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Research Article

Length-Weight and Length-Length Relationships of Four Fish Species from Jabal Awlya Dam Lake (Sudan)

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Abstract

Length-weight relationships were estimated for *Bagrus bajad* (Forsskål, 1775), *Bagrus docmak* Forsskål,1775) Lates niloticus(Linnaeus, 1758) and Clarias anguillaris (Linnaeus,1758) sampled from central fish markst in Khartoum (Sudan). The slopes (b) of the length-weight relationship ranges between 2.659 and 2.990. the slopes (b) of length – length relationships ranged between 1.02 and 1.12 negative allometry and isometry was represented for species in the study.

Keywords: Length-weight relationships, Length-length relationships, Relative Species Condition Factors, Jabal Awlya Dam Lake, Sudan.

Introduction

Size is generally more biologically relevant than age in fish, mainly because several ecological and physiological factors are more size-dependent than age-dependent. Consequently, variability in size has important implications for diverse aspects of fisheries science and population dynamics (Erzini et al. 1997).

Total (TL) and fork (FL) lengths are usually utilised in studies of fish growth, whereas standard length (SL) is mainly used in systematic studies. When making comparisons between populations, it is essential to use standard measures for all populations so that the results will be more reliable. This is why the length-length relationship of species under various environmental conditions should be known. Length – length relationship is also important for comparative growth studies (Moutopoulos and Stergiou, 2002).

The relationship between the length (L) and weight (W) of a fish is usually expressed by the equation W = $\boldsymbol{aL}^{\mathbf{b}}$ Values of the expone information on fish growth. When b = 3, increase in weight is isometric. When the value of b is other than 3, weight increase is allometric (positive if b > 3, negative if b < 3). These parameters (a, b) are important in stock assessment studies (Froese, 1998; Can et al. 2002;, Moutopoulos and, Stergiou, 2002).

Standing stock, yield and biomass are frequently estimated from length frequency data converted with length–weight relationships (LWRs) and length– length relationships (LLRs) are useful for standardization of length type when data are summarized (Froese 1998) . Moreover, the LWRs allow fish condition to be estimated. The condition factor either K Fulton Condition Factors (K) or Relative Species Condition Factors (Kn) is frequently used in the analysis of ontogenetic changes (Safran, 1992) and for between-regions life-history comparisons (Petrakis and Stergiou, 1995;, Weatherley and Gill, 1987).

LWRs and LLRs data are available for most European and North American estuarine fishes, while these data are unavailable in tropical fish species.

The present study describes the LWRs and LLRs *Bagrus docmak, Bagrus bajad, Lates niloticus* and *Clarias anguillaris* fish species caught in Jabal Awlya Dam Lake to contribute to the knowledge of the LWRs and LLRs of some freshwater fishes in Sudan.

Materials and Methods

Jabal Awlya Dam Lake (Sudan) located 40 km south of Khartoum with total area of about 1000Km^2. It is one of the main landing site in Khartoum state, all the landings used to be sold in the central fish market in Khartoum.

Data on length and weight of *Bagrus bajad* (Forsskål, 1775),, *Bagrus docmak* (Forsskål, 1775),, *Lates niloticus* (Linnaeus, 1758) and *Clarias anguillaris* (Linnaeus, 1758) fish species were collected from December 2009 to February 2010 from many samples from commercial catches landed in the central fish market in Khartoum (Sudan). All fish were measured for their total and standard length to the nearest 0.01 cm with a measuring board and weighed to the nearest 0.01 g accuracy using an electronic balance.

The relationships between total, standard lengths were determined according to the linear regression model. The length-weight relationships were estimated from the allometric formula, $W = a\ L^{b,}$ where W is total body weight (g), L the total length (cm), a and b are the coefficients of the functional regression between log W and log L (Ricker, 1968) were estimated using ABee ver.1.0. Software.

Statistically significant differences of the estimated values of b from the isometric value were confirmed using Student's-tesinwhich the null hypothesis was that b = 3 (Equation 3), with a confidence level of 99% (Sokal and Rohlf 1987): $ts = (b - 3) \times (Sb)^{-1}$ (3)

Where :ts is the value of the test and b student's is the obtained slope and tsb the standard error for the slopeLength – Length analysis:

The raletion between the different length Measurements were estimated by fitting the data to the following linear model

Equation (4):

(TL)= a+b(SL) (4)

Where: TL is the total length SL, the standard length (all of them in cm), a intercept and b the slope (Bagenal and Tesch, 1978).

To compare length and weight for a particular sample or individual, Condition factors are used (Safran- 1992). One is the condtion Fulton's factor (K), equal to W/L3 while another one is relative condition factor (Kn), Kn= W/aLb. In our study we used more homogenous formula of condtions factor K=100W/L3, to know the growth condtion of fish(Simon and Mazlan, 2008)

Results

Table(1) shows the results of the L–W relation for the four fish species studied, the sample size, the minimum, maximum and mean length (± S.E.), the minimum and maximum weight measured, the LWR parameters a and b, the standard error of the slope and the coefficient of determination, R^2

The parameters of the length–length relations for the four species are shown in Table (2). All relations were highly significant with coefficient of determination, R^2 >0.95. The values of the b the slope in the length-length relationships (LLRs) TL = a + b (SL) ranged between 1.02and1.12

Information on the kind of growth (isometric or allometric) of each species is furnished. The sample size varied from6 8 for *Bagrus docmak* to 100 for *Bagrus bajad and Clarias anguillaris*. All the relations were highly significant, with the coefficient of determination, R^2 higher than 79%. Slope values varied from 2.659 for *Bagrus bajad* to 2.99 for *Bagrus docmak*, whereas the latter was less than the estimates reported from other areas (Mekkawy, 1997).

The Student's-test result(t = 1.671, P = 0) confirmed the negative allometry in this case table (3). Likewise, b values(2.99) for *Bagrus bajad* in Jabal Awlya Dam Lake was less than the estimated value from Lake Victoria (Witte, and Winter, 1995 b=312) . In this case, the-test alsoStudent'sconfirmedthenegativet allometry (t = 1.671, P = 0). On the other hand, for *Lates niloticus* the estimated b= 2.9 value was lower compared with that from Lake Chad (Soriano et al.1992) , also the Student's-test confirmed the negative allometry value (t = 2.90, P = 0.010) and for *Clarias anguillaris* the estimated b value was(2.88) was lower than that from Ghana(Entsua et al, 1995) , also the-test confirmed Student's the negative allometry value (t=2.580,P=0.010) .

There were no significant differences in the predicted values of relative condition factor table (4) of *Bagrus docmak*,, *Lates* niloticus and *Clarias anguillaris* (ANOVA, P< 0.005). However there were marked differences between the prediction values of relative condition factor *Bagrus bajad* and the other three species (ANOVA, P<0.005).

Discussion

The sample of fishes used in this study did not include juveniles or very small individuals, possibly due to the collection of the data at the fish market and not at the landing site, and therefore the estimated relations should be limited to the size range used in the estimation of the linear regression parameters (Petrakis and Stergiou 1995, Santos et al. 2002).

The initial condition factor (K) and allometric coefficient (b) can be related to the ecological process and to the vital history (Wootton, 1990) A high allometric coefficient implies that the species gain weight faster than it grows in length. All allometric coefficients (b) estimated in this study were within the expected range of 2.2-3.4. And according to Benegal and Tesch (1978).

In fact, L–W relations are not constant, and can vary according to many factors like temperature, salinity, food availability, sex, gonadal development, spawning season, and feeding rate and coefficients a and b also vary species, and Sometimes between stocks of the same species (Stearn and Crandall 1984; Wootton 1990).

The LWR parameters (a, b) of the fish are affected by a series of factors such as season, habitat gonad maturity, sex, diet, stomach fullness, health preservation techniques and annual differences in environmental conditions (Froese,2006). Such differences in values b can be ascribed to one or a combination of most of the factors including differences in the number of specimens examined, area/season effects and distinctions in the observed length ranges of the specimens caught, to which duration of sample collection can be added as well (Moutopoulos and Stergiou, 2002).

As it was stated above that the data for this study was collected away from the landing site and due to the absence of the juveniles or very small individuals combined with time of the collection (winter) , so low value of (b) for all species can be expected and for these reasons good attention should be paid to time and duration of data collection in similar studies

Table (1) Length-Weight Relationships and Related Statistics of 4 Fish Species

Species	Sample Size,n	Length[b]	Total Length Characteristics				Weight Characteristics[c]		Parameter of the Relationships[d]				
			Mean	S.E	Min.	Max.	Min.	Max.	a	S.E (a)	b	S.E (b)	R^2
B. docmak	68	TL	61.7	±2.4	26	120	200	25000	0.4690	±0.1066	2.99	±0.0608	0.96
B. bajad	100	TL	55.9	±1.1	23	77	500	4100	0.0335	±1.930	2.659N	±0.1109	0.85
L. niloticus	99	TL	55.8	±2.4	32	138	500	42000	0.4439	±0.19271	2.9	±0.1128	0.79
C.anguillaris	100	TL	53.47	±1.5	18	86.5	220	4900	0.7510	±0.0484	2.88N	±0.0285	0.98

[b]Length (in cm) of the species is expressed as total length. [c]Weight (g) of the species is expressed as total body weight. [d]Kind of growth : N, negative allometry.

Table (2) Parameters of Length-Length Relationships of 4 Fish Species

Species	Sample Size, n	Total Length Characteristics				Standard Length Characteristics				Parameter of the Relationships TL = a + b SL				
		mean	S.E	Min. (cm)	Max. (cm)	mean	S.E	Min. (cm)	Max. (cm)	a	S.E (a)	b	S.E (b)	R^2
B. docmak	68	61.7	±2.4	26	120	53.45	±2.21	23	106	4.40	± 0.77	1.10	± 0.013	99
B. bajad	100	55.9	±1.1	23	77	47.245	± 0.968	19	79	2.917	±1.232	1.12	0.026	95
L. niloticus	99	55.8	±2.4	32	138	46.72	± 2.22	14.5	118	4.458	± 0.828	1.10	±0.016	98
C.anguillaris	100	53.47	±1.5	18	86.5	46.94	±1.50	13	73	5.81	± 0.35	1.02	±0.007	99

Table (3) statistically significant differences of the estimated values of b from the isometric value.

Species	ts		B	Sb	(b –3) / (Sb)
	df	tdf	the slope	standard error of the slope	
Bagrus docmak	66	1.671	2.99<3	±0.0608	16.39254
Bagrus bajad	98	1.671	2.66<3	±0.1109	7.995191
Lates niloticus	97	1.671	2.90<3	±0.1128	8.56974
Clarias anguillaris	98	1.671	2.88<3	±0.0285	33.68421

Table (4) Growth Conditions of Four Fish Species

Species	**Growth Conditions**				
	W= aL^b	**Fulton Condition Factors (K)**		**Relative Species Condition Factors (Kn)**	
		Mean	**S.E (K)**	**Mean**	**S.E (Kn)**
Bagrus docmak	W=0.4690L$^{2.99}$	11.6926	± 0.210149	0.0259797	±0.0004715
Bagrus bajad	W=0.00335L$^{2.65}$	9.09231	± 0.431329	1.051410	± 0.0399257
Lates niloticus	W=0.4439L$^{2.90}$	28.8382	± 6.59922	0.0947691	±0.0211221
Clarias anguillaris	W=0.7510L$^{2.88}$	9.609	±0.03690	0.0203243	±0.0006771

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