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

Yusuf Kenan Bayhan[1] , Sibel Alagöz Ergüden[2] , Deniz Ergüden[3]

ORCID IDs of the author:
Y.K.B. 0000-0002-7403-900X;
S.A.E. 0000-0003-4363-433X;
D.E. 0000-0002-2597-2151

[1]Adıyaman University, Vocational School Kahta, Department of Fisheries, Adıyaman, Turkey

[2]Çukurova University, Vocational School Imamoglu, Department of Fisheries, Adana, Turkey

[3]İskenderun University, Faculty of Marine Sciences and Technology, Department of Marine Science, Technical, Hatay, Turkey

Correspondence:
Sibel Alagöz Ergüden
E-mail:
alagozs@cu.edu.tr;
sibelerguden@gmail.com

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 distributionin the western Mediterranean (Merella, Quetglas, Alemany, & Carbonell, 1997 Porcu et al., 2013) and eastern Mediterranean (Bílge, Yapici, Fíliíz, & Cerím, 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, 1801from 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 Mediteraenan.

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.
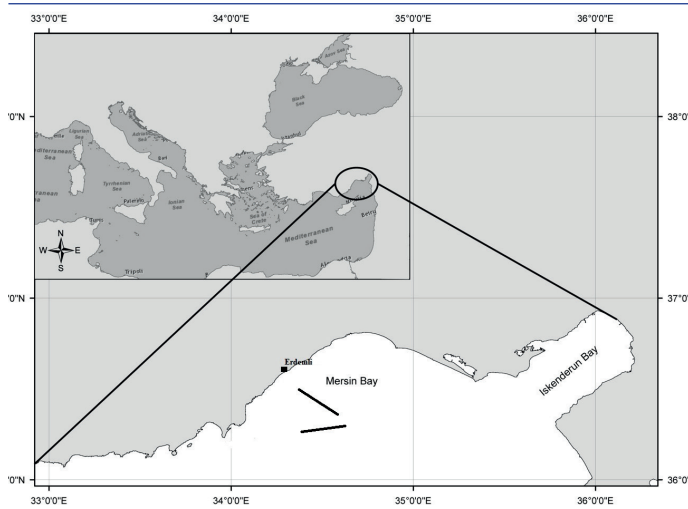

Figure 1. Sampling area.

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 3 fish species from 3 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.

Figure 2. *Nettastoma melanura* Rafinesque, 1810 in the North-eastern Mediterranean.

Figure 3. *Lampanyctus crocodilus* (Risso, 1810) in the North-eastern Mediterranean.

Figure 4. *Chauliodus sloani* Bloch & Schneider, 1801 in the North-eastern Mediterranean.

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 (Bílge 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).

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	TL (cm) L_{min}-L_{max} (L_{mean}±SD)	TW (g) W_{min}-W_{max} (W_{mean}±SD)	a	b	SE of b	95% CI of b	r^2	P	Growth Type
Nettasto-matidae		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-
	N. melanura	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	19.50-63.00 (37.61±12.21)	2.89-77.80 (27.66±20.01)	0.0021	2.573	0.072	2.428-2.719	0.967	<0.05	A-
Stomiidae		F	16	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	M	14	14.20-23.40 (17.71±2.78)	3.43-15.02 (6.71±3.85)	0.0005	3.261	0.172	2.885-3.636	0.967	<0.05	A+
		F+M	30	13.30-23.60 (18.00±2.93)	2.30-15.60 (7.14±4.08)	0.0004	3.383	0.104	3.171-3.195	0.974	<0.05	A+
Myctophi-dae		F	17	12.70-19.50 (16.97±1.81)	11.07-47.96 (29.67±9.93)	0.0020	3.373	0.143	3.069-3.678	0.973	<0.05	A+
	L. crocodi-lus	M	10	11.50-19.20 (16.16±2.18)	8.05-43.53 (25.92±11.42)	0.0014	3.496	0.194	3.050-3.944	0.976	<0.05	A+
		F+M	27	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+

N= sample size, L = Length [cm], min = Minimum, max = Maximum, $r2$ = Coefficient of determination, a = Intercept, b = Slope, SE of b = Standart error of b, CI = Confidence Interval, A (+) = Positive allometry, A (–) = Negative allometry

Table 2. Length-weight relationships of three deep-sea fish species from different geographical areas.

Reference	Locality	Country	Species	Sex	N	TL (cm) L_{min}-L_{max}	TW (g) W_{min}-W_{max}	a	b	r^2
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
Bílge 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$^{2.573}$ (R²=0.967) for *N. melanura,* W=0.0004 L$^{3.383}$ (R²=0.974) for *C. sloani* and W=0.0017 L$^{3.431}$ (R²=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), Bílge 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* andpositive 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-
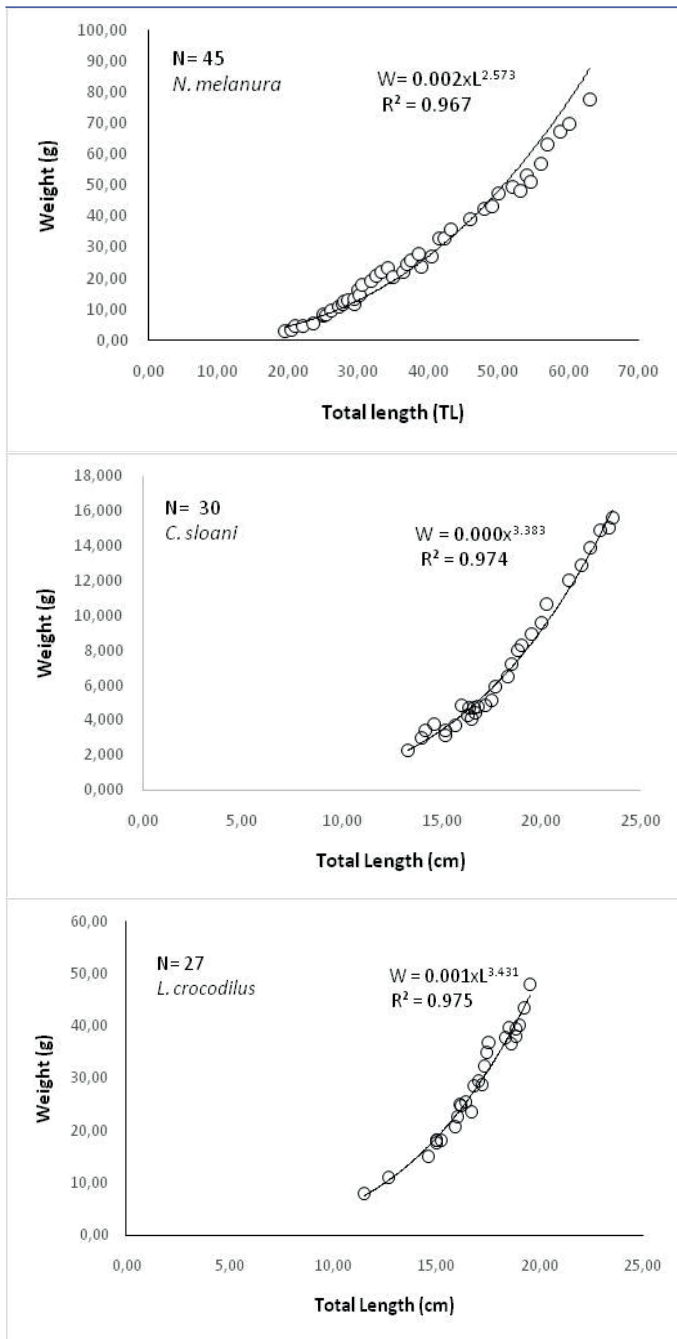
Figure 5. Length-weight relationship of combined sexes for three deep-sea fish species from the North-eastern Mediterranean, Turkey.

ues were generally in agreement with results for fishes of the same family obtained from other geographical regions except for *N. melanura*. These differences for *N. melanura* could be the result of ecological differences between regions or environmental differences (Frost, 1945). At the same time, the differences in the sampling time and sampling methods may also affect the relationships, as the numbers of specimens and length ranges of the species were distinct among localities (Tesch, 1971; Froese, 2006).

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 fulness 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 comperhensive 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.

REFERENCES

Bagenal, T. B. & Tesch, F. W. (1978). Methods for assessment of Fish Production in Fresh Waters, (3rd ed.). *IBP Handbook No. 3.* In T. Bagenal (Ed.)., (pp 101-136). London: Blackwell Scientific Publications, Oxford.

Beverton, R. J. H. & Holt, S. J. (1986). *On the dynamics of exploited fish populations.* London: Chapman and Hall.

Bílge, G., Yapici, S., Fíliíz, H. and Cerím, H. (2014). Weight-length relationshions for 103 fish species from the southern Aegean sea, Turkey. *Acta Ichthyologica et Piscatoria, 44*(3), 263-269. [CrossRef]

Deval, M. C., Güven, O. Saygu, I. & Kabapçioğlu, T. (2014). Length-weight relationships of 10 fish species found off Antalya Bay, eastern Mediterranean. *Journal of Applied Ichthyology, 30*(3), 567-568. [CrossRef]

Froese, R. (2006). Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. *Journal of Applied Ichthyology, 22*(4), 241-253. [CrossRef]

Froese, R. (1998). Length-weight relationships for 18 less-studied fish species. *Journal of Applied Ichthyology, 14*, 117-118. [CrossRef]

Froese, R. & Pauly, D. (2019). *Fishbase. Worldwide Web Electronic Publication.* Retrieved from http://www.fishbase.org (accessed 27.12.2019).

Frost, W. E. (1945). The age and growth of eels (*Anguilla anguilla*) from the Windermere catchment area. Part 2. *Journal of Animal Ecology, 14,* 106-l24. [CrossRef]

Garcia, C. B., Buarte, J. O., Sandoval, N., Von Schiller, D. & Mello, N. P. (1989). Length-weight relationships of demersal fishes from the Gulf of Salamanca, Colombia. *Fishbyte, 21*, 30-32.

Koutrakis, E. T. & Tsikliras, A. C. (2003). Length-weight relationships of fishes from three northern Aegean estuarine systems (Greece). *Journal of Applied Ichthyology, 19,* 258-260. [CrossRef]

Merella, P., Quetglas, A., Alemany, F. & Carbonell, A. (1997). Length-weight relationship of fishes and cephalopods from the Balearic Islands (western Mediterranean). *Naga, the ICLARM Quarterly, 20*(3/4), 66-68.

Pauly, D. (1993). Fishbyte section editorial. *Naga, the ICLARM Quarterly, 16,* 26.

Porcu, C., Follesa, M. C., Gastoni, A., Mulas, A., Pedoni, C. & Cau, A. (2013). The reproductive cycle of a deep-sea eel, *Nettastoma melanurum* (Nettastomatidae: Anguilliformes) from the south-eastern Sardinian Sea (central-western Mediterranean). *Journal of the Marine Biological Association of the United Kingdom, 93*(4), 1105-1115. [CrossRef]

Ricker, W. E. (1975). Computation and interpretation of biological statistics of fish populations. *Bulletin of the Fisheries Research Board of Canada, Bulletin, 191,* 1-400.

Tesch, F. W. (1971). *Age and growth.* In: W. E. Ricker (Ed.), Methods for assessment of fish production in fresh waters (pp 99-130). Oxford, Blackwell Scientific Publications.

Whitehead P. J. P., Bauchot M. L., Hureau J. C., Nielsen J., & Tortonese E. (Eds.) (1986). *Fishes of the north-eastern Atlantic and the Mediterranean.* Vols. I-III, UNESCO, Paris 1473 pp. ISBN: 92-3-002215-2.

Aquat Sci Eng 2020; 35(3): 89-93
Bayhan et al. Length-Weight Relationships for Three Deep Sea Fish Species in North Eastern Mediterranean, Turkey

94