

Weight-Length Relationships (WLRs) of Scaldback, *Arnoglossus kessleri* Schmidt, 1915 (Pleuronectiformes: Bothidae), Caught by Beam Trawl in the Southeastern Black Sea (Rize, Turkey)

Sabri BİLGİN^{1*} Hatice ONAY²

¹Sinop University Faculty of Fisheries and Aquaculture, TR57000, Sinop, Turkey

¹ORCID: <https://orcid.org/0000-0003-0155-8981>

²Recep Tayyip Erdoğan University Faculty of Fisheries and Aquaculture, TR53000, Rize, Turkey

²ORCID: <https://orcid.org/0000-0003-3463-7360>

Received date: 24.07.2019

Accepted date: 06.09.2019

How to cite: Bilgin, S. & Onay, H. (2019). Weight-Length Relationships (WLRs) of Scaldback, *Arnoglossus kessleri* Schmidt, 1915 (Pleuronectiformes: Bothidae), Caught by Beam Trawl in the Southeastern Black Sea (Rize, Turkey). *Anatolian Env. and Anim. Sciences*, 4(3), 354-358.

Atf yapmak için: Bilgin, S. & Onay, H. (2019). Güneydoğu Karadeniz'de (Rize, Türkiye) Krişli Trolle Yakalanan Dil Balığı'nın, *Arnoglossus kessleri* Schmidt, 1915 (Pleuronectiformes: Bothidae), Boy - Ağırlık İlişkisi. *Anadolu Çev. ve Hay. Dergisi*, 4(3), 354-358.

Abstract: The Scaldback, *Arnoglossus kessleri*, is an endemic fish to the Mediterranean and Black seas. The present study was conducted to determine the weight-length relationships (WLRs) of this endemic species caught by beam trawl on the Rize province coasts of the southeastern Black Sea, Turkey and to compare the WLRs parameters of *A. kessleri* from different geographical locality for contributing fisheries management of this fish species in the Black Sea. The WLRs parameters showed that *A. kessleri* exhibited positive allometric (or hyperallometric) growth characteristics for male and combined data (Pauly' t test, $P < 0.05$) and isometric growth for female (Pauly' t test, $P > 0.05$). The values of coefficient (r) for female, male and combined data of this species are different from zero ($P < 0.05$), indicated that *A. kessleri* has higher correlation in the WLRs equations. In addition to this, to compare the estimations calculated from the present study with other studies, $\log(a)$ values were plotted against values of slope (b), proved to be consistent with previous studies data for unsexed *A. kessleri* specimens. This study provides new basic information on the WLRs for *A. kessleri* populations, in support of sustainable fisheries management of this species and especially of the coastal waters in the Black Sea, Turkey.

Keywords: *Arnoglossus kessleri*, Black Sea, fisheries management, Scaldback, weight-length relationships (WLRs).

Güneydoğu Karadeniz'de (Rize, Türkiye) Krişli Trolle Yakalanan Dil Balığı'nın, *Arnoglossus kessleri* Schmidt, 1915 (Pleuronectiformes: Bothidae), Boy-Ağırlık İlişkisi

Öz: Dil balığı (*Arnoglossus kessleri*) Akdeniz ve Karadeniz'e endemik bir türdür. Bu çalışma, bu endemik dil balığın boy ağırlık ilişkisi (WLRs) parametrelerini belirlemek için güney doğu Karadeniz'de Rize ili civarında krişli trol ile örneklenen bireyler üzerinden yürütülmüş olup ayrıca türün Karadeniz'deki balıkçılık yönetimine katkı sağlamak amacıyla önceki çalışmalardan elde edilen WLRs parametreleri karşılaştırmıştır. WLRs parametreleri dişilerin izometrik büyüme (Pauly' t test, $P > 0,05$), erkek ve tüm bireylerin (dişi+erkek) ise pozitif allometrik (hyperallometric) büyüme (Pauly' t test, $P < 0,05$) özelliği gösterdiğini ortaya koymuştur. Korelasyon katsayısı (r) istatistiksel olarak sıfırdan farklı hesaplanmış olup ($P < 0,05$), bu sonuç dil balığı için hesaplanan WLRs denklemi parametreleri arasındaki ilişkinin güçlü olduğunu göstermiştir. Ayrıca, önceki çalışmalardan elde edilen $\log(a)$ ve b değerleri regresyona tabi tutulduğunda, bu çalışmada tüm *A. kessleri* bireyler için (dişi+erkek) elde edilen sonuçların önceki çalışmalarla tutarlı olduğu belirlenmiştir. Bu çalışma, Türkiye'nin Karadeniz kıyı sularında *A. kessleri* popülasyonlarının sürdürülebilir balıkçılık yönetimini desteklemek için türün boy ağırlık ilişkisi hakkında yeni temel bilgiler sunmaktadır.

Anahtar sözcükler: *Arnoglossus kessleri*, balıkçılık yönetimi, boy ağırlık ilişkisi (WLRs), Dil balığı, Karadeniz.

INTRODUCTION

Although there have been reports of six marine fish species distributed along the Turkish coasts belong to Bothidae family: *Arnoglossus imperialis* (Rafinesque, 1810), *Arnoglossus kessleri* Schmidt, 1915, *Arnoglossus laterna* (Walbaum, 1792), *Arnoglossus rueppelii* (Cocco, 1844), *Arnoglossus thori* Kyle, 1913 and *Bothus podas* (Delaroche, 1809), only three fish species belonging to this family: *A. kessleri*, *A. laterna* and *A. thori* have been reported from the Black Sea (Bilecenoğlu et al., 2014). According to FISHBASE (Froesa & Pauly, 2019) and the IUCN red list of threatened species (Golani et al., 2011; de Sola et al., 2014); Scaldback, *A. kessleri* (Pleuronectiformes: Bothidae), is endemic to the Mediterranean and Black seas and present all through the Mediterranean Sea coast, except for Morocco and Algeria. It also exists in the Aegean Sea, the Sea of Marmara, Crimean peninsula and the Sea of Azov (Golani et al., 2011; Bilecenoğlu et al., 2014; de Sola et al., 2014). It found on the upper part of the continental shelf, and feeds on small fish and invertebrates and its reproductive period is between May and August (Froesa & Pauly, 2019). It is uncommon species, but it is unknown if it is naturally rare, or rare due to fishing activities. Therefore, *A. kessleri* is listed as data deficient (DD) species in the IUCN red list of threatened species (Golani et al., 2011; de Sola et al., 2014).

Knowledge on biological features such as weight-length relationships (WLRs), growth characteristics, etc. of fish species are important tools for fisheries management. The WLRs is also useful for fisheries research because they allow estimating the condition and food and feeding, life histories of certain species such as reproduction activities and spawning (Stergiou & Moutopoulos, 2001). According to Pauly (1993) and Stergiou & Moutopoulos, (2001), the WLRs are very useful for fisheries research because they: (i) allow the conversion of growth-in-length equations to growth-in-weight for use in stock assessment models; (ii) allow the estimation of biomass from length observations; (iii) allow an estimate of the condition of the fish; and (iv) are useful for between region comparisons of life histories of certain species. Moreover, the WLRs parameters can be applied in different factors such as age, gonad activities, amount of food and feeding, sea water temperature, seasons etc. (Weatherley, 1972).

The WLRs parameters of *A. kessleri* were previously reported from different geographic regions such as Aegean Sea (Ilkyaz et al., 2008; Altın et al., 2015; Bayhan et al., 2008; Türker-Çakır et al., 2008), Marmara Sea (Ozen et al., 2009; Türker-Çakır et al., 2003; Keskin & Gaygusuz, 2010), Mediterranean (Ergüden et al., 2018) and also Black Sea (Ak et al., 2009). Moreover, previous research into the WLRs parameters of *A. kessleri* has been rather fragmentary in the Black Sea. Only one study has been conducted on the subject in the Black Sea coast of Turkey so far (Ak et al., 2009). The present study was conducted to determine the

weight length relationships (WLRs) of *A. kessleri* caught by experimental purposes beam trawl in the Black Sea, Turkey and to compare the WLRs parameters of *A. kessleri* from different geographical locality for contributing for marine biologist and fisheries managers to fisheries management of this fish species in the Black Sea.

MATERIALS and METHODS

Sample Collection: Samples of the Scaldback (*A. kessleri*) were collected via an experimental purposes beam trawl with 15 mm cod-end stretched mesh size up to 30 m water depths between December 2012 and November 2013 on the Rize province coasts of the southeastern Black Sea (Fig. 1).

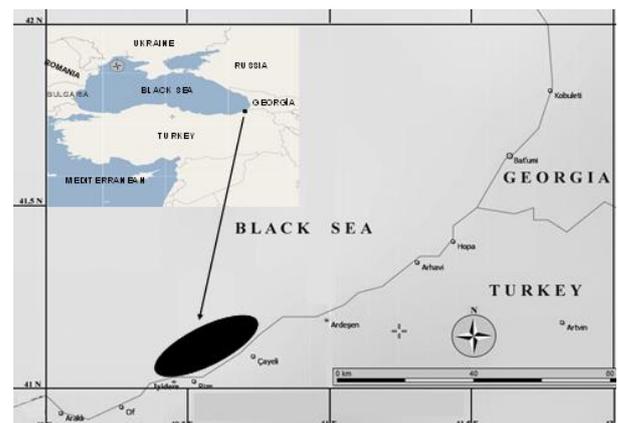


Figure 1. Beam trawl fishing operations sampling area on the Rize coasts in the southeastern Black Sea, Turkey.

Although beam trawl fishery is banned in the Rize province coasts of the southeastern Black Sea during the year, sampling surveys were conducted with a special permit to determine crab population dynamics project samples.

Weight-Length Relationships (WLRs): The total length (TL) and the wet body weight (W) of *A. kessleri* were measured after blot drying with a piece of clean towel. All specimens were measured to the nearest 0.1 cm and weighed to the nearest 0.01 g. The weight-length relationships (WLRs) parameters were calculated and analyzed using MS Excel software. However to compare the WLRs results for *A. kessleri* obtained in this study with the results of previous studies, the $\log(a)$ values were drawn against b values. The weight length relationship was estimated as:

$$W = aTL^b,$$

where W is the body weight (g), TL is the total length (cm), a is the intercept, and b is the slope of the regression line. Comparison of the difference of slope value from $b = 3$ (isometric growth), Pauly's t -test was performed (Pauly, 1984). Pauly's t -test statistic was calculated as below:

$$t = \frac{Sd_{\log TL} |b-3|}{Sd_{\log W} \sqrt{1-r^2}} \sqrt{n-2}$$

where Sd_{logTL} is the standard deviation of the log TL values, Sd_{logW} is the standard deviation of the log W values, n is the number of specimens used in the computation. The value of b is different from $b = 3$ if calculated t value is greater than the tabled t values for $n-2$ degrees of freedom (Pauly, 1984). Comparison of the difference of correlation coefficient (r) from zero t -test (Snedecor & Cochran, 1989) was calculated as follow:

$$t = \frac{r * \sqrt{(n - 2)}}{\sqrt{(1 - r^2)}}$$

where n is the number of fish used in the computation and r is the correlation coefficient. The value of correlation coefficient is different from zero if t value is greater than the tabled t values for $n-2$ degrees of freedom. T test was used to compare the means between the sexes in PAST ver 1.75b software package (Hammer et al., 2001). Differences were considered statistically significant when $P < 0.05$.

RESULTS

Size Structure: A total of 1548 *A. kessleri* (682 female, 866 male) were sampled between December 2012 and November 2013. Female total lengths ranged between 2.0 and 7.6 cm (mean 5.0 ± 0.03 cm) and male total lengths ranged between 3.0 and 8.1 cm (mean 5.3 ± 0.03 cm). Mean total length of *A. kessleri* was calculated between 2.0 - 8.1 cm (mean: 5.1 ± 0.02 cm, $n = 1548$) for combined data (female + male). Size frequency distribution were significantly different (Kolmogorov-Smirnov two-sample test; $d = 0.192$, $P = 9.05381E-13$) between female and male. The mean total length of male was significantly greater than female mean total length (t - test; $P = 1.1543E-09$).

Weight-Length Relationships (WLRs): The WLRs results and statistics of *A. kessleri* between male, female and combined sex showed below and in fig. 2.

$W = 0.0083TL^{3.000}$, $r^2 = 0.916$, $Sd_{logL} = 0.0701$, $Sd_{logW} = 0.2196$, $n = 682$, Pauly' t test = 0.000, $P > 0.05$, isometric growth (female).

$W = 0.0053TL^{3.287}$, $r^2 = 0.955$, $Sd_{logL} = 0.0763$, $Sd_{logW} = 0.2566$, $n = 866$, Pauly' t test = 11.846, $P < 0.05$, positive allometric (or hyperallometric) growth (male).

$W = 0.0063TL^{3.182}$, $r^2 = 0.940$, $Sd_{logL} = 0.0744$, $Sd_{logW} = 0.2441$, $n = 1548$, Pauly' t test = 8.913, $P < 0.05$, positive allometric growth (female+male).

The WLRs of *A. kessleri* samples collected from the Rize province coast in the Black Sea were showed that *A. kessleri* showed isometric growth ($b = 3.000$) characteristics for female (Pauly' t test, $P > 0.05$) and negative allometric growth ($b = 3.287$) for male (Pauly' t test, $P < 0.05$).

However, in order to comparison of the difference of correlation coefficient (r) from zero t -test (Snedecor and Cochran, 1989) was applied and the values of (r) for female ($r = 0.957$, t test: 297.089), for male ($r = 0.977$, t test: 135.443) and for combined data ($r = 0.970$, t tests: 155.675)

are different from zero ($P < 0.05$), indicated that *A. kessleri* has higher correlation in WLRs equations.

To compare the estimations calculated from the present study with other studies (showed in Table 1), $\log(a)$ values were plotted against values of b (fig. 3), proved to be consistent with previous studies data for *A. kessleri*.

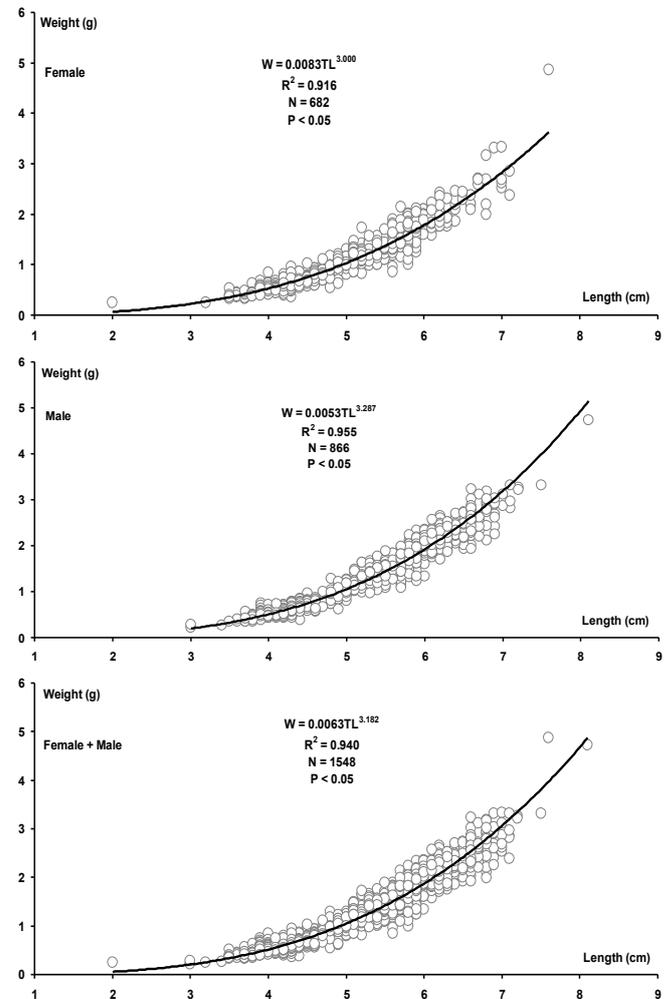


Figure 2. Weight - length relationships (WLRs) of the Scaldback (*Arnoglossus kessleri*) in the Black Sea.

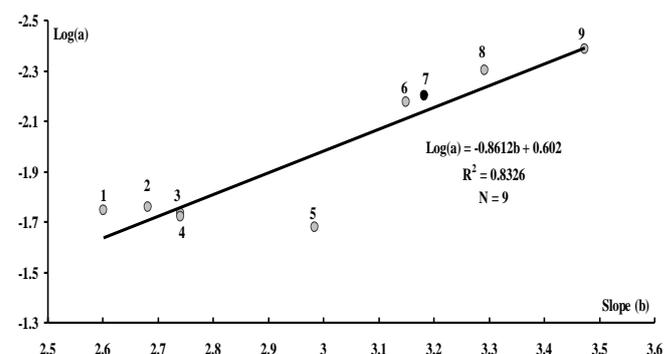


Figure 3. Test plot of $\log(a)$ against b for different WLRs of the Scaldback (*Arnoglossus kessleri*). Black dot = present study parameter. Grey dot = estimated parameters of different studies conducted from Black Sea (5: Ak et al., 2009; 7: present study), Marmara Sea (2: Türker-Çakır et al., 2003; 6: Ozen et al., 2009; 9: Keskin and Gaygusuz, 2010), Aegean Sea (1: Bayhan et al., 2008; 3: Ilkyaz et al., 2018); 8: Altın et al., 2015) and Mediterranean Sea (4: Ergüden et al., 2018).

DISCUSSION

In all previous studies, except for the present study conducted in the Black Sea and Ergüden et al., (2018)'s study conducted in the Iskenderun Bay (Eastern Mediterranean), the b values were reported regardless of fish sexes (Table 1). The reported b values for unsexed specimens ranged between 2.600 and 3.474 (mean: 2.997 ± 0.093 , $n = 9$). From the reported b values for *A. kessleri* populations from Black Sea, Marmara Sea, Aegean Sea and Mediterranean, it can be inferred that this fish species exhibits different growth characteristics. Beside this, our data fit the regression for the species *A. kessleri* excellently and growth parameters are highly similar to three of the previous 9 studies conducted in Aegean Sea (Altın et al., 2015) and Marmara Sea (Ozen et al., 2009; Keskin & Gaygusuz, 2010) (see Table 1). In the literature, this is the second study evaluating the WLRs parameters by sex for the relevant *A. kessleri* fish species. When the b values were evaluated according to sexes, our b values (3.287 in male and 3.000 in female) were different than Ergüden et al. (2018)'s study (2.790 in male and 2.680 in female). The b values of the WLRs showed that females ($b = 3.000$) have isometric growth type, while males ($b = 3.287$) have hyperallometric or positive allometric growth type. Based on the slope (b) of the relation between weight and length, it can be checked whether the growth of a fish species is isometric ($b = 3$), hypoallometric ($b < 3$) and/or hyperallometric ($b > 3$) (Froese, 2006; Froese et al., 2011). Namely, if the slope is equal to 3, all fish dimensions

increase at the same rate (isometric growth), if the slope < 3 , a fish increases less in weight than predicted by its increase in length, i.e., it becomes more elongated (hypoallometric or negative allometric), if the slope > 3 , a fish increases more in weight than predicted by its increase in length, i.e., it becomes less elongated or more roundish (hyperallometric or positive allometric) (Froese et al., 2011). The differences in the b values may be due to seasonal changes in the water temperature and the maturity stage, different sampling area, age, sex and differences of other biotic and abiotic factors such as salinity, competition, food and feeding, degree of stomach fullness, etc. The correlation coefficient (r) both female and male for *A. kessleri* has higher correlation in the WLRs equations and also $\log(a)$ values were plotted against b values for *A. kessleri* (fig. 3) proved to be consistent with previous studies data. Similar result for different fish species such as thornback ray (*Raja clavata*) and turbot (*Scophthalmus maximus*) was reported by Bilgin & Köse (2018) from the Black Sea.

In conclusion, the present study reports new WLRs parameters for both female and male of the native species, *A. kessleri* inhabiting the Black Sea and provides some essential information on *A. kessleri* from the Rize province coasts of the southeastern Black Sea. The data on the WLRs parameters are expected to be helpful in fisheries management especially of the coastal waters in the Black Sea, Turkey, since the species has been declared as a data deficient (DD) species in the IUCN red list of threatened species (Golani et al., 2011; de Sola et al., 2014).

Table 1. The weight - length relationships (WLRs) parameters of Scaldback (*Arnoglossus kessleri*), from different geographical locality. TL: total length (cm), a : intercept, b : slope, n : number of samples. Data (a and b) marked with (*) has been used to draw of test plot of $\log(a)$ against b in figure 3.

a	b	r^2	n	TL range (cm)	Sex	Locality	References
0.0185	2.740	0.961	7	6.9-9.6	Unsexed*	Aegean Sea	İlkyaz et al., (2008)
0.0050	3.292	0.933	393	1.3-11.2	Unsexed*	Aegean Sea	Altın et al., (2015)
0.0179	2.601	0.878	76	6.0-8.9	Unsexed*	Aegean Sea	Bayhan et al., (2008)
0.0067	3.150	0.974	44	2.9-9.8	Unsexed*	Marmara Sea	Ozen et al., (2009)
0.0174	2.682	0.869	32	5.2-9.5	Unsexed*	Marmara Sea	Türker-Çakır et al., (2003)
0.0041	3.474	0.968	24	4.2-8.7	Unsexed*	Marmara Sea	Keskin & Gaygusuz, (2010)
0.0190	2.740	0.957	133	7.0-11.9	Unsexed*	Mediterranean	Ergüden et al., (2018)
0.0210	2.984	0.725	60	4.3-9.8	Unsexed*	Black Sea	Ak et al., (2009)
0.0063	3.182	0.940	1548	2.0-8.1	Unsexed*	Black Sea	Present study
0.0170	2.790	0.960	65	7.0-11.9	Male	Mediterranean	Ergüden et al., (2018)
0.0053	3.287	0.955	866	2.0-7.6	Male	Black Sea	Present study
0.0220	2.680	0.953	68	7.7-11.8	Female	Mediterranean	Ergüden et al., (2018)
0.0083	3.000	0.916	682	2.0-7.6	Female	Black Sea	Present study

ACKNOWLEDGEMENTS

We thank to Ozay Köse, Burak Taşçı, Yusuf Ceylan and Ahmet Kalkavan for their help in the field work. This study was supported by Scientific Research Project Coordination Unit of Recep Tayyip Erdoğan University. Project number is 2010.103.03.1.

REFERENCES

- Ak, O., Kutlu, S. & Aydın, I. (2009). Length-weight relationship for 16 fish species from the eastern Black Sea, Türkiye. *Turkish Journal of Fisheries and Aquatic Sciences*, **9**, 125-126.
- Altın, A., Ayyıldız, H., Kale, S. & Alver, C. (2015). Length-weight relationships of forty-nine fish

- species from shallow waters of Gökçeada Island, northern Aegean Sea. *Turkish Journal of Zoology*, **39**, 971-975. doi: 10.3906/zoo-1412-15.
- Bayhan, B., Sever, T.M., & Taşkavak, E. (2008).** Length-weight relationships of seven flatfishes (Pisces: Pleuronectiformes) from Aegean Sea. *Turkish Journal of Fisheries and Aquatic Sciences*, **8**, 377-379.
- Bilecenoğlu, M., Kaya, M., Cihangir, B. & Çiçek, E. (2014).** An updated checklist of the marine fishes of Turkey. *Turkish Journal of Zoology*, **38**, 901-929. Doi: 10.3906/zoo-1405-60.
- Bilgin, S. & Köse, O. (2018).** Length-weight relationships (LWRs) of target fish turbot, *Scophthalmus maximus* (Pleuronectiformes: Scophthalmidae) and non-target fish thornback ray, *Raja clavata* (Rajiformes: Rajidae) caught by turbot gill net fishery in the Black Sea, Turkey. *Cahiers de Biologie Marine*, **59**, 615-622. Doi: 10.21411/CBM.A.546928E7.
- De Sola, L., Nielsen, J., Monroe, T., Costa, M. & Herrera, J. (2014).** *Arnoglossus kessleri* (errata version published in 2016). The IUCN Red List of Threatened Species 2014:e. T194897A103945339. <http://dx.doi.org/10.2305/IUCN.UK.2014-3.RLTS.T194897A49088611.en>. (Downloaded on 23 July 2019).
- Ergüden, S.A., Altun, A. & Ergüden, D. (2018).** Length-weight relationship and condition of *Arnoglossus kessleri* Schmidt, 1915 in Iskenderun Bay (Eastern Mediterranean, Turkey). *Sakarya University Journal of Science*, **22**, 1617-1622. Doi: 10.16984/saufenbilder.347576.
- Froese, R. (2006).** Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. *Journal of Applied Ichthyology*, **22**, 241-253. Doi: 10.1111/j.1439-0426.2006.00805.x.
- Froese, R. & Pauly, D. (2019).** FishBase. World Wide Web electronic publication. www.fishbase.org, version (02/2019).
- Froese, R., Tsikliras, A.C. & Stergiou, K.I. (2011).** Editorial note on weight-length relations of fishes. *Acta Ichthyologica et Piscatoria*, **41**, 261-263. Doi: 10.3750/AIP2011.41.4.01.
- Golani, D., Kada, O., Nouar, A., Quignard, J.P. & Cuttelod, A. (2011).** *Arnoglossus kessleri*. The IUCN Red List of Threatened Species 2011:e. T194897A8917203. Downloaded on 23 July 2019.
- Hammer, Ø., Harper, D.A.T. & Ryan, P.D. (2001).** PAST: Paleontological Statistics Software Package for Education and Data Analysis. *Palaeontologia Electronica*, **4**, 1-9.
- Ilkyaz, A.T., Metin, G., Soykan, O., & Kinacigil, H. (2008).** Length-weight relationship of 62 fish species from the Central Aegean Sea, Turkey. *Journal of Applied Ichthyology*, **24**, 699-702. doi: 10.1111/j.1439-0426.2008.01167.x
- Keskin, C. & Gaygusuz, Ö. (2010).** Length weight relationships of fishes in shallow waters of Erdek Bay (Sea of Marmara, Turkey). *IUFS Journal of Biology*, **69**, 87-94.
- Ozen, O., Ayyildiz, H., Oztekin, A. & Altin, A. (2009).** Length-weight relationships of 17 less-studied fish species from Çanakkale, Marmara region of Turkey. *Journal of Applied Ichthyology*, **25**, 238-239. Doi: 10.1111/j.1439-0426.2009.01235.x.
- Pauly, D., (1984).** *Fish population dynamics in tropical water: a manual for use with programmable calculators*. The International Center for Living Aquatic Resources Management, Makati, Metro Manila, Philippines, 323 p.
- Pauly, D. (1993).** Fishbyte Section Editorial, Naga, *The ICLARM Quarterly*, **16**, 26-27.
- Snedecor, G.W. & Cochran, W.G. (1989).** *Statistical methods*, Iowa State University Press: Ames, Iowa, 803 pp.
- Stergiou, K.I. & Moutopoulos, D.K. (2001).** A review of length-weight relationships of fishes from Greek marine waters. Naga, *the ICLARM Quarterly*, **24**, 23-39.
- Türker-Çakır, D., Akahn, S., Ünlüoğlu, A., Bayhan, B. & Hoşsucu, B. (2003).** The flatfish species in Edremit Bay and length-weight relationships for three of them *Citharus linguatula* (Linnaeus, 1758), *Arnoglossus laterna* (Walbaum, 1792), *Arnoglossus kessleri* (Schmidt, 1915). *Ege University Journal of Fisheries & Aquatic Sciences*, **20**, 529-536.
- Türker-Çakır, D., Koç, H.T., Basusta, A. & Basusta, N. (2008).** Length-weight relationships of 24 species from Edremit Bay, Aegean Sea. *e-Journal of New World Sciences Academy*, **3**, 47-51.
- Weatherley, A.H. (1972).** *Growth and ecology of fish populations*. Academic Press, London, UK, 293 p.

*Corresponding author's:

Doç. Dr. Sabri BİLGİN

Sinop University Faculty of Fisheries and Aquaculture, TR57000, Sinop, Turkey

E-mail : sbrbilgin@hotmail.com

ORCID : <https://orcid.org/0000-0003-0155-8981>

Tel : +90 (368) 287 62 54-3391

Fax : +90 (368) 287 62 69