Length weight relationship and condition factor of Lethrinus nebulosus (Forsskål, 1775) and Lethrinus microdon (Valenciennes, 1830) along Thoothukudi coast, Gulf of Mannar

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Original Article

Abstract

Estimation of length-weight relationship and condition factor of two commercially important Lethrinus species, *Lethrinus nebulosus* and *Lethrinus microdon* along Thoothukudi coast was studied from January 2019 to December 2019. A total of 736 samples of the two species were subjected to morphometric investigation for evaluating their total length and total body weight and analyzed season wise. The results indicate an isometric growth pattern with growth exponent, b values of 2.90 and 2.84 for *L. nebulosus* and *L. microdon* respectively. There was a strong positive correlation (r = 0.99-1.0) between the length and weight of fish samples examined while the coefficient of determination (R^2) varied between 0.97-1.0 during all four seasons. The relative condition factor (Kn) was 1.0 for both species while Fulton's condition factor (Kc) was observed to be 1.52 and 2.08 for *L. nebulosus* and *L. microdon* respectively.

Keywords:*Condition factor, correlation, isometric, length-weight, season*

Introduction

Emperor fishes or Pigface breams (Family:Lethrinidae) are indigenous to the tropical and subtropical Indo-Pacific region, encompassing the Indian Ocean and Western Pacific that form a vital component of commercial, recreational and artisanal fisheries of the world (Carpenter and Allen, 1989). They are tropical reef-associated fishes that inhabit nearshore and offshore coral reefs, coralline lagoons, seagrass beds, mangroves, preferably with sandy or rubble substrate and found at depths up to 100 m. They are demersal feeders consuming a wide range of prey including polychaetes, molluscs, echinoderms, crustaceans and small fishes and are targeted by commercial fishers typically by means of hook & line, traps, gill nets and trawls (Carpenter and Allen, 1989). The southeast coast of India contributes the major share of landings of pigface breams in India that includes commercially important and dominant species of *Lethrinus nebulosus* (spangled emperor) and *Lethrinus microdon* (small tooth emperor). These lethrinids contribute year around fishery along this coast and possess high demand in local and national market which may result in increased fishing pressure leading to their over exploitation.

Determination of length-weight relationships (LWR) of commercially important fish is significant in assessing the relative well-being of the fish population exposed to similar or different conditions of food, density, climate or environmental factors (Anwa and pepple, 2011). LWRs could also be used in fish stock assessment and comparing ontogeny of fish population from different regions (Falaye *et al.*, 2015) thereby helps in management, conservation and culture of the concerned species. The relationship between the somatic weight (W) and length (L) of fish is expressed using the equation $W = aL^b$ for nearly all species of fish (Schneider *et al.*, 2000). Length and weight data of any fish species provide baseline information including growth pattern, health, habitat conditions, life history, fish fatness and condition, as well as morphological characteristics that is eventually utilized in the fishery research, stock assessment and resource management (Le Cren, 1951; Schneider *et al.*, 2000; Froese, 2006) meta-analysis, and recommendations for users about weight-length relationships, condition factors and relative weight equations. Historical review traces the developments of the respective concepts. The meta-analysis explores 3929 weight-length relationships of the type $W = aL^b$ for nearly all species of fish (Schneider *et al.*, 2000). These factors may differ among fish species depending the body shape and physiological factors such as maturity and spawning that may change over seasons or even days (De Giosa *et al.*, 2014). Hence, Le Cren (1951) reported that relationship between length and weight of fish may depart from the ideal value of 3.0, as a result of environmental conditions or condition of the fish themselves. Therefore, the *b*-value for every fish species could be significantly greater ($b>3$) or less ($b<3$) than the ideal value, indicating allometric growth pattern (Jisr *et al.*, 2018).

An additional important biometric tool is the condition factor derived using the LWR to quantify whether a population is healthy in relation to other fish population (Stevenson and Woods, 2006). The condition factor of any fish reflects the physical and biological circumstances that fluctuate by interactions among feeding condition, parasitic infections and physical factors (Le Cren, 1951). Analyzing different fish body lengths can give valuable information regarding maturation and spawning in the life- span of the fish, although further examination of different months can give definite indication concerning the breeding season.

The statistical relationship between these two parameters has great significance with regard to their morphology, biology, nutrition, condition and growth rate that proves to be a valuable tool in differentiating small taxonomic units, within populations of different species (Kuriakose, 2017). Hence the present article deals with Length-weight and condition factor analysis of samples taken from commercial catch of lethrinids along Thoothukudi coast so as to provide an effective tool for fisheries management and sustainable utilization of the resource.

Material and methods

Sample collection

Thoothukudi (8.80629° N and 78.14317° E) a port town in Tamil Nadu was selected as the study site; having an average annual production of approximately 95 to 110t of Lethrinids or Pigface breams. The fishery is supported by nine species but dominated with *Lethrinus nebulosus* and *Lethrinus microdon* captured by traditional hook and line roughly 6 to 11 nautical miles from the shoreline. Fortnightly samples were collected for a period of 12 months from January to December 2019 and studied as four seasons namely post-monsoon (January-March), summer (April-June), Pre-monsoon (July-September) and monsoon (October-December). A total of 736 specimens

Table 1. Morphometrics and Length-weight relationship parameters of *L. nebulosus* and *L. microdon,* from January to December 2019.

Species	Seasons	N	TL (cm)		TW(g)		a	S.E ($\times 10^{-4}$)		'b'	S.E	r	R^2	t-Test	Growth
			Min	Max	Min	Max									
L.nebulosus	Post monsoon	93	8.7	45.6	10.8	1386.1	0.0158	4.09	2.94	0.0172	1.0	1.0	9.53	I	
	Summer	90	8.6	52.8	10.5	2129.9	0.0156	4.21	2.93	0.0012	0.99	1.0	9.38	I	
	Pre monsoon	90	8.7	52.1	10.8	2048.2	0.0157	5.27	2.82	0.1027	0.99	0.98	9.28	I	
	Monsoon	90	8.5	48.2	10.1	1630.7	0.0159	4.41	2.93	0.0003	1.0	1.0	9.38	I	
L.microdon	Post monsoon	95	9.3	48.6	19.1	2159.4	0.0214	9.62	2.86	0.0087	0.99	0.99	9.64	I	
	Summer	94	8.7	55.0	15.8	3076.0	0.0211	10.65	2.84	0.0372	0.98	0.97	9.44	I	
	Pre monsoon	94	6.8	52.3	7.8	2663.5	0.0211	10.43	2.86	0.0125	0.99	1.0	9.59	I	
	Monsoon	90	9.2	43.2	18.0	1542	0.0216	9.55	2.87	0.0102	0.99	0.99	9.37	I	

(*N = number of samples, TL = total length, TW = total weight, a = intercept of the regression, b = slope of the regression (growth exponent), I = isometric growth, r = correlation coefficient, R^2 = coefficient of determination, t-value = absolute value of t-test parameter to compare calculated slope to 3 at level of significance $p < 0.05$.)

were analyzed during the study period. The total length of fish was measured to the nearest 1mm and weighed to the nearest 0.1g for both the species.

Length-weight relationship

The statistical relationship between length and weight was calculated using the parabolic equation given by Froese (2006): $W = aL^b$, Where, W = weight of fish (g), L = length of fish (cm), a = constant and b = a regression coefficient expressing relationship between length-weight (Le Cren, 1951). The values of 'a' and 'b' were determined from the transformed logarithm values of length and weight using the equation $\text{Log } W = \text{Log } a + b \text{ Log } L$ with the aid of Microsoft Excel. Correlation coefficient (r) and coefficient of determination (R^2) were computed using Student's t-test to determine the seasonal growth pattern of *L. nebulosus* and *L. microdon*. Student's t-test was applied to verify the type of growth: isometric ($b = 3.0$), positive allometric ($b > 3.0$) or negative allometric ($b < 3.0$) (Sokal and Rohlf, 1987). In all cases a statistic significance of 5% was adopted. As seasonal variations tend to have effect over '*b*'(Lalrinsanga *et al.*, 2012), fishes were grouped under different class intervals and evaluated season wise (Post-monsoon, summer, pre-monsoon and monsoon).

Condition factor 'K'

Seasonal changes in condition factor are useful in determining the biological alterations in the fish. Following equations were used to assess the condition of the fish species under study:

(a) Fulton's condition factor (Kc) by Fulton (1904): $Kc = W \times 100/ L^3$ and

(b) Relative condition factor (Kn) by (Le Cren, 1951): $Kn = W/W`$

Where, W= Observed body weight (g), L= Observed length of fish (cm), W` = Calculated weight estimated from the length-weight relationship. Good growth condition of the fish is deduced when K = 1, while if K < 1 means the organism is said to be in average or poor growth condition.

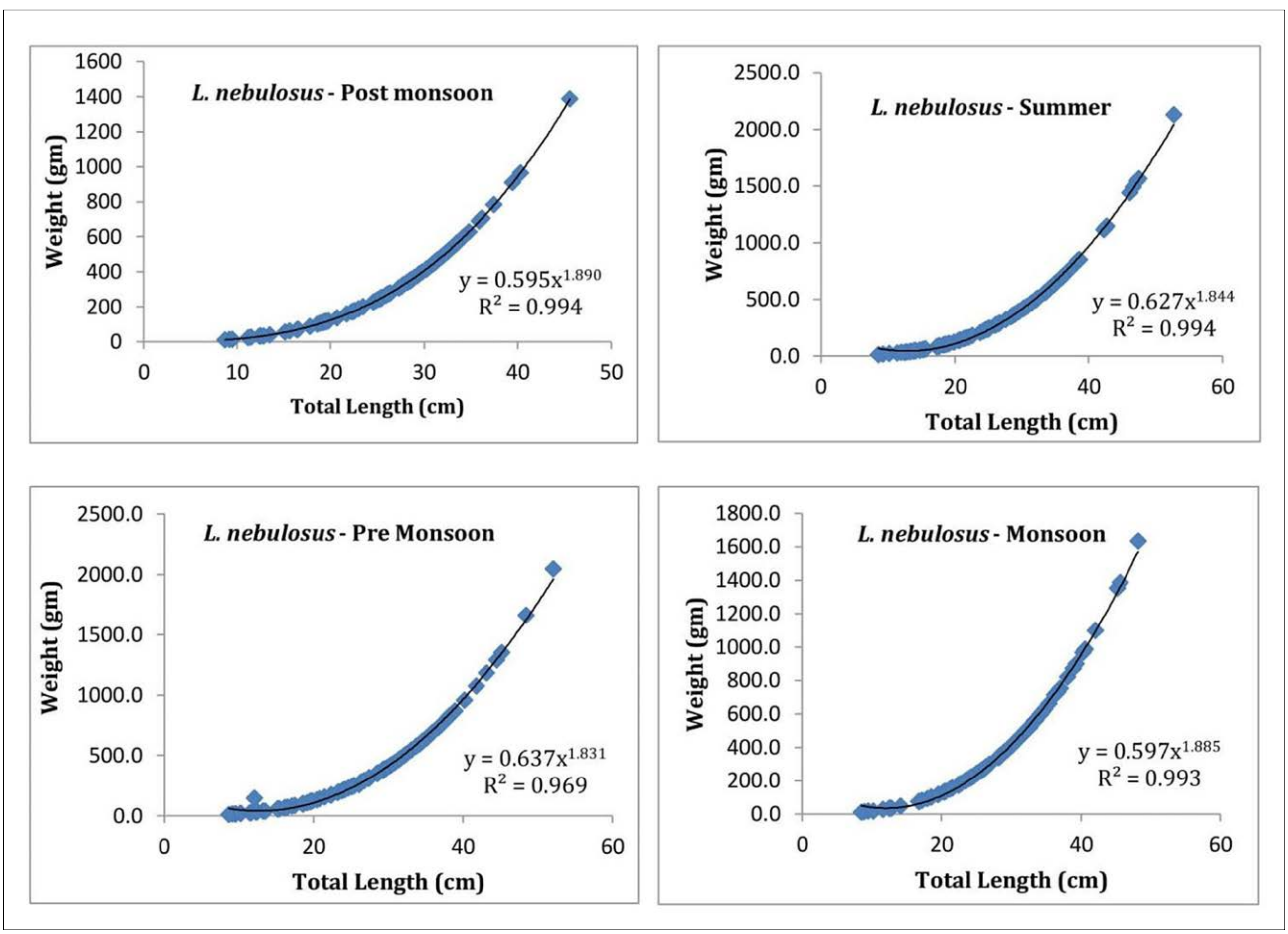

Fig. 1. Length-weight relationship showing exponential growth pattern and Linear regression graph of *L. nebulosus.*

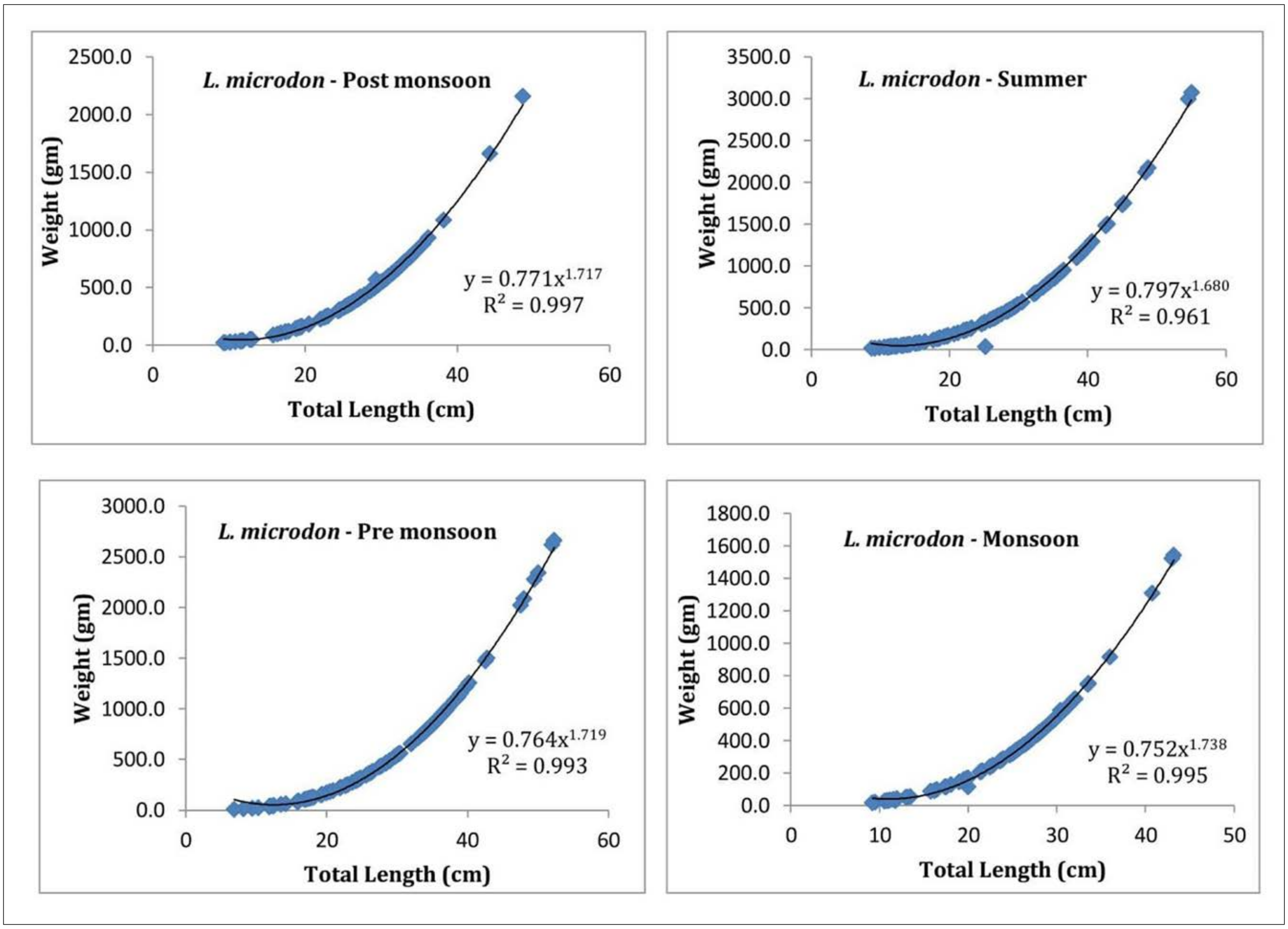

Fig. 2. Length -weight relationship showing exponential growth pattern and Linear regression graph of *L. microdon.*

Results and discussion

Length-weight relationship

Estimating length-weight parameter is an essential factor since the values obtained facilitate determining the performance of fish species in the particular habitat. LWR of any fish could be affected by a number of factors including season, habitat, gonad maturity, sex, diet, stomach fullness, health and differences in the length ranges of the specimens caught (Katsanevakis and Thessalou-legaki, 2007). Table 1 and 2 represents length-weight parameters of *Lethrinus nebulosus* (n=363) and *Lethrinus microdon* (n=373) recorded in all four seasons. The highest average total length was estimated at 27.01±0.90 cm and 27.76±1.10 cm and total weight of 383.89±33.97 g and 607.09±61.14 g for *L.nebulosus* and *L. microdon* respectively. The larger specimens were recorded highest during the pre-monsoon and monsoon seasons clearly indicating their aggregations for spawning. Juveniles were recorded throughout all four seasons that ranged between 6.8 to 10.8 cm in length and were recorded highest during the monsoon and post-monsoon seasons. The regression slope or growth coefficient, b for both species ranged from a minimum value of 2.82 and 2.84 to a maximum value of 2.94 and 2.87 for *L. nebulosus* and *L. microdon* respectively. The observed 'b' value suggest that length-weight relationship follow cube law, and since the value of b is closer to 3, it shows isometric growth pattern of the species in its natural

Table 2. Table showing condition factors Kn (relative condition factor) and Kc (Fulton's condition factor) of *L. nebulosus* and *L. microdon,* from January to December 2019.

Species	Seasons	Kn	Kc
L.nebulosus	Post Monsoon	1.0	1.49
	Summer	1.0	1.51
	Pre Monsoon	0.99	1.58
	Monsoon	1.0	1.52
L.microdon	Post Monsoon	1.0	2.08
	Summer	1.01	2.08
	Pre Monsoon	1.0	2.07
	Monsoon	1.0	2.08

habitat. The maximum b value of 2.94 was observed in post-monsoon for *L.nebulosus*.

According to Le Cren (1951) when b is equal to 3 or close to 3, growth in the fish is said to be isometric, i.e. fish becomes more robust as they increase in length, but when 'b' is far less or greater than 3, growth in the fish is allometric, i.e. the fish becomes thinner with increasing length. As suggested by Abowei (2009) in the present study also the growth pattern for *L.nebulosus* and *L.microdon* were found to be isometric indicating that the fish increases in length and weight proportionately or at the same rate and this value correlates with Mohammed *et al.* (2016) and Vasantharajan *et al.* (2013). The higher b value observed post monsoon implies standardized growth pattern after the spawning period while decreased value of regression coefficient during pre-monsoon typically reflects change in body form when the weight of the fish is altered by environmental conditions, especially temperature, food supply, life stages, sex, fishing area, and sample size variations (Ricker, 1973).

The length-weight analysis also revealed mean coefficient determination (R^2) values of 0.987 and 0.986 for *L.nebulosus* and *L.microdon* respectively which indicates increase in total length with proportionate increase in body weight (Hossain *et al.*, 2009). This agrees with earlier studies involving fish species from different aquatic habitats (Laleye, 2006).The scatter plots of the total length and body weight relationships of both species are shown in Figs. 1 and 2, clearly reflecting the exponential growth in weight with increasing length and all the linear regressions are statistically significant ($p<0.001$).

Fish growth rate is not constant and may change either continuously or abruptly during its lifetime (Katsanevakis and Thessalou-legaki, 2007) due to genetics, ontogenetic shifts in diet and differences in seasons. Under natural conditions, most fishes tend to change their body shape as they grow or increase in size and become heavier in one season and lighter in another. Therefore, estimation of growth is imperative not only to obtain a better knowledge of the growth process in fishes, but also to establish an accurate standpoint to calculate maximum sustainable yield or yield-per-recruit useful in fishery management.

Condition factor (Kn and Kc)

In fisheries science, condition factor is a valuable index for monitoring feeding intensity, age and growth rates in fish (Famoofo and Abdul, 2020). As reported by Abobi & Ekau, (2013), condition factor defines the state of wellbeing of fish and reflects through variations over physiology of fish. Two types of condition factors namely Fulton's condition (Kc) and relative condition factor (Kn) were measured during the study. For *L.nebulosus* the value of Kc ranged from 1.49 to 1.58; whereas for *L.microdon* it was between 2.07 to 2.08 (Fig. 3) showing better growth conditions. The minimum value of 'K' could be attributed to reproductive cycles, feeding rhythms or stress related factors such as inadequate food and competition for resources especially during the post monsoon and summer seasons. Moreover the mean values indicate healthy nature of fish population as the values are greater than 1. According to Maurya *et al.* (2018) if the K value is ≥ 0.5, the fish is said to be adequately fed; correspondingly in the present study Kc >1 was obtained for both species (Abowei, 2009; Eyo *et al.*, 2015; Mohammed *et al.*, 2016; Ogunola & Onada, 2017) throughout the four seasons. The relative condition factor Kn ranged between 0.99 and 1.0 similar to the observation made by Jisr *et al.* (2018) signifying the status of wellbeing of these fish species. The results clearly indicate the suitability of the ecological conditions in the Tuticorin waters of southeast coast of India for the growth of Lethrinus species especially *L. nebulosus* and *L. microdon*. A similar observation was made by Zaahkouk *et al.* (2017) for *L. lentjan* in the Egyptian Red Sea.

Furthermore, slight variations in K values may be due to fluctuations in different length groups of fishes sampled during different seasons. Moreover K>1 is as a result of year round spawning (all seasons) from January to December; or could be attributed to accumulation of fat as a result of availability or abundance of food resources in their natural environment (Yilmaz and Polat, 2011) including their ability to develop a self-regulating mechanism to adapt harsh environmental conditions.

The current research provides adequate information on the seasonal variation in length-weight relationship and condition factor for the commercially important Lethrinus species from Tuticorin coastal waters. There was highly significant correlation ($p < 0.05$) for the LWR of both species which followed cubic law thus exhibiting isometric growth pattern. Higher the values of condition factor better the state of wellbeing, which was clearly observed in the present study. Hence, these results suggest a stable environmental condition with balanced prey and predator density (Blackwell *et al.*, 2000) including Fulton's condition factor K being more favorable to *L. microdon* and *L. nebulosus* in this coast. The Kn and Kc values also indicate the healthy nature of both fish population. The data presented constitute a valuable guideline for establishing future biometric studies for fishes collected along south-east coast, providing data for stock assessment and population estimation for sustainable management and conservation of reef fishery.

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