Technical contribution

Length–weight relationships and growth parameters of two endemic fish species (*Floridichthys polyommus* Hubbs, 1936 and *Fundulus persimilis* Miller, 1955) from the Yucatan Peninsula, Mexico

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Summary

This study reports length-weight relationships and growth parameters for *Floridichthys polyommus* Hubbs, 1936 and *Fundulus persimilis* Miller, 1955 from La Carbonera, a karstic tropical coastal lagoon on the northwestern coast of the Yucatan Peninsula, Mexico. Specimens were collected between April 2009 and March 2010. The resulting length-weight relationship for *F. polyommus* was: $W = 0.0180 Lt^{3.37}$ and $W = 0.0142 Lt^{3.35}$ for *F. persimilis*. This study presents the first estimation for both species of the von Bertalanffy growth model parameters, the growth performance index, the L_{50}, and is the first report of the length-weight relationship for *F. persimilis*.

Introduction

Floridichthys polyommus Hubbs, 1936 and *Fundulus persimilis* Miller, 1955 are members of the Ciprinodontiformes order, and known colloquially as Ocellated Killifish and Yucatan Killifish, respectively. They are endemic fish species of ecological importance in the northern part of the Yucatan Peninsula coastal lagoons (McEachran and Fechhelm, 1998), and both present sexual dimorphism. The Ocellated Killifish is an abundant species in many Yucatan coastal lagoons, and more frequently found during the rainy season (Arceo-Carranza and Vega-Cendejas, 2009; Gallardo-Torres et al., 2012).

The aim of this study was to assess the length-weight relationships (LWR) and to estimate the growth parameters of *F. polyommus* and *F. persimilis* from La Carbonera lagoon in the northwestern Yucatan Peninsula.

Materials and methods

Samples of *F. polyommus* and *F. persimilis* were collected during daytime between April 2008 and March 2009 in La Carbonera, a karstic coastal lagoon located in northwestern Yucatan Peninsula, Mexico (21°13′ – 21°14′N; 89°52′ – 89°54′W). Specimens were obtained with a small purse seine, euthanized in ice slurry, preserved in formaldehyde (4%) and transported to the laboratory where total length (LT, ±1 mm) and weight (W, ±0.1 g) were obtained. Data were grouped by sex and also as juveniles and adults considering the gonadic development and the L_{50} (Bonilla-Gómez et al., 2011; Tzeek-Tuz et al., 2012).

To obtain the parameters *a* and *b* of the LWR we used a regression analysis of the log-converted weight and total length data. The 95% confidence intervals (CI 95%) for *b* were calculated to determine if the hypothetical value of isometry (3) fell between these intervals (Froese, 2006). Parameters of the von Bertalanffy growth function (VBGF) were determined through the ELEFAN-I software included in the package FAO-ICLARM Fish Fisheries Stock Assessment Tools (FiSAT II) (Gayanilo et al., 1997), using length frequency distribution with class intervals of 1.0 cm total length. We also calculated the growth performance index (ϕ') proposed by Munro and Pauly (1983).

Results

A total of 1049 organisms of *F. polyommus* (44.2% males and 55.8% females) and 976 organisms of *F. persimilis* (44.5% males, 55.5% females) were collected during the study period (Table 1). The exponent *b* in the combined LWRs was not statistically different from the isometric value (*F. polyommus*: t-test = −1.1425, P > 0.05; *F. persimilis*: t-test = 0.0467, P > 0.05). No differences were found between sexes in either species, indicating a similar growth in each population, independently of the sex. Since *b* is close to 3, *a* is the condition factor (Froese, 2006).

Length at maturity (L_{50}) was 3.67 cm for *F. polyommus* and 7.96 cm for *F. persimilis* (Table 2). Therefore, LWR were obtained for juvenile size classes ($<L_{50}$) and adults ($\geq L_{50}$) (Fig. 1). In both cases, the slopes for juvenile and adults did not differ (*F. polyommus*, t-test = 0.605, P > 0.05; *F. persimilis*, t-test = 0.742, P > 0.05) but the origin of each equation, hence the condition factor for juvenile and adults, was significant (*F. polyommus*, t-test = 3.07, P < 0.05; *F. persimilis*, t-test = 2.00, P < 0.05).

Table 1

Descriptive statistics and estimated parameters of length-weight relationships (LWR), male, female and combined sexes (total) of *Floridichthys polyommus* and *Fundulus persimilis* at La Carbonera lagoon, Yucatan, Mexico, April 2008 to March 2009. Juveniles are included in the LWR calculations

Species		N	Total length (cm)		Total weight (g)		Regression parameters					
			Min	Max	Min	Max	a	b	SE (b)	CI 95% (a)	CI 95% (b)	r^2
F. polyommus	Males	464	2.18	10.18	0.20	21.10	0.0221	3.386	0.024	0.0217–0.0226	3.341–3.433	0.9780
	Females	585	1.81	10.31	0.10	23.80	0.0195	3.355	0.018	0.0190–0.0200	3.319–3.391	0.9834
	Total	1049	1.81	10.31	0.10	23.80	0.0180	3.373	0.012	0.0176–0.0183	3.348–3.398	0.9843
F. persimilis	Males	434	3.41	12.30	0.05	19.50	0.0140	3.486	0.048	0.0138–0.0143	3.392–3.581	0.9227
	Females	542	4.20	13.67	0.60	37.60	0.0163	3.156	0.043	0.0161–0.0165	3.070–3.243	0.9052
	Total	976	3.41	13.67	0.05	37.60	0.0142	3.355	0.037	0.0140–0.0144	3.294–3.416	0.9227

N, sample size; a, scaling constant; b, slope; SE, standard error; CI, confidence intervals; r^2, coefficient of determination.

Table 2

Growth parameters of VBGF and growth performance index (ϕ'), *Floridichthys polyommus* and *Fundulus persimilis*, La Carbonera lagoon, Yucatan, Mexico

Species	N	L_{50} (cm)	L_∞ (cm)	k (year^{-1})	t_0	ϕ'
F. polyommus	1049	3.67	11.55	0.910	−0.1924	2.084
F. persimilis	976	7.96	14.70	0.940	−0.1640	2.307

N, sample size; Lt, total length; L_∞, asymptotic length; k, growth constant; t_0, hypothetical age at which fish length is zero; L_{50}, total length at which 50% of individuals are able to spawn.

The estimated equations of the VBGF for total length were: $Lt = 11.55\,[1-e^{-0.91\,(t-0.192)}]$ for *F. polyommus* and $Lt = 14.70\,[1-e^{-0.94\,(t-0.164)}]$ for *F. persimilis* (Table 2).

Discussion

The exponent b close to the isometric value was also obtained for *F. polyommus* (Vega-Cendejas et al., 2012). No previous reports of LWR for *F. persimilis* have been published.

Growth parameters of the VBGF for *F. polyommus* and *F. persimilis* have not been reported previously. According to results of the growth performance index (ϕ') on the coast of the Yucatan Peninsula, both species could be considered as fast growing. The uncertainty associated with the growth rate (k) estimates by the length frequency analysis suggests the need to further investigate the population dynamics of these species in order to obtain demographic trends accounting for temporal variations. Precise estimations of the LWR and VBGF are necessary to account for environmentally-driven variations in demographic parameters that are needed to contribute to the conservation of endemic species in a valuable area.
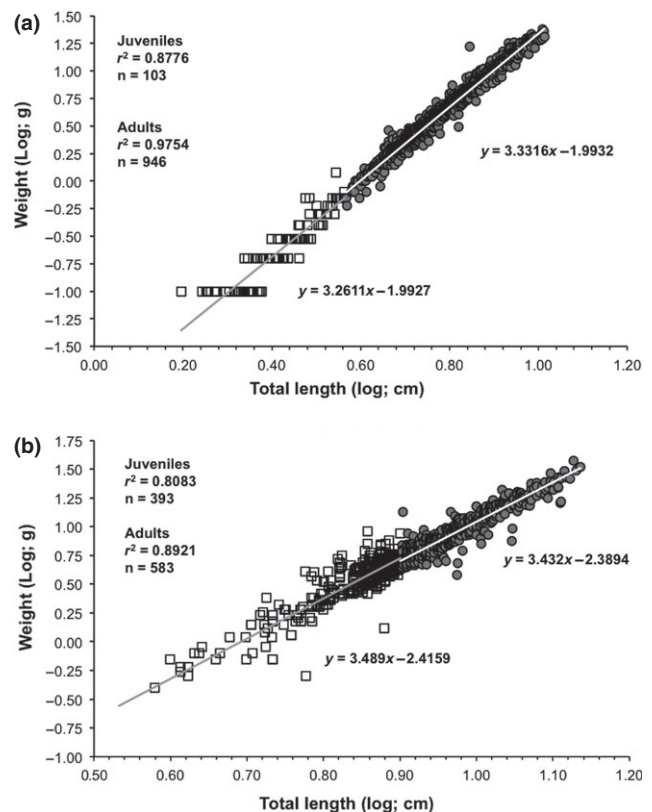
Fig. 1. Log-log plot of weight and length for juvenile and adult *Floridichthys polyommus* (a) and *Fundulus persimilis* (b) from La Carbonera lagoon, Yucatan, Mexico. Onset of gonadal development (L_{50}) occurs at 3.67 cm TL (log = 0.57) in *F. polyommus* and at 7.96 cm (log = 0.90) in *F. persimilis*

References

Arceo-Carranza, D.; Vega-Cendejas, M. E., 2009: Spatial and temporal characterization of fish assemblages in a tropical coastal system influenced by freshwater inputs: northwestern Yucatan peninsula. Rev. Biol. Trop. **57**, 89–103.

Bonilla-Gómez, J. L.; López-Rocha, J.; Badillo, M.; Tzeek, J.; Chiappa-Carrara, X., 2011: Growth and mortality of *Lagodon rhomboides* (Pisces: Sparidae) in a tropical coastal lagoon in northwestern Yucatan Mexico. Rev. Mar. Cost. **3**, 99–109.

Froese, R., 2006: Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. J. Appl. Ichthyol. **22**, 241–253.

Gallardo-Torres, A.; Badillo-Alemán, M.; Galindo De Santiago, C.; Loera-Pérez, J.; Rioja-Nieto, R.; Chiappa-Carrara, X., 2012: Listado taxonómico de los peces de la Laguna Boca de la Carbonera, Yucatán: un primer paso para el manejo y evaluación de los recursos costeros del norte de Yucatán. In: Recursos Acuáticos Costeros Del Sureste, Vol. II. A. J. Sánchez, X. Chiappa-Carrara and R. Brito Pérez (Eds). CONCIYTEY - UNAM, Mérida. pp. 270–288.

Gayanilo, F. C. Jr.; Sparre, P.; Pauly, D., 1997: The FAO-ICLARM Stock Assessment Tools (FiSAT). FAO Computerized Information Series (Fisheries). No. 8. FAO, Rome, 168 pp.

McEachran, J. D.; Fechhelm, J., 1998: Fishes of the Gulf of Mexico, Vol.: Myxiniformes to Gasterostiformes. University of Texas Press, Austin, 1112 pp.

Munro, J. L.; Pauly, D., 1983: A simple method for comparing the growth of fishes and invertebrates. ICLARM Fishbyte **1**, 5–6.

Tzeek-Tuz, J.; Bonilla-Gómez, J. L.; Badillo-Alemán, M.; Chiappa-Carrara, X., 2012: Length-weight relationship and parameters of growth for the checkered puffer *Sphoeroides testudineus* from a karstic tropical coastal lagoon: La Carbonera, Yucatan Mexico. J. Appl. Ichthyol. **28**, 859–860.

Vega-Cendejas, M. E.; de Santillana, M. H.; Arceo, D., 2012: Length-weight relationships for selected fish species from a coastal lagoon influenced by freshwater seeps: Yucatan peninsula Mexico. J. Appl. Ichthyol. **28**, 140–14.

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