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SHORT COMMUNICATION

LENGTH–WEIGHT AND LENGTH–LENGTH RELATIONSHIPS OF THE HOGFISH, *LACHNOLAIMUS MAXIMUS*, OFF THE NORTHERN COAST OF THE YUCATAN PENINSULA, MEXICO

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INTRODUCTION

The Hogfish, *Lachnolaimus maximus* (Walbaum, 1792), (Teleostei: Labridae) is a monandric, protogynous hermaphrodite wrasse (McBride and Johnson 2007) inhabiting structured reef habitats of the western North Atlantic Ocean, Gulf of Mexico (GOM), and the Caribbean Sea (Westneat 2002), where it has high economic importance (McBride and Murphy 2003) as a fishery resource. Off the Florida coast, it reaches a maximum size of 84 cm fork length (FL) and a maximum body weight of 10 kg (McBride and Richardson 2007). Due to heavy fishing pressure, there is evidence of an overfished condition for *L. maximus* (McBride and Murphy 2003, Ault et al. 2005) with population declines of 60%. Regionally, due to this condition it is classified as vulnerable by the International Union for Conservation of Nature (Choat et al. 2010); thus, it is important to record as much biological information as possible to understand its population dynamics in the region.

In Mexico, relatively nothing is known regarding the biology and fishery of *L. maximus* despite being intensively harvested by spearfishing in the Yucatan Peninsula (Sánchez—Aké and Medina-Quej 2008), yet there is an urgent need to implement fishery management strategies for this species. Its length—weight relationships (LWRs) have not been previously estimated from the southern GOM, and no record of any LWR from Mexico is available in Fishbase (Froese and Pauly 2014). Length—length relationships (LLRs) and LWRs are useful for conversion purposes when comparisons are made with literature values and consequently to estimate fish biomass (Ault et al. 2005, Aburto-Oropeza et al. 2011). The aim of this study was to describe the LWRs and LLRs of the *L. maximus* taken off the northern coast of the Yucatan Peninsula, Mexico, in the southern GOM.

MATERIALS AND METHODS

Recreational fishermen captured fish under clear water conditions with spear guns in shallow (5—10 m deep) coastal areas <5 km from shore between April and September each year from 2011—2013. Collection sites were off the coast of Chuburná (21°15′68N; 89°54′11W) and Chelem (21°15′93N; 89°47′89W), on the northern coast of the Yucatan Peninsula, Mexico. Fish were measured to fork (FL), standard (SL), total length (TL, cm), and whole wet weight (W, g) was recorded. All LLRs (TL—FL, FL—SL, FL—TL, and SL—TL) were estimated using linear regressions on $\log_{10}$ data. The LWRs were calculated as $\log_{10}W = \log_{10} a + b \log_{10}TL$, where "*a*" is the intercept of the regression curve (coefficient related to body form) and "*b*" is the regression coefficient (exponent indicating isometric growth) (Le Cren 1951, Froese 2006). Based on the slope (*b*) of the LWR, one can estimate whether fish growth is isometric (b = 3, all fish dimensions increase at the same rate), hypoallometric ($b < 3$) or hyperallometric ($b > 3$) (Froese 2006, Froese et al. 2011). Exploring which growth (i.e., isometric or allometric) is exhibited by a given species provides inference on how fish body proportions may vary at a given geographic area or during a specific season.

The *b*—value of each LWR, for each year, was verified by Student's t—test in order to determine if growth matched the isometric type (b=3), following the equation $t = (b—3)/Sb$, where t = Student t—value, b = slope, Sb = slope of standard error. Fish body size was compared between years with a one-way ANOVA (α=0.05) and a Tukey HSD post-hoc test was used to identify differences. Regression slopes of the LWRs were compared between years (year as covariate) using an ANCOVA. Normality was determined with the Kolmogorov-Smirnov test, and homogeneity of variance was verified with the Bartlett´s test. Regression analyses were carried out using Statgraphics Centurion, and performed according to Sokal and Rohlf (2012). Some obvious outliers were detected with the Dixon´s test and removed from the regression analysis as recommended by Froese et al. (2011) using a criteria of line best fitting.

RESULTS AND DISCUSSION

A total sample of 292 fish was collected with specimens ranging from 16.6—36.5 cm FL (26.4 ± 0.23 se) and 94—842 g (392.3 ± 8.0 se) (Table 1). Significant differences were detected in fish size between years (ANOVA: $F_{2, 291}$ = 11.28, p <

TABLE 1. Principal parameters and linear relations (y = a + bx) between fork length and whole wet weight per year, and combined (data pooled), for the Hogfish, Lachnolaimus maximus, from the northern coast of the Yucatan Peninsula, Mexico.

Year	**n**	**Month** March	April	May	June	July	Aug	Sep	**FL (cm), mean ± se (min – max)**	**W (g), mean ± se (min – max)**	**Regression Parameters** ***a*** **(se)**	***b*** **(se)**	**r^2**
2011	56	0	0	7	0	15	31	3	25.6 ± 0.54 (19.5–34.5)	395.6 ± 18.5 (200–660)	–0.77 (0.11)	2.39 (0.08)	0.95
2012	107	38	12	25	17	0	15	0	27.8 ± 0.36 (21.0–35.0)	448.3 ± 14.2 (210–42)	–0.74 (0.08)	2.33 (0.05)	0.95
2013	129	0	0	0	12	37	40	40	25.6 ± 0.33 (16.6–35.5)	344.6 ± 11.3 (94–770)	–1.29 (0.05)	2.70 (0.04)	0.97
Total	292	38	12	32	29	52	86	43	26.4 ± 0.23 (16.6–35.5)	392.3 ± 8.2 (94–842)	–1.15 (0.05)	2.58 (0.03)	0.95

FL = fork length; W = fish wet weight; a = intercept value; b = regression slope; r^2 = coefficient of determination; se = standard error; n = number of fish sampled; min = minimum; max = maximum.

0.05), with larger fish found in 2012. Calculated LWRs were significantly different from zero ($p < 0.05$), with r^2 ranging from 0.95–0.97 (Table 1), which indicates strong model fits over the fish size range examined. Additionally, the LLRs calculated for *L. maximus* in this study had r^2 values ranging from 0.84–0.92 (Table 2). These equations can be useful for conversion purposes to calculate from a given length into another for data comparisons.

For *L. maximus* off the northern coast of the Yucatan Peninsula the exponent *b* in the LWRs (data pooled = 2.58; range = 2.33–2.70) was significantly lower than the isometric value (*b* = 3) each year (2011: n = 56; t_s = –7.896; 2012: n = 107, t_s = –6.428; 2013: n = 129, t_s = –6.783); thus, *L. maximus* exhibited hypoallometric growth. This means that the fish becomes less rotund as the growth increases, and also implies that either large specimens have changed their body shape to become more elongated or small specimens were in better nutritional condition at the time of sampling (Froese 2006). In fact, the LWR calculated for *L. maximus* off the northern Yucatan Peninsula was based on whole wet weight. Consequently, the slope in the regression line is less steep and low compared to that if the LWR was based on gutted weight. No previous growth type was ever calculated for *L. maxiums* from the southern GOM; thus, this represents a first report.

There were significant differences between the yearly slopes of the LWRs (ANCOVA, $F_{5,291}$ = 245.9, $p < 0.05$), which may be a reflection of growth variation, as LWR can fluctuate due to the influence of temperature, salinity, food availability, and reproduction (Froese et al. 2011). This may imply fish growth is experiencing variation according to food availability between years. However, it is possible such variations may be also be due to the influence of reproductive processes on individual growth (i.e., differential growth by sex), since *L. maximus* is hermaphroditic (McBride and Johnson 2007). Spawning is concentrated during winter and spring (December to May), peaking in April (McBride and Johnson 2007) off the Florida coast. The reproductive season is still unknown for *L. maximus* in the southern GOM, and reproductive aspects were not explored in this study.

This work is the first study describing the LWRs and LLRs for *L. maximus* off the northern coast of the Yucatan Peninsula, southern GOM. The size range of *L. maximus* we examined (16.6–35.5 cm FL) was relatively lower than fish studied by Sánchez–Aké and Medina–Quej (2008; 26 –54 cm FL) in Holbox, on the northeastern coast of the Yucatan Peninsula. Such differences may reflect fishery selectivity, variation in fishing seasons, and the influence of reproductive season. In Holbox, fish were speared from August to November but in our study they were speared from April to September. Distance to shore and depth in both locations (i.e., Holbox and our study area) were relatively similar. Additionally, the exponent *b*, calculated for *L. maximus* in the northern coast of the Yucatan Peninsula (*b* = 2.50), was similar to that calculated for specimens taken off Holbox (*b* = 2.52; Sánchez–Aké and Medina–Quej 2008), in the northeastern coast of the Yucatan Peninsula. This implies

TABLE 2. Linear relations (y = a + bx) between lengths (FL, TL, SL; data pooled) for the Hogfish, Lachnolaimus maximus, from the northern coast of the Yucatan Peninsula, Mexico.

Relationship	**n**	**Regression Parameters** ***a*** **(± se)**	***b*** **(± se)**	**r^2**
TL–FL	292	0.02 (0.02)	1.01 (0.17)	0.92
FL–SL	292	0.44 (0.03)	0.73 (0.02)	0.84
FL–TL	292	0.08 (0.02)	0.91 (0.01)	0.92
SL–TL	292	–0.25 (0.03)	1.08 (0.02)	0.90

FL = fork length; TL = total length; SL = standard length; a = intercept value; b = regression slope; r^2 = coefficient of determination; se = standard error; n = number of fish sampled.

that the environmental conditions (i.e., temperature, salinity) and food availability may be similar in both locations. Such differences may reflect growth rate variation as consequence of the prevailing environmental conditions in which *L. maximus* could be exposed to at geographic level. However, any differences in *b* would also depend on the weight used to estimate the LWR; in this particular case, whole wet weight of *L. maximus* was used in both locations.

Since *L. maximus* is recognized by the IUCN as vulnerable (Choat et al. 2010), it is imperative to record information not only on its biology but also on fishery landings in order to estimate possible effects of overfishing. Unfortunately, the fishery status for *L. maximus* off the northern coast of the Yucatan Peninsula is unknown. However, data presented herein on length—weight relations of *L. maximus* in this region may be the first step in understanding regional biological aspects. Our study will be useful in providing some baseline data for fish stock assessments and population dynamics on this species in the region.

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Literature Cited

Aburto-Oropeza, O., B. Erisman, G.R. Galland, I. Mascareñas-Osorio, E. Sala, and E. Ezcurra. 2011. Large recovery of fish biomass in a no-take marine reserve. PLoS One: 6(8): e23601. DOI: 10.1371/journal.pone.0023601.

Ault, J. S., S.G. Smith, and J.A Bohnsack. 2005. Evaluation of average length as an estimator of exploitation status for the Florida coral—reef fish community. ICES Journal of Marine Science 62:417–423. DOI: 10.1016/j.icesjms.2004.12.001.

Choat, J.H., D. Pollard, and Y.J. Sadovy. 2010. *Lachnolaimus maximus*. The IUCN Red List of Threatened Species. Version 2015.2. www.iucnredlist.org. Downloaded on 26 June 2015.

Froese, R. 2006. Cube law, condition factor and weight—length relationships: history, meta—analysis and recommendations. Journal of Applied Ichthyology 22:241–253. DOI: 10.1111/j.1439—0426.2006.00805.x.

Froese, R. and D. Pauly (Eds.). 2014: FishBase. www.fishbase.org. Viewed on 10/06/2015

Froese, R., A.C. Tsikliras, and K.I. Stergiou. 2011. Editorial note on weight—length relations of fishes. Acta Ichthyologica et Piscatoria 41:261–263. DOI: http://dx.doi.org/10.3750/AIP2011.41.4.01.

Le Cren, E.D. 1951. The length—weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). Journal of Animal Ecology 20:201–219. DOI: 10.2307/1540.

McBride, R.S. and M.D. Murphy. 2003. Current and potential yield per recruit of hogfish, *Lachnolaimus maximus*, in Florida. Proceedings Gulf Caribbean Fisheries Institute 54:513–525.

McBride, R.S. and M.R. Johnson. 2007. Sexual development and reproductive seasonality of hogfish (Labridae: *Lachnolaimus maximus*), an hermaphroditic reef fish. Journal of Fish Biology 71:1270–1292. DOI: 10.1111/j.1095—8649.2007.01580.x

McBride, R.S. and A.K. Richardson. 2007. Evidence of size selective fishing mortality from an age and growth study of hogfish (Labridae: *Lachnolaimus maximus*), a hermaphroditic reef fish. Bulletin of Marine Science 80:401–417.

Sánchez-Aké, E.O. and A. Medina-Quej. 2008. Análisis de la pesquería de Boquinete, *Lachnolaimus maximus*, en la Isla de Holbox, Quintana Roo, México. Proceedings Gulf and Caribbean Fisheries Institute 60:287—296.

Sokal, R. R. and F.J. Rohlf. 2012. Biometry: the principles and practice of statistics in biological research. 4th edition. W. H. Freeman and Co., New York, NY, USA, 937 p.

Westneat, M. W. 2002. Labridae. In: Carpenter, K.E., ed.The Living Marine Resources of the Western Central Atlantic. Vol. 3: Bony Fishes, Part 2 (Opistognathidae to Molidae), Sea Turtles and Marine Mammals. FAO Species Identification Guide for Fishery Purposes and American Society of Ichthyologists and Herpetologists Special Pub. No. 5, Food Agriculture Organization, Rome, Italy, p. 1701–1722.