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Seasonal Changes of Length -Weight Relationship and Condition Factor of Five Fish Species in Lake Baringo, Kenya

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Abstract

This study describes the length-weight relationships (LWR) and relative condition factor (K) of five fish species in Lake Baringo, Kenya. A total of 483 fishes consisting of *Barbus intermedius, Clarias gariepinus, Labeo cylindricus, Oreochromis niloticus baringoensis* and *Protopterus aethiopicus* were collected on monthly basis from Lake Baringo between September 2012 and August 2013. There was a significant difference ($P < 0.05$) in the weight at unit length (b) of the length weight relationship between the wet and dry season in all the fish species. However, there was no significant difference ($P > 0.05$) in condition factor between the two seasons. In all the five species studied, the sex ratio did not deviate from the expected sex ration of 1:1. The b values were within the range of 2.2 and 3.4 in both the dry and the wet seasons respectively, indicating an isometric growth of the fishes. The condition factor (K) for all the five species from Lake Baringo was well above 1 suggesting a relatively good physiological condition of the fishes in the lake.

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The seasonal variation influenced the length-weight relationship of the fishes but did not affect the condition factor and the sex ratio of all the fish species in Lake Baringo. The authors recommend a further study taking into account the fluctuations of water quality parameters.

Keywords: Seasonal Changes; Length-Weight Relationship; Condition Factor; Lake Baringo

1. Introduction

Currently, the fish community of Lake Baringo comprises seven species namely: *Aplocheliches* sp, *Barbus intermedius australis, Barbus intermedius lineomaculatus, Clarias gariepinus, Labeo cylindricus, Oreochromis niloticus baringoensis* and *Protopterus aethiopicus.* However, only five species, namely: *C. gariepinus, O. n. baringoensis, P. aethiopicus, L. cylindricus* and *B. intermedius* are economically exploited. Lake Baringo is a highly variable system, governed primarily by seasonal changes in lake levels [1]. These changes are well correlated with changes in water quality, lake vegetation and composition of plankton community [2]. The lake is characterized by high turbidity due to erosion of fine volcanic soils in the catchment [3].

Fisheries management and research often require the use of biometric relationships in order to transform data collected in the field into appropriate indices. Quantitative aspects of fish such as length-weight relationship, condition factor, sex ratio, growth, recruitment, and mortality are important tools for studying fish biology [4]. Length and weight measurements can give information on the stock composition, life span, mortality, growth and production [5]. Relative weight and relative condition factor (K) are common factors for indication of the condition of fish [6]. It reflects information on the physiological state of the fish in relation to its welfare [7]. Condition factor (K) also gives information when comparing two populations living in different 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 [8,9, 10]. The study of the condition factor is thus important for understanding the life cycle of fish and contributes to adequate management of the fish and, therefore, to the maintenance of equilibrium in the ecosystem [10].

The LWR of fishes is important for fisheries biology and fish stock assessments in all water bodies [11]. Based on the LWR, the average weight of the fish of a given length group can be easily estimated by establishing a mathematical relation between the two [12]. The LWR applications are significant when estimating the standing stock biomass and comparing the ontogeny of fish population from different regions [13]. Length-weight data often shows indication of gonad development of fish and are useful for regional comparisons and histories of specific species [14]. Data on length weight relationship can also provide important clues on climate and environmental changes and change in human subsistence [14, 15]. Length weight relationship and condition factor are important to the fisheries as they help to predict the best length and time suited to harvest a particular species of fish [16].

The ecological and commercial importance of the commercial fish species of Lake Baringo cannot be underestimated. The age and growth of young-of-the year of some exploited fish population are necessary input for rational management decisions for both capture fisheries and aquaculture [17]. However, information on

LWR, condition factor and sex ratio for most exploited fish species are scarce. The influence of seasonal dynamics of these important biometric indices of Lake Baringo fish species are equally missing. This study aimed at providing more information on the seasonal fluctuations of LWR, condition factor and sex ratio of five major fish species of Lake Baringo.

2. Materials and methods

2.1 *Study area*

Fish samples were obtained from Lake Baringo, Kenya a shallow equatorial freshwater lake with a surface area of approximately 137 km^2 located in the eastern arm of the Rift Valley, Kenya. The lake lies between 0^o 32' and 0^{o}45' N, 36^o 00' and 36^{o}10' E at an altitude of 975 m above sea level. Lake Baringo has no surface outlet, with its 'freshness' being attributed to the presence of an underground outlet at its northern end [18]. The surface covers approximately 130 km^2 [19]. This lake is characterized by dry and wet season. The dry season starts from September to February while the wet season starts from March to August [19].

Fig 1. A map of Lake Baringo showing the sampling stations (from [3])

2.2 *Collection of fish species*

In this study samples of 483 fish were collected monthly from September 2012 to August 2013 using 100m long gillnet of different sizes ranging from 1.5 to 5 inches. The nets were set in different sampling stations; N2, C2 and S2 (see figure 1) in the evening and retrieved in the morning. *C. gariepinus* and *P. aethiopicus* were caught using hook lines. The fish samples were then taken to the Kenya Marine and Fisheries Research Institute, Baringo station laboratory for analysis.

2.3 *Length-Weight Relationship*

Fish were mopped on a filter paper to remove excess water from their body in order to ensure accuracy before weighing [20]. Weight and length of each individual fish was measured by using a sensitive weighing balance (0.1 g) and a measuring board (0.1 cm) respectively. The length was measured as total length (TL). Linear transformation of length and weight of the fish was made using natural logarithm at the observed lengths and weights. The length-weight relationship (LWR) was calculated based previous studies [20]. The LWR was used to calculate the regression coefficient (slope of regression line of weight and length). The parameter "b" of the length-weight relationship were estimated using the formula $W= aL^b$.

Where: W = the weight of the fish in grams,

L = the total length of the fish in centimetres

a = exponent describing the rate of change of weight with length

b = weight at unit length

The expression of the relationship was represented by the following formula:

$\text{Log } W = b \log L + \log a$

2.4 *Condition factor*

The value of ‘b’ from the weight-length relation was used to compute the condition factor. The relative condition factor was calculated as:

Kn = W / ^W

Where:

Kn = relative condition factor

W = the observed weight in grams

^W = calculated weight derived from length weight relationship was calculated by the formula ^W = aL^b

Where:

W = the weight of the fish in grams,

L = the total length of the fish in centimeters

a = exponent describing the rate of change of weight with length

b = weight at unit length

2.5 *Sex ratio determination*

Each fish was dissected ventrally using a small scissor inserted through the vent. Also a semi circular cut was made laterally on the side of fish for better observation. The gonads which are two parallel tubules located on the dorsal wall of the abdominal cavity were then examined with the naked eye. In the case of sexually mature fishes, a dissecting microscope was used to examine the sexually mature ones. The males have gonads with smooth exterior, while the females have gonads with a rough exterior [21]. Both males and females were counted separately and recorded.

2.6 *Statistical analysis*

ANOVA was used to determine significant differences in the length-weight relationships and condition factor between the dry and the wet seasons using Minitab Statistical Software version 14. Values with $P < 0.05$ were considered significantly different.

3. Results

The sample size, minimum and maximum lengths and weights, length-weight relationships, (b) values, coefficient of determination (r^2) is shown in Table 1 and Table 2. The b value ranged from 2.29 in *L. cylindricus* during the dry season to 3.08 for *O. niloticus* during the wet season. The relative condition factor ranged from 0.3 in *B. intermedius* during the dry season to 3.7 in *O. niloticus* during the wet season. The highest mean condition factor of 1.21±0.2 was recorded for tilapia in the wet season.

There was a significant difference (ANOVA, $p < 0.05$) in the parameter b of the length weight relationship between the wet and dry season in all the species. However, there was no significant difference (ANOVA, $p>0.05$) in condition factor between the two seasons. The mean condition factor for all the species was above 1 except for *B. intermedius* sp. in the wet season which had a mean value of 0.92 ± 0.02. In all the five species studied the sex ratio was close to the expected ratio of 1:1

Table 1: Length-weight relationship, regression coefficient and condition factor parameters recorded in Lake Baringo during the wet season

Species	N	b	R^2	Condition Factor (K)		Total Length (cm)		Total Weight (g)	
				Mean	Range	Mean	Range	Mean	Range
B.intermediu	130	2.82	0.87	0.92±0.02	0.71-2.04	18.4±0.32	12-25	89.04± 1.12	10.5-350
C. gariepinus	40	3.25	0.97	1.05±0.12	0.74-1.95	44.24±0.12	17.5-63	786.14±1.03	34-2100
L. cylindricus	48	2.70	0.79	1.03±0.11	0.70-1.14	16.2±0.22	11-23.5	54.81±0.89	17.4-157
O. niloticus baringoensis	265	3.08	0.90	1.21±0.2	0.80-3.70	16±0.31	8-33	109.88±0.95	6.2-675
P.aethiopicus	39	3.02	0.93	1.10±0.14	0.43-3.00	62±0.76	17-94	1281.39±2.32	124.3-6000

Table 2: Length-weight relationship, regression coefficient and condition factor parameters recorded in Lake Baringo during the dry season

Species	N	b	R^2	Condition Factor (K)		Total Length (cm)		Total Weight (g)	
				Mean	Range	Mean	Range	Mean	Range
B.intermedius	152	2.80	0.87	1.00±0.15	0.3-0.80	19.91±0.52	13.2-24	76.20± 0.21	28-375
C.gariepinus	43	2.94	0.90	1.06±0.34	0.722.30	44.19±0.97	21-70	888.59±0.13	62.5-3000
L.cylindricus	57	2.29	0.82	1.04±0.07	0.541.88	16.63±0.41	9-35.4	46.33± 0.34	11-250
O.niloticus baringoensis	232	3.04	0.92	1.13±0.15	0.591.89	15.61±0.58	9-28	85.76± 1.30	12-500
P.aethiopicus	79	2.85	0.92	1.05±0.11	0.712.81	67.64±0.71	37-97	1484.37±1.4	300-4800

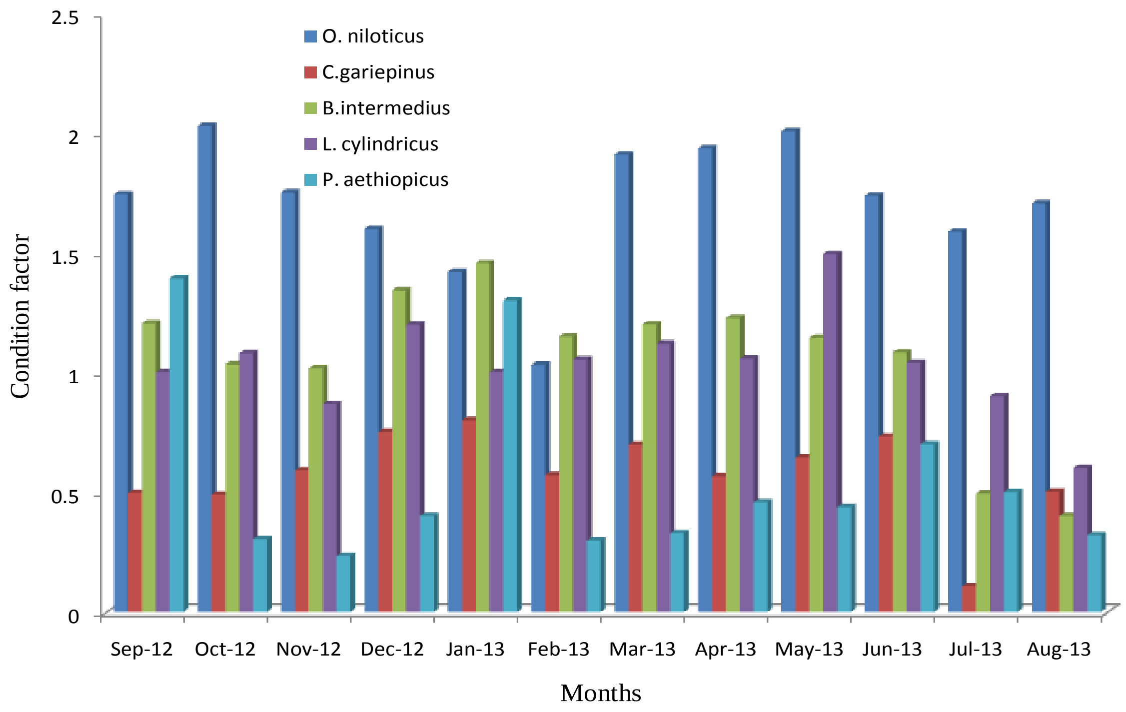

Fig 2. Condition factor of five species of fish in Lake Baringo from September 2012 to August 2013

4. Discussion

According to the weight at unit length (b) obtained for all of the species in this study the fish showed isometric growth pattern in both dry and wet seasons. This observation is similar to previous studies [22, 23, 24]. The condition factor for all the five species from Lake Baringo was well above 1 in all the seasons. Other studies have found K values greater than 1 in freshwater species [25]. These results show that the fish were physiologically in stable condition. The different feeding habits of the fishes, which might have enabled them to obtain food all year round, could have been relevant for their stable physiological condition. Therefore the seasonal variations did not influence the condition factor of fishes analyzed. However, some authors reported seasonal difference in condition factor in *Chromidotilapia guntheri*, and *Tilapia mariae* in a Man-made Lake in Imo State, Nigeria [26, 27]. Nonetheless, the climatic conditions and perhaps the water quality dynamic of the water bodies might have played significant roles in shaping the condition factor of the fishes.

Studies on *P. aethiopicus* from Lake Baringo indicated that the mean relative condition factor was close to1 and did not vary much between months [28]. Results in this study also indicate that there was no variation in the condition factor for *P. aethiopicus* between the wet and dry season. The differences in condition factor among the fishes could have been due to the different number of fishes examined in the two seasons, effects and distinctions in the observed length ranges of the specimens [28, 29]. High condition factor values indicate favorable environmental conditions while low values indicate less favorable environmental conditions [30].

When the weight at unit length (b) is equal to 3, growth is called isometric and when it is less or greater than 3 it is allometric [31, 32]. Seasonal fluctuations of value (b) of length -weight relationship is directly related to the weight affected by ecological factors such as temperature, food supply, spawning conditions and other factors, such as sex, age, fishing time and area and fishing vessels [33,34]. Changes in (b) value can also be attributed to factors such as overfishing and competition for food [35].

The sex ratio obtained in this study both in the dry and wet season was 1:1. This is in agreement with the natural laws of genetical recombination of alleles. An understanding of the sex ratio of fish in different seasons is essential for obtaining information on seasonal segregation of the sexes and their differential growth. Sex ratio reveals segregation or aggregation of males and females in accordance with environmental conditions, the differential behavior of sexes, and due to fishing [36].

5. Conclusion and recommendations

The seasonal variation influenced the length-weight relationship of the fishes but did not affect the condition factor and the sex ratio of all the fish species in Lake Baringo. The authors recommend a further study taking into account the fluctuations of water quality parameters. This is the first study on the length-weight relationship and condition factor of 5 fish species, and the first record of the differences of length-weight relationship between seasons in Lake Baringo.

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