

Length-weight relationship and relative condition factor of *Arapaima gigas* Schinz, 1822 from extractive reserve of Juruá river, Amazonas, Brazil

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ABSTRACT: *Arapaima gigas* (pirarucu) is a large fish greatly appreciated in Amazon region. The present work determined the weight-length relationship and the relative condition factor (Kn) of eviscerated pirarucu specimens from the extractive reserve (RESEX) of Juruá river, Amazonas, Brazil. The relative frequency distributions by weight class indicated amplitude between 20,000 and 115,000g and the classes of greatest frequency were between 30,000 and 80,000g. The equation that describes this relationship is $W = 0.0092L^{3.0157}$, showing an isometric growth. Kn presented values of 0.98 ± 0.01 , ranging between 0.94-1.01. The results indicate that fish stock of *A. gigas* in the RESEX of Juruá river presents good management conditions since most of the fish caught presented commercial weight and high utilization of meat, and also the equations of weight-length relationship and Kn values can be considered as reference for *A. gigas* eviscerated of the studied region.

Keywords: pirarucu, biometric, homeostasis, management.

Relação peso-comprimento e fator de condição relativo do *Arapaima gigas* Schinz, 1822 oriundo da reserva extrativista do rio Juruá, Amazonas, Brasil

RESUMO: *Arapaima gigas* pirarucu é um peixe de grande porte bastante apreciado pelos povos da Amazônia. Neste trabalho foram determinados a relação peso-comprimento e o fator de condição relativo (Kn) de espécimes de pirarucu eviscerados, da Reserva Extrativista do Rio Juruá, Amazonas. As distribuições de frequências relativas por classe de peso indicaram uma amplitude entre 20.000 e 115.000 g, onde as classes de maior frequência foram as compreendidas entre 30.000 e 80.000 g. A equação que descreve a relação é $W = 0.0092L^{3.0157}$, demonstrando um crescimento do tipo isométrico. O Kn apresentou valor médio de $0,98 \pm 0,01$, com variação entre 0,94-1,01. Os resultados do presente estudo nos permitem concluir que o estoque pesqueiro de *A. gigas* da RESEX do baixo rio Juruá encontra-se em boas condições de manejo, visto que a maior proporção dos peixes pescados esteve dentro da faixa de peso comercial e com maior aproveitamento de carne, além do mais as equações da relação peso-comprimento e os valores do Kn podem ser utilizadas como parâmetros de referências para o *A. gigas* eviscerada da região estudada.

Palavras-chave: pirarucu, biometria, bem estar, manejo.

Arapaima gigas (pirarucu) is a teleost, Osteoglossiforme of the Arapaimidae family, with distribution restricted to the rivers of South America. This species is considered the largest scale fish of fresh water in the world (ONO et al., 2004). Due to the large size and tasty meat the pirarucu is an important protein source for the peoples of Amazon, and also is commercialized as ornamental fish because of its exuberant size and beauty (CAVERO et al., 2003; BRANDÃO et al., 2006).

For several decades the natural stocks of pirarucu experienced high fishing pressure, making it one of the species most protected by Brazilian federal laws. Aiming to protect the natural stocks, the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA) restricted the minimum size of capture to 150cm in 1989 (Portaria N.º.1534/89

IBAMA), and in 1991 the same agency forbade fishing in the period from December 1 to May 31 (Ordinance N.º 480/91, IBAMA), thus protecting the reproduction period of the species in Amazon area. According to Isaac et al. (2000), the natural stocks of pirarucu decreased despite the efforts that are being carried out, a fact that is a warning for the adoption of management and conservation plans. Currently, the IBAMA restricted even more the exploration of pirarucu, banning fishing in the state of Amazonas, allowing only in management areas such as the Mamirauá Sustainable Development Reserve (VIANA et al., 2007) and in Extractive Reserves (RESEX) implemented in other regions of Amazon such as down Juruá River, Jutai River, Auati-Paraná (Amazonas, Brazil) and other regions of the states of Pará and Acre.

Knowledge of the population structure of a fish species is a biological tool that assists the achievement of management and conservation plans. In this regard, the establishment of the weight-length relationship (WLR) is very used in biological studies to help understand the ecology of fishing stocks and allows the determination of biomass of a fish population (TAVARES-DIAS et al., 2010). Through the intercept of WLR one can estimate the type of growth of the species, allometric positive ($b > 3.0$) or negative ($b < 3.0$) (LE CREN, 1951; FROESE, 2006). WLR also can be used to determine the relative condition factor (Kn), which enables to evaluate the health status of fish in natural environment, since reflects the nutritional condition (LE MOS et al., 2006; TAVARES-DIAS et al., 2010). These studies do not exist for *A. gigas* from extractive reserves (RESEX), however for cultivated pirarucu the growth types reported are isometric (TAVARES-DIAS et al., 2010) and negative allometric (SCORVO-FILHO et al., 2004), and negative allometric growth in fish from natural environments (RUFFINO; ISAAC, 1995).

The objective of this study was to determine the weight-length relationship and the relative condition factor of *A. gigas* specimens from the RESEX of Juruá river, Amazonas, Brazil. The result of this study has practical value and provides subsidies for the improvement of management procedures of the extractive chain of pirarucu.

In the area of extractive reserves of Juruá, the management of pirarucu occurs since 2006 with the participation of the communities surrounding the reserve and is currently occupied by more than 8000 inhabitants. Specimens of *A. gigas* were collected according to the management plan established, in the Extractive Reserve of Juruá river, Amazonas, Brazil, in the period from 2007 to 2011, using trawl nets. After being caught fish were killed and eviscerated to the removal of the internal organs. Subsequently, mass (g) and total length (cm) of each fish were measured. Data of mass and total length were used to determine the weight-length relationship (WLR) by the logarithmic $\ln Wt = \ln a + \ln Lt$. Relative condition factor (Kn) was determined using the formula $Kn = Wt/aLt^b$ (LE CREN, 1951), where \ln (Ln), regression coefficients (a), slopes (b), and total length (Lt).

The t-test was used to compare Kn and the expected value (1.00) and to compare the intercept of WLR (b) to 3.00. Confidence interval (CI 95%) for b was determined by the formula $CI = b \pm 1.96 (SE)$. Chi-square test (χ^2) was used to verify differences between occurrence relative frequencies by length class obtained by morphometry (total length) ($p < 0.050$ significance level).

A number of 1159 *A. gigas* specimens were assessed, measuring 178.65 ± 17.86 cm (mean \pm SD), with amplitude of total length between 150.0 and 236.0cm. Fish weighed $52,245.47 \pm 16,836.23$ g. Relative frequency distribution by weight class for all evaluated

fish indicated an amplitude comprised between 20,000 and 115,000 g, and classes of highest frequency were between 30,000 and 80,000g [$\chi^2 = 897.496$, d.f. = 17; $P < 0.001$ (Figure 1)].

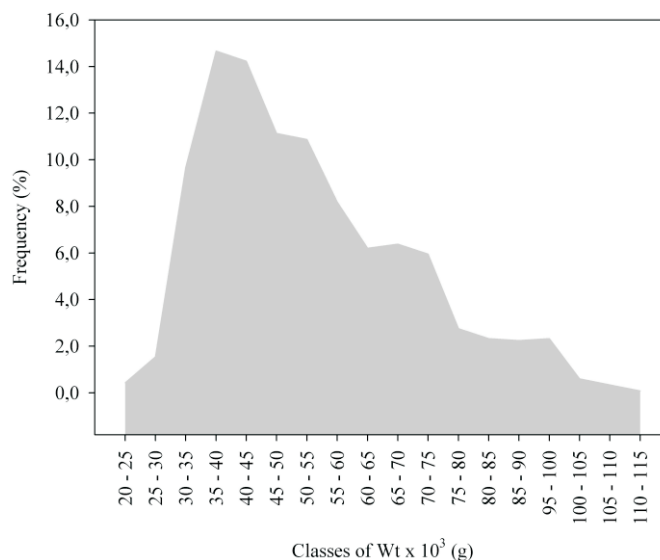


Figure 1. Frequency distribution of eviscerated weight class for *A. gigas* specimens from Juruá River assessed from 2007 to 2011.

The results of WLR for the eviscerated *A. gigas* specimens from the RESEX of Juruá River are presented in Figure 2. Growth was isometric type ($b = 3.00$, t -test = 0.615, d.f. = 2316; $P > 0.050$), with CI 95% of b between 2.965 and 3.067. Kn was 0.98 ± 0.01 on average, with amplitude ranging from 0.94 to 1.01. The Kn was statistically lower compared to the ideal value ($Kn = 1.00$) (Mann-Whitney U test = 1338645.000; $P < 0.001$).

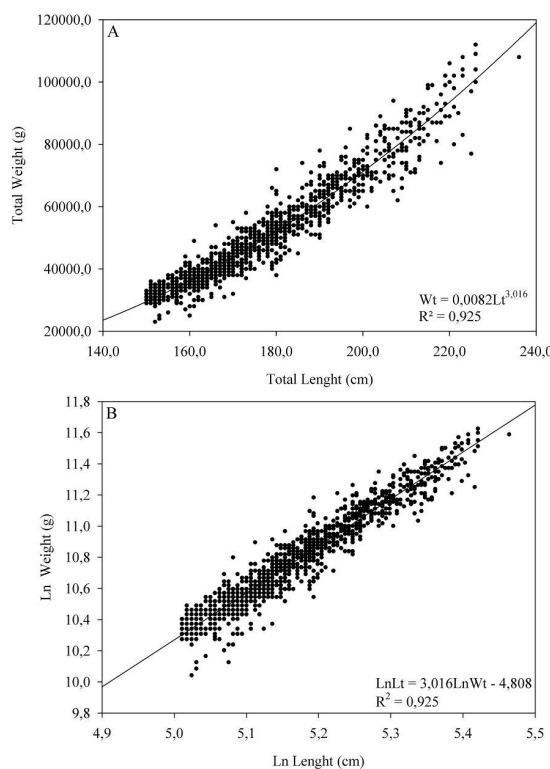


Figure 2. Weight-length relationship of eviscerated *A. gigas* from Juruá river assessed from 2007 to 2011. Total values (A) and transformed (logarithmized) values (B).

The results showed that average weight of eviscerated fish was higher than that of pirarucu commonly sold in markets of Brazilian, Amazon, which is 150 cm. Imbiriba et al. (1994) studying *A. gigas* from down Amazonas River, Pará, collected fish with $64 \pm 28.2 \cdot 10^3$ g, demonstrating that this weight range is possible to obtain a higher meat yield than in lower weight ranges. Evaluation of weight frequency distribution in natural fish population provides an understanding of the fishing pressure that is being imposed on this population (BEATTY; KOENIG, 1976), and also demonstrates the body portion that can be used after slaughter (IMBIRIBA et al., 1994).

WLR can be used to estimate fish weight when length is known and vice-versa (OSCOZ et al., 2005; FROESE, 2006) and the equation proposed by this relationship provides important information about weight and biomass, which allows comparisons between different cropping systems (OSCOZ et al., 2005; TAVARES-DIAS et al., 2010). Thus, the isometric type growth observed in the present study for eviscerated *A. gigas* from the RESEX of down Juruá River corroborates with the results obtained by Tavares-Dias et al., (2010) that investigate the same species at the stages of fingerlings, juveniles and young fish in semi-intensive cultivation in Central Amazon. Under other conditions, positive allometric growth was observed in *A. gigas* from intensive cultivation in São Paulo, Brazil (SCORVO-FILHO et al., 2004) and also in specimens cultivated in Loreto, Peru (ALCÂNTARA et al., 2005). On the other hand, negative allometry was reported by Alcântara e Guerra (1992) and Ruffino e Isaac (1995) for captive specimens of down Amazonas River, Brazil. This diversity of results indicates that pirarucu presents ontogenic variations whereas, during the early stages of its development, there is a greater increase in length, and subsequently, a larger increase in weight (ALCÂNTARA; GUERRA, 1992; CAVERO et al., 2003) and in the adult phase greater increase of weight than length occurs (TAVARES-DIAS et al., 2010).

Kn is a qualitative physiological tool that can indicate the body condition of the fish and that can be used to compare the health status of the same species in different environments (LE CREN, 1951; NASH et al., 2006; TAVARES-DIAS et al., 2011). The results obtained in the present study demonstrate poor body condition when Kn was compared to the ideal value (1.00), however must be considered that fish were evaluated eviscerated and that weight of organs can affect the results. In non-eviscerated *A. gigas* specimens evaluated by Tavares-Dias et al. (2010) the Kn was close to the ideal described for the species, but the study of Scorvo-Filho et al. (2004), with *A. gigas* grown in raceways systems, showed high values of Kn. Despite showing an upward trend, we can not establish a comparative standard.

The results of the present study indicate that fishing stock of *A. gigas* from the down Juruá River RESEX presents good management conditions according IBAMA (1989) because most of the fish caught was in the range of commercial weight and presented high meat utilization. In addition, the biometric values obtained can

be considered as reference for the specimens of the studied area since provide subsidies to future studies on fisheries management.

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