



Research note

Growth and mortality of *Sphoeroides testudineus* (Tetraodontiformes: Tetraodontidae) in a tropical coastal lagoon in northwestern Yucatán Peninsula

Crecimiento y mortalidad de *Sphoeroides testudineus* (Tetraodontiformes: Tetraodontidae) en una laguna costera tropical en el noroeste de la península de Yucatán

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Abstract. This study reports growth parameters and mortality for *Sphoeroides testudineus* from La Carbonera, a karstic tropical coastal lagoon on the northwestern coast of the Yucatán Peninsula, Mexico. A total of 461 specimens were collected between April 2009 and March 2010. We obtained the length-weight relationship and the growth parameters of von Bertalanffy growth model (VBGM) by length frequency analysis. Additionally, mortality was estimated and analyzed. Exponent b indicated an isometric growth pattern. The growth parameters of VBGM were: $L_{\infty} = 29.50$ cm, $k = 0.77$ year⁻¹ and $t_0 = -0.168$ years. The instantaneous natural mortality was 1.53 year⁻¹.

Key words: length-weight relationship, growth, *Sphoeroides testudineus*, coastal lagoon.

Resumen. Este estudio reporta parámetros de crecimiento y mortalidad para *Sphoeroides testudineus* de La Carbonera, una laguna costera cársica tropical en la costa noroeste de la península de Yucatán, México. Un total de 461 ejemplares se recogieron entre abril de 2009 y marzo de 2010. Se obtuvo la relación talla-peso y los parámetros de la ecuación de crecimiento de von Bertalanffy mediante el análisis de la frecuencia de tallas. Adicionalmente, se estimó y analizó la mortalidad. El exponente b indicó un patrón de crecimiento isométrico todo el año. Los parámetros del modelo de la ecuación de crecimiento de von Bertalanffy fueron: $L_{\infty} = 29.50$ cm, $k = 0.77$ año⁻¹ y $t_0 = -0.168$ años. La mortalidad natural instantánea fue 1.53 año⁻¹.

Palabras clave: relación talla-peso, crecimiento, *Sphoeroides testudineus*, laguna costera.

The growth of juvenile fish is considered one of the most important factors contributing to the future recruitment of adult populations within a habitat. Length and weight relationship (LWR) parameters (a and b) are necessary variables to understanding the dynamics of a fish population (Pitcher and Hart, 1982).

Sphoeroides testudineus, a member of family Tetraodontidae, is known vernacularly as Checkered Puffer and locally as “pez globo” (Spanish). An important estuarine-dependent fish, Checkered Puffer is listed as a dominant species in many Yucatán coastal lagoons (Arceo-Carranza and Vega-Cendejas, 2009). The aim of the study was to present the LWR and to estimate instantaneous natural mortality rate of *S. testudineus* from the La Carbonera lagoon in northwestern Yucatán Peninsula.

Samples of *S. testudineus* were collected during the daytime between April 2009 and March 2010 in the La Carbonera, a karstic coastal lagoon in northwestern Yucatán Peninsula, Mexico (21°13'–21°14' N, 89°52'–89°54' W) (Fig.1). Fish were caught with a 40 m long seine net, with 1 m deep and 1.27 cm (0.5 inch) stretch mesh, in 9 sampling stations along the lagoon in each field trip. Collected specimens were euthanized in ice slurry, preserved in formaldehyde (10%) and then transported to the laboratory, where they were measured (± 0.1 mm) and weighed (± 0.01 g).

A relationship between total length and weight was used to estimate the equation: $W = a L_t^b$, where, W represents the weight (g), L_t is the total length (cm), the parameter a is a scaling constant and b is the slope of the model. To determine a and b we used a least-squares regression analysis. To assess the isometry of the estimated

b parameter was evaluated with the t -test ($H_0: b = 3.0$; with $\alpha = 0.05$) using STATISTICA 7 software. Parameters of the von Bertalanffy growth function (VBGF) were determined through the ELEFAN-I software included in the package FAO-ICLARM Stock Assessment Tools (FiSAT II) (Gayanilo et al., 1997), using length frequency distribution with class intervals of 2 cm of total length. The VBGF is expressed as follows: $L_t = L_\infty [1 - \exp^{-k(t-t_0)}]$, where L_t is the length at age t , L_∞ is asymptotic length, k is the growth rate, and t_0 is the hypothetical age at which fish length is zero. In order to assess the variability of k , taking into account the uncertainty in the estimation of asymptotic length, estimated values of maximum length and its 95% confidence interval from the routine Maximum Length Estimation included in FiSAT II (Gayanilo et al., 1997) were used to obtain a range of possible values of k . The parameter t_0 was calculated using the empirical formula of Pauly (1979). The instantaneous rate of total mortality (Z) was determined by the length converted catch curve (Pauly, 1983), which in the absence of exploitation in the area of study is equivalent to the instantaneous rate

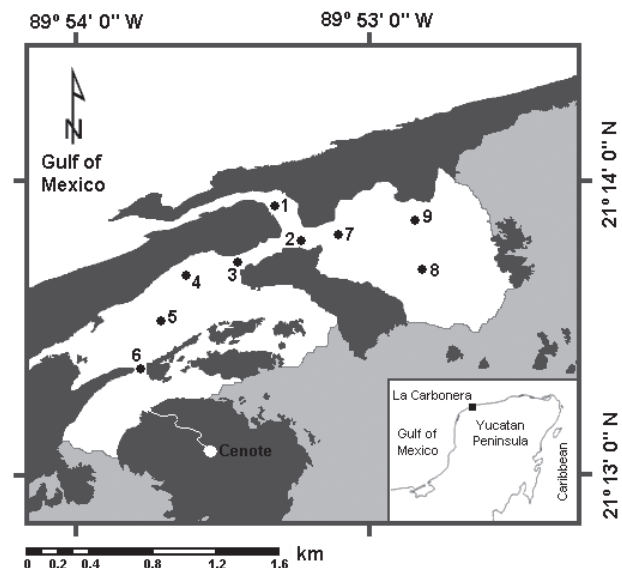


Figure 1. Map of the La Carbonera coastal lagoon with the sampling stations and the “cenote” (sinkhole). The line indicates the maximum level of the water in the rainy season, the high black zone is the wetland and the black spots are patches of mangrove.

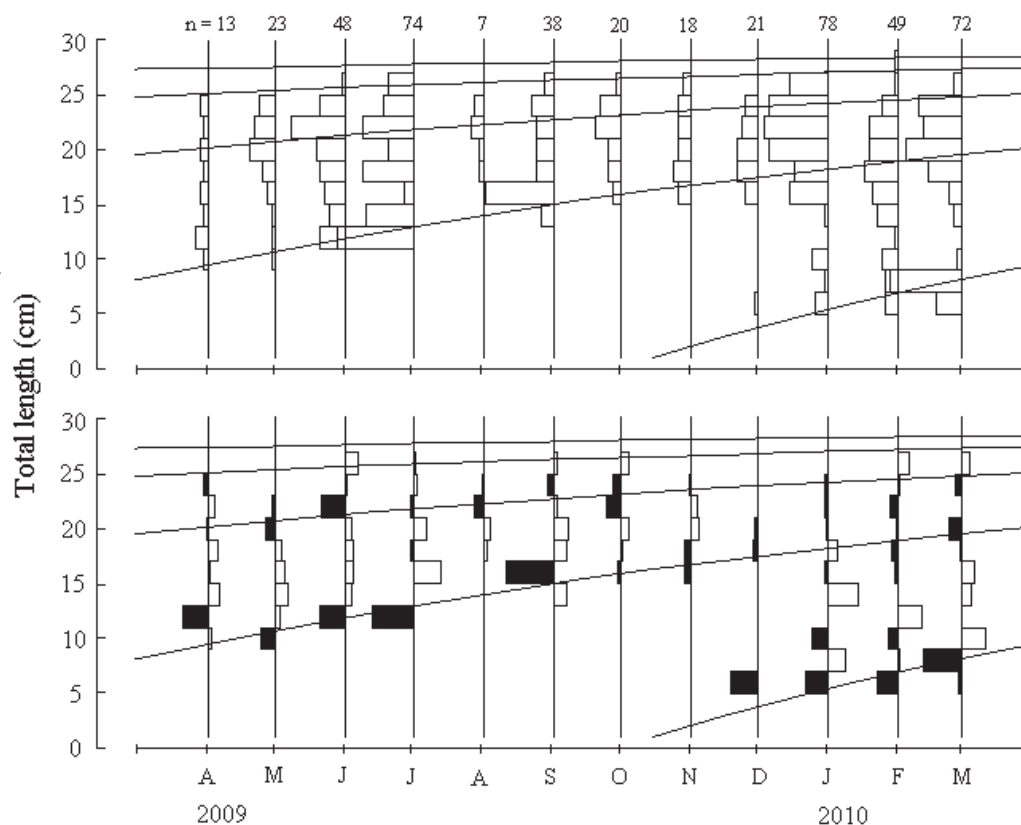


Figure 2. Monthly variation of the growth curve based on length frequency data (above) and restructured length frequency data (below) computed in ELEFAN-I of *Sphoeroides testudineus* from La Carbonera lagoon, Yucatán, Mexico.

of natural mortality (M). Additionally, an independent estimate of M was carried out using the empirical equation proposed by Pauly (1980).

A total of total of 461 organisms were collected with approximately one third per climatic season (dry, rainy, and north winds). The exponent b in the combined LWRs was not statistically different from the isometric value ($t = -0.58$; $p > 0.05$). LWR can fluctuate due to temperature and salinity or food availability and reproductive activities (Wootton, 1990); however we found no differences in b between climatic seasons (Table 1). Similar results were obtained by Mallard-Colmenero et al. (1982) from Laguna de Términos, Campeche, Gulf of Mexico. Other puffers, in particular, *Sphoeroides spengleri*, have been reported in Yucatán with allometric values ($b < 3$) (Vega-Cendejas et al., 2012), perhaps because smaller specimens were in better conditions at the time of sampling (Froese, 2006).

Growth parameters for *S. testudineus* were: $L_{\infty} = 29.50$ cm, $k = 0.77$ year⁻¹ and $t_0 = -0.168$ years, and we estimated

the monthly variation (Fig. 2). According to these results, the growth rates of *S. testudineus* along the northwestern coast of the Yucatán is higher than those which Pauly (1991) found in the Biscayne Bay, Florida. This could be due to environmentally induced variations (Munro and Pauly, 1983; Bonilla-Gómez et al., 2011).

The total mortality instantaneous rates (Z) estimated by the length converted catch curve was 1.67 year⁻¹ (0.22 - 3.12; 95% confidence interval). The natural mortality instantaneous rate (M) was 1.53 year⁻¹ in relation to the average temperature of the sampling period (28.6° C). These are the first estimates of mortality for *S. testudineus* in the Yucatán Peninsula. Estimates of total mortality by the length converted catch curve (Pauly, 1983) are equivalent to the natural mortality rate ($Z = M$) due to the absence of commercial fishing of this species in the study area.

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Table 1. Seasonal estimated parameters of length-weight relationships of *Sphoeroides testudineus*, La Carbonera, Yucatán

Season	n	Length (cm)		Weight (g)		Regression parameters		
		Minimum	Maximum	Minimum	Maximum	a	b	r ²
Dry	156	4.09	25.60	1.70	367.60	0.0790	3.043	0.9843
Rainy	139	10.05	26.00	29.20	430.00	0.0437	2.918	0.9647
North Winds	166	4.82	26.50	2.20	388.40	0.0570	2.947	0.9799
Combined	461	4.09	26.50	1.70	430.00	0.0611	2.978	0.9792

n, number of specimens considered in analysis; a, scaling constant; b, slope; r², coefficient of determination.

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Literature cited

- Arceo-Carranza, D. and M. E. Vega-Cendejas. 2009. Spatial and temporal characterization of fish assemblages in a tropical coastal system influenced by freshwater inputs: northwestern Yucatan peninsula. *Revista de Biología Tropical* 57:89-103.
- Bonilla-Gómez, J. L., J. López-Rocha, M. Badillo, J. Tzeek and X. Chiappa-Carrara. 2011. Growth and mortality of *Lagodon rhomboides* (Pisces: Sparidae) in a tropical coastal lagoon in northwestern Yucatan, Mexico. *Revista de Ciencias Marinas y Costeras* 3:99-109.
- Froese, R. 2006. Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. *Journal of Applied Ichthyology* 22:241-253.
- Gayaniilo Jr., F. C., P. Sparre and D. Pauly. 1997. The FAO-ICLARM Stock Assessment Tools (FiSAT). FAO Computerized Information Series (Fisheries) No. 8. FAO, Rome, Italy. 168 p.
- Mallard-Colmenero, L., A. Yáñez-Arancibia and F. Amezcua-Linares. 1982. Taxonomía, biología y ecología de los tetraodontidos de la Laguna de Términos, sur del Golfo de México (Pises: Tetraodontidae). *Anales del Instituto de Ciencias del Mar Limnología, Universidad Nacional Autónoma de México* 9:161-212.
- Munro, J. L. and D. Pauly. 1983. A simple method for comparing growth of fishes and invertebrates. *ICLARM Fishbyte* 1:5-6.
- Pauly, D. 1979. Theory and management of tropical multispecies stocks: A review with emphasis on the Southeast Asian demersal fisheries. *ICLARM Studies Review* 1:1-35.
- Pauly, D. 1983. Some simple methods for the assessment of tropical fish stocks. FAO, Fisheries Technical Paper No. 234. Rome, Italy. 52 p.
- Pauly, D. 1991. Growth of the checkered puffer *Sphoeroides testudineus*: postscript to papers by Targett and Pauly & Ingles. *ICLARM Fishbyte* 9:19-22.
- Pitcher, T. J. and P. J. Hart. 1982. Fisheries ecology. Chapman

- and Hall, London. 414 p.
- Vega-Cendejas, M. E., M. H de Santillana and D. Arceo. 2012. Length-weight relationships for selected fish species from a coastal lagoon influenced by freshwater seeps: Yucatan peninsula, Mexico. *Journal of Applied Ichthyology* 28:140-142.
- Wootton, R. J. 1990. *Ecology of teleost fishes*. Chapman and Hall, London. 404 p.