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RESEARCH NOTE / NOTA CIENTÍFICA

LENGTH-WEIGHT AND LENGTH-LENGTH RELATIONSHIPS FOR 12 FISH SPECIES FROM AN ESTUARINE ECOSYSTEM FROM GULF OF CALIFORNIA, MEXICO

RELACIONES PESO-LONGITUD Y LONGITUD PATRÓN-LONGITUD TOTAL PARA 12 ESPECIES DE PECES DE UN ECOSISTEMA ESTUARINO DEL GOLFO DE CALIFORNIA, MÉXICO

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ABSTRACT

Length - weight (LW) and standard length - total length (LL) relationships were assessed for 12 fish species caught in the Mulege River estuary (middle Gulf of California), Mexico. Fish were sampled in November 2011 and January 2012, using cast nets and gill nets (mesh size 3 mm). Parameters of the LW and LL relationships were estimated using the log-linear and simple linear regressions. Values of b parameter ranged from 2.39 in *Lile stolifera* (Jordan & Gilbert, 1882) to 3.16 in *Mugil curema* Valenciennes, 1836. LL relationships were significantly correlated, ranging 0.851 to 0.999. This study reports for the first time, LL relationships for three species (*Ctenogobius sagittula* (Günther, 1861), *Erotelis armiger* (Jordan & Richardson, 1895), and *L. nigrofasciata* Castro-Aguirre, Ruiz-Campos & Balart, 2002). The information reported here will be useful to generate a baseline for regulation as well as for a sustainable fishery management in one of the two positive estuarine ecosystems known in the Gulf of California.

Key words: Fish growth – b coefficient – Mulege estuary – regression models

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RESUMEN

Las relaciones Peso - longitud (LW) y longitud patrón- longitud total (LL), fueron evaluadas para 12 especie de peces capturados en el estuario del Río Mulegé (parte media del Golfo de California). Los peces fueron recolectados en noviembre de 2011 y enero de 2012, utilizando atarraya y redes de enmalle (luz de malla 3 mm). Los parámetros de las relaciones LW y LL fueron estimados mediante regresión log-transformada y lineal simple. Los valores del parámetro b variaron de 2.39 en *Lile stolifera* (Jordan & Gilbert, 1882) a 3.16 en *Mugil curema* Valenciennes, 1836. Las relaciones LL mostraron correlación significativa, variando de 0.851 a 0.999. Se reporta por primera vez la relación LL para tres especies (*Ctenogobius sagittula* (Günther, 1861), *Erotelis armiger* (Jordan & Richardson, 1895) and *L. nigrofasciata* Castro-Aguirre, Ruiz-Campos & Balart, 2002). La información aquí reportada servirá para generar líneas base para la regulación y un manejo sustentable de las pesquerías en uno de los dos estuarios positivos en el Golfo de California.

Palabras clave: Crecimiento en peces – coeficiente b – estuario Mulegé – modelos de regresión

INTRODUCTION

The western coast of the Gulf of California (GC) is characterized by a scarcity of rivers draining into the gulf, only two of them (Colorado and Mulege), forming estuaries in the upper and middle gulf regions (Castro-Aguirre *et al.*, 1995; González-Acosta *et al.*, 2021).

Estuary ecosystems from northwestern Mexico such as that of Mulege River have not been enough studied. The fish fauna reported for this estuary is composed by 47 species, 38 genera and 22 families (Ruiz-Campos *et al.*, 2003; González-Acosta *et al.*, 2021). However, information on LL (standard length – total length) and LW (length – weight) relationships for the fish species from the Mulege estuary is not yet available, so that the generation of this type of information will be of usefulness to estimate different aspects on fish population dynamics (e. g., the standing stock biomass, ontogenetic changes, growth rates and age structure) and to predict the mean fish biomass of this ecosystem (e. g., Froese, 2006). Thus, in this study data of LW and LL relationships for 12 estuarine fish species from the Mulege River estuary are reported.

MATERIALS AND METHODS

Fish were collected in the Mulege River estuary (26°53.54' N- 111°57-58" W) in November 2011

and January 2012, using castnets and gillnets (mesh size 3 mm). Specimens were taxonomically identified using generalized keys (e. g., Osburn & Nichols, 1916; Follett, 1960; Fischer *et al.*, 1995; Castro-Aguirre *et al.*, 1999), measured in standard (SL) and total (TL) length with a digital caliper (precisión 0.1 mm), and weighed with an electronic balance (precisión 0.1 g).

The LW parameters were estimated using the log-linear regression: $\log W = \log a + b \log SL$; where W is the weight (g), SL the standard length of fish (cm), a is a constant empirically determined, and b the allometric coefficient (Froese, 2006). To determine when b value was close to (isometric growth) or different from 3.0 (allometric growth), a Student's t -test was performed. The 95% confidence intervals (CI) of parameters a and b were calculated, as well as coefficient of determination (r^2) to assess the fit of the model. Additionally, the LL relationships were calculated by the simple linear regression: $TL = b SL + a$, using pooled data over the study period.

Ethical aspects: The present study does not have ethical conflicts.

RESULTS

A total of 1079 specimens of 12 fish species (six families and 10 genera) were analyzed. On the table 1 the results of LW relationships, number of specimens (n), size range, and a and b values are

Table 1. Parameters of length-weight (LW) and total length-standard length (LL) relationships for 12 fish species caught in the Mulege River estuary (middle Gulf of California).

Family	Species	n	Length (cm)				Weight (g)				LW				LL			
			Min	Max	Min	Max	Min	Max	a	b	r ²	G	a	b	r			
CLUPEIDAE	<i>Lile nigrofasciata</i>	61	5.3	7.3	2.1	5.4	0.2199	2.517	0.6893	A	0.672	0.7147	0.9015*					
	<i>Lile stolidifera</i>	190	4.2	8.4	0.9	0.67	0.1872	2.3912	0.4645	A	0.8730	0.6612	0.8509*					
	<i>Opistonema libertate</i>	17	6.1	10.5	2.4	13.7	0.2603	2.7442	0.881	I	0.4658	0.7532	0.987*					
ELEOTRIDAE	<i>Erotelis armiger</i>	90	2.8	8.2	0.2	3.0	0.0629	2.4232	0.9439	A	-0.0013	0.8153	0.9883*					
	<i>Diapterus brevirostris</i>	112	1.9	17.9	2.4	23.0	0.1517	3.0516	0.7861	I	-0.269	0.7716	0.9962*					
GERREIDAE	<i>Eucinostomus currani</i>	16	1.8	6.1	0.1	5.3	0.1524	3.1183	0.9676	I	0.1447	0.7326	0.9943*					
	<i>Eugerres lineatus</i>	24	4.6	17.4	1.5	120.0	0.2594	3.0044	0.9784	I	-0.5864	0.7913	0.996*					
	<i>Gerres cinereus</i>	82	3.9	16.4	1.1	68.2	0.1091	2.887	0.8973	I	0.2149	0.7159	0.9942*					
GOBIIDAE	<i>Ctenogobius sagittula</i>	183	2.3	8.2	0.09	4.9	0.7445	3.0305	0.9015	I	1.0567	0.5914	0.9567*					
LUTJANIDAE	<i>Lutjanus argentiventris</i>	57	3.1	15.0	0.7	89.5	0.1159	2.9454	0.9214	I	0.1973	0.7795	0.9909*					
MUGILIDAE	<i>Mugil cephalus</i>	219	2.1	33.0	0.1	456.0	0.3159	2.9118	0.9751	A	0.0856	0.7872	0.9991*					
	<i>Mugil curema</i>	28	2.3	12.4	0.2	31.4	0.1832	3.1604	0.9196	I	0.1679	0.7568	0.9972*					

In bold are presented first reports of LL relationships; * indicates a significant correlation. A and I represent allometric and isometric growth (G), respectively.

summarized. Estimations of LW relationships indicated coefficients of significant determination (r^2 , $P < 0.001$) ranging from 0.4645 in *Lile stolifera* (Jordan & Gilbert, 1882) to 0.9184 in *Eugerres lineatus* (Humboldt, 1821). Values of b parameter ranged from 2.39 in *L. stolifera* to 3.16 in *Mugil curema* Valenciennes, 1836.

Student's t -test allowed us to determine eight species with isometric growth while four species had an allometric growth (Table 1). Moreover, LL relationships were also highly correlated for all the species (LL; $r^2 > 0.85$, $P < 0.001$; Table 1) with values ranging between 0.851 for *L. stolifera* and 0.999 for *Mugil cephalus* Linnaeus, 1758.

DISCUSSION

From 12 fish species examined here, ten of them (83%) showed values of b parameter within the expected range (2.5 to 3.5) for fishes (Froese, 2006). Likewise, the LL relationships for three species: *Ctenogobius sagittula* (Günther, 1861), *E. armiger* (Jordan & Richardson, 1895), and *Lile nigrofasciata* Castro-Aguirre, Ruiz-Campos & Balart, 2002 are reported for the first time (Froese & Pauly, 2021). Five species (42%) showed b values within the intervals reported in FISHBASE data (Froese & Pauly, 2021) and Ruiz-Campos *et al.* (2006); while other two species (*Diapterus brevirostris* (Sauvage, 1879) and *L. nigrofasciata*) had b values within the respective range reported for the Mexican Pacific (González-Acosta *et al.*, 2004; Rojas-Herrera *et al.*, 2009; Velázquez-Velázquez *et al.*, 2009; Sandoval-Huerta *et al.*, 2015). Other fish species as *E. armiger*, *L. nigrofasciata*, *L. stolifera*, and *Opistonema libertate* (Günther, 1867) had lower b values than those reported in the Mexican Pacific (see authors cited above), while *C. sagittula* and *E. lineatus* had higher b values than those reported in this same region (Table 1).

The LL and LW parameters reported here will be useful to generate a baseline for regulation as well as for a sustainable fishery management in the Mulege estuary, which represents one of the two positive estuarine ecosystems known in the gulf of California.

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