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Full Length Research Paper

Length-weight relationship of largescale mullet, *Liza macrolepis* (Smith, 1846), off the southwestern coast of Taiwan

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***Liza macrolepis* inhabits marine, estuarine, and fresh water throughout most tropical and temperate regions of the world. *L. macrolepis* were collected using samples caught by set net in the southwestern of Taiwan in this study. Length-weight and length-length, fork (FL), standard (SL), and total (TL) lengths relationships are derived, respectively. The relationships between lengths are all significantly linear ($p < 0.001$), the *b* value in the length-weight relationship for this value is significantly lower than 3 in the winter ($p < 0.001$), when the temporal changes are taken into account, indicating that only the sampling time affected the growth pattern of *L. macrolepis*. Growth is isometric in the spring, summer fall and, but it is negative and allometric in the winter.**

Key words: *Liza macrolepis*, Length-Weight relationship (LWR), growth.

INTRODUCTION

Length-weight relationships (LWR) have number of important applications in fish stock assessment (Binohlan and Pauly, 1998; Garcia et al., 1989; Haimovici and Velasco, 2000; Koutrakis and Tsikliras, 2003; Valle et al., 2003; Ecoutin et al., 2005; Fafioye and Oluajo, 2005; Chu et al., 2011) Dulčić and Kraljević, 1996; Froese, 1998; Le Cren, 1951; Mazlan et al, 2008; Petrakis and Stergiou, 1995; Shafi and Quddus, 1974 and seasonal variations in fish growth can be tracked in this way (Ritcher et al., 2000). In addition, the length-weight relationship indicates the degrees of stabilization of taxonomic characters in fish species and very useful in the management and exploitation of fish populations (Pervin and Mortuza, 2008), and useful for comparing life history and morphological aspects of populations inhabiting different regions (Gonçalves et al., 1997, Stergiou and Moutopoulos 2001).

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Liza macrolepis is inhabited marine, estuarine, and fresh water through-out most tropical and temperate regions of the world. Also, it is an important food source for black-face spoon-bill, therefore, the survey of the fishery resources in southwest of Taiwan is crucial.

The early studies on *Liza macrolepis* were mainly on reproduction biology and life history (Kendall and Gray, 2008). However, the estimation of the length-weight relationship was common in these studies; they presented no evidence about the length-length relationship. Therefore, the purpose of this study was to build the life history parameters of *Liza macrolepis*, and specifically the length-weight relationship. The length-length relationship and length-weight relationship are also analyzed by seasons. These results derived from this study can be used as input data for further stock assessment of the *Liza macrolepis* off the coast of southwestern coast of Taiwan.

MATERIALS AND METHODS

The specimens of *Liza macrolepis* were collected on a monthly

Table 1. Length-length relationships of *Liza macrolepis* caught by set-net in the southwestern of Taiwan.

Length	N	b	a	SE	r^2	Confidence limit (95%)
TL-FL	400	-1.39535	1.08846	0.00544	0.99	1.07776~ 1.09915
TL-SL	399	4.62614	1.1717	0.00922	0.96	1.15358~ 1.18983
FL-SL	399	6.66924	1.0672	0.00961	0.97	1.04831~ 1.08609

N = Number; TL = Total length; FL = Fork length; SL = Standard length; n = Number; a, b = Regression coefficients; SE = Standard error; r^2 = Correlation coefficient; Confidence Limits (95%) = range of b.

Table 2. Length-weight relationship parameters of *Liza macrolepis* according to the sex and the seasons.

Factor	N	a	B ± SE	SE of b	r^2	Confidence limits (95%)	t value (difference of b from 3)
Females	230	1.9891E-05	2.94	0.0213	0.99	2.90~2.98	-2.73
Males	172	2.0676E-05	2.93	0.0221	0.99	2.89~2.98	-3.02
Spring	111	1.94E-05	2.95	0.0326	0.99	2.88~3.01	-1.59
Summer	32	1.91E-05	2.94	0.0539	0.99	2.83~3.05	-1.18
Fall	41	1.54E-05	3.00	0.0354	0.99	2.93~3.07	0.04
Winter	218	2.14E-05	2.93	0.0171	0.99	2.89~2.96	-4.29*
Overfall	402	2.0109E-05	2.94	0.0143	0.99	2.91~2.97	-4.24*

basis from February 2006 to March 2007. These fish were caught by fyke nets in the southwestern coast of Taiwan. Set in lakes and streams for the catching of fish. Having swum into the net the fish are unable to escape past the fyke (non-return) entrance. A bag-shaped, cylindrical or cone-shaped fish trap, mounted on rings, with funnels which direct the fish into successive compartments. The net is fixed in place by stakes or anchors. Fish are deflected towards the mouth of the bag by leader nets set obliquely on either side of the mouth. Among these catches, about 30 specimens were selected randomly to measure fork length (FL) to nearest 0.1mm and bodyweight (BW) to nearest 0.1 g. The length-weight relationship is described by the following exponential regression equation: $W = aL^b$, where W is the body weight (kg), L is the fork length (cm), the parameters a and b are calculated by least-squares regression for males and females seasonally (spring, summer, fall and winter). Weight-length relationships' curves are compared with all four seasons, and the variation in b values from 3 are tested by the t-test for evaluating growth curve. When the b value in length-weight relationship is equal to or did not show statistically significant deviation from 3, the growth is isometric, whereas the positive or negative allometric growth occurred when the b value deviated significantly from 3 (Ricker, 1975; Erkoyuncu, 1995).

RESULTS

The results of the relationships among total, fork and standard lengths were determined by using the length measures of 400, 399, 399 *Liza macrolepis* specimens, respectively (Table 1). From our investigation, all relationships were significantly linear ($p < 0.001$, $r^2 > 0.96$). The length-weight relationship determined for different seasons, and b values varied between 2.93 and 3.00. These values calculated for spring, summer, fall and winter as 2.95, 2.94, 3.00, and 2.93 respectively. The variations in b values from 3 were not statistically significant and indicated an isometric growth for both sexes, and the overall population when the Seasons effects were not taken into account (Table 2 and Figures 1 to 5. The variations in b values from 3 were not statistically significant in the spring, summer, fall or, but were in the winter ($p < 0.001$), implying that while the growth of *Liza macrolepis* was negatively allometric during the winter; it was isometric during the rest of the year. The results for combine values of both sexes also indicated the positive allometric growth (BW = 0.0054, TL = 3.053, and r^2 = 0.964).

DISCUSSION

Liza macrolepis are an economically important species in Gulf; there are few studies on the basic biology of this species (Elsamra et al., 1986; Kendall and Gray, 2008). In this study, was estimated the length-weight (according to sampling time) and length-length (overall) relationships of *Liza macrolepis* in the southwestern coast of Taiwan. The length-length relationships were found to be significantly linear in this study. Moutopoulos and Stergiou (2002) determined significantly linear relationships among TL, FL and SL in some fish species in the Aegean Sea. These significantly linear relationships among the length parameters showed that certain fish species exhibited characteristic morphological features (Murat et al., 2004). The b value was used in the length-weight relationship as the indicator of the growth type of *Liza macrolepis*, to find out whether there deviation from isometric growth had occurred the sampling times. When the seasonal variations were considered, the b value reached its maximum

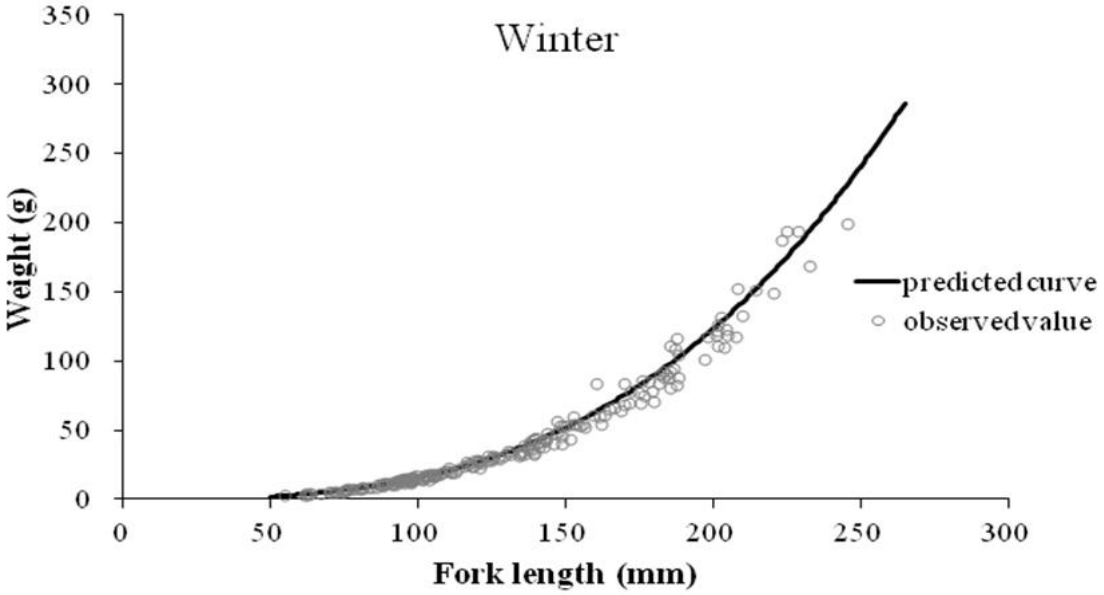

Figure 1. Length-weight relationships for *Liza macrolepis* in the winter.

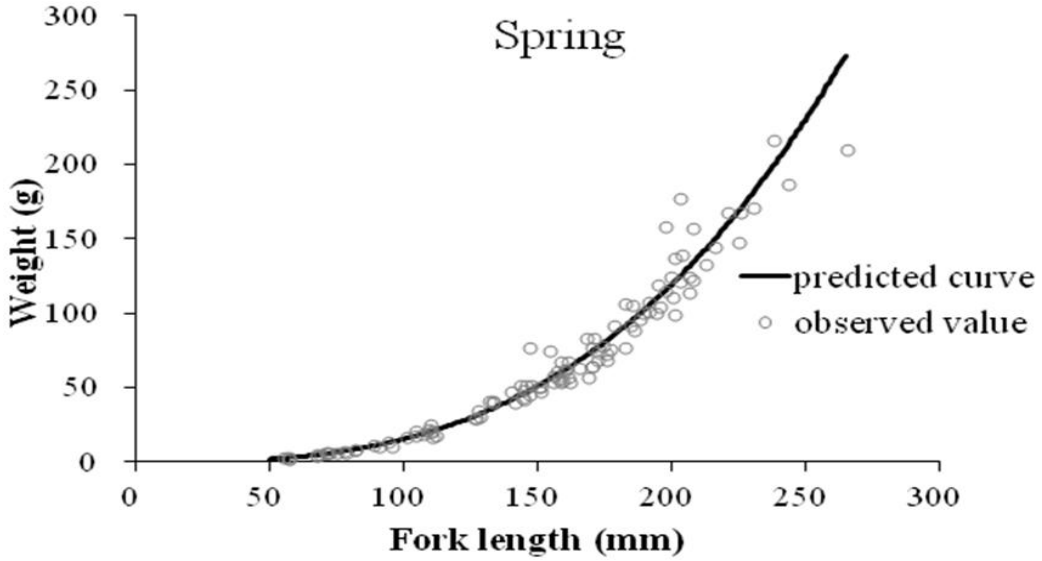

Figure 2. Length-weight relationships for *Liza macrolepis* in the spring.

value of 3.00 (r^2 = 0.99, N = 41) during the fall and its minimum value of 2.93 (r^2 = 0.99, N = 218) during winter. In this study, the *b* value recorded in the winter was significantly lower than 3 ($p < 0.001$) indicated a negative allometric growth during this season. However, the *b* value recorded in the overall was significantly lower than 3 ($p < 0.001$) indicated a negative allometric growth during this study period. The *b* value in the length-weight relationship of fish can be used as an indicator of food intake and growth pattern, and may differ according to such biotic and abiotic factors as water temperature, food availability and habitat type (Wootton, 1992; Avsar, 1998). However, this study refer to these fish feed insufficiently and show low *b* values during the fall. However, adequate feeding and gonad development increases fish weight and *b* values (Nikolsky, 1963; Arslan, 2003). The fishes continue to grow in their life. Rapid growth indicates abundant food supply and other favorable conditions, whereas slow growth is likely to indicate non-availability of food (Veeramani et al., 2010). The result of this study, during the winter, when biological resources were insufficient and certain abiotic factors as water temperature were inadequate, *Liza macrolep is* living off the southwestern coast of Taiwan could not feed sufficiently

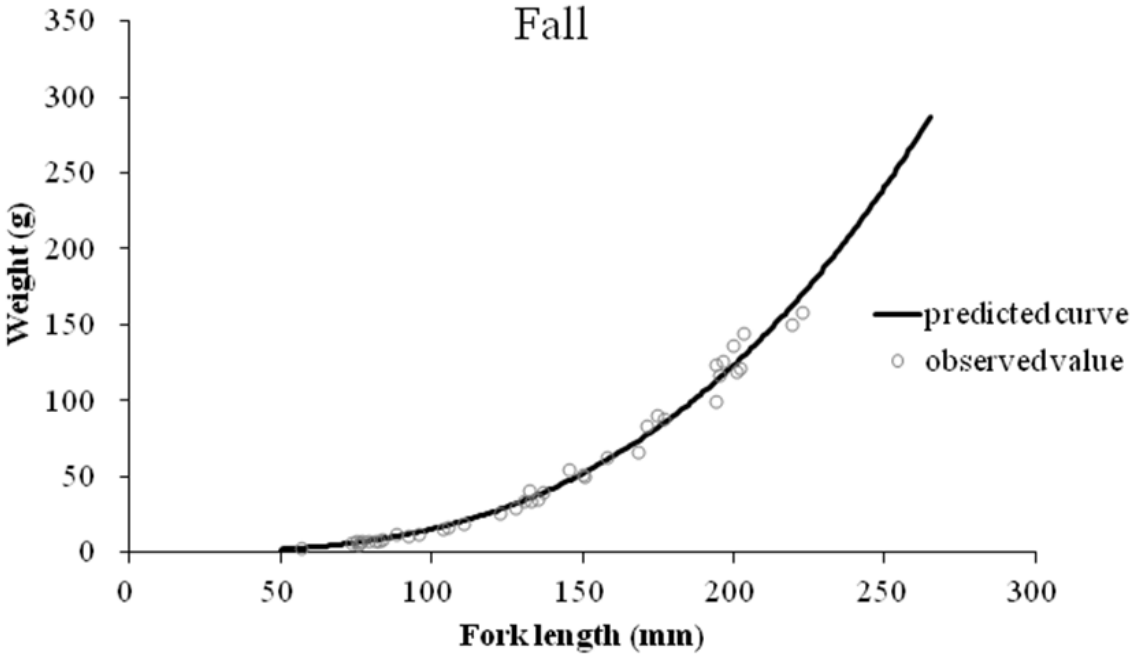

Figure 3. Length-weight relationships for *Liza macrolepis* in the fall.

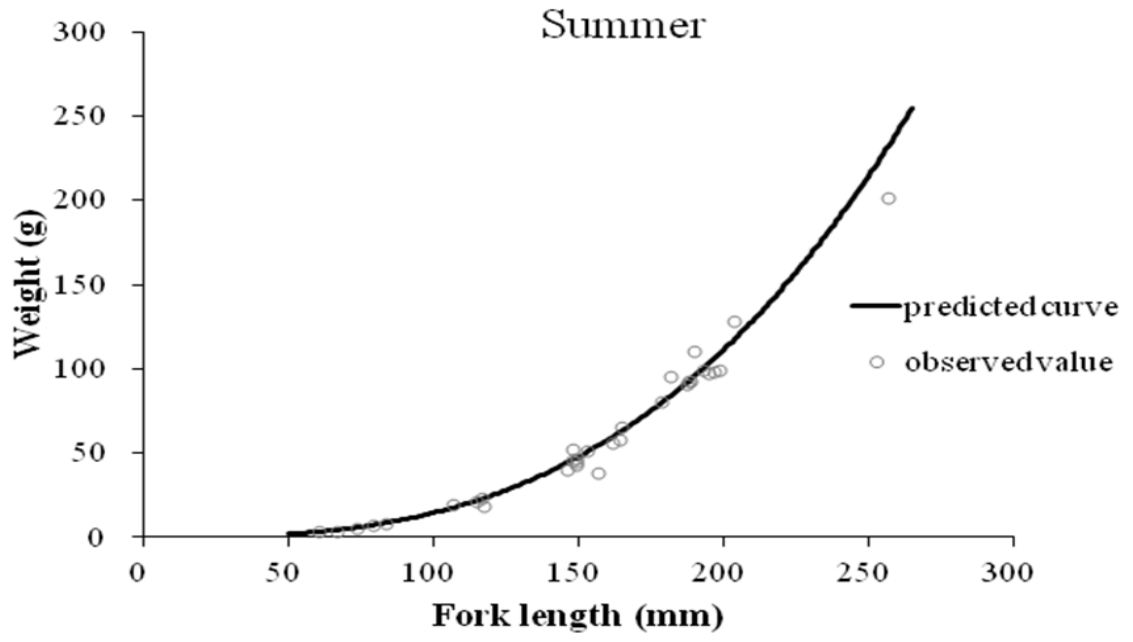

Figure 4. Length-weight relationships for *Liza macrolepis* in the summer.

and demonstrated a negative allometric growth. In contrast, environmental conditions did not change the normal isometric growth of this species during the rest of the year, both females and males showed the same growth type. García-Berthou and Moreno-Amich (1993) cited that the use of the multivariate analysis of covariance (MANCOVA) could be applied most appropriate the use of this measurement. This method have the advantages of eliminates the effect of the individual size, the increment in the variability when comparing variables by means of a ratioand the anomalous characteristics of estimating mean true values of the ratio.

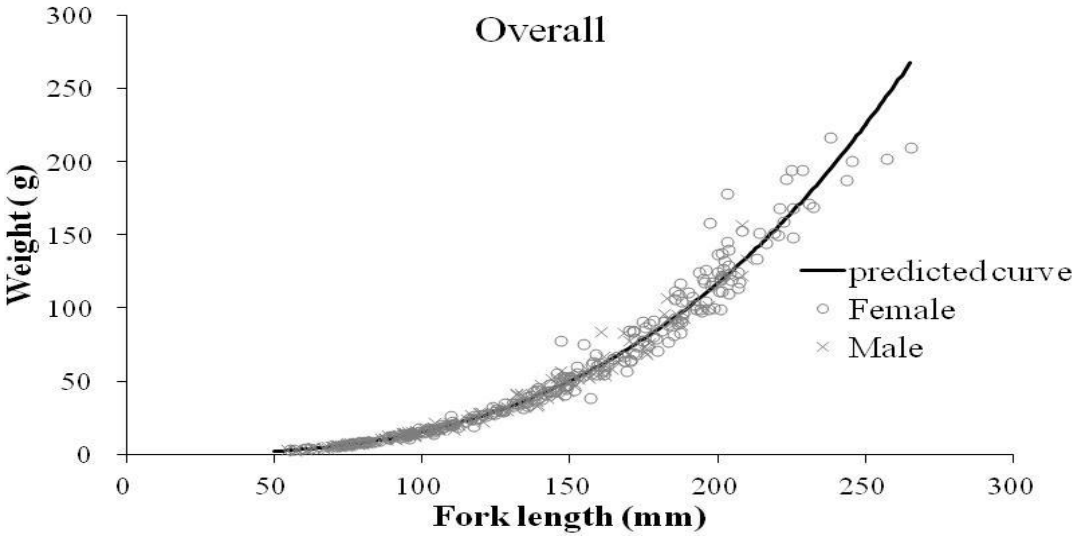

Figure 5. Length-weight relationships for *Liza macrolepis* in the overall.

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