The condition factor of fishes from two river basins in *São Paulo* state, Southeast of Brazil

Leandro Muller Gomiero* and Francisco Manoel de Souza Braga

*Departamento de Zoologia, Instituto de Biociências, Universidade Estadual Paulista (Unesp), C.P. 199, 13506-900, Av. 24-A, n. 1515, Rio Claro, São Paulo, Brasil. *Autor para correspondência. e-mail: leanmg@rc.unesp.br*

ABSTRACT. This work describes the relative condition factor of the *Hypostomus strigaticeps*, *Astyanax altiparanae*, *Astyanax scabripinnis*, *Astyanax fasciatus*, *Astyanax* sp1., *Characidium* aff. *zebra*, *Piabina argentea*, *Hypostomus ancistroides*, *Hypostomus* sp1., *Parodon tortuosus*, *Serrapinus heterodon*, and *Bryconamericus* sp., of the APA of São Pedro and Analândia (22°-23°S and 47°30'-48°30'W). The condition factor provides information about the physical state of the animal in the environment. In order to compare different species, the relative condition factor was used. Variations in this factor were correlated with variations through the year and with subsequent alterations in the physiological state of the fishes. The relative condition factor was shown to be efficient in indicating changes in fish condition throughout the year.

Key words: freshwater fishes, *Corumbataí* and *Jacaré-pepira* basins, relative condition factor.

RESUMO. O fator de condição de peixes de duas bacias no Estado de São Paulo, Sudeste do Brasil. Neste trabalho foi obtido o fator de condição relativo de *Hypostomus strigaticeps*, *Astyanax altiparanae*, *Astyanax scabripinnis*, *Astyanax fasciatus*, *Astyanax* sp1., *Characidium* aff. *zebra*, *Piabina argentea*, *Hypostomus ancistroides*, *Hypostomus* sp1., *Parodon tortuosus*, *Serrapinus heterodon* e *Bryconamericus* sp. da APA de São Pedro e Analândia (22°-23°S e 47°30'-48°30'W). O fator de condição fornece indicações do estado de bem estar do peixe no ambiente. Para a comparação de espécies distintas foi utilizado o fator de condição relativo, relacionando as variações deste fator ao longo do ano e conseqüentes alterações fisiológicas dos peixes. O fator de condição relativo mostrou-se eficaz como ferramenta para evidenciar as mudanças nas condições dos peixes durante as estações do ano.

Palavras-chave: peixes de água doce, bacia do Corumbataí e Jacaré-pepira, fator de condição relativo.

Introduction

One important derivative of growth is the condition factor or ponderal index, defined by the expression $K = W/L^3$, where W = weight, L = length. Another means to define it is $K = W/L^b$, where b is given from the weight/length relationship, expressed by $W = aL^b$ (Braga, 1986). Le Cren (1951) showed that the condition factor can be described by $K = W/aL^b$ or $K = W/W'$, and called it "relative condition factor" (K_n), where aL^b is equal to the weight/length relationship.

The condition factor indicates the fish welfare in the habitat. To compare species of different sizes, the relative condition factor was considered the best index (Bolger and Connolly, 1989). According to these authors, changes in the condition factor based on length-weight relationships reflect seasonal alterations in the metabolic balance, maturation patterns and stomach repletion.

Drops in condition factor values may indicate the reproductive period and/or changes in the foraging habits of certain species (Gomiero and Braga, 2003). In general, main drops in condition factor values within an annual cycle are related to reproductive events. The literature contains examples such as *Hoplias malabaricus* (Barbieri, 1989); *Plagioscion squamosissimus* (Braga, 1997); *Paralonchurus brasiliensis* (Braga, 1993); *Hypostomus* aff. *plecostomus* (Barbieri and Verani, 1987); *Astyanax scabripinnis* (Barbieri, 1992a,b); *Rhinelepis aspera* (Agostinho *et al.*, 1990); *Astyanax bimaculatus* (Santos *et al.*, 1995); *Apareiodon affinis*, *Apareiodon ibitiensis*, and *Parodon tortuosus* (Barbieri *et al.*, 1985).

The aim of this work was to characterize the relative condition factor of some fish species from

two protected areas in the *cuestas* of *São Pedro* and *Analândia*, *São Paulo* State, Brazil. Variations in the relative condition factor were correlated through the year and among the species.

Material and methods

A total of 12 samples were made bimonthly from February 2000 to December 2001.

The study region is located in a protected area in the *cuestas* of *São Pedro* and *Analândia.* The protected area (APA) is located approximately between the latitudes 22° and 23°S and the longitudes 47° 30' and 48° 30'W. Part of the area is in the *Depressão Periférica* and the other in the basaltic *cuestas*, both in the interior of *São Paulo* State, southeastern Brazil. Two study sites were determined: 1. Sub-basin of the *Corumbataí* River, with four sample points: *Cabeça* River (point 1) - 22º 22' 49''S, 47º 39' 55''W, *Lapa* Stream (point 2) - 22º 23' 38" S, 47º 47' 16''W, *Passa-Cinco* River (point 3) - 22º 25' 02''S, 47º 42' 47''W, and *Corumbataí* River (point 4) - 22º 08' 15''S, 47º 39' 37''W; 2. Basin of the *Jacaré-Pepira* River, with three sample points: *Tamanduá* Stream (point 5) - 22º 21' 17" S, 47º 45' 00''W, *Jacaré-Pepira* River (point 6) - 22º 17' 53''S, 48º 11' 35''W, and *Água Branca* Stream (point 7) - 22º 26' 20''S, 48º 47' 45''W (Figure 1).

At each sample point, individuals were collected using gill nets with mesh sizes of 1.5; 2.0; 2.5, and 3.0 cm, measured between adjacent knots (5 m long and 1.5 high). In addition to the nets, whenever possible, purse seines with a mesh size of 1.5 cm (1.5 m high), sieves, and traps were also used.

Fish effort was standardized, keeping time and the quantity of instruments employed at each point constant. Afterwards, specimens were put in plastic containers containing 10% formalin. Each container was labeled with the date and sample site. Fishes were identified in the laboratory up to the lowest taxonomic level. Each individual was measured: total length (cm), standard length (cm) and total mass (g). The relative condition factor was estimated for the most abundant species occurring in both studied basins. In the *Corumbataí* basin, the following species were analyzed: *Hypostomus strigaticeps* (Regan, 1908), *Astyanax altiparanae* Garutti and Britski, 2000, *Astyanax scabripinnis* (Jenyns, 1842), *Characidium* aff. *zebra* (Eigenmann, 1909), *Piabina argentea* Reinhardt, 1867, *Hypostomus ancistroides* (Ihering, 1911), *Parodon tortuosus* (Eigenmann and Norris, 1900), *Astyanax* sp1. Baird and Girard, 1854, *Serrapinus heterodon* (Eigenmann, 1915), and *Bryconamericus* sp. Eigenmann, 1907. In the Jacaré-Pepira basin, the species were *H. strigaticeps*, *A. altiparanae, Astyanax fasciatus* (Cuvier, 1819), *Hypostomus* sp1. Lacepède, 1803, and *Astyanax* sp1.

The weight/length and condition factor were analyzed according to Santos (1978) and Braga (1986). Weight-length relationship was estimated for each species according to the expression $W = aL^b$, where W = weight, L = length, a = intercept, and b = regression coefficient. The parameters a and b were estimated after mass and length were log-transformed and subsequent line adjustment using the criterion of least squares.

The relative condition factor was also evaluated. It is given by: $K=W/W'$, where W is the fish mass and W' is the mass estimated by $W = aC^b$. The relative condition factor was used to compare species. Considering W and W' by species group, it is possible to compare the condition factor among them (Le Cren, 1951).

Results and discussion

The parameters a (intercept), b (regression coefficient), r (correlation coefficient), and N (number of specimens analyzed) of the length-weight relationships are shown in Table 1.

The variation of relative condition factor was greater in the *Corumbataí* basin (Figure 2).

The species *Hypostomus strigaticeps*, *Piabina argentea*, *Hypostomus ancistroides*, and *Parodon tortuosus*, from the *Corumbataí* basin, exhibited the lowest values of relative K in August, which coincided with the period before reproduction, when gonads initiate their development. Furthermore, this is the coldest period of the year and fishes diminished foraging intensity. The reproduction peak of *Hypostomus* aff. *plecostomus* at *Monjolinho* Dam occurred in the spring (Barbieri and Santos, 1987), with the condition factor indicating the spawning period (Barbieri and Verani, 1987).

The species *Astyanax altiparanae* showed the lowest value in December (summer), when reproduction occurred. The low value of relative K in June for *Astyanax scabripinnis* may indicate a drop in foraging activity in the winter. In these characids, reproduction occurs during spring and summer, with a decrease in the stomach repletion index and accumulated fat during the winter (Nomura, 1975; Barbieri *et al.*, 1982; Rodrigues *et al.*, 1989).

The species *Characidium* aff. *zebra* showed the most variable relative K values in the six analyzed periods (February, April, June, August, October, and December). The two greater drops occurred in April and October, showing a decrease in foraging activity in the winter and the reproductive period in the spring (Figure 2).

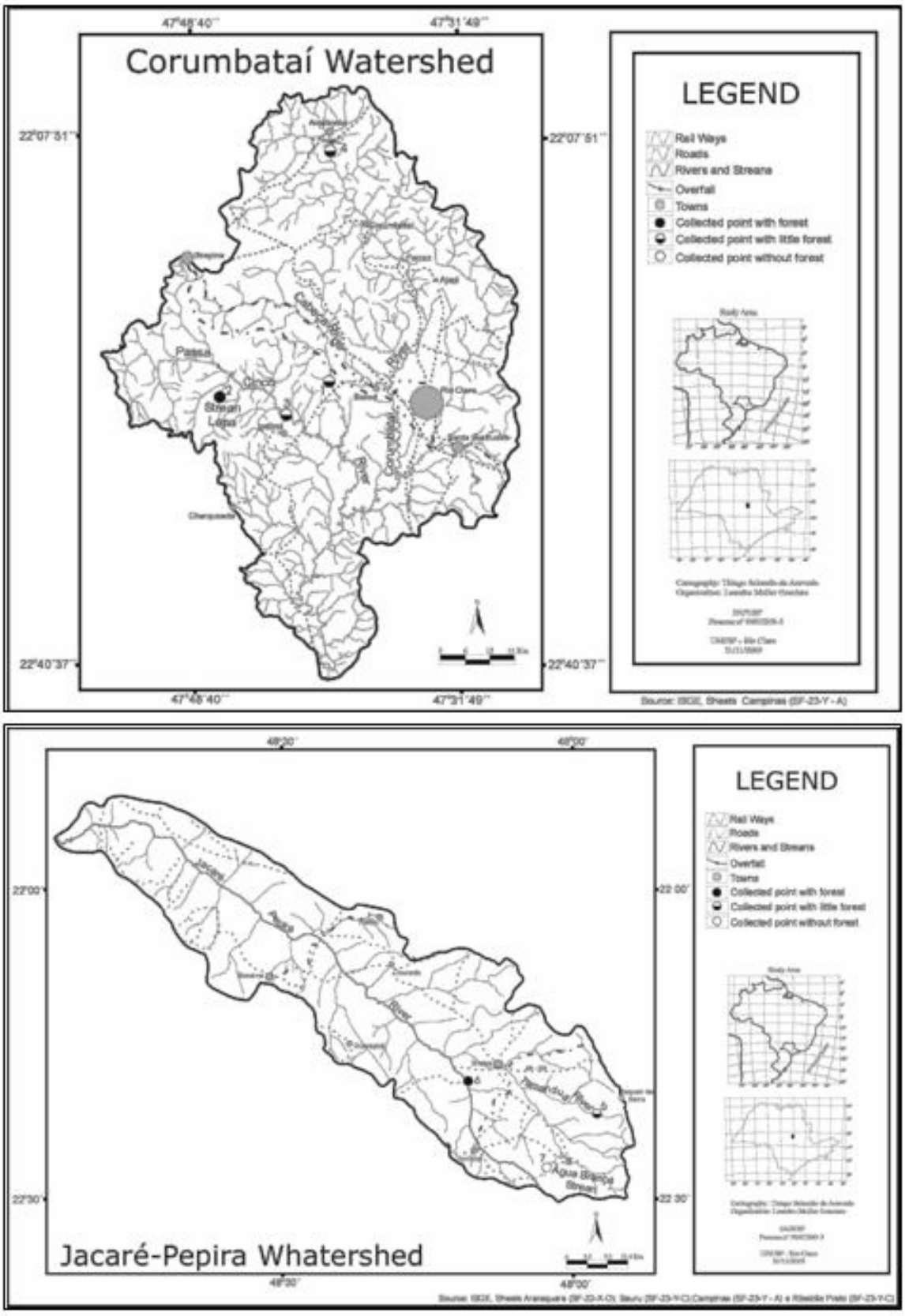

Figure 1. Maps of study region with the sites of samples.

Table 1. Estimated parameters (*a*: intercept; *b*: regression coefficient; *r*: correlation coefficient, and *N*: number of specimens analyzed) of the length-weight relationships for the studied species in periods I (February), II (April), III (June), IV (August), V (October), and VI (December), in both basins. Species: Hst (*Hypostomus strigaticeps*), Aal (*Astyanax altiparanae*), Asc (*Astyanax scabripinnis*), Cze (*Characidium* aff. *zebra*), Par (*Piabina argentea*), Han (*Hypostomus ancistroides*), Pto (*Parodon tortuosus*), Asp1. (*Astyanax* sp1.), She (*Serrapinus heterodon*), Bsp. (*Bryconamericus* sp.), Afa (*Astyanax fasciatus*), and Hsp1. (*Hypostomus* sp1.).

Corumbataí basin

Period	I				II				III			
	a	b	r	N	a	b	r	N	a	b	r	N
Hst	0.006	3.19	0.97	46	0.014	2.5	0.97	42	0.015	2.89	0.99	21
Aal	0.011	3.07	0.96	52	0.038	2.57	0.97	11	0.001	3.81	0.97	5
Asc	0.004	3.58	0.98	53	0.004	3.63	0.96	26	0.005	3.46	0.96	28
Cze	0.008	3.01	0.96	9	0.0008	4.35	0.91	5				
Par	0.007	3.2	0.95	18	0.009	3.02	0.97	6	0.005	3.4	0.97	22
Han	0.024	2.6	0.98	7	0.019	2.73	0.97	28	0.015	2.81	0.97	16
Pto	0.017	2.93	0.94	10	0.005	3.4	0.93	13				
Asp1	0.011	3.03	0.98	23	0.012	3.0	0.99	10	0.013	2.99	0.98	10
She	0.011	3.01	0.94	3								
Bsp					0.011	2.89	0.94	38	0.021	2.57	0.85	42

Period	IV				V				VI			
	a	b	r	N	a	b	r	N	a	b	r	N
Hst	0.018	2.83	0.99	15	0.013	2.96	0.99	29	0.008	3.1	0.99	25
Aal	0.010	3.1	0.90	19	0.010	3.09	0.94	13	0.013	2.97	0.97	40
Asc	0.005	3.46	0.94	26	0.016	2.7	0.98	68	0.009	3.19	0.98	107
Cze	0.005	3.21	0.98	8	0.001	4.14	0.95	6	0.004	3.37	0.96	17
Par	0.023	2.56	0.97	7	0.008	3.11	0.95	61	0.019	2.65	0.94	102
Han	0.010	3.02	0.98	13	0.015	2.82	0.98	31	0.057	2.35	0.90	3
Pto	0.029	2.67	0.97	3	0.004	3.41	0.98	13	0.003	3.49	0.97	10
Asp1	0.007	3.33	0.99	3	0.007	3.26	0.98	50	0.006	3.45	0.97	10
She					0.023	2.51	0.98	3	0.013	2.71	0.89	16
Bsp												

Jacaré-Pepira basin

Period	I				II				III			
	a	b	r	N	a	b	r	N	a	b	r	N
Hst	0.011	2.99	0.99	14	0.007	3.14	0.99	9	0.010	2.99	0.99	6
Aal	0.019	2.93	0.94	15	0.316	1.75	0.80	9				
Afa	0.016	2.90	0.99	4								
Hsp1					0.015	2.84	0.98	9				
Asp1	0.005	3.49	0.98	36	0.008	3.25	0.98	93	0.011	3.03	0.98	149

Period	IV				V				VI			
	a	b	r	N	a	b	r	N	a	b	r	N
Hst												
Aal	0.007	3.30	0.99	14	0.008	3.22	0.99	5				
Afa	0.006	3.31	0.97	47	0.024	2.63	0.99	4	0.005	3.33	0.97	11
Hsp1	0.026	2.64	0.97	4								
Asp1	0.010	3.16	0.98	65	0.011	3.05	0.98	45	0.010	3.08	0.98	119

The condition factor may be influenced by the developmental stage of the gonads and by the degree of stomach repletion (Barbieri *et al.*, 1982; Barbieri, 1989). Thus, it is a good indicator of the spawning period and can also indicate changes in population density, foraging conditions (Braga, 1986), and occurrence of seasonality in the environmental conditions (Braga *et al.*, 1985).

The variation of the relative condition factor was more homogeneous in the *Jacaré-pepira* basin (Figure 3).

In the *Jacaré-Pepira* basin, the species *Hypostomus strigaticeps* and *Hypostomus* sp1. exhibited the lowest values of relative *K* in April (winter), which could be explained by a drop in foraging intensity.

The species *Astyanax altiparanae* and *Astyanax fasciatus* showed drops coinciding with the winter (decrease in foraging activity) and spring (reproduction peak).

Astyanax sp1. showed a variable relative condition factor throughout the analyzed period, with low values in April and October. Spawning peaks in this species occur during the autumn and winter. This fact could explain the low value in April (winter), but the reason for the drop in October (summer) remains unknown (Figure 3).

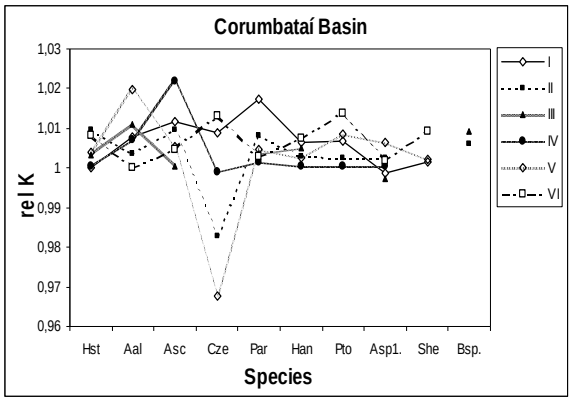

Figure 2. Relative condition factor (rel*K*) for the studied species in the Corumbataí basin in periods I (February), II (April), III (June), IV (August), V (October), and VI (December). Species: Hst (*Hypostomus strigaticeps*), Aal (*Astyanax altiparanae*), Asc (*Astyanax scabripinnis*), Cze (*Characidium* aff. *zebra*), Par (*Piabina argentea*), Han (*Hypostomus ancistroides*), Pto (*Paradon tortuosus*), Asp1 (*Astyanax* sp1.), She (*Serrapinus heterodon,*), and Bsp. (*Bryconamericus* sp.).

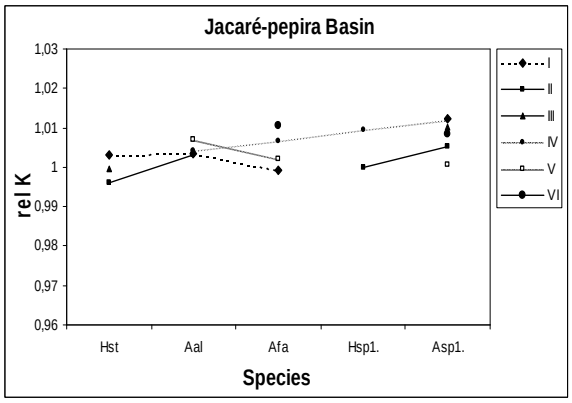

Figure 3. Relative condition factor (rel*K*) for the studied species in the *Jacaré-Pepira* basin in periods I (February), II (April), III (June), IV (August), V (October), and VI (December). Species: Hst (*Hypostomus strigaticeps*), Aal (*Astyanax altiparanae*), Afa (*Astyanax fasciatus*), Hsp1. (*Hypostomus* sp1.), and Asp1. (*Astyanax* sp1.).

The relative condition factor was shown to be an efficient instrument and indicates changes in fish condition throughout the year, and can also be used to indicate spawning period and/or decrease in foraging activity.

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Received on August 30, 2004.
Accepted on March 29, 2005.