Studies on Length-weight relationship of two Cichlid fish species, Oreochromis mossambicus (Peters, 1852) and Etroplus suratensis (Bloch, 1790) from the downstream region of Meenachil River, Kerala, India.

Reema Rose Mani[1*], Simimol Sebastian[2], Athira A S[3]

[1]*Research Scholar, Department of Zoology, Alphonsa College, Pala, Kottayam District, Kerala, India.
Email id:reemarosemani@gmail.com
[2]Assistant Professor, Department o f Zoology, Alphonsa College, Pala, Kottayam District, Kerala, India.
Email id:simirosejoice@gmail.com
[3]Research Scholar, Department of Zoology, Alphonsa College, Pala, Kottayam District, Kerala, India

Abstract
The length–weight relationships (LWRs) of two cichlid fish species, Oreochromis mossambicus (Peters, 1852) and Etroplus suratensis (Bloch, 1790) were studied from the downstream region of Meenachil river, Kerala, India. A total of 346 specimens were sampled bi-monthly during a period of February 2021 to February 2022 using gill nets with various mesh sizes (3.5 cm–9 cm) and cast nets with a 1.5 cm mesh size. The intercept value (a) for Oreochromis mossambicus (Peters, 1852) and Etroplus suratensis (Bloch, 1790**)** was found to be 0.0735 and 0.0405 respectively. The growth exponent (b) indicated a negative allometric growth pattern (b < 3.0) for Oreochromis mossambicus (Peters, 1852) and Etroplus suratensis (Bloch, 1790**)** with values of 2.41 and 2.83 respectively. This work serves as the first reference on the length-weight relationship of Oreochromis mossambicus (Peters, 1852) and Etroplus suratensis (Bloch, 1790) from the Meenachil river.

Keywords: length-weight relationship, Oreochromis mossambicus , Etroplus suratensis, Meenachil river, Negative allometric growth.

INTRODUCTION

Fish size and weight can be used as a metric to measure the health of a species, the success of its habitat, and the abundance of its population. The relationship between body length and weight plays a significant role in fishery biology, aiding in outlining the fundamental biological characteristics and identifying whether the growth patterns of fish are allometric or isometric. (Lalrinsanga *et al*., 2012). The length-weight relationship plays an important role in sustaining the taxonomic traits of the species (Pervin and Golam Mortuza, 2008). Length and weight records are useful and common outputs in fish sampling programs. These parameters give data for stock assessment(Rosli and Isa, 2012; and Duzgunes, 2013) as well as provide a comprehensive status about the health, growth rates, lifespan and well-being and mortality of fish (Jisr *et al*., 2018; Pradeep, 2018). It also helps in determining the average weight of fish of a specific length group through the establishment of a mathematical link between the length and weight of fish (Beyer, 1987). LWRs are a non-destructive fish monitoring procedure which is crucial for fish from damaged habitats. This could streamline field renitoring procedures and reduce measuring time, which is better for understanding its ecological role and monitoring the health of its population (Yang *et al.*, 2022; Castro *et al.,* 2019). It is also to be noted that the weight- length connections of the same species vary depending on the geographic location's environmental circumstances (Dagtekin *et al.,* 2022).
Although many studies have been conducted on the length-weight relationship of fishes in Kerala rivers, a limited number of works have been reported in the Meenachil River. The length-weight relationship, condition factor and relative condition of *Labeo dussumieri* from the lower reaches of the Meenachil river was studied by Anilakumari and Monsi (2017). Length-weight relationship and condition factor of *Horabagrus brachysoma* from the riverine stretches of Vembanad lake was reported by Bindu & Padmakumar (2019). Renjithkumar *et al.,* (2021) reported the LWR of 14 fish species (Actinopterygii) from the Chalakudy River, Western Ghats, India. Length-Weight Relationship and Condition factor of a large predatory catfish, *Wallago attu* from the rivers of central Kerala was reported by Rufus *et al*., (2015). The present investigation has been undertaken to assess the Length - Weight relationships (LWRs) of two Cichlid fish species from the downstream region of the Meenachil River, Kerala, India.

MATERIALS AND METHODS

The Meenachil River, which has a catchment area of 1272 km^2 and measures roughly 78 km in length, is referred to as the sacred river of the Kottayam district. The river begins in the Western Ghats and flows through the towns of Poonjar, Teekay, Erattupetta, Palai, Ettumanoor and Kottayam before confluences into the Vembanadu lake. A total of 346 specimens representing the Cichlid family were collected bi-monthly from February 2021 – February 2022 using gill nets with various mesh sizes (3.5 cm –9 cm) and cast nets with
1.5 cm mesh size. Fish specimens were identified according to Jayaram (1981) and Talwar and Jhingran (1991). Total

length of samples (TL in cm) from mouth to the end of the caudal fin was measured to the nearest 0.1 cm by using a measuring scale validated against a vernier calliper and weight was measured with an accuracy of 0.01 gm using an electronic balance. The length–weight relationship was calculated using the expression (Le Cren, 1951; Froese, 2006).

$$W = aL^b$$

This equation is then logarithmically transformed into Log W = Log a + b Log L Where, W= Weight of fish in grams, L= Length of fish in centimeters. The coefficient of determination (r^2) and 95% confidence limit, a and b are the regression parameters where a is the intercept and b is the allometric growth coefficient for the parameters of a and b (Cl 95%) were estimated. Extreme outliers were removed from the regression analysis by plotting length and weight pairs (Froese *et al.,* 2011).

RESULTS

A total of 346 fish specimens of two species belonging to the Cichlidae family were analyzed during the study. The sample size (n), total length and weight measurements, estimates of a and b for the length-weight relationship, the coefficient of the regression (r^2) and 95% Cl of a and b are given in Table 1 for each species. The coefficient of determination (r^2) values was estimated as 0.963 for *Oreochromis mossambicus* and 0.965 for *Etroplus suratensis*. The exponent **b** values were calculated as 2.419 for *Oreochromis mossambicus* and 2.8303 for *Etroplus suratensis*. The constant values of **a** were determined as 0.0735 for *Oreochromis mossambicus* and 0.0405 for *Etroplus suratensis* (Table 1).

Species	N	Length Range (cm)	Weight Range (gm)	a	95% Cl a	b	95% Cl b	r^2
Oreochromis mossambicus	201	7.8-23.3	15.2-174	0.0735	0.0565-0.0923	2.419	2.3535-2.4847	0.963
Etroplus suratensis	145	5.9-22.1	6.8-262	0.0405	0.0285-0.0606	2.8303	2.7417-2.9189	0.965

Table 1: Descriptive statistics and estimated length–weight relationship parameters of species collected from the downstream region of Meenachil river from February 2021 to February 2022.

n, number of individuals; a, intercept; b, slope; CL, confidence limits; r^2, coefficient of determination.

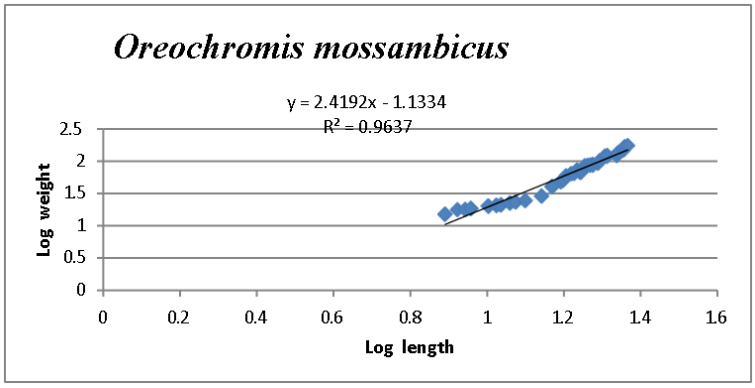

Fig. 1. Scattered plot for LWR of *Oreochromis mossambicus*

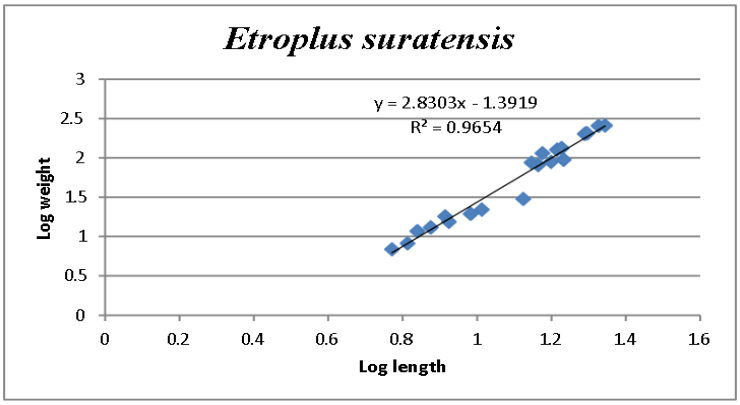

Fig. 2. Scattered plot for LWR of *Etroplus suratensis*

DISCUSSION

The length-weight relationship (LWR) is essential for giving insightful data on the trophic level and life history of fish (Sileesh *et al*., 2020). The growth pattern of each fish species is determined by the b values in LWRs. The expected b value of fish generally ranged from 2.5-3.5 as reported by Froese(2006). When b = 3, the fish grows isometrically ie, weight rises as the third power of length while an organism's size remains constant. If b < 3.0, fish experiences a, negative allometric growth in which it becomes more slender as it grows larger and b > 3.0 they exhibit positive allometric growth implying that they get a plumber or deeper–bodied as it grows longer (Froese, 2006; Riedel *et al*., 2007). However it is quite unusual to spot a fish with a b value of 3 in its native habitat (Allan, 1938).

The regression trend in the present study indicated that both *Oreochromis mossambicus* and *Etroplus suratensis* exhibited negative allometric growth patterns (b < 3), with b values 2.419 and 2.8303 respectively. The negative allometric growth pattern of fish species indicated that the fish species grew at a relatively slow rate or in other words increase in length does not correspond to the increase in weight (Ahmed, 2018). The negative allometric growth was influenced by energy loss on gonad development during mating season (Das *et al*., 1997). The present study reports coincide with some of the previous reports on the growth pattern of these fishes from other water bodies, others are not. Vaitheeswaran *et al.,* 2016 studied the Length-Weight relationship in *Etroplus suratensis* from Jameelabad, Pulicat Lake, Southeast coast of India and reported a b value of 1.0368 which is significantly different from the isometric value. Roshni *et al.* (2016) reported a b value of 2.67 for the same species collected from the Vembanad lake whereas Padmakumar and Bindu (2021) observed the b value ranged between

2.81 and 3.03 *in Etroplus suratensis* from Vembanad wetland system, South-west coast of India. Similarly, a variation in the allometric growth pattern was observed by Karna *et al.* (2012, 2020) from Chilika Lake, the b value ranged between 2.998 and 3.134. Negative allometric growth was also reported by Remya *et al.*, 2021 in *Oreochromis mossambicus* and *Etroplus suratensis* collected from the Kayamkulam lake with b values of 2.998 and 2.068 respectively. Also, Bindulekha (2018) observed a slight variation of b values 2.938 and 2.793 in *Oreochromis mossambicus* from Vellayani lake and Veli lake respectively. In contrast, there are different results of growth types for *Oreochromis mossambicus* (Peters, 1852) and *Etroplus suratensis* obtained from earlier estimates (Achakzai and Baloch, 2013; Herath *et al*., 2014; Lal *et al*., 2016). The shape and fatness of the fish species have a significant impact on the value of parameter b in the length-weight relationship (Gubiani *et al*., 2009). The discrepancy in LWR values of fishes can be attributed to the combination of one or more factors such as differences in habitats, sample size (n), seasonal fluctuations, variability in sampling sites, sex, gonad maturity, health, diet and stomach fullness (Moutopoulos and Stergiou, 2002; Chen *et al.,* 2017; Reis, 2020). Contrary to LWR parameter a, parameter b may change throughout the year, even on a daily basis, depending on the habitat (Özaydın and Taşkavak, 2006;Turker and Bal, 2018).In addition to all these factors, the availability of food and environmental factors including temperature, pH, and dissolved oxygen were thought to have the biggest impact on the b values of LWRs (Muchlisin *et al.,* 2010). The result of the study thus provided evidence that environmental factors played an important role in determining the size and weight of fish.

The current study offered the first preliminary data on LWRs of fish species from Meenachil River, Kerala, India. Based on the present study, it was concluded that the length-weight relationship indicated negative allometric growth according to the cube law Therefore, it is advised to conduct research over a longer period with seasonal change, taking into account physicochemical water parameters, fish sex, and biodiversity of the area to better the conservation and management system for fishery resources in Meenachil river.

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