

Short Communication

Allometry coefficient variations of length-weight relationship of Scombridae family caught along the Tuticorin coast, Bay of Bengal

Yosuva Mariasingarayan¹, Jeyapragash Danaraj^{1,2}, Manigandan Vajravelu¹, Machendiranathan Mayakrishnan¹, & Saravanakumar Ayyappan^{*1}

¹Centre of Advanced Study in Marine Biology, Faculty of Marine Sciences, Annamalai University, Parangipettai, Tamil Nadu-608 502, India

²Karpagam Academy of Higher Education (Deemed to be University), Coimbatore, Tamil Nadu-641 021, India

*[E-mail: asarvaan@gmail.com]

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The present study assesses length-weight relationship (LWR) of *Auxis thazard*, *Auxis rochei*, *Euthynnus affinis*, and *Katsuwonus pelamis* caught by gill net along the Tuticorin coastal area. The fitted regression model resulted (log-transformed) in slope values extending from 2.9 to 3.8. The logarithmic data exhibiting the exponent value $b > 3$ and $b < 3$, confirms that the tuna species showed both negative and positive allometric growth. Particularly, *K. pelamis* ($b < 3$) indicated the negative allometric growth. The regression slope value for all the species was found to be highly significant ($P < 0.05$). All the species showed positive allometric growth, except *K. pelamis*, which exhibited negative allometric growth. Findings in the present study conclude that LWR does not follow the cubic relationship. Furthermore, studies should be carried out for more fish species to enlighten biologists about the status and growth condition of the fishes in the natural waters.

[Keywords: Allometric, Isometric, Neritic, Oceanic, Scombridae, Tuna]

Introduction

The family Scombridae consists of mackerels and tuna with 15 genera and 49 species that frame the reason for most imperative fisheries business in the world¹. Tuna are industrially vital pelagic species for the most part caught in tropical and sub-tropical regions. Along the Tamil Nadu coast, neritic (*Auxis thazard*, *Auxis rochei*, *Euthynnus affinis*, *Sarda orientalis*) and oceanic fish (*Thunnus albacares*, *Thunnus obesus*, *Katsuwonus pelamis*) are generally obtained². Length-weight relationship (LWR) of fishes constitutes a successful apparatus in fishery science and is required for setting up yield condition.

Studies on the length-weight relationship (LWR) are of considerable importance that yields authentic biological information with two objectives. At first, it establishes the mathematical relationship between two variables, i.e. length and weight to calculate the unknown variable from the known variable and second, it turns to reflect its fitness, general well-being, gonad development and suitability of the environments for fish survival. Of the length and weight measurement, length is simpler to quantify and can be changed into weight in which the catch is perpetually communicated. Weight of the fish would differ as the cube of length³⁻⁵, yet they may withdraw altogether from their real relationship⁶. Fishes normally do not retain the same shape or body outline throughout their life span and the specific gravity of tissues may remain constant.

Nevertheless, most researchers have described the establishment of relationship between the length and weight of individuals as essential for the calculation of production, biomass of fish population⁷ and morphological comparisons among the species and among populations from the same or different habitats. Various reports definite with respect to LWR showed encouraging conduct of these species at various shorelines of Tamil Nadu⁸⁻¹². However, the recent information on the LWR of fish species, these studies get to date back, after which there has been a change in the pattern of fish species as they do not retain their original shape and size throughout their life span and most of the studies attempted along the various coast of India, with a lack of studies along Tamil Nadu coast. Hence, the present study records the LWR of *Auxis thazard*, *Auxis rochei*, *Euthynnus affinis*, and *Katsuwonus pelamis* caught along Tuticorin coast.

Materials and methods

Specimens of *A. thazard*, *A. rochei*, *E. affinis*, and *K. pelamis* were caught from Tuticorin coastal water (08°53.320' N, 078°10.390' E) in 2016. Measurements on length and weight were made in Tharuvaikulam landing centre at Tuticorin (Fig. 1). The total length (from the tip of snout to tip of the lower caudal lobe) of each fish was measured with a measuring tape and the body weight was measured by an electronic balance (at an accuracy of 0.5 g). Prior

to the weight measurement, the excess water on the fishes was removed with blotting paper.

The LWR of fishes can be described by the exponential function:

$$W = aL^b$$

Where, W = Weight, L = Length, a = is a constant and b = is an exponent.

Since linear transformation is necessary to deal with length-weight data in terms of regression the log of length is plotted against the log of weight thus making the relationship linear. Rewriting the above in terms of this transformation an equation in the linear form

$$Y = a+bx \text{ is obtained,}$$

$$W = aL^b$$

$$\text{Log } W = \text{Log } (aL^b)$$

$$\text{Log } W = \text{Log } a + b \text{ Log } L$$

Where, ‘Log a’ represents the point at which the regression line intercepts the Log W axis and ‘b’ represents the slope of the line.

Results

The LWR regression parameters and significance of correlation for *A. thazard*, *A. rochei*, *E. affinis*, and *K. pelamis* were calculated and summarized (Table 1). The values of constant ‘a’ and exponent ‘b’ were determined from the logarithmic data to verify the “cube law” for the species studied. The ‘b’ value of all the species were calculated using linear fit method and lies between 2.94 and 3.38. The logarithmic data

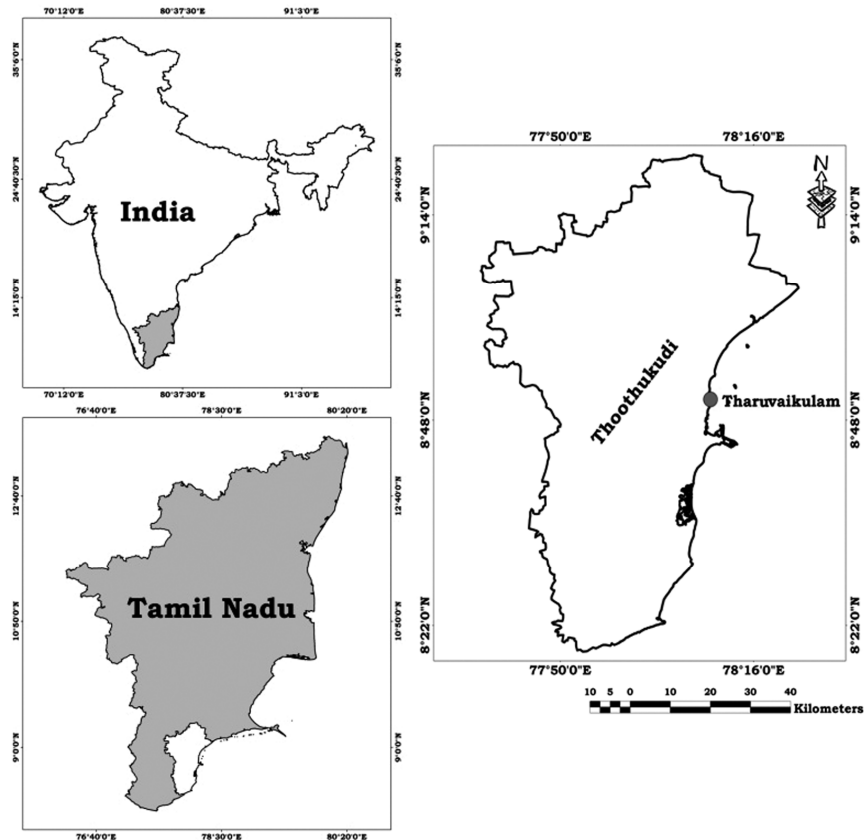


Fig. 1 — Map showing the study area

Table 1 — Number of samples (n), standard length, total weight and parameters of length-weight relationship of Tuna species

Family/ Species	Sample size (n)	Length (cm)		Weight (g)		Length-weight relationship			
		Min	Max	Min	Max	a	b	r ²	Growth Pattern
<i>A. thazard</i>	371	20	49	80	2000	-2.41	3.3840	0.87	Positive Allometric
<i>A. rochei</i>	247	18	37	70	770	-2.52	3.34	0.89	Positive Allometric
<i>E. affinis</i>	356	19.5	62.5	90	4090	-2.28	3.2928	0.956	Positive Allometric
<i>K. pelamis</i>	226	29	64	650	3900	-1.77	2.94	0.91	Negative Allometric

exhibiting the exponent value $b > 3$ and $b < 3$, confirms that tuna species showed negative and positive allometric growth. Since 'b' value is greater and less than 3 all the species in the present study showed positive allometric growth, except *K. pelamis* ($b < 3$) which indicated negative allometric growth (Figs. 2 a-d). The slope values for all the species were found to be highly significant ($P < 0.05$). The dotted lines between the linear fit are 95 % confidence limits for the slope parameter. From the regression line, a strong positive relationship between the length and weight of tuna species has been interpreted. The correlation coefficient ' r^2 ' was found to be high in *E. affinis* (0.956) and *K. pelamis* (0.91), whereas least r^2 value was exhibited by *A. thazard* (0.87). The logarithmic length and weight of tuna species

differ significantly in accordance to regression coefficients or slopes among the species. The logarithmic equation for the LWR of fish species obtained from the sample regression statistics was tabulated (Table 2). Owing to the changes in the morphology of the species studied, the regression lines from the weight on the length depart significantly from b value 3.

Table 2 — Length-weight relationship (LWR) and logarithmic length-weight relationship of tuna fishes

Species	LWR	log LWR
<i>A. thazard</i>	$W = 0.0039L^{3.3767}$	$\log W = -2.4068 + 3.3767 \log L$
<i>A. rochei</i>	$W = 0.0031L^{3.4439}$	$\log W = -2.5292 + 3.4439 \log L$
<i>E. affinis</i>	$W = 0.0052L^{3.2969}$	$\log W = -2.2849 + 3.2969 \log L$
<i>K. pelamis</i>	$W = 0.0167L^{2.9481}$	$\log W = -1.7772 + 2.9481 \log L$

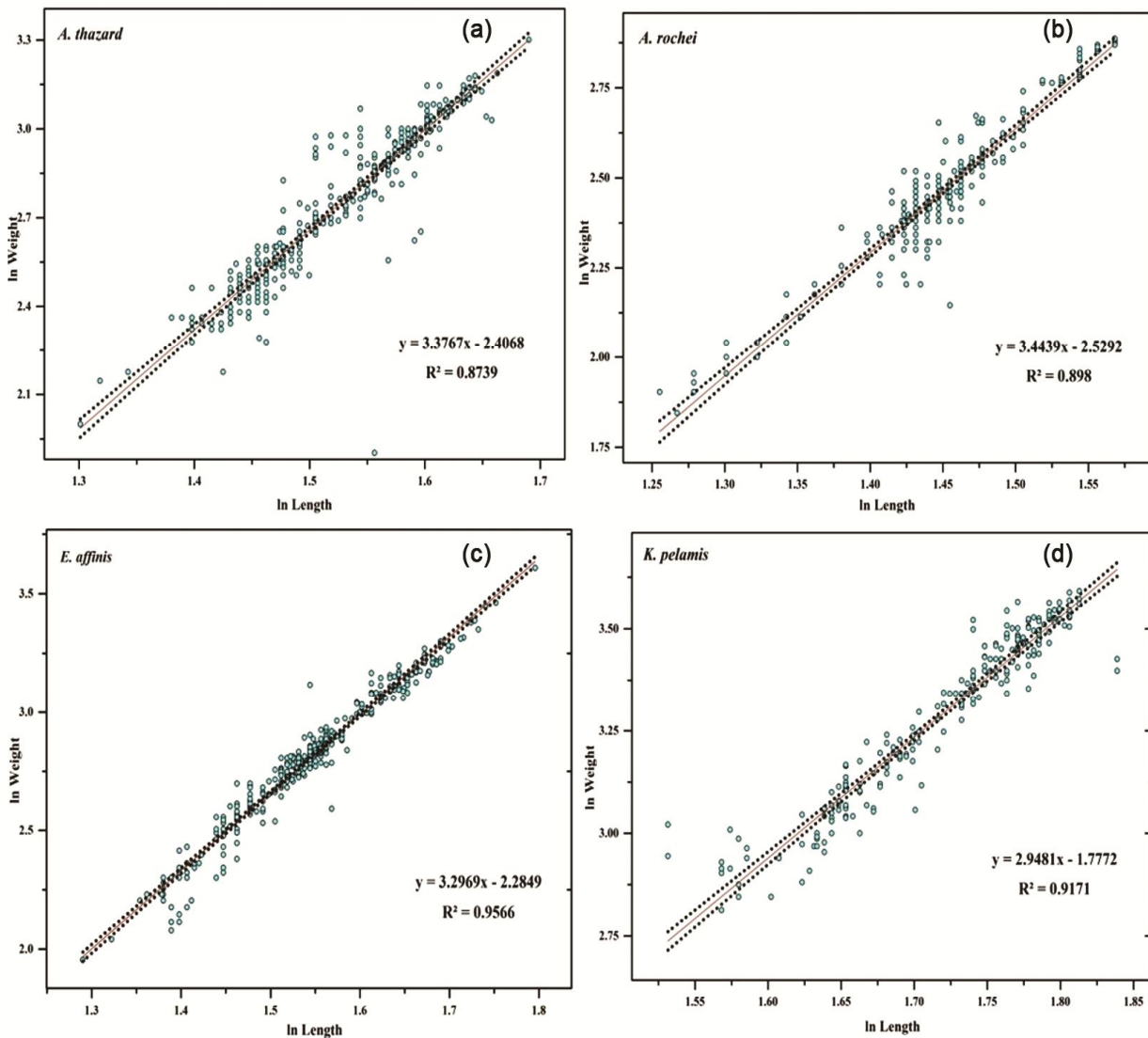


Fig. 2 — Logarithmic linear regression of weight on length of tuna species along Tuticorin coast

Discussion

In general, reports on LWR in different species of tuna along Indian coast are limited. The present study portrayed with the relevance of basic cubic relationship from the LWR of four fish species caught along the Tuticorin coast. The LWR of fish species are significant for the cultivars, fishery managers to ascertain the growth of fishes. The LWR of fish species were observed to be highly significant ($P < 0.05$) with a correlation coefficient (r^2) of 0.956, 0.91 in *E. affinis* and *K. Pelamis*, respectively; whereas other species *A. thazard* (0.873), *A. rochei* (0.898) showed least r^2 values. The regression values were found to be quite lower in the earlier studies of Al-Zibdah and Odat¹⁰ for *E. affinis* (0.899) and *K. pelamis* (0.812) from Gulf of Aquaba. Noegroho *et al.*¹³ detailed the LWR of *A. thazard*, *E. affinis* and *A. rochei* shown with r^2 estimation of 0.955, 0.961 and 0.78, which coincided with the present study.

The outcomes acquired from the present study portray that the coefficient of correlation for LWR was observed to be high in *E. affinis*, and *K. pelamis*. The increase in length of fish is proportional to the increase in weight and vice-versa. These findings were upheld by the prior reports from different fishes of different water bodies¹⁴. The allometric model seems most appropriate for describing the LWR of fishes and can be applied to the vast majority of relationship and morphological characteristics with body length^{15,16}.

The exponential value of LWR (b) for all the species differs in response to the environmental parameters, for example, temperature, food supply, spawning condition and biological factors such as dissolved oxygen content in water, sex and age of fish¹⁷. Exponent values 'b' for different fishes have been reported and ranged between 2.5 to 4.0^{18,19} and 2.0 to 4.0^{20,21}. The present findings document the 'b' value of 2.94 for *K. pelamis*, which indicates negative allometric growth, whereas other species such as *A. thazard* (3.38), *A. rochei* (3.34) and *E. affinis* (3.29) indicated positive allometric growth. The weight of the fish is considered as a function of length and the fish is said to be isometric, when the exponent 'b' value would be equal to 3 ($b = 3$). It would have happened when the fish species holds same body shape and its particular gravity throughout their lifetime²². The variability of growth pattern can also depend on the season and the environmental condition in the fished area²³.

In the present study, exponent 'b' value was found to be $b > 3$ for species *viz.* *A. thazard*, *A. rochei*, *E. affinis*, and $b < 3$ for *K. pelamis*. All species showed allometric growth pattern which indicates that the fish became lighter and heavier for particular length as it increased in size. Noegroho *et al.*¹³, reported the exponent 'b' value for *A. thazard* (2.805), *E. affinis* (3.012) and *A. rochei* (3.089), where *E. affinis* and *A. rochei* showed the positive allometric growth and *A. thazard* showed negative allometric growth. The obtained 'b' value of 3.171 for *A. thazard* in Veraval²⁴ and for *A. rochei* collected from Mediterranean²⁵ showed 'b' value of 3.292 (Allometric), whereas *E. affinis* collected from the Ligurian sea showed the b value of 3.674²⁶, 2.9 for *K. pelamis*¹⁰. The present study coincided with previous works and does not take the cube law. It is applicable just for those species, which keep up the shape and particular gravity for the duration of their life²⁷, but the shape and the type of fish, may change with time. Consequently, the LWR of these fishes may vary from the cube law.

The present study concludes that LWR of all the species showed allometric growth pattern with an exponent 'b' value more or less than 3 ($b > 3$ or $b < 3$) which are not followed in the cubic relationship. Therefore, LWR studies should be carried out more to enlighten the fishery biologists about the status and growth condition of the fishes in the natural waters and for successful fishery management.

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