



Length-weight relationship and relative condition factor of Yellowstripe scad, *Selaroides leptolepis* (Cuvier, 1833) in the Visayan Sea, Philippines

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ABSTRACT

The length-weight relationship (LWR) and relative condition factor (K_n) are essential biometric tools in fishery studies. They provide information about the fish's growth, condition, and suitability in its habitat. The LWR of 680 samples of *Selaroides leptolepis* or yellowstripe scad collected from commercial trawls fishing in the Visayan Sea was studied to determine its growth condition. The results indicated that *S. leptolepis* exhibited an isometric growth ($b = 3.023$), indicating an equal growth rate of the fish's length size and body weight. The relative condition factor (K_n) values of the studied species fluctuated between 0.95 to 1.10 from November 2018 to October 2019 study period. The increased concentration of phytoplankton during the dry season had been observed that might influenced the K_n values > 1 , which indicated a state of well-being of yellowstripe scad during this season. The current study would provide baseline data about LWR and the relative condition factor of *S. leptolepis* in the Visayan Sea. These data are valuable for establishing a monitoring and management system for this fish species.

Introduction

Length-weight relationship (LWR) has been used in studying fish life history, ecology, physiology, and biology, such as morphological characters, gonad maturity level, fatness, habitats, and growth patterns (Thomas *et al.*, 2003; Froese, 2006; Froese *et al.*, 2011; Muchlisin *et al.*, 2010; Nehemia *et al.*, 2012). The length-weight relationship is expressed in a formula, which is used to estimate the weight (W) using a particular length (L) (Beyer, 1987; Pauly, 1993).

The growth of fish in length and weight happen during its lifetime. However, many factors influence the nature of the fish's growth: habitat, food availability, physicochemical parameters, geographical location, sexual maturity, age, and size (Kachari *et al.*, 2017; Bulanin *et al.*, 2017). These factors will create the body shape of the fish either in isometric growth or allometric growth.

The relative condition factor (K_n) is also an essential biometric tool derived from the length-

weight relationship (Le Cren, 1951). K_n is a way to measure the overall health of a fish (fatness or well-being) by comparing its weight with the average weight in a given sample to assess the suitability of a water environment for the growth of fish (Beyer, 1987; Yilmaz *et al.*, 2012; Muchlisin *et al.*, 2017; Mensah, 2015).

The investigated species in this study was *Selaroides leptolepis* or yellowstripe scad. It is a coastal species that occurs throughout the Indo-West Pacific from the Persian Gulf, east to the Philippines, north to Japan (Smith-Vaniz, 1984), and south to southern Queensland, Australia (Randall, 1995), and the East Indian Region. The yellowstripe scad is predominantly an inshore species and occurs in large demersal schools over soft substrates. Although it is most common for yellowstripe scad to inhabit between 40 and 60 m depth (Isa, 1999), the water depths in the Philippines where they occurred frequently were observed at 20 – 50 m in the Visayan

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Sea (Arce, 1986) and 15 m in the Manila Bay (Calvelo, 1987).

In the Philippines, the yellowstripe scad is locally known as "*salay ginto, dalimuan, karabahas, and salay-salay*". It has an oblong body and golden lateral band running from above the eye to the tail, and it is one of the most common species in Philippine waters (Calvelo, 1987). The yellowstripe scad is the only member of the monotypic genus *Selaroides* and one of the thirty genera in the Carangidae family (Nelson, 2016).

Although some studies on *S. leptolepis* were conducted around the Visayan Sea (Arce, 1986; Guanco *et al.*, 2009), none of these previous studies were concentrated on the biometrics (LWR and K_n) of the yellowstripe scad. Further, the water parameters of the said fishing ground, particularly the chlorophyll-*a* concentration and sea surface temperature, were investigated, which may influence fish growth. Hence, this study aimed to estimate the LWR, and assess the K_n value to evaluate the water's fitness for fish growth. This information will permit future studies on the management and conservation of *S. leptolepis* of the same fishing environment.

Materials and Methods

Study site and collection of data

The study focused on the *Selaroides leptolepis* that landed at Bancal Fishing Port caught by trawl fishing in the Visayan Sea. The Visayan Sea has an estimated total area of 5,184 km² with the coordinates between 11° – 12° N and 123° - 124° E (BFAR, 2002). The fishing area of the commercial trawlers in the Visayan Sea for *S. leptolepis* as shown in Figure 1.

Samples were collected twice a week from November 2018 to October 2019 using stratified random sampling. Each specimen was weighed using a 5,000 g digital weighing scale (Cascade) up to the nearest 0.01 gram, and the total length (TL) of the fish was measured to the nearest 0.1 cm using a 30 - cm fish measuring board. A total of 680 specimens was examined for the whole study period. Environmental data such as the daytime sea-surface temperature (SST) and chlorophyll-*a* concentration used in this study were obtained from Aqua-MODIS L3 monthly composite satellite images with a 4 km spatial resolution, which were downloaded from <http://oceancolor.gsfc.nasa.gov>. Chlorophyll-*a* and SST data were analyzed using the SeaDAS 7.4 program.

Length-weight relationship (LWR)

The length-weight relationship (LWR) was computed using the formula by Le Cren (1951) in Equation:

$$W = aL^b$$

where:

W = weight of fish (g)

a = a coefficient related to the body form

L = total length of fish (cm)

b = the slope of the relationship

The logarithmic form of LWR formula was expressed in this Equation:

$$\log W = \log a + b \log L$$

where:

$\log W$ = logarithm of weight (g)

$\log a$ = a logarithm coefficient

b = the slope of the relationship

$\log L$ = logarithm of total fish length (cm).

The logarithmic form was used to estimate the significance level of r^2 through linear regressions.

The

Relative condition factor (K_n)

The relative condition factor (K_n) was calculated using an expression by Le Cren (1951) in Equation (3):

$$K_n = \frac{W_o}{W_c} \quad (3)$$

where:

K_n = relative condition factor

W_o = observed weight (g)

W_c = calculated weight derived from LWR

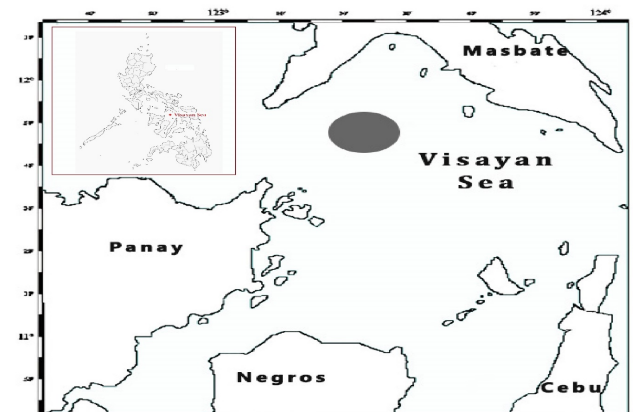


Figure 1. The Visayan Sea map shows the fishing area where *Selaroides leptolepis* were caught by commercial trawlers (dark gray color).

Results

Length frequencies of 680 samples of *S. leptolepis* ranged from 9.5 to 18.0 cm were analyzed, and the computed mean length was 13.60 ±0.04 cm. The weights obtained ranged from 10.0 to 66.0 g, and the mean weight was 26.92 ±9.17 g.

Length-weight relationship (LWR)

The parameters a, b, and r² were determined for the relationship between the body length and weight. The estimated growth pattern (b) and the constant (a) were 3.023 and 0.0097, respectively. The value of growth pattern b = 3.023 of the samples showed an isometric growth. The equation describing the length-weight relationship was: W = 0.0097 L^{3.023}, with the level of significance (r²) of 0.946. The graph of the LWR is presented in Figure 2.

Relative condition factor (K_n)

Values of relative condition factor (K_n) of yellowstripe scad in the Visayan Sea from November 2018 to October 2019 ranged from 0.95 to 1.10 (mean 1.02 ±0.04) (in Figure 3). The smallest relative condition factor value was recorded in October 2019, while the highest value was computed in March 2019.

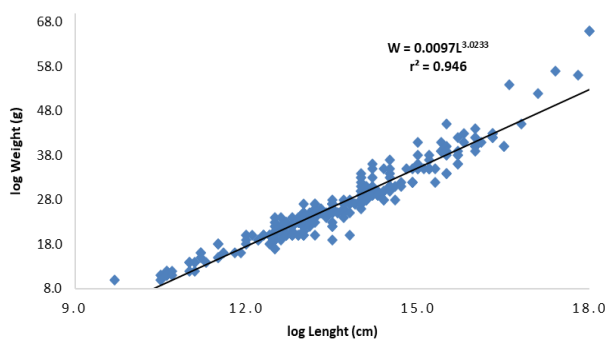


Figure 2. Length-weight relationship of *Selaroides leptolepis* in the Visayan Sea.

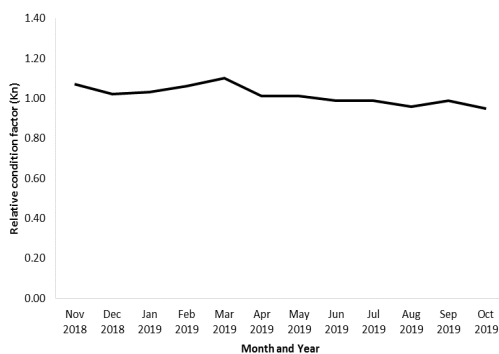


Figure 3. Monthly relative condition factor of *Selaroides leptolepis* in the Visayan Sea.

Discussion

In the study of Pauly (1984), growth coefficient b values closer to 3 mean isometric growth in fish and significantly different from 3 values indicate

allometric growth. The fish's growth condition is affected by many factors such as availability of food, reproductive cycles, habitat, and physicochemical parameters of the environment. The estimated b value (3.023) of *S. leptolepis* in the Visayan Sea exhibited an isometric growth (t-test, p > 0.05), indicating an equal growth rate of the length size and bodyweight of the fish. Furthermore, the studied fish's good body growth might be attributed to the high chlorophyll concentration in the Visayan Sea (Cordero et al., 2004) that has significantly contributed to the area's functional trophic level. In confirmation of the study Cordero et al. (2004), a high chlorophyll-a concentration in the Visayan Sea during the dry season of March 2019 monitoring is presented in Figure 4. In the study of Campos et al. (2002), the sea surface temperature in the Visayan Sea had ranged from 29.5 – 29.8 °C in April and May 2001. In Figure 5, the SST recorded in March 2019 in the Visayan Sea obtained from the Aqua-MODIS L3 data estimated 29.0 – 32.0 °C. According to Trombetta et al. (2019), the rising water temperature is the main driver of phytoplankton blooms in the coastal waters. Hence, the increased concentration of these microscopic organisms during the dry season was favorable to the tropical fishes inhabited in the Visayan Sea.

The b value of yellowstripe scad in this study was comparatively similar to Arce (1986) in the Visayan Sea and other studies conducted in the Philippines and abroad (Table 1).

Table 1. Values of the "a" and "b" coefficients for *S. leptolepis* obtained from other studies in the Philippines and abroad.

Location	a	b	Length Type	r ²	n	Source
Visayan Sea, Philippines	0.00629	3.190	TL	0.995	203	Arce, 1986
Davao Gulf, Philippines	0.01350	3.212	SL	0.996	25	Gumanao et al. 2016
Central Visayas, Philippines	0.01700	3.000	-	-	-	Federizon, 1993
Beibu Gulf, China	0.01400	3.070	TL	0.997	435	Wang et al. 2011
Rayong, Gulf of Thailand, Thailand	0.00745	3.101	TL	0.982	25	Yanagawa, 1994
Wondama Bay, Indonesia	0.00302	3.410	TL	0.910	116	Sala et al. 2018
Visayan Sea, Philippines	0.0097	3.023	TL	0.946	680	Present study

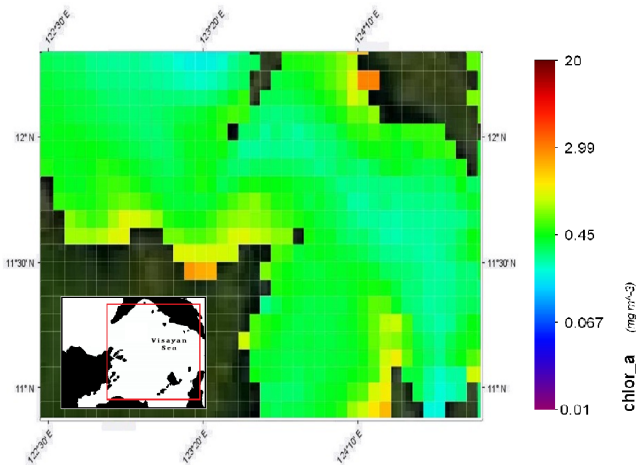


Figure 4. Map showing the chlorophyll-*a* concentration recorded in the Visayan Sea when *S. leptolepis* were sampled. (Image from Aqua-MODIS data).

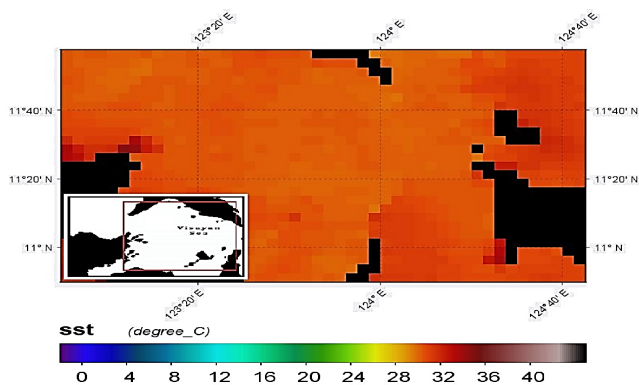


Figure 5. Map showing the horizontal distribution of sea surface temperature (°C) in the Visayan Sea waters recorded in March 2019. (Image from Aqua-MODIS data).

The value of K_n is influenced by the age of fish, sex, season, stage of maturation, the fullness of gut, type of food consumed, amount of fat reserve, degree of muscular development, habitat, and environmental factors (Morato *et al.*, 2001). The *S. leptolepis*' relative condition factor in the current study from November 2018 to October 2019 fluctuated between 0.95 to 1.10. The mean value (1.02 ± 0.04) of the yellowstripe scad's relative condition factor showed a typical fish in good condition for the whole study period. It is explained in the study of Fulton (1902) that a fat fish will have a higher condition factor, like 1.2 or even 1.5, while a skinny fish will be below 1, like 0.8 or less. Furthermore, it is supported in the studies of Restiangsih *et al.* (2016) and Jisr *et al.* (2018) that the K_n value ≥ 1 is inferred as a good growth condition of the fish while the organism with K_n value < 1 is in poor growth condition. In Le Cren's (1951) study, the deviation of K_n from 1

reveals information concerning the differences in food availability and consequence of physiochemical features on fish species' life cycle.

In the study of Calvelo (1987) in Manila Bay, Philippines, *S. leptolepis* in both sexes had reached maturity at almost the same size, 12 cm (TL) for females and 13 cm (TL) for males. In the total samples of yellowstripe scad collected ($N = 680$), 82.35% of the samples were ≥ 12 cm TL. However, the specimen's gonadal condition was not investigated in this study to compare with the result of Calvelo (1987) on yellowstripe scad.

The relative condition factor of *S. leptolepis* in the Visayan Sea was comparatively good ($K_n > 1$) from November to May. These months are the dry season of the Philippines in which the SST is increasing that favors the growth of phytoplankton that serve as food for the fishes, while during the wet season, K_n values are < 1 . The relative condition factor of the studied species in the Visayan Sea might be influenced by the season because the Philippines' climate is divided into two major seasons: rainy season from June to November, and dry season from December to May (PAGASA, 2021). In the study of De Giosa *et al.* (2014), high K_n values were observed during the warm period that increased the feeding intensity of fish due to high food availability when the temperature is at its optimum. In the study of Kasim (2003) in India, spawning of *S. leptolepis* was observed in October and July. During spawning, the K value of a female fish has decreased rapidly because of decreasing its feeding activity, reserve lipids in the body, and shed its eggs (Lizama and Ambrósio, 2002). The estimated K_n value was > 1 in November in this study, probably influenced by the start of the Philippines' dry season. However, information regarding the spawning period of *S. leptolepis* in the Philippines from the previous study conducted was not confirmed only the size of their first maturity.

Conclusions

This study provided valuable information on the LWR and K_n of *Selaroides leptolepis* caught in the Visayan Sea. The LWR of the studied fish showed an isometric growth attributed to food availability or physiochemical factors that affect the fish's life cycle. The mean of the K_n value (1.02 ± 0.04) for one year was > 1 , showing the examined species' overall well-being. *S. leptolepis* exhibited a better growth condition during the warm season because of increased feeding activity due to food abundance present in the environment. The present investigation results will

be significant for future studies on the monitoring, conservation, and management aspects of this species in the Visayan Sea.

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