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Advances in Applied Science Research, 2013, 4(4):123-128

ISSN: 0976-8610
CODEN (USA): AASRFC

Length-weight relationship and growth of the green –rough-back pufferfish *Lagocephalus lunaris* (Bloch and Schneider, 1801), off Visakhapatnam, east coast of India

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ABSTRACT

The length – weight relationship for males and females of Lagocephalus lunaris (Bloch and Schneider, 1801) collected at Visakhapatnam were W = 0.000115 $L^{2.6210}$ and W = 0.00047 $L^{2.8993}$ respectively. A single length-weight relationship is given for both the sexes as W = 0.000066 $L^{2.7381}$. Analysis of covariance conducted to test the difference between the regression slopes of males and females of L. lunaris showed no significant difference (P > 0.05). The age and growth were estimated by applying ELEFAN 1 method, it confirmed the longevity of the fish to be 61 months. The growth rate was high during the first year and then it declines during subsequent years. The Von Bertalanffy's growth parameters were Lα = 239.60, K = 2.2, to = -0.146 and Ø = 5.1012/yr.

Key words: *Lagocephalus lunaris*, length - weight relationship, age and growth

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INTRODUCTION

L. lunaris commonly known as green-rough-back pufferfish is a slow moving solitary fish of shallow coastal waters, found in tropical and temperate waters. They are caught mainly by trawl nets and purse seines. Approximately 120 species of these fishes are known all over the world, of which only 80 species of these fishes of the Order Tetrodontiformes are known to produce a virulent neurotoxic substance called 'tetrodotoxin' that can yield valuable and potential biomedical compounds [7, 11]. Even though these fishes are toxic, they are eaten in countries like Japan after some special processing. If cleaned and dressed properly, the fish is edible and considered a delicacy [13]. Of the seven species occurring at Visakhapatnam fishing harbour (Latitude 17º 41´N, Longitude 83º 17´ E), *L. spadiceus* and *L. lunaris* are common and abundant in the catches. The present study is a first attempt to give an account of length-weight relationship and age and growth studies of *L. lunaris* from Visakhapatnam, east coast of India.

MATERIALS AND METHODS

The present study was based on the length and weight data of 514 specimens (236 males in size range of 105-225 mm TL and weight 22-184 g; 278 females in size range of 110-230 mm TL and weight 31-300 g) collected from commercial trawl catches at Visakhapatnam fishing harbour thrice in a month during January 2008 to December 2009. The samples were not available during May due to fishing holidays from 15th April to 31st May which were implemented for conservational purpose.

The random samples of pufferfishes collected in fresh condition from trawl catches at Visakhapatnam fishing harbour. The collected fish samples were immediately brought to the laboratory for further analysis. After removing the excess moisture by blotting paper, the total length (nearest 1 mm) and weight (nearest 1g) of each specimen were measured. The three samples in a month were pooled and treated as a single sample of the month. The length – weight relationship (LWR) was calculated employing hypothetical formula $W = aL^b$ [2] where W is body weight (g), L is total length (mm),'a' is a coefficient related to body form and 'b' is an exponent indicating isometric growth when equal to 3 [12]. The equation can be expressed in the logarithmic form as Log W = Log a + b Log L. For testing the difference between the regression slopes of males and females, analysis of covariance was employed [10].

Age and growth was estimated by applying ELEFAN – 1 (Electronic Length Frequency Analysis) method, FiSAT - II software package, version 1.2.2 to get the estimates of asymptotic length (Lα) and growth coefficient (K) [5]. By using these values 't_o' was calculated by Pauly's equation [4]. The Von Bertalanffy's growth model was used to fit growth curve to the length frequency data [14]. The equation was expressed as:

$L_t = L\alpha\ (1\text{-}e^{-k(t-o)})$

Where
L_t = Length at age t
Lα = Asymptotic size
K = Growth coefficient
t = Age of the individual fish at '0' size

The growth performance index (Ø) was estimated according to Pauly and Munro [6] as:

$Ø = \text{Log } K + 2 \text{ Log } L\alpha$

Where
k = Growth constant/yr
Lα = Asymptotic length

RESULTS

Length-weight relationship (LWR):
The regression equations for the length-weight relationships of males and females were calculated as:

Males: $W = 0.000115\ L^{2.6210}$ (r = 0.82)

Females: $W = 0.00047\ L^{2.8993}$ (r = 0.93)

The length – weight data of males and females can be pooled to obtain a common regression equation for both sexes as $W = 0.000066\ L^{2.7381}$ (r = 0.88). The comparison of regression lines in Table 1 showed no significant difference ($p > 0.05$) between the slopes of two sexes at 5% level and showed negative allometric growth for individual sexes. The scattered diagram of observed weight against length revealed a curvilinear relationship between the two variables in Figures 1 and 2.

Age and growth studies:
The best fit estimates of asymptotic length (Lα) and growth constant (K) were estimated by ELEFAN – 1. Lα was 239.60 mm and K was $2.2yr^{-1}$ with highest R_n value 0.155 in Figure 3. Calculated growth performance index (Ø) was 5.1012 and 't_o' was -0.146. The length of the fish at specific time in *L. lunaris* was expressed as:

$Lt = 239.60(1\text{-}e^{-2.2(t-0.146)})$

On the basis of this formula, growth curves were drawn in Figure 4 according to Von Bertalanffy's growth equation. The length obtained in mm at ages of 3, 6, 9 and 12 months were 49.00, 129.63, 176.16 and 203.00 respectively.

Table 1: Comparison of regression lines of length-weight relationship in males and females of *L. lunaris*

	DF	x^2	y^2	Xy	Regression Coefficients Intercept (Log a)	Slope (b)	Deviation from Regression DF	S.S	MSS
Within Females	278	0.328169	12.54304	3.996854	- 3.32759	2.89932	277	9.7844709	-
Males	236	0.352247	3.455402	3.602308	- 3.94074	2.6210	235	1.0355916	-
							512	10.820063	0.0702601
Pooled	514	0.680416	15.998442	7.599162	- 4.1802	2.7381	513	10.897233	0.0703047
			Difference between slopes				1	0.07717	0.07717
	Slopes	F = 1.0983474		D.F. 1, 512	Not Significant at 5% level (3.84)		p > 0.05		

Table 2: Von Bertalanffy's growth data of *L. lunaris*

$L\infty$ = 239.60 mm; K = 2.2; t_o = -0.146 years

t (years)	t-t0	K(t-t0)	e-k(t-to)	1- e-k(t-to)	lt = L∞ (1- e-k(t-to))
0.17	0.021	0.0455	0.9556	0.0444	10.638
0.33	0.187	0.4121	0.6622	0.3378	80.937
0.5	0.354	0.7788	0.4589	0.5411	129.65
0.66	0.514	1.1308	0.3227	0.6773	162.28
0.83	0.684	1.5048	0.2221	0.7779	186.38
1	0.854	1.8788	0.1527	0.8473	203.01
1.16	1.014	2.2308	0.1074	0.8926	213.87
1.33	1.184	2.6048	0.0739	0.9261	221.89
1.5	1.354	2.9788	0.0508	0.9492	227.43
1.66	1.514	3.3308	0.0357	0.9643	231.05
1.83	1.684	3.7048	0.0246	0.9754	233.71
2	1.854	4.0788	0.0169	0.9831	235.55
2.16	2.014	4.4308	0.0119	0.9881	236.75
2.33	2.184	4.8048	0.00819	0.9918	237.64
2.5	2.354	5.1788	0.00563	0.9944	238.25
2.66	2.514	5.5308	0.00396	0.996	238.65
2.83	2.684	5.9048	0.0027	0.9973	238.95
3	2.854	6.2788	0.00187	0.9981	239.15
3.16	3.014	6.6308	0.0013	0.9987	239.29
3.33	3.184	7.0048	0.000907	0.9991	239.38
3.5	3.354	7.3788	0.00062	0.9994	239.45
3.66	3.514	7.7308	0.00043	0.9996	239.5
3.83	3.684	8.1048	0.0003	0.9997	239.53
4	3.854	8.4788	0.0002	0.9998	239.55
4.16	4.014	8.8308	0.00014	0.9999	239.57
4.33	4.184	9.2048	0.0001	0.9999	239.58
4.5	4.354	9.5788	0.000069	0.9999	239.58
4.66	4.514	9.9308	0.000048	1	239.59
4.83	4.684	10.305	0.000033	1	239.59
5	4.854	10.679	0.000023	1	239.59
5.16	5.014	11.031	0.000016	1	239.6

Basing on the ELEFAN -1 method, *L. lunaris* attained a total length of 203.00 mm during first year, 235.55 mm during second year and 239.95 mm during third year. The longevity of *L. lunaris* was 61 months as shown in Figure 4 and Table 2.

Figure 1: Scattered diagram showing relationship between length and weight in males of *L. lunaris*

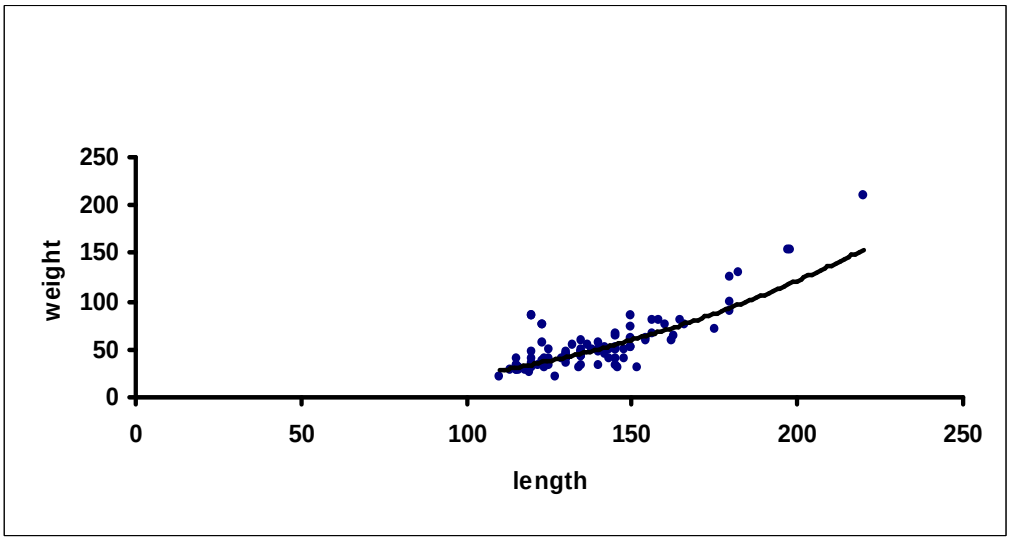


Figure 2: Scattered diagram showing relationship between length and weight in females of *L. lunaris*

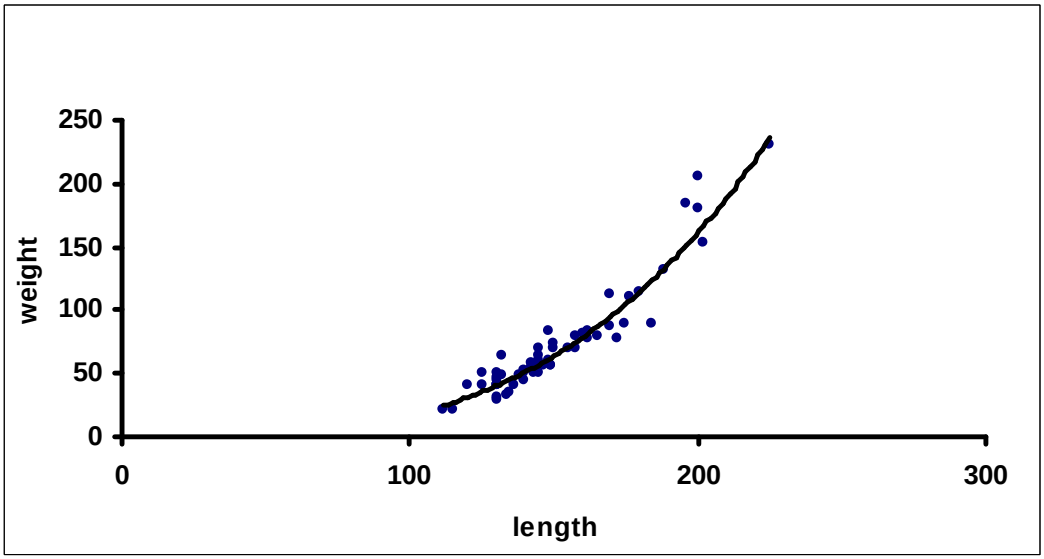
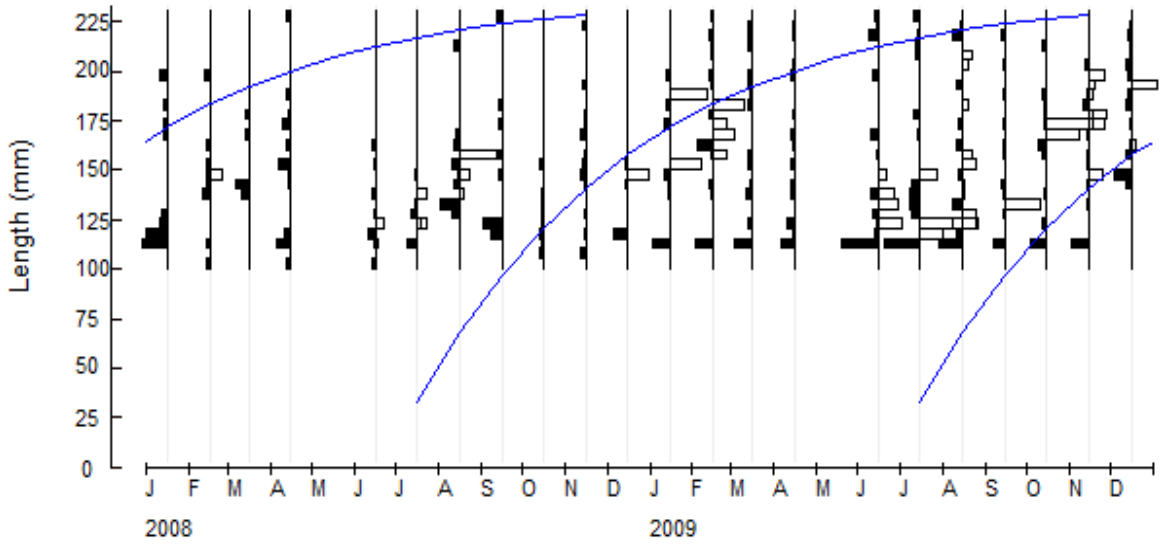
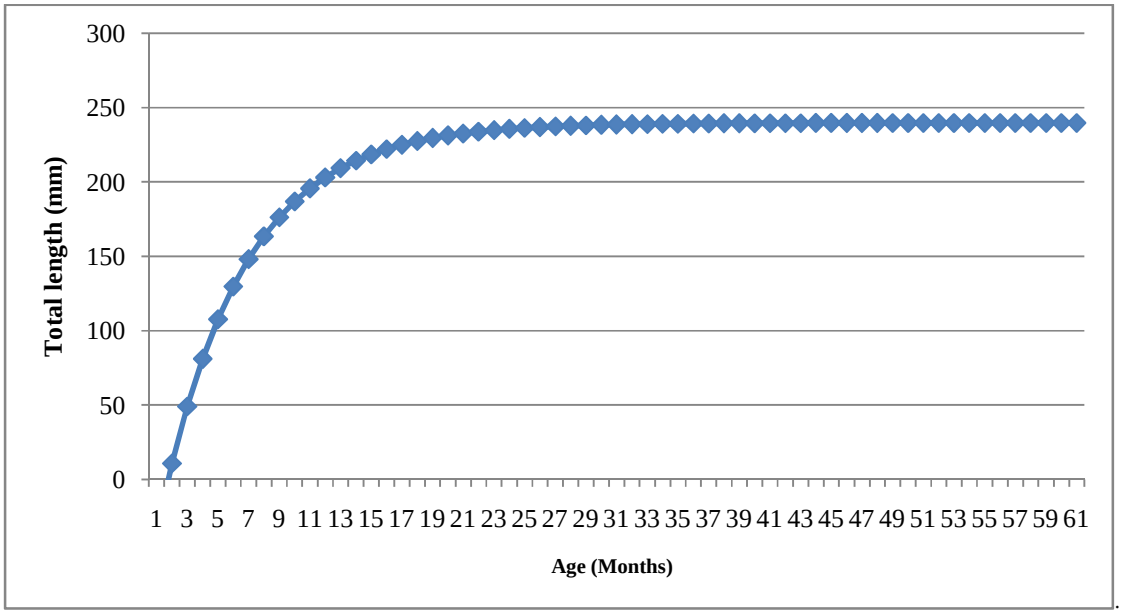


Figure 3: **Estimation of L∞ and K of *L. lunaris* using ELEFAN I method**



L∞ (Asymptotic length)	[239.60]
K (Growth constant)	[2.2]
SS (Starting sample)	[22.00]
SL (Starting length)	[230.50]
Computed Rn	[0.155]

Figure 4: Von Bertalanffy's growth curve of *L. lunaris*



DISCUSSION

A separate equation for length - weight relationship is given as $W = 0.000115\ L^{2.6210}$ for males, $W = 0.00047\ L^{2.8993}$ for females and $W = 0.000066\ L^{2.7381}$ for combined sexes in the present study. Spiegel [12] stated that growth to be isometric if the regression constant b = 3.0, positive allometric if b > 3.0 and negative allometric if b < 3.0. In the present study on *L. lunaris*, negative allometric growth was observed in both the sexes. Analysis of covariance

showed that 'F' was not significant at 5% level. It can be suggested that the difference between slopes of males and females was not significant ($p > 0.05$).

Sabrah *et al.* [9] also studied the length-weight relationship on similar species of *L. sceleratus* to be $y = 0.0160099\ X^{2.904471}$ ($r^2 = 0.9883$) for males, $y = 0.0209024\ X^{2.84187}$ ($r^2 = 0.9803$) for females and $y = 0.0187120\ X^{2.86761}$ ($r^2 = 0.9835$) for combined sexes. Analysis of covariance showed that there was no significant difference ($p>0.05$) in the co-efficient of regression between males and females. Naik and Jalihal [3] also gave two separate expressions of length-weight relationships for males and females of *L. spadiceus*, on the west coast of India. Comparision of regression lines showed significant difference between the slopes of the two sexes. Rukmini Sirisha and Yedukondala Rao [8] also studied the length-weight relationship for males and females of similar species *L. spadiceus* on east coast of India to be Log W = -4.00617 + 2.6774 log L (r = 0.90) for males, Log W = -4.2843 + 2.7822 log L (r = 0.93) for females and Log W = -4.2859 + 2.7763 log L (r = 0.92) for combined sexes. The comparison of regression lines showed significant difference between the slopes of two sexes and showed negative allometric growth. Kurma Rao and Ramesh Babu [1] also studied the length-weight relationship of *Mugil cephalus* to be log w = -3.65+2.66 log L for males and log w = -3.80+2.74 log L for females. The comparison of regression lines showed no significant difference between males and females.

Age and growth was estimated using ELEFAN-1 which showed that the rate of growth was high during initial months and then it declines with advancement of age indicating that the fish after attaining a particular size showed low growth rates. The Von Bertalanffy's growth parameters calculated were $L\alpha = 239.60$, $K = 2.2$, $t_o = -0.146$ and $Ø = 5.1012$/yr in the present study. Sabrah *et al.* [9] estimated the age and growth of *L. sceleratus* using ELEFAN -1 programme and Wetherall's method. Model progression analysis indicated 10 distinct age groups in *L. sceleratus*. The parameters of Von Bertalanffy's growth model were $L\alpha = 81.1$mm, $k = 0.26$/yr, $Ø = 3.23$. There was no significant difference ($p>0.05$) at 95% level of mean lengths at age for the different growth models. He also reported that the rate of growth is rapid during first four years of life and then it slows down in *L. sceleratus*.

Acknowledgements
The authors are thankful to the Head, Dept. of Marine Living Resources, Andhra University, Visakhapatnam for providing laboratory facilities during the course of the work.

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