Length-Weight Relationships for Three Deep Sea Fish Species in North Eastern Mediterranean, Turkey

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ABSTRACT

In the present study, length–weight relationships (LWRs) were estimated for three deep sea fish species, namely, *Nettastoma melanura* Rafinesque, 1810; *Lampanyctus crocodilus* (Risso, 1810); and *Chauliodus sloani* Bloch & Schneider, 1801 in the north-eastern Mediterranean Sea. A total of 102 fish samples were collected from Mersin Bay (Erdemli coast). Their length–weight relationship b values ranged between 2.458 and 3.496, and all regressions were found to be significant for all three species (p<0.001). This study is the first reference on length–weight relationships for these three deep-sea fish species from the North-eastern Mediterranean Sea coast of Turkey. Besides, Length–weight relationships for *C. sloani* and *L. crocodilus* were not yet available in Fishbase for the Eastern Mediterranean, and hence these results obtained from this study will be useful to researchers and fisheries biologists in the field.

Keywords: Deep sea fishes, Length-weight parameters, Blackfin sorcerer, Jewel lanternfish, Sloane's viperfish, Mersin Bay

INTRODUCTION

In fisheries biology and fisheries management, length-weight relationships (LWRs) data are useful to determine the weight of an individual fish of known length or total weight from the length–frequency distribution (Garcia, Buarte, Sandoval, Von Schiller, & Mello, 1989; Froese, 1998; Koutrakis & Tsikliras, 2003). Besides, these relationships are an important component of FishBase (Froese & Pauly, 2019).

To date, there are a limited number of studies on the population of three deep-sea fish species length-frequency distribution in the western Mediterranean (Merella, Quetglas, Alemany, & Carbonell, 1997 Porcu et al., 2013) and eastern Mediterranean (Bilge, Yapıcı, Filiiz, & Cerim, 2014; Deval, Güven, Saygu, & Kabapçioğlu, 2014). The present study shows the first-time results of an investigation of length-weight relationships of three deep-sea fish species: Blackfin sorcerer, *Nettastoma melanura* Rafinesque, 1810; Jewel lanternfish, *Lampanyctus crocodilus* (Risso, 1810); and Sloane's viperfish *Chauliodus sloani* Bloch & Schneider, 1801 from Mersin Bay (N.E. Mediterranean, Turkey).

Although biological studies on the deep sea fish fauna are limited in the Mediterranean Sea, this paper provides the first information on the length-weight relationships of three deep sea fish species in the North eastern Mediterranean Sea coast of Turkey. Besides, Length–weight relationships for *C. sloani* and *L. crocodilus* were not yet available in Fishbase for the Eastern Mediterranean.

MATERIALS AND METHODS

Study area

The present study recorded deep sea fish specimens from the Mersin Bay Erdemli coast, Tur-
key) (Figure 1). Mersin Bay is an important fishing area of the Northeastern Mediterranean Sea due to its nutrient-rich fresh water inputs.

During the sea surveys, 102 deep sea fish specimens belonging to three family were caught by commercial bottom trawler at a depth of 400 to 595 m off Mersin Bay (Erdemli coast) (Coordinates; 36° 12' 383 N - 034° 23' 019'' E; 36° 08' 926'' N - 034° 42' 057'' E). Samplings were carried out between June and July 2019. The trawler was equipped with 44 mm stretched mesh size nets at the cod-end. Trawling lasted 4 hours and the trawling speed was 2.7 knots (Figure 1). Captured fish specimens were photographed on board and then preserved in ice boxes for examination in the laboratory. In the laboratory, each fish was measured for total length to the nearest 0.1 cm, weight was measured to the nearest 0.1 g, and the sex was determined by macroscopic observation of the gonads.

Estimation of the length-weight relationship was made by adjustment of an exponential curve to the data (Ricker, 1975): $W = aL^b$. Where; W is body weight (g), L is total length (cm), a is a coefficient related to body form, and b is an exponent indicating isometric growth when equal to 3 (Beverton & Holt, 1996). The parameters a and b were estimated by linear regression on the transformed equation: $\log(W) = \log(a) + b \log(L)$. The b value for each species was tested by a t-test at the $p=0.05$ significance level to verify if it was significantly different from 3 (Pauly, 1993). All statistical analyses were performed using SPSS v. 21.0. Species identification was done according to Whitehead et al. (1986). The scientific name for each species was checked against FishBase (Froese & Pauly, 2019).

RESULTS

Lengths (TL) and weights (g) of a total of 102 fish specimens belonging to three fish species from three families were measured, recorded, and analyzed (Figure 2, Figure 3, and Figure 4). The sample size, minimum maximum length as well as the LWRs, the coefficient of determination ($r^2$), the standard error and confidence interval (CI) of b for each species are presented in Table 1.

The exponent b often has a value close to three, but varies between two and four (Tesch 1971). In the present study, b values (based on TL) of the N. melanura species were negative allometric growth for males, females and sexes combined (b<3). However, b values of L. crocodilus and C. sloani were positive allometric growth for males, females and sexes combined (b>3), (t-test: $p<0.05$).

In the present study, 102 specimens had b values within the expected range of 2.5-3.5 (Bilge et al., 2014; Deval et al., 2014) for three deep sea fish species (N. melanura, C. sloani and L. crocodilus). The calculated allometric coefficient b ranged from a minimum of 2.458 for males of N.melanura, to a maximum 3.496 for males of L. crocodilus. All regression values were found to be highly significant ($p<0.001$), with the coefficient of determination ($r^2$) values being >0.95 for all three fish species (Table 1).
The length-weight relationship for the three deep sea fish species was found as $W=0.0021 L^{2.573}$ ($R^2=0.967$) for $N. melanura$, $W=0.0004 L^{3.383}$ ($R^2=0.974$) for $C. sloani$ and $W=0.0017 L^{3.431}$ ($R^2=0.975$) for $L. crocodilus$. Estimation of length-weight relationship of combined sexes for the three fish species are given in Figure 5.

Porcu et al. (2013) reported positive allometric growth (male; $b=3.247$, female; $b=3.602$) for $N. melanura$ from South-eastern Italy. Similarly, Deval et al. (2014) stated in the Antalya Bay, Turkey positive allometric growth ($b=3.180$), Bilge et al. (2014) reported positive allometric growth ($b=3.143$) for $L. crocodilus$ in the study conducted from the southern Aegean Sea, Turkey, and Merella et al. (1997) reported in the western Mediterranean negative allometric growth ($b=2.980$) for $L. crocodilus$ and positive allometric growth ($b=3.180$) for $C. sloani$.

The previous studies on the presence for length characteristics of the length–weight relationships of the three deep-sea fish species in the other Mediterranean regions are given in Table 2. For all of the studied species presented in this paper, the $b$ val-

### Table 1.

Descriptive statistics and length–weight relationships (LWRs) for three deep-sea fish species, North-eastern Mediterranean coast of Turkey.

| Family        | Species     | Sex | N  | L (cm) | TW (g) | a    | b    | SE of b | 95% CI of b | $r^2$ | P     | Growth Type |
|---------------|-------------|-----|----|--------|--------|------|------|---------|-------------|------|-------|-------------|
| Nettastomatidae | $N. melanura$ | F   | 27 | 19.50-63.00 (34.57±12.21) | 2.89-77.80 (23.05±19.84) | 0.0017 | 2.622 | 0.111 | 2.393-2.851 | 0.957 | <0.05 | A-          |
|               |             | M   | 18 | 21.00-58.80 (42.08±11.01) | 4.56-67.56 (34.56±18.71) | 0.0032 | 2.458 | 0.084 | 2.280-2.637 | 0.982 | <0.05 | A-          |
|               |             | F+M | 45 | 13.30-23.60 (18.26±3.13)  | 2.30-15.60 (7.52±4.36)   | 0.0003 | 3.474 | 0.132 | 3.191-3.757 | 0.980 | <0.05 | A+          |
|               | $C. sloani$  | F   | 16 | 14.20-23.40 (17.71±2.78)  | 2.30-15.60 (7.71±4.35)   | 0.0005 | 3.261 | 0.172 | 2.885-3.636 | 0.967 | <0.05 | A+          |
|               |             | M   | 14 | 11.50-19.50 (16.16±2.18)  | 10.07-47.96 (29.67±9.93) | 0.0004 | 3.383 | 0.104 | 3.171-3.195 | 0.974 | <0.05 | A+          |
|               |             | F+M | 30 | 11.50-19.50 (16.67±1.95)  | 8.05-47.96 (28.28±10.46) | 0.0017 | 3.431 | 0.108 | 3.028-3.654 | 0.975 | <0.05 | A+          |
|               | $L. crocodilus$ | F   | 17 | 12.70-19.50 (16.97±1.81)  | 3.43-15.02 (6.71±3.85)   | 0.0005 | 3.261 | 0.172 | 2.885-3.636 | 0.967 | <0.05 | A+          |
|               |             | M   | 10 | 11.50-19.50 (16.67±1.95)  | 8.05-47.96 (28.28±10.46) | 0.0017 | 3.431 | 0.108 | 3.028-3.654 | 0.975 | <0.05 | A+          |

### Table 2.

Length-weight relationships of three deep-sea fish species from different geographical areas.

| Reference | Locality                  | Country          | Species          | Sex | N  | TL (cm) | TW (g) | a    | b    | SE of b | 95% CI of b | $r^2$ | P     | Growth Type |
|-----------|---------------------------|------------------|------------------|-----|----|---------|--------|------|------|---------|-------------|------|-------|-------------|
| Deval et al. (2014) | Antalya Bay, eastern Mediterranean | Turkey | Nettastoma melanura | Mixed | 75 | 25.1 - 79.8 | 5.4 -255.5 | 0.00020 | 3.180 | 0.940 |
| Porcu et al. (2013) | South-eastern Sardinian Sea | Italy | Nettastoma melanura | Male | 171 | 30.2 - 66.8 | - | 0.00200 | 3.247 | 0.820 |
|               |                           |                 |                  | Female | 226 | 32.5 - 75.3 | - | 0.00004 | 3.602 | 0.860 |
| Bilge et al. (2014) | Southern Aegean Sea | Turkey | Lampanyctus crocodilus | Mixed | 80 | 9.4 - 16.2 | - | 0.00690 | 3.143 | 0.967 |
| Merella et al. (1997) | Balearic Islands (western Mediterranean) | Spain | Lampanyctus crocodilus | Mixed | 25 | 9.0 - 21.0 | - | 0.00510 | 2.980 | 0.990 |
| Merella et al. (1997) | Balearic Islands (western Mediterranean) | Spain | Chauliodus sloani | Mixed | 11 | 15.1 - 30.5 | - | 0.00090 | 3.180 | 0.988 |

The length-weight relationship for the three deep sea fish species was found as $W=0.0021 L^{2.573}$ ($R^2=0.967$) for $N. melanura$, $W=0.0004 L^{3.383}$ ($R^2=0.974$) for $C. sloani$ and $W=0.0017 L^{3.431}$ ($R^2=0.975$) for $L. crocodilus$. Estimation of length-weight relationship of combined sexes for the three fish species are given in Figure 5.

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The previous studies on the presence for length characteristics of the length–weight relationships of the three deep-sea fish species in the other Mediterranean regions are given in Table 2. For all of the studied species presented in this paper, the $b$ val-
Length and weight relationships are used widely in fish exploration and supervision, and LWRs are essential to recognize the ecology and life of fish species (Froese, 2006). However, the length-weight relationship in fishes is affected by a number of factors including season, habitat, gonad, sex, diet and stomach fullness and preservation techniques (Tesch, 1971; Bagenal and Tesch, 1978), all of which were not accounted for in the present study.

CONCLUSION

The present study was conducted to give length and weight data of three fish species. To date, no information regarding the C. sloani and L. crocodilus fish species for the Eastern Mediterranean is available in Fishbase (Froese & Pauly, 2019).

To the best knowledge of the authors, this study presented the first comprehensive reference on length-weight relationships for three deep sea fish species from the Eastern Mediterranean coast of Turkey. The results obtained from this study are useful to researchers and fisheries biologists, because the data were sampled from a fairly deep waters area.

Conflicts of interest: The authors have no conflicts of interest to declare.

Ethics committee approval: This study was conducted in accordance with the ethics committee procedures of animal experiments.

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