Acta Apuroquia Vol.1 (2):14-20, 2010

ISSN 1836-9056

LENGTH-WEIGHT RELATIONSHIP OF THE SEVERAL COMMERCIAL FISH SPECIES IN THE APURE RIVER, VENEZUELA.

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RESUMEN
La conversión de las medidas de tallas en pesos, fueron realizadas a través de un análisis de regresión lineal simple. El promedio de la pendiente de la recta de regresión “b” fue significativamente diferente de 3. La distribución de los valores de “b” de las diferentes especies con respecto al antilogaritmo de “a” mostró una distribución moderadamente normal. La grafica del antilogaritmo de “a” versus la pendiente “b” mostró que *H. armatus* aparece como un punto fuera de la distribución y sus implicaciones ecológica son consideradas.

Palabras claves: relación talla-peso, peces comerciales, río Apure, Venezuela.

ABSTRACT
The conversions of length into weight measurements were accomplished by a simple linear regression model. The slope mean was significantly different from 3. The distribution of slope (b) of the species showed a moderate fit to a normal curve. The plot of anti-log (a) versus (b) showed that *H. armatus* appears as an “outlier” and the ecological implications of this are discussed.

Key words: weight-length relationship, commercial fish species, Apure River, Venezuela.

Recibido: 03/05/2009 Aceptado: 19/09/2009

INTRODUCTION

Length-weight relationships are very useful for fisheries research because they allow the conversion of length data into weight data for use in stock assessment models and allow the estimation of biomass from length observations. They also allow estimating the condition of the fish, and are useful for comparisons among regions of life histories of certain species (Froese and Pauly 1998; Moutopoulus and Stergiou 2000).

In the Apure River the ichthyological communities have been poorly studied, and very little biological information is available, including for most of the commercially important species. Moreover, a fisheries management plan is necessary in the region to regulate the small-scale fishery. And this requires basic information on population dynamics of the target species.

The present work is based on data collected within the framework of the project "Population Dynamics of large catfish in the Apure River", carried out with the aid of the Universidad Nacional de los Llanos Occidentales "Ezequiel Zamora" (UNELLEZ) and Fondo Nacional de Investigaciones Científicas y Tecnológicas (FONACIT). This study presents the length-weight relationship (LWR) parameters of the most abundant commercial fish species in the Apure basin. Because of the ecological and economic importance of these species, data on their functional LWR are important for fish stock assessment.

MATERIALS AND METHOS

STUDY AREA

The drainages of the Apure and Arauca rivers are part of the Orinoco watershed at the western floodplains of Venezuela (7º 56'00" N; 68º 00' 00" W). This is an area of approximately 167,000 km^2 of alluvial plain formed by the silts coming from the Andean Mountains. The small slope (1%) and low elevation (46 m above sea level) allow water from these to flood large areas from the end of May to October. The predominant vegetation is natural savanna and forest (gallery forest), and the lands are mainly used for agriculture cattle ranching (figure 1).

The approximate length of the Apure and Arauca rivers covered by this study is 250 km and 290 km respectively, with variable channel widths from 50 m to 800 m, the average minimum and the maximum depths are 2.16 m and 7.82 m respectively. The average flow of the rivers varies from 2000 m^3/s (January-April) to 4000 m^3/s (May-December). Water temperature varies from 26ºC to 30ºC. The precipitation for the area under study was 1459 mm/year from 1996 to 2001 (Taphorn, 1992).

Samplings of the species were made monthly from commercial fishermen from January 1996 to December 2001, using gill nets from 120m to 240m in length and 3-5m in width, and 40, 45, 50, and 60 mm stretched net. Also, some fishes (catfishes mainly) were captured in the main channel of the Apure river using a canoe trawl similar to that described by Lopez-Rojas (1980). The tow duration was 10-20 min at a speed of 2 knots.

Data on standard length (SL) and fork length (FL) were measured in cm and eviscerated weight in g for each fish. Simple linear regression models can generally accomplish conversions between length and weight measurements. The weights and lengths were transformed into logarithms and the resulting linear relationship was fitted by the least square regression, using W as the dependent variable (Anderson & Gutreuter. 1983). The parameters "a" and "b" of the length-weight relationship were estimated using the logarithmic transformation of the equation: $W= a*L^b \Rightarrow Ln(W) = a + b*Ln(L)$ Where: W=total weight; L=standard length; a= ordinate intercept; b= regression coefficient.

For detecting allometry in the growth of the species, the Student's test proposed by Pauly (1984) was used. The significance of the regression was assessed by testing the hypotheses: Ho :$\beta = 0$ against Ha: $\beta \neq 0$ (Zar,1996).$t= [sd_{(x)} / sd_{(y)}] * [|b-3| / \sqrt{1-r^2}] * [\sqrt{n-1}]$ Where: t = test students observed value; sd(x) = standard deviation Ln(L); sd(y) = standard deviation Ln(W); r^2 = determination coefficient; b = regression coefficient; n = number of observations.

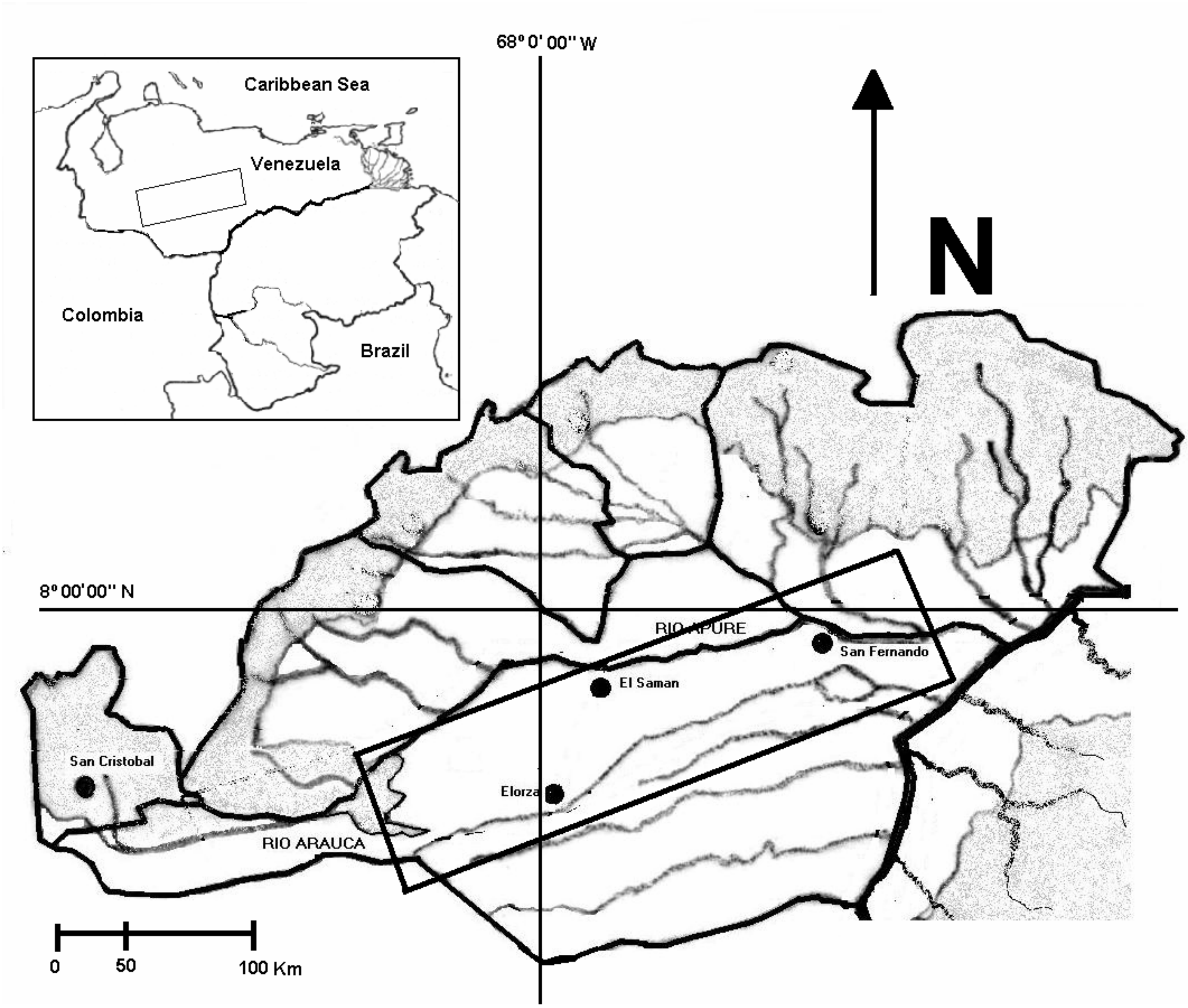

Figure 1 Part of the Apure River drainage showing the study area (Lower Apure)

The normality of the "b" distribution was also tested by means of the Kolmogorov-Smirnov test, as well as symmetry and kurtosis of the normal fit (Zar, 1996). All the data were processed with the aid of the Systat 7.0 software.

RESULTS AND DISCUSSION

The results of the length-weight relationship, considering 24 fish species which belong to 12 families and 4 orders, from the Apure River are summarized in table 1. All the data are referred to commercially important species in the Apure River. In terms of Orders, Siluriformes and Characiformes, dominated the records with 14 (58.1%) and 8 (33.3%), species respectively.

All regressions were highly significant, with the regression coefficient (r) ranging from 0.7 to 0.98 ($P<0.05$). The "b" values ranged from 2.086 for *Pterygoplichthys pardalis* to 3.31 for *Pygocentrus cariba*. The mean "b" was 2.55 (sd=0.343) and significantly different from 3 (t-test; $p<0.05$), and only three species (i.e. 12%) had "b" equal to 3, and 85% of the "b" values ranged between 2.08 and 2.98. This implies that the "cube law" is applied to any commercial species in the Apure River.

Table 1. Parameters of length-weight relationship for the 24 species of Apure River arrangement by taxonomic categories, including the maximum and minimal length in centimeters.

ORDEN-FAMILIES	SPECIES	a	b	r	max	min.	n	b=3
CLUPEIFORMES								
CLUPEIDAE	*Pellona flavipinnis*	0,162	2,38	0,95	100	20	127	
CHARACIFORMES								
CHARACIDAE	*Colossoma macropomum*	0,412	2,14	0,97	104	18	207	
	Piaractus brachypomum	0,242	2,29	0,98	99	20	163	
	Mylossoma duriventre	0,166	2,50	0,82	88	15	120	
	Pygocentrus cariba	0,015	3,31	0,93	36	17	163	
CYNODONTIDAE	*Hydrolycus armatus*	0.016	2.08	0.95	85	23	27	
ERITHRINIDAE	*Hoplias malabaricus*	0,012	2,98	0,96	47	30	308	***
PROCHILODONTIDAE	*Prochilodus mariae*	0,022	3,02	0,86	46	21	849	***
ANOSTOMIDAE	*Schizodon isognathus*	0.195	2.29	0.77	38	20	47	
SILURIFORMES								
PIMELODIDAE	*Pseudoplatystoma orinocense*	0,020	2,88	0,95	107	42	361	
	Pseudoplatystoma metaense	0,010	3,04	0,96	119	34	562	***
	Brachyplatystoma rouseauxii	0,185	2,36	0,89	106	26	190	
	Brachyplatystoma juruensis	0.159	2.31	0.86	96	23	132	
	Brachyplatystoma vaillantii	0.077	2.55	0.94	93	22	63	
	Phractocephalus hemiliopterus	0,037	2,77	0,91	110	31	59	
	Zungaro zungaro	0.039	2.69	0.92	120	26	32	
	Leiarius marmoratus	0.256	2.21	0.85	82	20	45	
	Goslinia platynema	0.042	2.67	0.79	81	36	596	
	Pinirampus pirinampu	0.216	2.30	0.87	82	20	86	
CALLICHTHYIDAE	*Hoplosternum littorale*	0,023	2,93	0,95	23	7	201	
LORICARIIDAE	*Pterygoplichthys pardalis*	0,255	2,08	0,82	33	29	185	
AGENEOSIDAE	*Ageneiosus sp*	0,036	2,74	0,93	70	26	69	
DORADIDAE	*Oxydoras níger*	0,232	2,31	0,98	112	22	171	
PERCIFORMES								
CICHLIDAE	*Caquetaia kraussii*	0.010	3.40	0.87	31	19	39	
SCIAENIDAE	*Plagioscion squamosissimus*	0,143	2,42	0,97	88	19	144	

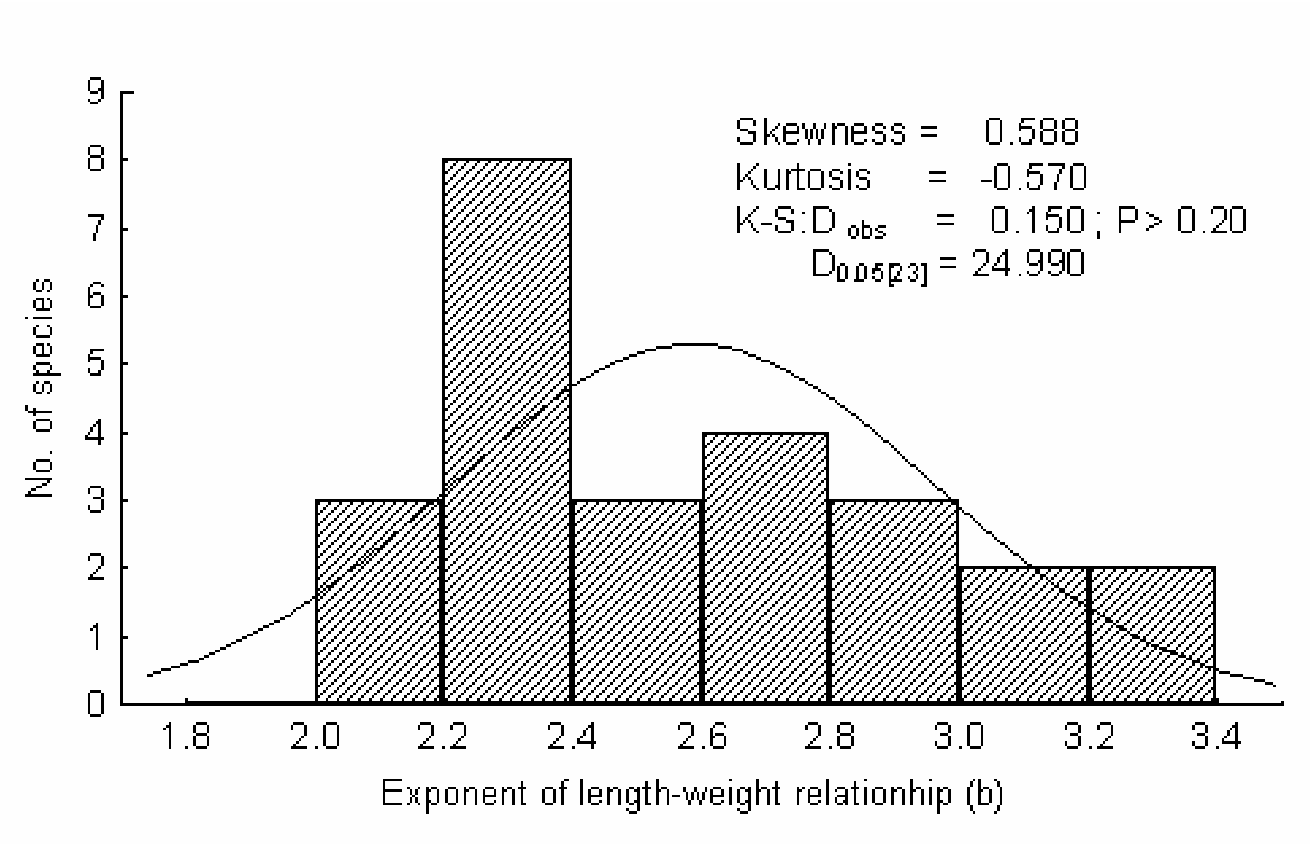

Figure 2. Some statistics applied to distributions of values of “b” for 24 fish species from the Apure River.

The distribution of the LWR exponents (b) of the 24 species showed symmetry and good kurtosis. But the Kolmogorov-Smirnov test showed a moderated fit at normal curve (see Figure 2).Several authors have suggested that a plot of Ln(a) versus “b” for all known length-weight relationships for the species results in a linear relationship, and that this relationship can be used to identify outliers. We have applied this method to all the species and it was observed that *Colossoma macropomum* showed the behavior of an outlier by presenting a value “b” very high and which was validated by means of a residues distribution analysis (Figure 3 and 4). Likewise in the case of *Hydrolycus armatus,* which also showed the behavior of an outlier by presenting a very low value “b”, but other explanations, are possible.

The result of the intercept-slope relationship for this species would be considered as “questionable”, but it also could be an evident case of failing to fit the “cube law”. *H*. *armatus* is a carnivorous pelagic fish with large pectoral fins, a very compressed body and great capacity to jump out of the water. It can increase its length at a rate of 3, possibly due to ecological adaptations. The estimated parameters in this study could be applied to those commercial species with the specific length ranges analyzed.

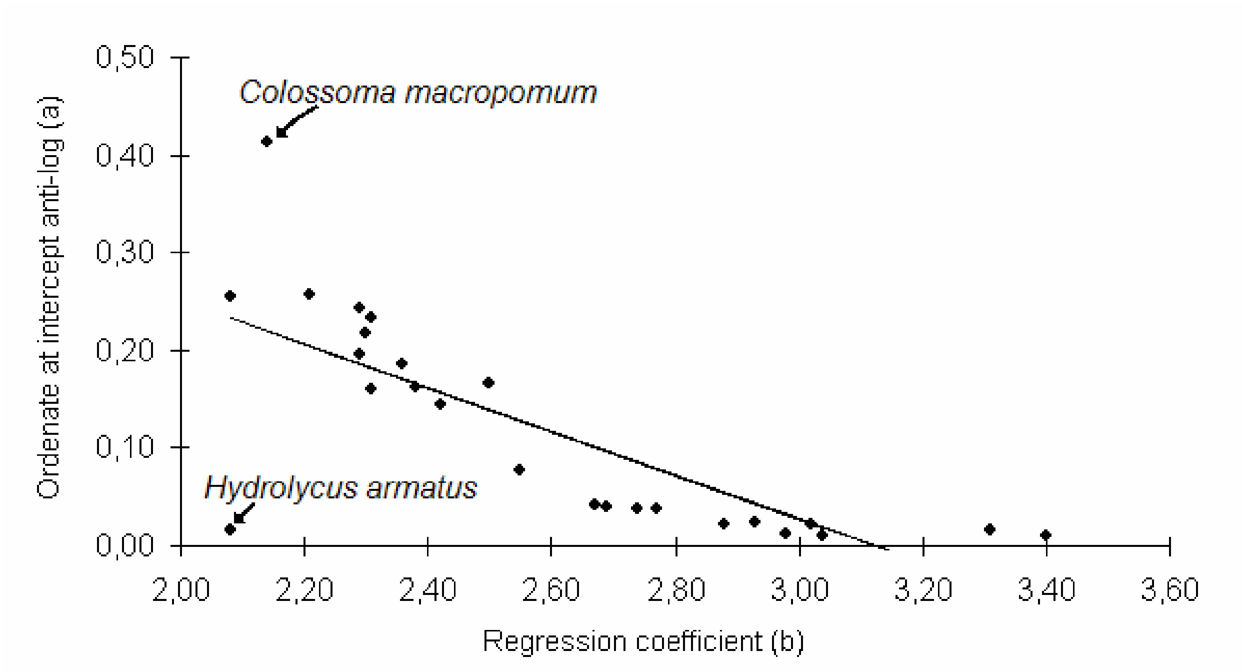

Figure 3 Plot of linear regression between Ln “a” versus “b” for all known length-weight relationships of the species analyzed from the Apure River.

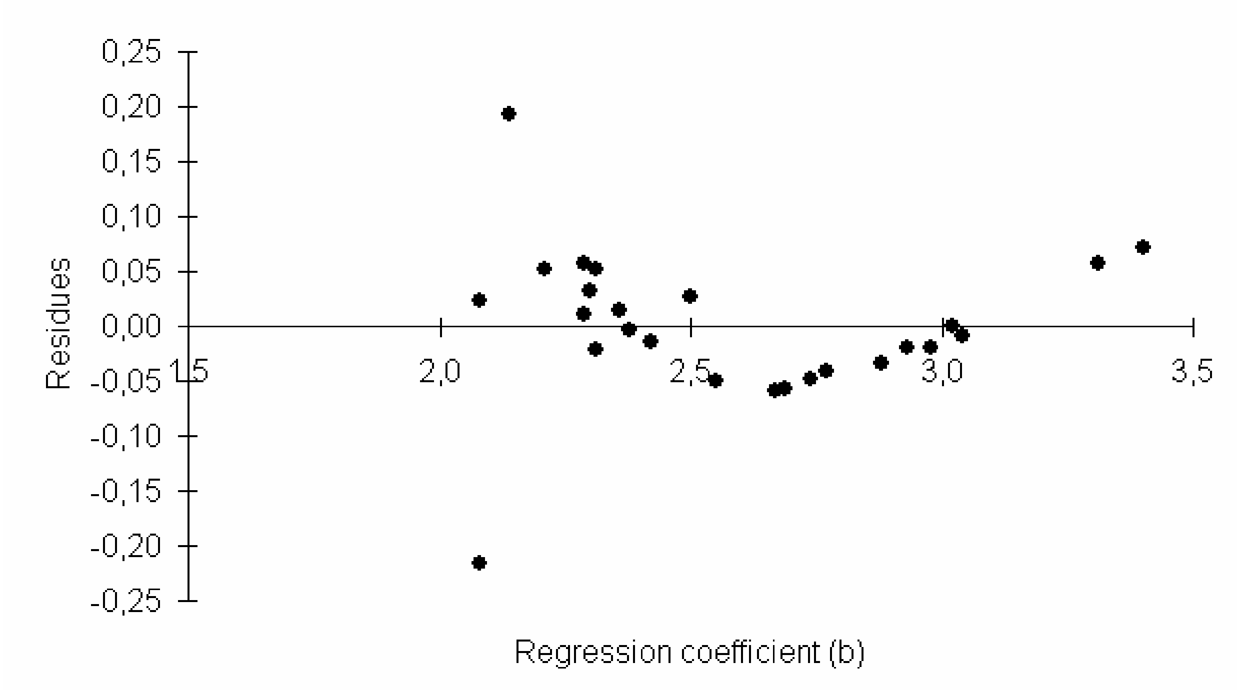

Figure 4 Plot of the distribution residuals of the linear regression between Ln “a” versus “b” for all known length-weight relationships of the species from the Apure River.

The results of length-weight relationship (LWR) for the most abundant commercial fish species in the Apure drainage would be an aid for generating other types of information necessary for fish stock assessment.

ACKNOWLEDGMENTS

The authors want to thank Gabriel Carrillo for reviewing the manuscript in English; Hender Castillo and Carlos Guevara for processing the data. The first author is also grateful to the Universidad Nacional de los Llanos Occidentales "Ezequiel Zamora" (UNELLEZ) for the financial aid (Research Project Nº 41101102) and Fondo Nacional de Investigaciones Científicas y Tecnológicas (FONACIT) for the Research Fellowship granted (Research Project S1-99000994).

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