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Weight-length relationship and condition of the characiform *Triportheus guentheri*

Alexandre L. Godinho
Departamento de Zoologia, Universidade Federal de Minas Gerais, Instituto de Ciências Biológicas, 31270–901 Belo Horizonte, Minas Gerais, Brazil

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Synopsis

The sources of variations in the weight-length relationship parameters, and in the Fulton's, allometric, and relative condition factors (K) of the characiform fish *Triportheus guentheri* were investigated. The use of these indices as indicators of condition were also discussed. The 2899 females and 2491 males were captured with gill nets from January 1986 to March 1988 in Três Marias Reservoir (18° 15′S and 45° 15′ W), Brazil. Weight-length relationship parameters varied monthly in both sexes mainly due to the skewness of the relative frequency of the number of fish per body length. This suggests that a selective sample and/or the population length structure may strongly influence the estimate of those parameters. The K showed high correlations ($r \geq 0.99$) among themselves. Their variations were ascribed to carcass weight in both sexes when analyzed by month, or to the ovary weights when analyzed by female gonad development intervals. The monthly weight-length relationship parameters of *T. guentheri* presented low or null correlation with K, except for the female's coefficient of regression. Problems using these parameters as indicators of condition suggested that they are not good indices to express condition. Some restrictions regarding the use of K are discussed.

Introduction

This study presents the results of a two-year investigation regarding the weight-length relationship parameters and condition factor of *Triportheus guentheri* (Garman 1890) (Characiformes, Characidae) in Três Marias Reservoir (18° 15′ S and 45° 15′ W), São Francisco River, Brazil.

The relationship between weight (W) and body length (L) has been represented by the equation $W = aL^b$. Bagenal & Tesch (1978) suggested that within a population the parameter 'a' frequently presents seasonal variations, whereas 'b' is nearly constant throughout the year. However, 'a' and 'b' are highly correlated because they are covariates (Weisberg 1985) and because of the high correlation between weight and length. Thus, seasonal variations of 'b' must be more frequent than suggested by Bagenal & Tesch (1978).

The weight-length relationship parameters have been used in the calculation of condition factor as well as estimators of fish condition. The term 'condition' can be used to express the fish's general well being (Le Cren 1951). In less abstract terms, it means that between fish of the same length, the heaviest will be in better condition (Ricker 1975, Bagenal & Tesch 1978).

The condition factor (K), a standard index in fish ecology (Bolger & Connolly 1989), can be used to monitor within-population influence of environ-

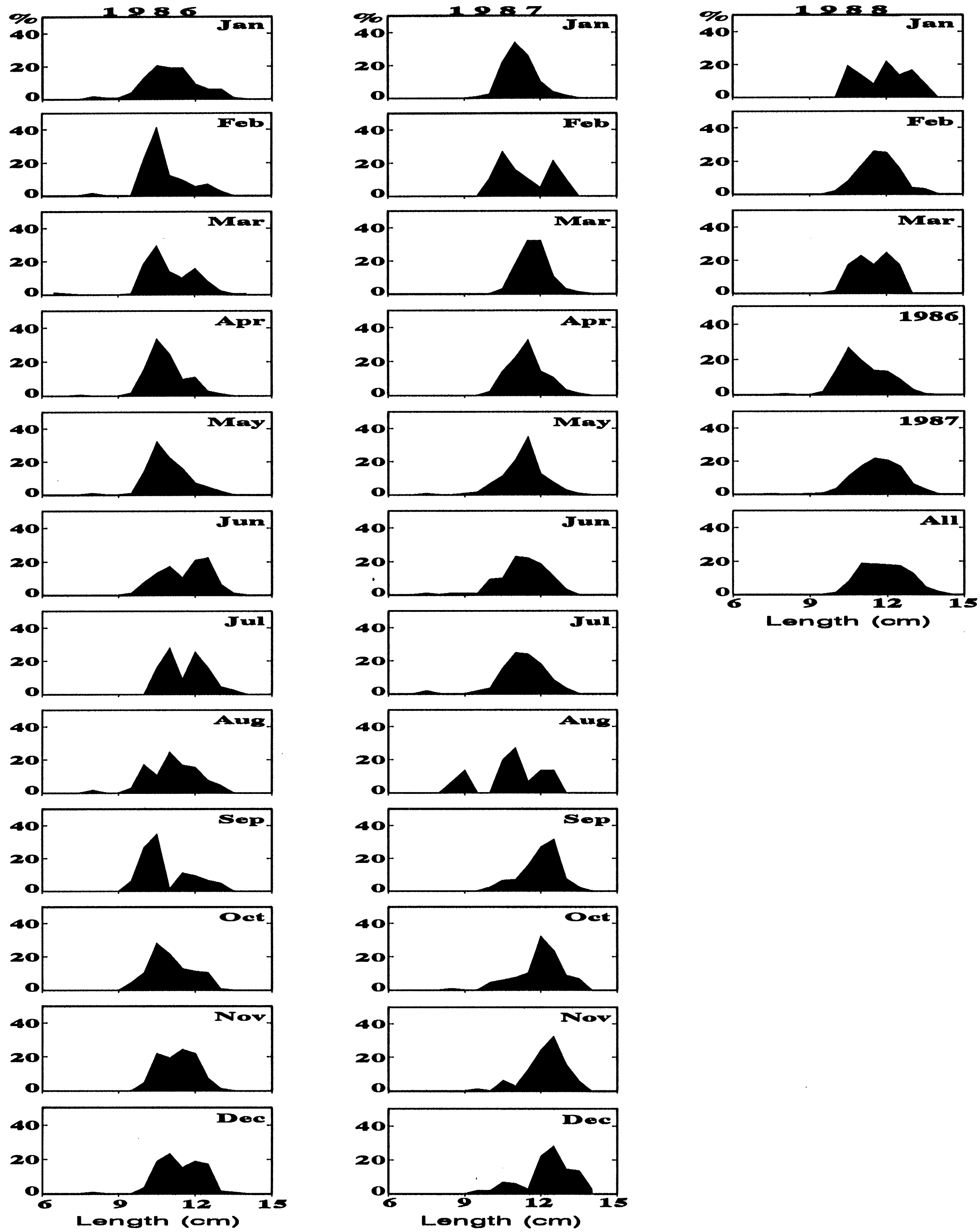

Figure 1. Relative frequency of the number of fish per 0.5 cm standard length class by month, year and over the entire sampling period of *Triportheus guentheri* females in Três Marias Reservoir.

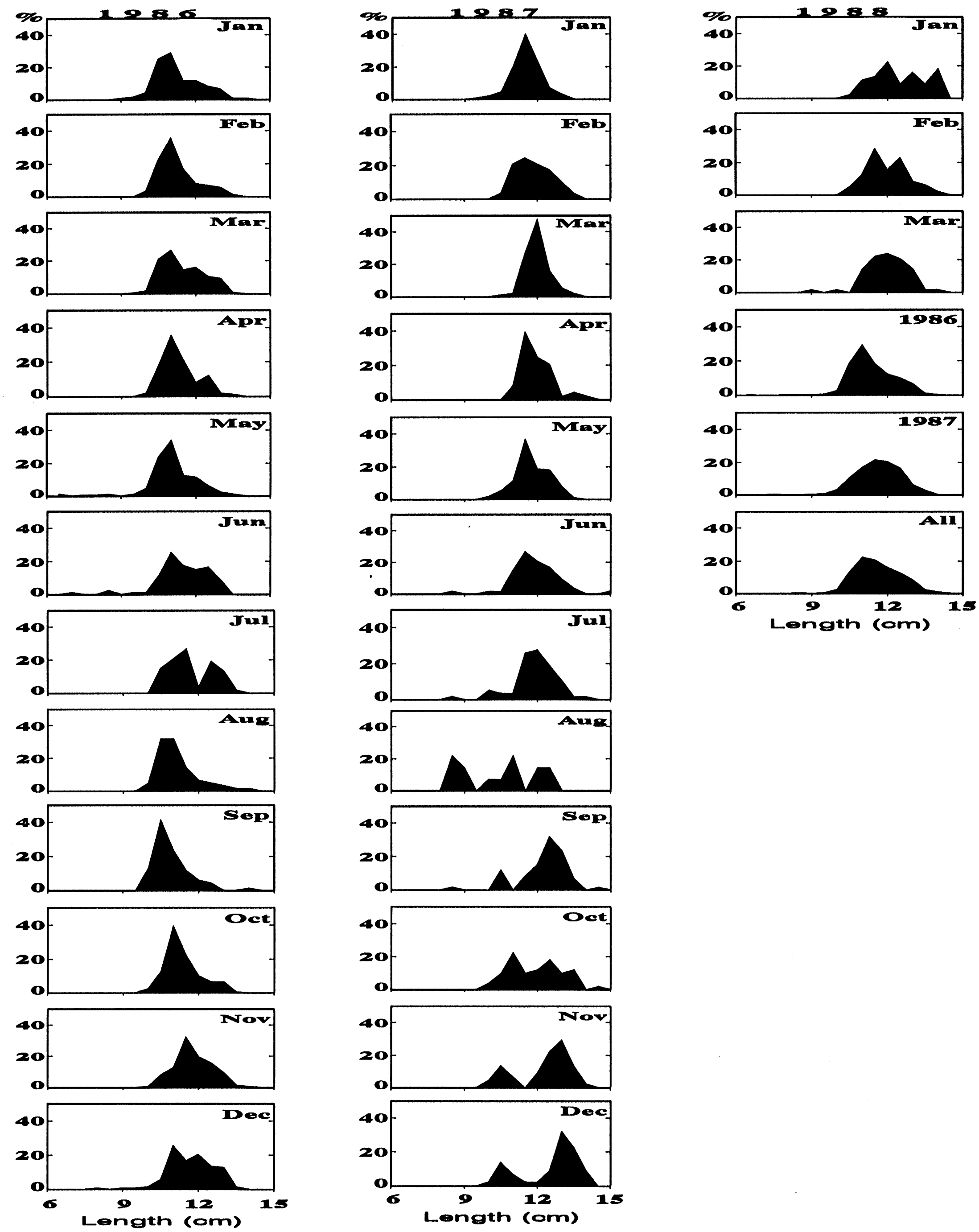

Figure 2. Relative frequency of the number of fish per 0.5 cm standard length class by month, year and over the entire sampling period of *Triportheus guentheri* males in Três Marias Reservoir.

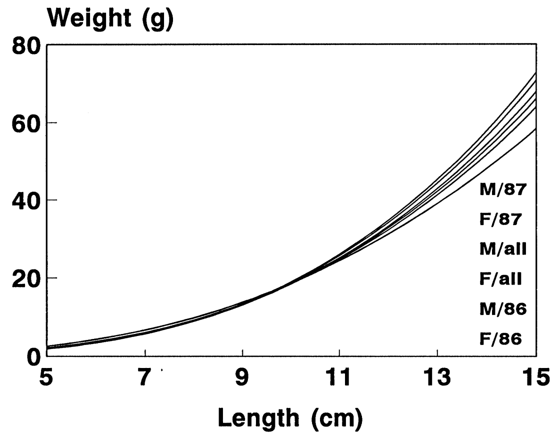

Figure 3. Weight-length relationship of *Triportheus guentheri* females (F) and males (M) in Três Marias Reservoir for 1986 and 1987 and over the entire sampling period (all). The legend is arranged according to the curves.

mental change over time (Ney 1993). Seasonal changes in this index, with minimum values just after spawning, have been often observed (Jobling 1993).

Some assumptions are associated with the use of condition factors. For example, Fulton's condition factor, the most commonly used (Ricker 1975, Bolger & Connolly 1989), is not constant along the length when growth is allometric (Braga 1986). In this case, only individuals of approximately the same length can be compared (Ricker 1975, Maceina & Murphy 1988). Although relative and allometric condition factors may be used in this situation, both present the inconvenience of using the parameters of the weight-length relationship (Bolger & Connolly 1989). Moreover, the relative condition factor can not be used to compare condition between populations (Murphy et al. 1990).

In the present article, I analyze sources of variation in both the weight-length relationship parameters and the condition factors (Fulton's, allometric, and relative) of the characiform fish *Triportheus guentheri* in Três Marias Reservoir, southeastern Brazil. The use of these parameters and condition factors as indicators of fish condition are also discussed.

The site and species under study

Três Marias Reservoir was filled in 1961 and occupies a maximum surface area of 1142 km^2. It is a warm monomictic type of reservoir with great nutrient scarcity and the epilimnion water temperature varying from 23.5 to 29.5° C during the year (Esteves et al. 1985). The annual water level variation ranged from 4.0 to 10.9 m during 1979 to 1990. The highest water level occurred between March to June and the lowest in December (Godinho 1994).

The surface-feeding *T. guentheri* reaches 15 cm standard length and 70 g body weight. It feeds almost exclusively on allochthonous arthropods, and was an abundant species at the time of sampling (personal observation). It has adhesive eggs, mul-

Table 1. F statistic and degrees of freedom (df) of the covariance analysis for slopes (b) and intercepts (a) between weight-length relationships of *Triportheus guentheri* at Três Marias Reservoir. Only the following relationships were tested: same sex between years (e.g. females/86 vs. females/87), between sexes of same year (e.g. males/86 vs. females/86) and between sexes of the entire sampling period (e.g. males/all vs. females/all).

Group	b (slope)				a (intercept)			
	Females/86	Females/87	Females/all	Males/87	Females/86	Females/87	Females/all	Males/87
Females/86		122.38*** 2699^{df}				605.50*** 2700		
Males/86	46.3*** 2915			25.48*** 2281	97.46*** 2916			208.55*** 2282
Males/87		0.67 2065				11.34*** 2066		
Males/all			4.32* 5386				39.58*** 5387	

The relationships were considered different when, at least, one of their parameters was statistically different (* $p < 0.05$, *** $p < 0.001$).

tiple spawning, and reproduces in Três Marias over 5 to 7 months each year, mainly between November and February (Godinho 1994).

Methods

Samplings of *T. guentheri* were made monthly from January 1986 to March 1988 with gill nets of 3, 4, 5 and 6 cm stretched mesh. The nets were set in the afternoon and removed the next morning. The 2899 females and 2491 males captured were fixed in 10% formalin and stored in 70% ethanol. Left ovary fragments from about 13% of the females were fixed in Bouin's fluid for 3 to 6 hours and were processed for embedding in paraffin and for staining in hematoxylin-eosin.

The ovaries were classified as resting, maturing, partially spent, totally spent, and recovering intervals. Maturing and recovering intervals were subdivided into 5 and 2 subintervals, respectively, according to classes of the gonadosomatic index. The intervals and subintervals were recognized after Godinho (1994).

The following biometric indices were determined for each fish: coelomic fat index ($CFI = FW \cdot BW^{-1} \cdot 100$), stomach fullness index ($SFI = SW \cdot BW^{-1} \cdot 100$), gonadosomatic index ($GSI = 2\ GW \cdot BW^{-1} \cdot 100$), and visceral-somatic index ($VSI = VW \cdot BW^{-1} \cdot 100$), where BW = body weight, FW = coelomic fat weight, SW = stomach weight, GW = right gonad weight, and VW = viscera weight.

The weight-length relationship was obtained by predictive linear regression according to the equation $\mathrm{Log}_e W = \mathrm{Log}_e a + b\ \mathrm{Log}_e L$, where W = weight in grams and L = standard length in centimeters. For each sex, this relationship was determined monthly, yearly (except for 1988), and for the entire sampling period.

The weight-length relationship obtained for the entire sampling period was compared between sexes. Those determined yearly were compared between and within sexes for each year. Comparisons to test slopes (b) and intercepts (a) homogeneity were made by covariance analysis (ANCOVA) after Snedecor & Cochran (1989). For each 'b', a t test (Sokal & Rohlf 1995) was used to determine whether $b = 3$.

The Fulton ($K = W \cdot L^{-3}$), allometric ($K_a = W \cdot L^{-b}$), and relative ($K_n = W \cdot a^{-1} \cdot L^{-b}$) condition factors were calculated for each fish. The parameters 'a' and 'b' of the weight-length relationship used to calculate K_a and K_n were those obtained for each sex over the entire sampling period.

Stepwise regression, at 0.15 significance level for entry into the model, was performed in each sex for the monthly b. The independent variables were (i) water level taken at the first day of each month (WL), (ii) skewness of the relative frequency of the number of fish per length class, and (iii) monthly means of K, CFI, SFI, GSI, and VSI. All analyses were processed with the aid of the SAS system.[1]

[1] SAS Institute Inc. 1985. SAS User's Guide: basics, version 5 edition. SAS Institute Inc., Cary. 1290 pp. SAS Institute Inc. 1985. SAS User's Guide: statistic, version 5 edition. SAS Institute Inc., Cary. 956 pp.

Table 2. Weight-length relationship ($W = a L^b$, W = weight (g) and L = standard length (cm)), correlation (r), standard error of b (SE), and summary of t test (t) for b (H_o: $b = 3$) for *Triportheus guentheri* at Três Marias Reservoir.

Sex	Year	N	a	b	r	SE	t
Female	1986	1,395	0.0282	2.82	0.94	0.028	6.28*
Female	1987	1,308	0.0101	3.27	0.95	0.028	9.48*
Female	all	2,899	0.0134	3.14	0.94	0.021	6.61*
Male	1986	1,524	0.0153	3.08	0.95	0.026	3.20*
Male	1987	761	0.0093	3.31	0.96	0.034	8.91*
Male	all	2,491	0.0117	3.20	0.95	0.020	9.85*

All = entire sampling period, * $p < 0.001$.

Results

Length frequency curves (i.e. the relative frequency of the number of individuals per standard length class of 0.5 cm) for females and males, per month, year, and for the entire sampling period are shown in Figures 1 and 2, respectively. Fish measuring 10 to 14 cm were the most frequently captured. Only very few smaller or larger fish were captured.

Skewness of these curves appeared in various months and varied from – 1.1 to 0.8 in females and – 1.3 to 1.6 in males. The skewness values were normally distributed in both sexes (Shapiro-Wilk statistic: W = 0.97 and p = 0.54 for females and W = 0.95 and p = 0.28 for males). Among the curves of 1986, 1987, and for the entire sampling period, that of 1986 was the least skewed (females = – 0.12 and males = – 0.06).

Various curves presented more than one modal class. The monthly standard length mean varied from 11.3 cm to 12.8 cm for females and 10.5 cm to 12.6 cm for males, with the coefficient of variation ranging from 4.9 to 10.6 for females and 4.1 to 14.3 for males.

Weight-length relationship

Significant differences between weight-length relationships of females and males occurred in 1986, 1987, and for the entire sampling period (Table 1, Figure 3). Significant differences also occurred in

Table 3. Weight-length relationship ($W = a L^b$, W = weight (g) and L = standard length (cm)), correlation (r), and summary of t test (t) for b (H_o: b = 3) for *Triportheus guentheri* at Três Marias Reservoir from January 1986 to March 1988.

Month	Female					Male				
	N	a	b	r	t	N	a	b	r	t
Jan/86	132	0.019	2.94	0.95	0.66	136	0.012	3.16	0.95	1.77*
Feb	74	0.085	2.33	0.88	4.56***	88	0.015	3.08	0.93	0.60
Mar	221	0.022	2.91	0.97	1.84*	229	0.008	3.34	0.96	5.27***
Apr	175	0.040	2.69	0.95	4.55***	148	0.020	2.99	0.93	0.11
May	209	0.041	2.68	0.94	4.66***	193	0.018	3.04	0.97	0.79
Jun	77	0.057	2.53	0.95	4.75***	80	0.015	3.09	0.97	1.07
Jul	44	0.023	2.89	0.97	0.94	53	0.020	2.96	0.96	0.32
Aug	66	0.044	2.64	0.94	2.92**	63	0.022	2.94	0.94	0.47
Sep	64	0.038	2.72	0.97	3.30**	69	0.045	2.65	0.92	2.55**
Oct	133	0.034	2.75	0.96	3.30**	198	0.019	3.01	0.95	0.18
Nov	83	0.025	2.89	0.93	0.82	148	0.017	3.06	0.96	0.83
Dec	117	0.013	3.16	0.95	1.65	119	0.010	3.26	0.97	3.32***
Jan/87	128	0.060	2.53	0.87	3.78***	152	0.015	3.11	0.92	1.00
Feb	19	0.020	2.98	0.96	0.08	29	0.029	2.84	0.94	0.86
Mar	94	0.053	2.61	0.90	2.91**	94	0.039	2.75	0.90	1.81*
Apr	176	0.038	2.75	0.91	2.74**	49	0.021	2.99	0.93	0.06
May	134	0.026	2.88	0.96	1.62	113	0.021	2.97	0.93	0.31
Jun	119	0.013	3.17	0.97	2.42**	53	0.009	3.34	0.97	3.09**
Jul	122	0.013	3.16	0.97	2.28*	58	0.011	3.26	0.97	2.31*
Aug	15	0.013	3.18	0.98	1.14	14	0.022	2.91	0.97	0.46
Sep	159	0.012	3.21	0.96	2.80**	60	0.010	3.29	0.98	3.01**
Oct	135	0.006	3.45	0.96	5.33***	50	0.006	3.48	0.97	3.66***
Nov	103	0.009	3.33	0.96	3.29**	45	0.007	3.42	0.98	4.57***
Dec	104	0.009	3.37	0.98	5.06***	44	0.007	3.46	0.99	5.40***
Jan/88	37	0.023	2.91	0.95	0.52	45	0.009	3.29	0.96	1.90*
Feb	101	0.067	2.48	0.91	4.47***	97	0.032	2.79	0.89	1.44
Mar	58	0.032	2.77	0.90	1.30	64	0.027	2.85	0.92	0.98

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

the weight-length relationship within sex when comparing the years 1986 and 1987.

The values of the parameter 'b' of the weight-length relationship for each sex obtained per year, and for the entire sampling period were shown to be statistically different from 3, although some of these values differed only slightly, such as that for males 1986 (Table 2).

The weight-length relationship calculated monthly for each sex had a correlation coefficient higher than 0.87 (Table 3). The monthly 'a' and 'b' presented negative correlations greater than – 0.90 in both sexes. The 'b' varied from 2.33 to 3.45 for females and from 2.65 to 3.48 for males (Figure 4). Normal distribution of 'b' was found in both sexes (Shapiro-Wilk statistic: $W = 0.97$ and $p = 0.65$ for females and males), and 'b' differed significantly from 3 in several months.

Parameter 'b', estimated monthly, showed significant positive correlation with K in females but not in males (Table 4). It also presented in both sexes significant correlations with GSI, VSI, WL and the skewness of the length frequency curve. Highest correlations were observed with WL and skewness in females and GSI, skewness and WL in males. The correlations with WL and skewness were negative in both sexes. Multiple regression analysis indicated that (i) 68% of 'b' variation for the females was due to skewness (partial $r^2 = 54\%$) and WL (partial $r^2 = 14\%$) and (ii) 42% of 'b' variation for the males was due to GSI (partial $r^2 = 28\%$) and skewness (partial $r^2 = 14\%$). Usually, 'b' was lower in months when the females had $GSI < 4$ and higher when the GSI was ≥ 4 (Figure 5). The correlations between 'a' and K were low in the females and not significant in the males (Table 4).

Condition factors

In both sexes, the individual's Fulton condition factor (K) presented, due to the higher number of observations, significant correlation with standard length (Table 5). A correlation coefficient close to zero between K_a or K_n and standard length occurred in both sexes. The individual's K, K_a or K_n showed high positive correlation.

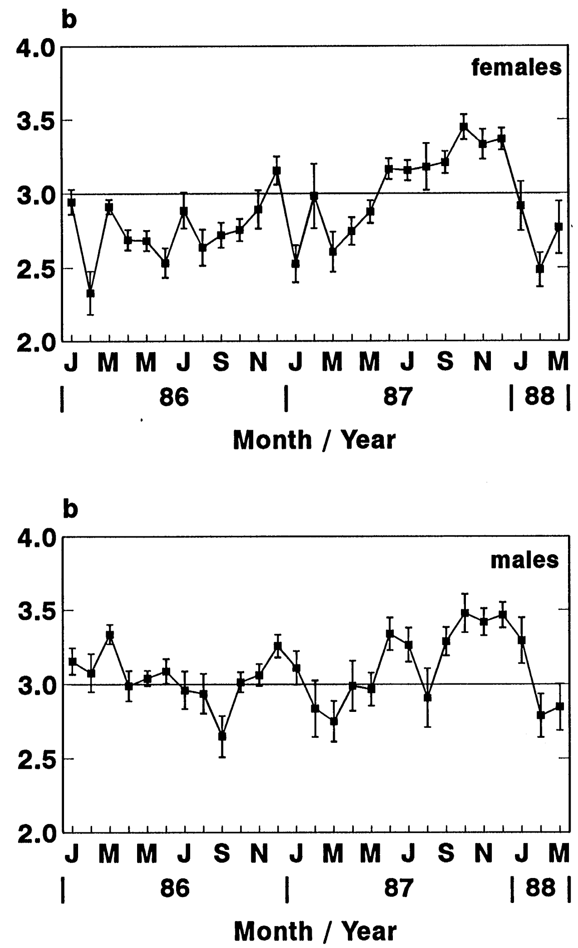

Figure 4. Monthly variations of the weight-length relationship slope (b) of *Triportheus guentheri* females and males in Três Marias Reservoir from January 1986 to March 1988 (error bars = standard errors of b).

The condition factors K, K_a, and K_n by month, and by ovarian development interval, presented similar variation tendencies (Figure 6) and high correlation (Table 4). The monthly condition factors showed no apparent pattern of seasonal variation in both sexes. Regarding the ovarian development interval, K were higher at later phases of the maturation process (Figures 6, 2c–e).

The female condition factors showed higher positive correlations with GSI and VSI, and negative correlations with WL (Table 4). The correlations with SFI and skewness of the length frequency curve were low and close to the significant level of 5%. The amount of coelomic fat, represented by the

CFI, did not correlate with the condition factors. The correlations of male condition factors were low with the biometric indices and null with skewness.

The condition factors, when calculated by ovarian development interval, were highly correlated with GSI and VSI and did not correlate with the other biometric indices (Table 4). The correlation of skewness of length frequency curve with WL was low in females and null in males.

Discussion

To estimate the parameters of the weight-length relationship, I have used the predictive (ordinary least-squares) regression. Ricker (1973) suggested the use of the geometric mean functional regression instead of the predictive regression for the determination of these parameters because weight and length are random variables. However, this suggestion is not widely accepted by statisticians (Bagenal & Tesch 1978) and in the majority of the situations they have been determined by predictive linear regression.

Table 4. Correlation matrix between monthly population variables of females and males by ovarian development interval of *Triportheus guentheri* at Três Marias Reservoir.

	a	K	K_a	K_n	CFI	SFI	GSI	VSI	WL	Skewness
Female										
b	– 0.94***	0.60***	0.58**	0.58**	– 0.01	0.29	0.51**	0.54**	– 0.65***	– 0.74***
a		– 0.46*	– 0.45*	– 0.45*	– 0.01	– 0.19	– 0.38*	– 0.39*	0.48*	0.66***
K			1.00***	1.00***	– 0.08	0.40*	0.55**	0.60***	– 0.67***	– 0.39*
K_a				1.00***	– 0.08	0.40*	0.52**	0.57**	– 0.63***	– 0.38*
K_n					– 0.08	0.40*	0.52**	0.57**	– 0.63***	– 0.38*
CFI						– 0.01	– 0.61***	– 0.49**	0.03	– 0.22
SFI							0.19	0.40*	– 0.37	– 0.36
GSI								0.97***	– 0.69***	– 0.28
VSI									– 0.75***	– 0.37*
WL										0.43*
Male										
b	– 0.95***	0.21	0.14	0.14	0.06	0.18	0.53**	0.40*	– 0.48*	– 0.49**
a		– 0.01	0.06	0.06	– 0.05	– 0.09	– 0.44*	– 0.32	0.32	0.49**
K			0.99***	0.99***	0.21	0.39*	0.27	0.41*	– 0.46*	– 0.29
K_a				1.00***	0.14	0.39*	0.20	0.35	– 0.38	– 0.24
K_n					0.14	0.39*	0.20	0.35	– 0.38	– 0.24
CFI						0.03	– 0.36	0.25	– 0.07	– 0.23
SFI							0.23	0.03	– 0.42*	– 0.27
GSI								0.50*	– 0.69***	– 0.23
VSI									– 0.57**	0.40*
WL										0.35
Ovarian development interval										
K			1.00***	1.00***	– 0.19	– 0.48	0.87***	0.88***		
K_a				1.00***	– 0.15	– 0.49	0.86**	0.87***		
K_n					– 0.15	– 0.49	0.86**	0.87***		
CFI						– 0.06	– 0.58	0.57		
SFI							– 0.49	0.48		
GSI								1.00***		

b and a = weight-length relationship parameters, K = Fulton condition factor, K_a = allometric condition factor, K_n = relative condition factor, CFI = coelomic fat index, SFI = stomach fullness index, GSI = gonadosomatic index, VSI = visceral-somatic index, WL = reservoir water level, and skewness of the length frequency curve; number of observations for each pair of variables = 27, except for ovarian development interval, which n = 10; * = p ≤ 0.05, ** = p ≤ 0.01, *** = p ≤ 0.001.

Although weight-length relationships of fish are commonly determined, few authors have evaluated the obtained equations. Discussions about this relationship are found in Le Cren (1951), Frost & Kipling (1967), Ricker (1973 1975), Rossi-Wongtschowski (1977), Bagenal & Tesch (1978), Dawe (1988) and Maceina & Murphy (1988).

The weight-length relationship of *T. guentheri* varied between sexes and between years, posing difficulty in choosing a single equation to represent it. Among the equations obtained, the most adequate was considered the one for 1986 for each sex because the length frequency curves in this year were less skewed.

The high negative correlations found between 'a' and 'b' (Table 4) were due to their covariance (Weisberg 1985) and to the high correlations between weight and length. To avoid repetition, I will discuss the biological context of the 'b' variation.

In *T. guentheri*, 'b' has shown great variability throughout the year. Within a time sufficiently short to enable only inexpressive growth in length, variations in 'b' values would occur when individuals of different length changed their weight at different rates or direction. For example, if larger individuals of a population increased their weight, and the smaller ones maintained or reduced it, then 'b' would increase. If random variations of the weight occurred in fish of different lengths, then 'b' would tend to remain constant. The causes of 'b' variations may be more easily identified when a population is organized into only two life-history periods (e.g. juveniles and adults). Thus, the relationship between 'b' and GSI of females *T. guentheri* is explained by the fact that, during reproductive months, 'b' changed due to the increase in weight of the female ovaries whereas juvenile females tended to maintain their weight.

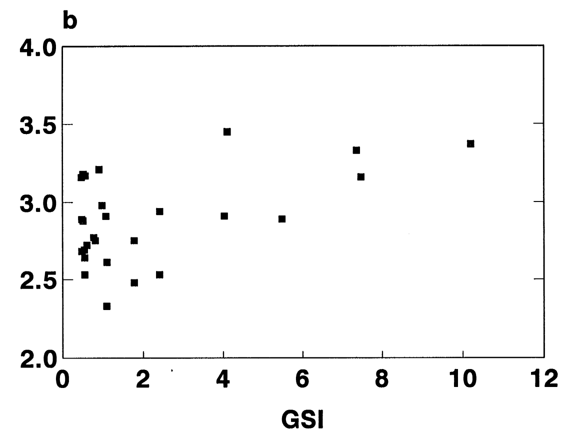

Figure 5. Scattered plot of monthly weight-length relationship slope (b) by gonadosomatic index (GSI) of *Triportheus guentheri* females in Três Marias Reservoir.

Table 5. Correlation matrix between individual's standard length (L), Fulton (K), allometric (K_a) and relative (K_n) condition factors for *Triportheus guentheri* at Três Marias Reservoir.

	K	K_a	K_n
Female			
L	0.13*	0.01	0.01
K		0.99*	0.99*
K_a			1.00*
Male			
L	0.20*	0.01	0.01
K		0.98*	0.98*
K_a			1.00*

Number of observations for each pair of variables for females = 2899 and for males = 2491; * = $p < 0.001$.

The ovaries of *T. guentheri* are the coelomic organs that attain the highest weight, reaching 19% of body weight and 90% of the coelomic viscera's weight. Thus, monthly ovarian variations were responsible for the correlation between 'b' and VSI.

The negative correlation between 'b' and the skewness of the length frequency curve in both sexes of *T. guentheri* indicate that larger b were due to the higher percentage of smaller fish in the sample and smaller b, to the higher percentage of larger fish. This indicates that the length structure of the sample may have significant influence on 'b'. The length structure of the sample does not necessarily represent the *T. guentheri* length population structure because of gill net selectivity but does show how a population structure may influence 'b'.

The Três Marias' water level showed negative correlation with 'b' in both sexes, being stronger in females. An eventual influence of the water level on the skewness of the length frequency curve should not be considered since the correlations between these two variables were low or null. I suggest that the correlation between 'b' and WL was not a

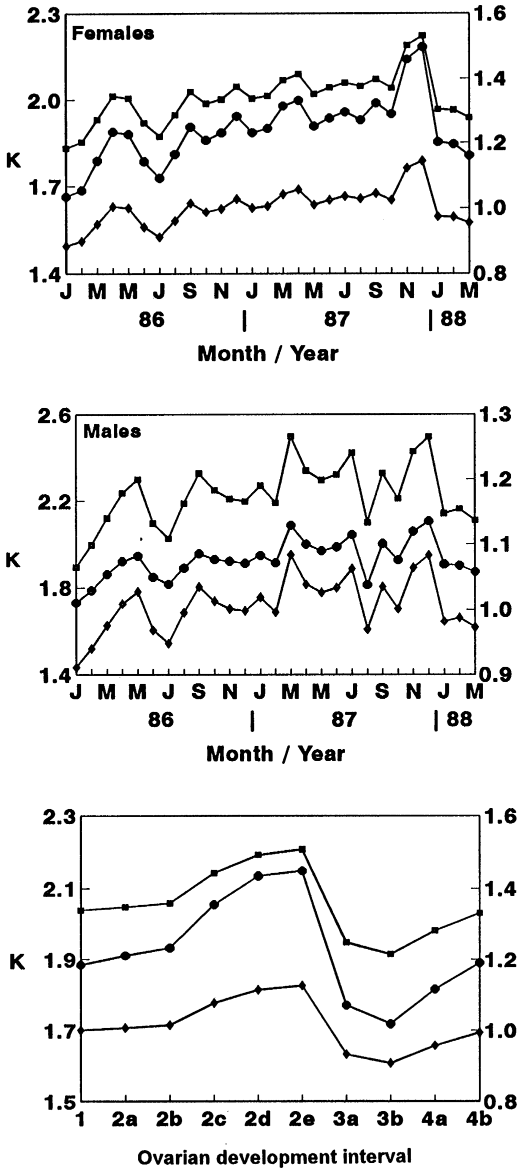

Figure 6. Allometric (K_a, ■), Fulton (K, ●), and relative (K_n, ◆) condition factors of females and males by month and by ovarian development interval of *Triportheus guentheri* in Três Marias Reservoir (for ovarian development interval: numbers = intervals and letters = subintervals; 1 = resting, 2 = maturating, 3 = spent, and 4 = recovering).

cause-and-effect relationship. The lowest water levels coincided with the *T. guentheri* reproductive time (Godinho 1994). At this time of the year the fish, particularly the adult females, were proportionally heavier since those at the most advanced maturation intervals had a greater condition factor.

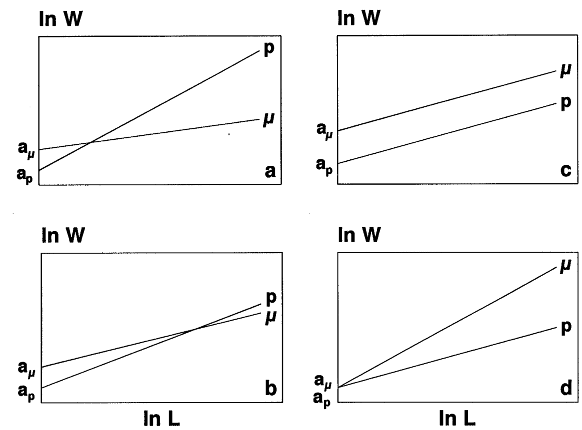

Figure 7. Weight-length relationship (ln W = ln a + b ln L) of two groups of fish with different b and a (a, b) equal b and different a (c), and different b and equal a (d) (modified from Bolger & Connolly, 1989).

Their largest weight induced the increase in the slope of the weight-length relationship. On the contrary, the highest water level was observed during the sexual resting time, when the adult females were lighter and the weight-length relationship, consequently, less slanted. This situation also explains the correlations between K and water level, especially in females.

The causes for male monthly variations of 'b' were not as evident as for the females. Although stepwise regression had indicated male's GSI as the most important variable to explain the variations of 'b', the testis alone is not able to change 'b' due to its small weight (the highest GSI was 1.1).

The parameter 'a' of the weight-length relationship has been used to express condition (Bolger & Connolly 1989) and it is frequently called a condition factor (Santos 1978, Braga 1986, Barbieri & Verani 1987). However, 'a' showed low or no significant correlation with the condition factors of *T. guentheri*.

The comparison of condition between groups using 'a' is only valid when the b are equal (Le Cren 1951). The following examples illustrate such restriction. In these examples, it is assumed that between two fish of the same length the heaviest one will be in better condition (Ricker 1975, Bagenal & Tesch 1978). In any two groups (e.g. sex, population, species) of fish represented here by μ and ρ, when the parameter a_μ is slightly bigger than a_ρ and b_μ is much smaller than b_ρ, the respective lines of the weight-length relationship intersect each other at small lengths (Figure 7a). Thus, despite a_μ being greater than a_ρ, the ρ-group has heavier individuals throughout most lengths, and therefore, are in better condition according to the current definition of condition. The smaller the difference between b, the larger the length where the line intersections will be (Figure 7b). When b's are equal, 'a' will be a good indicator of the condition (Figure 7c).

When a are equal, and b_μ is greater than b_ρ, the fishes' condition, estimated via 'a', will be the same between the two groups (Figure 7d). However, the relationship between the conditions of μ and ρ is not constant along the length. As fish length increases the difference in weight also increases. The same situation occurs when a_μ and b_μ are grater than the respective ρ parameters. In summary, the use of the parameter 'a' for analysis of the condition between groups should be restricted to the cases when b are equal, but this situation is not commonly observed (Bolger & Connolly 1989).

The parameter 'b' has also been used to express condition (Bolger & Connolly 1989). According to these authors, it can only be used when 'a' of the groups to be compared is the same. However, even in these cases it does not seem to be a good indicator of condition, because the body weight difference between fish of the same size in each group is not constant along the length (Figure 7d).

Despite many restrictions on using the weight-length relationship parameters as indicators of condition, they have been used in 25% of the articles that deal with this subject, published in two of the more important journals of fish biology between 1969 and 1986 (Bolger & Connolly 1989). Cone (1989) suggested that they are the best method available for evaluation of fish condition.

The Fulton condition factor (K) also has problems for comparisons between groups. The correlation commonly found between K and fish length when 'b' is different from 3, associated with a selective sample of particular sizes, may lead to an inaccurate estimate of K. The capture of a greater number of either small or big individuals can, respectively, under or overestimate K if the correlation is positive. The reverse is true if the correlation is negative. This error is directly proportional to the absolute value of the slope between K and length. It explains the negative correlations found between K and skewness of the frequency length curve of *T. guentheri* females. Determining the condition factor from mean values of K in each length class constitutes a methodological alternative to be evaluated.

When 'b' of the weight-length relationship is different from 3, the allometric condition factor (K_a) eliminates the influence of fish size (Braga 1986). For this reason, K_a is more appropriate than K for comparisons of condition within the same group.

The correlation between K and length, together with 'b' not equal to 3, suggests the use of K_a or K_n in the analyses of *T. guentheri* condition. However, K, K_a, and K_n presented the same pattern of both temporal and ovarian development interval variations. Moreover, they showed high correlations among them, and similar correlations with the biometric indices, WL and skewness. Thus, the use of one of them would not influence interpretation.

Variations of K, K_a, and K_n along the ovarian development intervals were strongly influenced by the variations in the ovarian weight, whereas this did not occur when analyzed by month. The ovarian weight had a greater influence on K only in months with greater GSI (Godinho 1994). The testis influence on K was negligible due to its low weight. Carcass weight was responsible for the monthly variations of K in both sexes (Godinho 1994). I agree with Bolger & Connolly (1989) that a careful examination of the data set and the assumptions for each index should be made before index selection.

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