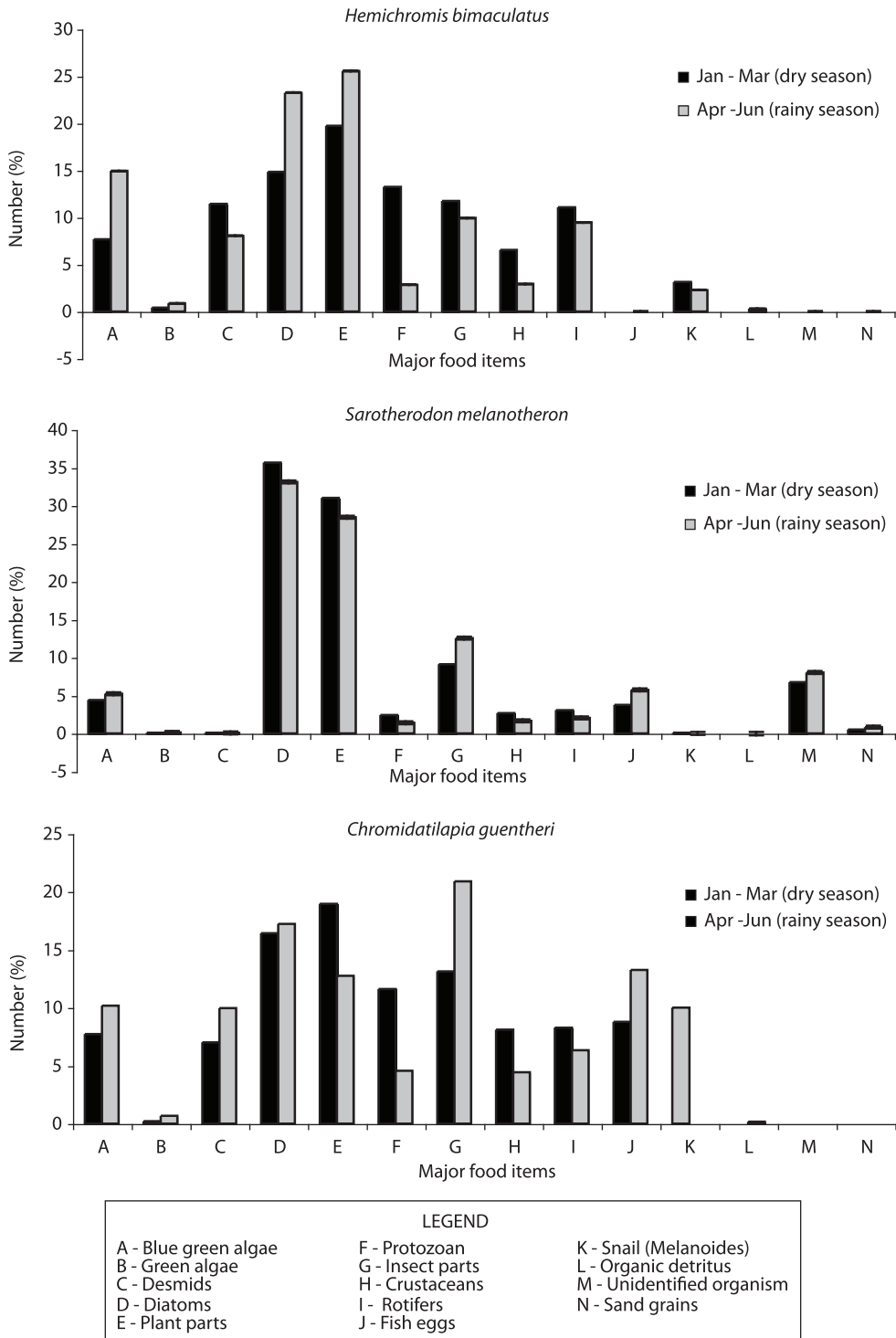


Fig. 2. Seasonal variation in the composition of the diet of three cichlid species.

C. guentheri were not significantly different 3. The mean K for the three cichlid species are greater than one, and this shows that these fish species are above average condition within the lake (Wade 1992). The variation in mean K values observed during different months for the three species showed only significant difference for *H. bimaculatus*, whose mean K value was higher during dry season. This appears to be related to the breeding activities of the fish due to depletion of reserves during rainy season. Condition factor has also been closely linked with reproductive cycle for fishes in other water bodies Salzen (1958), Fagade and Olaniyan (1972), Ugwumba (1990), Aboaba (1993), Saliu (1997).

In the three cichlids species, over 70 % of specimens had food in the stomach and this together with wide variety of food organisms encountered in the stomach contents indicate availability of food organisms within the study area. The results of the stomach content analyses showed that the three species examined, are omnivorous since they combine both plant and animal material as source of food (Fagade 1983).

Fagade and Olaniyan (1983) also reported that diet of *C. guentheri* in IITA reservoir, was dominated by plant materials and a wide variety of invertebrates were also included in the diet. Fagade (1973) showed that *Tilapia melanotheron* in Lagos Lagoon principal food items were algal filaments, diatoms and unidentified organic matter. Fragments of higher plants, arthropod appendages and some animal species were also included in the diet. According to Ugwumba and Adebisi (1992) *S. melanotheron* in Awba reservoir most important food organisms were blue green algae, mainly *Microcystis* and *Aeglellun*. Also included are other phytoplankters, zooplankters, insect larvae, vascular plant materials, organic debris, remains of unidentified organisms and sand grains.

Seasonal variation occurs in the composition of the diet of the three cichlid species because availability of food organisms are often cyclic due to factors of their life histories or to climate, or other environmental conditions. Seasonal variation in the feeding

habits of fish resulting from climatic changes has been reported by Moriarty and Moriarty (1973), Ikusemiju (1975), Tuderancea *et al.* (1988). The diet and feeding intensity can vary even during the diurnal cycle (Keast and Welsh (1968), Elliot (1970), Ikusemiju (1975).

RESUMEN

Se investigó la relación de peso-longitud (LWR), factor de condición (K) y contenidos estomacales de tres peces cíclidos (*Hemichromis bimaculatus*, *Sarotherodon melanotheron* y *Chromidotilapia guentheri*) en la reserva de Eleiyele, Nigeria, África. El LWR muestra una correlación significativa para las tres especies y el crecimiento exponencial (b) indica que *H. Bimaculatus* tiene crecimiento alométrico negativo, mientras *S. melanotheron* y *C. guentheri* tienen un crecimiento alométrico isométrico. El factor de condición para las tres especies fue mayor a uno, y varía con el tamaño y la época. El análisis de los contenidos estomacales reveló que las tres especies son omnívoras, variando la composición relativa de cada tipo de alimento con la estación del año.

Palabras clave: Relación longitud-peso, factor de condición, dieta, *Hemichromis bimaculatus*, *Sarotherodon melanotheron*, *Chromidotilapia guentheri*.

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