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Short Communication

Length-weight relationships of *Atherina boyeri* Risso, 1810 and *A. hepsetus* Linnaeus, 1758 (Teleostei: Atherinidae) from some inland, brackish water and marine systems of Turkey

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Members of Genus *Atherina* inhabit inshore marine environments as well as brackish and freshwater habitats. Growth properties of *Atherina* species remain poorly understood, despite their wide distribution. This study aims to present the length–weight relationships of Mediterranean sand smelt, *Atherina hepsetus* Linnaeus, 1758 and Big-scale sand smelt, *Atherina boyeri* from some inland, brackish water and marine systems of Turkey. During the study conducted from November 2014 to June 2017, a total number of 1183 fish specimens ranging from 2.5-15.4 cm in total length and 0.06-23.9 g in weight were analyzed. The slope value *(b)* of the length weight relationships obtained for *A. boyeri* and *A. hepsetus* were between 2.563-3.412 with an average value of 3.26 and between 2.523-3.118 with an average value of 2.81, respectively. While eight populations of *A. boyeri* showed negative allometric growth pattern, seven of them exhibited positive allometric growth pattern. The only one population of *A. hepsetus* showed positive allometric growth pattern, whereas its three populations had negative allometric growth pattern. This study also provides new maximum length recorded for *A. hepsetus*.

[**Keywords**: Anatolia, Coastal areas, Estuaries, Freshwater, Sand smelt]

Introduction

Atherinidae is represented by two native species (Mediterranean sand smelt, *Atherina hepsetus* Linnaeus, 1758 and Big-scale sand smelt, *Atherina boyeri* Risso, 1810), and one alien species, Red Sea hardyhead silverside, *Atherinomorus forskalii* (Rüppell, 1838) in the Mediterranean Coast of Turkey[1]. *A. boyeri* is the most frequent Atherinid species of the Turkey coast, while the other species are sparse.

The genus *Atherina*, commonly known as smelts, inhabit naturally in the lagoons and estuaries of Black Sea, Sea of Azov and Mediterranean. Moreover, *A. boyeri* was introduced into many lakes for stock enhancement purposes or due to accidental transfer[2-4]. Adaptability to variable environmental conditions allows the *A. boyeri* to become established in many aquatic habitats outside their native range. Abundance of this small pelagic fish has significantly increased in some altered and natural lake systems of Turkey more recently (personal obs, Deniz Innal).

The importance of growth parameters and length weight relationships has been emphasised by various researchers. For the successful management of populations of *Atherina* species, it is important to understand the relationship between length and weight of these fishes in their natural environment. In Turkey, sand smelts have been poorly studied and very little biological information is available[3-9]. This study presents the existence and length-weight relationship for Mediterranean sand smelt and Big-scale sand smelt, from some inland, brackish water and marine systems of Turkey.

Material and Methods

The study was carried out in 19 different locations (Zonguldak-Ereğli; İstanbul-Çilingöz; Rize; Bursa-Mudanya; İzmir-Çandarlı; Gelibolu-Saros; Çanakkale Gulf; Izmit Gulf; Demirköprü Dam Lake; Gölmarmara Lake; Eğirdir Lake; Bafa Lake; Yumurtalık Lagoon Lake; Köyceğiz Lagoon Lake; Seyhan River Estuary; Ceyhan River Estuary; Köprüçay River Estuary; Beşgöz Creek; Kopak Creek) in Turkey. Field studies were conducted from November 2014 to June 2017. Specimens were sampled using various fishing gear (Shore seine net and purse seine). Fish specimens were identified to species level according to Whitehead *et al.*[10]. Specimens were measured to the nearest 0.1 cm total length and weighted to the nearest 0.01 g total weight. Length-weight relationships were estimated for the total sample according to the allometric equation suggested by Ricker[11], $W = aL^b$. Where, W = mass in grams; L = total length in centimeters. “a” is intercept and “b” is regression coefficient indicating the shape of fish in terms of isometric or allometric growth type. The b values of length–weight regressions were compared to 3 using Student’s *t*-test to ascertain the growth type.

Results

Locality, size range (cm, TL; gr, W), coefficients of length–weight relationship (*a*, *b*), and the determination coefficient (r^2) were given in Table 1.

Overall, 1448 individuals comprising both species were analyzed. Out of the total fish samples, 1183 (81.7 %) were *Atherina boyeri* and 265 (18.3 %) were *Atherina hepsetus* (Table 1). Total length ranged between 2.5 and 13.6 cm with an average value of 6.45 for *A. boyeri* and ranged between 8.5 and 15.4 cm with an average value of 12.00 for *A. hepsetus*. The weight of 0.06-16.5 g with mean value of 2.45 and 3.9-23.9 g with mean value of 12.32 for *A. boyeri* and *A. hepsetus*, respectively were recorded. These results provide new maximum length and weight for *A. hepsetus* along the Turkish Coast.

In total, seventeen population of *A. boyeri* was categorized related to their habitat type. These were divided into three categories as fresh water, brackish and marine water. The size structures of the individuals were different among these ecosystems. The length ranges were 2.5-10.5 cm in brackish water, 3.1-12.5 cm in marine and 3.8-13.6 cm in freshwater populations while the weights ranges were 0.06-8.42 g in brackish water, 0.2-12.8 g in marine and 0.27-16.5 g in freshwater populations.

As seen in Table 1, the sample size ranged from 6 from Seyhan river to 217 from Köyceğiz lagoon lake. Values of 'a' and 'b' varied among the populations of *A. boyeri* and *A. hepsetus*. The study showed that the slope *b* value of the length-weight relationships of *A. boyeri* was 3.26 (1183 individuals), while same

Table1 — Locality, size range (cm, TL; gr, W), length–weight parameters *a* and *b*, and the determination coefficient (r^2) of *Atherina* species (Growth pattern; N: negative allometry; P: positive allometry)

Species	Locality	N	TL (cm)	Weight (g)	a	b	95% CI of b	r^2	Growth pattern
			Min-Max	Min-Max					
Atherina boyeri	Brackish water populations								
	Seyhan Estuary	6	4.7-7.2	0.5- 1.81					
	Beşgöz Estuary	14	3.2-5.6	0.18-1.13	0.003	3.412	3.3823-3.4553	0.96	P
	Kopak Estuary	14	5.2 -7.4	0.87-2.38	0.008	2.825	2.8066-2.8464	0.94	N
	Köprüçay Estuary	14	4.3-6.8	0.5- 2.7	0.005	3.169	3.1373-3.1851	0.97	P
	Yumurtalık Lagoon	82	3.6- 6.3	0.24 -1.7	0.004	3.302	3.2938-3.3182	0.96	P
	Ceyhan Estuary	154	3.6-7.2	0.1- 2.3	0.007	2.987	2.9808-2.9992	0.92	N
	Bafa Lagoon	184	2.5-10.5	0.06-8.42	0.004	3.327	3.3155-3.3376	0.97	P
	Köyceğiz Lagoon	217	2.5-7.9	0.1- 2.75	0.012	2.563	2.5488-2.5801	0.9	N
	All Brackish water populations	685	2.5-10.5	0.06-8.42					
Atherina boyeri	Marine populations								
	Coast of Izmir-Çandarlı	7	7.5-9.1	2.7-4.01					
	Coast of Mudanya-Bursa	22	9.2-11.5	6.5-12.8	0.018	2.63	2.6128-2.6495	0.73	N
	Coast of Zonguldak-Ereğli	43	6.7- 10.6	2.4 -10.5	0.007	3.098	3.0843-3.117	0.94	P
	Coast of İstanbul -Çilingöz	55	7.1-9.6	2.4-6.9	0.009	2.87	2.8605-2.8808	0.85	N
	Coast of Rize	93	8.6-12.5	3.9-12.4	0.006	3.041	3.0305-3.046	0.85	P
	Coast of Gelibolu	103	3.1- 8.5	0.2 -4.1	0.005	3.162	3.1505-3.1684	0.97	P
	All Marine populations	323	3.1-12.5	0.2-12.8					
Atherina boyeri	Freshwater populations								
	Gölmarmara Lake	20	3.8-4.7	0.36-0.64	0.001	2.58	2.5617-2.5935	0.88	N
	DemirköprüDam Lake	41	3.9-13.6	0.4- 16.5	0.008	2.949	2.9367-2.9624	0.99	N
	Eğirdir Lake	114	3.9-6.6	0.27-1.45	0.006	2.781	2.7629-2.7961	0.83	N
	All Freshwater populations	175	3.8-13.6	0.27-16.5					
Atherina boyeri	Total	1183	2.5-13.6	0.06-16.5					
Atherina hepsetus	Marine populations								
	Coast of Çanakkale	20	8.5-11.1	3.9-9	0.005	3.118	3.1005-3.1376	0.84	P
	Coast of Mudanya-Bursa	31	13.3 -15.2	14.4-23.9	0.007	2.97	2.9657-2.9792	0.81	N
	Coast of Izmit	32	10.5-15.4	8.7-22.5	0.014	2.736	2.7225-2.7481	0.91	N
	Coast of Rize	182	9.2-13.5	5.8- 16.4	0.023	2.523	2.5182-2.5268	0.86	N
Atherina hepsetus	Total	265	8.5-15.4	3.9-23.9					

(Growth pattern; N: negative allometry; P: positive allometry)

exponent was equal to 2.81 for *A. hepsetus* (Fig. 1). When considering each region separately, the highest *b* value (3.412) was found in Beşgöz Creek, whereas the lowest *b* value (2.563) was recorded in Köyceğiz Lagoon. The *b* values calculated in three ecosystems differed from each other (Fig. 2).

The highest value of parameter *b* value (3.2934) was calculated in fresh water ecosystem, whereas the lowest *b* value (3.0191) was found in marine water. Among *Atherina* populations, the determination coefficient (r^2) ranged from 0.73 to 0.98. 57.9 % of the species had r^2 values higher than 0.90, 36.8 % had r^2 values between 0.80-0.90 while 5.3 % had r^2 values lower than 0.80. Based on the all individuals results of the *t*-test, the growth exponent, *b* values of both species were significantly different ($p < 0.05$) from 3 (Table 1). *A. boyeri* has an positive allometric growth type, while *A. hepsetus* has a negative allometric growth type.

Discussion

Atherinidae is an important family in terms of ecological tolerance and wider distribution. We investigate the length-weight relationships of two sand smelt species from 19 different populations. No information on length-weight relationships of the selected fish species was available for the present study areas, except for the three localities that had been previously studied. This study revealed that slope *b* value of the length-weight relationships of *A. boyeri* remained within the range of 2.563-3.412, while this value was within the range of 2.523-3.118 for *A. hepsetus*. Two growth patterns (negative allometry and positive allometry) were observed among the populations studied herein. While eight populations of *A. boyeri* showed negative allometric growth pattern, seven of them exhibited positive allometric growth pattern. The only one population

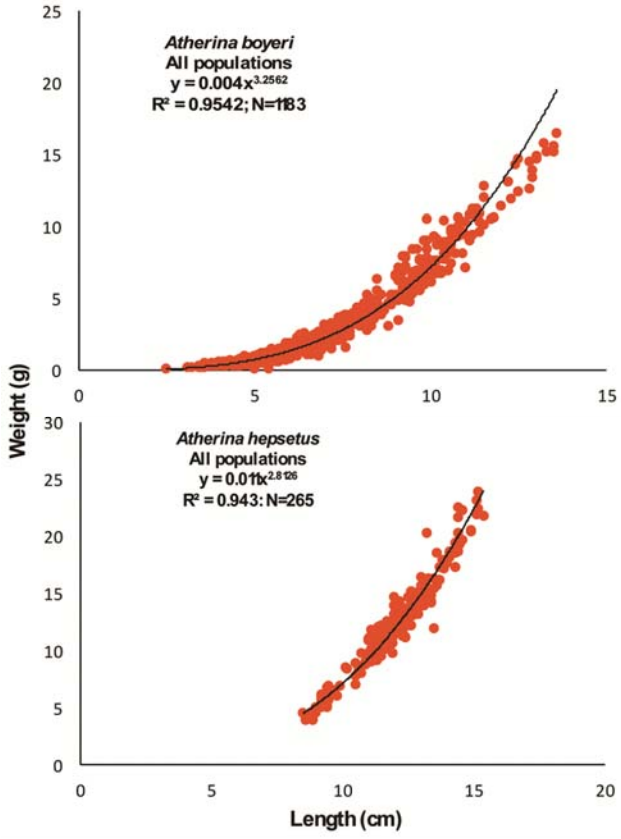

Fig. 1 — Length weight relationships of *A. boyeri* and *A. hepsetus*

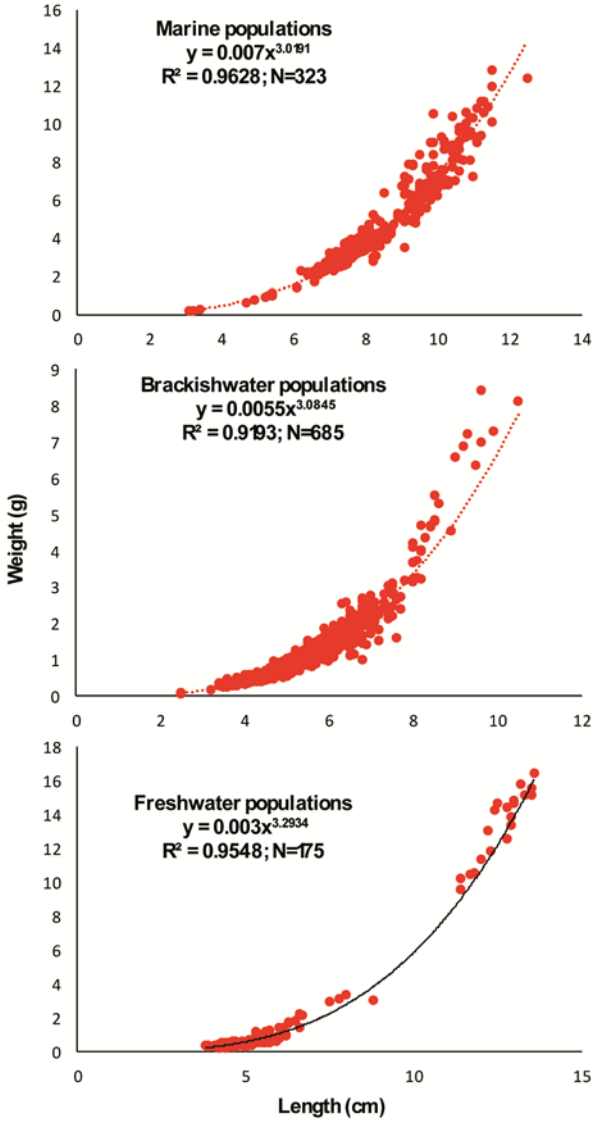

Fig. 2 — Length weight relationships of freshwater, brackish water and marine populations of *A. boyeri*

showed positive allometric growth pattern for *A. hepsetus*, while three populations showed negative allometric growth pattern.

The parameter *b* values for these fish species varied in many studies conducted in different regions[7-9,12-24]. Length-weight relationships are an important parameter for comparative growth studies[25]. The comparison of the *b* value in our work and in those previously reported by other authors showed variations and similarities among regions (Table 2). The slope *b* value of the LWR equations showed a great variation from one population to another within the same species (Table 2).

The factors affecting the b value has been reported by various authors[25-27]. The difference between the localities depends on changing habitat conditions such as temperature, pH, salinity and dissolved oxygen and biotic parameters. For some populations, the data

Table 2 — Summary of estimated length-weight parameters for *Atherina* species in Turkish waters

Species	Localite	N	Length	Length range (cm)		Weight range (g)		a	b	r^2	Reference
			Type	Min	Max	Min	Max				
Brackish water populations											
A. boyeri	Köyceğiz Lagoon	217	TL	2.5	7.9	0.1	2.75	0.012	2.563	0.9	Present study
A. boyeri	Kopak Estuary	14	TL	5.2	7.4	0.87	2.38	0.008	2.825	0.94	Present study
A. boyeri	Homa Lagoon	103	TL	3.4	10.6	0.29	8.4	0.007	2.963	0.999	(12)
A. boyeri	Gediz Estuary	121	TL	3.2	10.1	0.24	7.29	0.0073	2.985	0.9993	(13)
A. boyeri	Ceyhan Estuary	154	TL	3.6	7.2	0.1	2.3	0.007	2.987	0.92	Present study
A. boyeri	Köprüçay Estuary	14	TL	4.3	6.8	0.5	2.7	0.005	3.169	0.97	Present study
A. boyeri	Yumurtalık Lagoon	82	TL	3.6	6.3	0.24	1.7	0.004	3.302	0.96	Present study
A. boyeri	Küçükçekmece Lagoon	15	TL	3.9	11.1			0.0035	3.31	0.992	(14)
A. boyeri	Bafa Lagoon	184	TL	2.5	10.5	0.06	8.42	0.004	3.327	0.97	Present study
A. boyeri	Beşgöz Estuary	14	TL	3.2	5.6	0.18	1.13	0.003	3.412	0.96	Present study
A. boyeri	Sarıkum Lake	25	TL	8.5	11.5	5	13				(15)
A. boyeri	Seyhan Estuary	6	TL	4.7	7.2	0.5	1.81				Present study
A. hepsetus	Gediz Estuary	83	TL	4.3	9	0.52	4.91	0.0058	3.069	0.9901	(13)
A. hepsetus	Homa Lagoon	66	TL	5	10.6	0.79	8.1	0.0059	3.06	0.998	(12)
Marine populations											
A. boyeri	Coast of Mudanya-Bursa	22	TL	9.2	11.5	6.5	12.8	0.018	2.63	0.73	Present study
A. boyeri	Coast of İstanbul-Çilingöz	55	TL	7.1	9.6	2.4	6.9	0.009	2.87	0.85	Present study
A. boyeri	Coast of Rize	93	TL	8.6	12.5	3.9	12.4	0.006	3.041	0.85	Present study
A. boyeri	İzmir Bay	596	TL	4.3	9.7	0.45	5.29	3.00E-06	3.196	0.932	(5)
A. boyeri	Coast of Zonguldak-Ereğli	43	TL	6.7	10.6	2.4	10.5	0.007	3.098	0.94	Present study
A. boyeri	Coast of Gelibolu	103	TL	3.1	8.5	0.2	4.1	0.005	3.162	0.97	Present study
A. boyeri	Candarli Bay	1558	TL	1	9.4	0.004	5.59	0.0043	3.187	0.972	(16)
A. boyeri	Erdek Bay	606	TL	2.5	11.2			0.0045	3.215	0.974	(17)
A. boyeri	Gökçeada Island	4490	TL	1	13.5	0.01	18.25	0.003	3.398	0.978	(18)
A. boyeri	İzmir Bay	138	FL	4.8	9.8	0.6	4.86	0.0048	3.165	0.98	(19)
A. boyeri	Marmara Sea	14	TL	7.6	11.7	1.84	8.4	0.0015	3.485	0.992	(20)
A. boyeri	Coast of Izmir-Çandarlı	7	TL	7.5	9.1	2.7	4.01				Present study
A. hepsetus	Coast of Mudanya-Bursa	31	TL	13.3	15.2	14.4	23.9	0.007	2.97	0.81	Present study
A. hepsetus	Coast of Çanakkale	20	TL	8.5	11.1	3.9	9	0.005	3.118	0.84	Present study
A. hepsetus	Coast of Rize	182	TL	9.2	13.5	5.8	16.4	0.023	2.523	0.86	Present study
A. hepsetus	Coast of Izmit	32	TL	10.5	15.4	8.7	22.5	0.014	2.736	0.91	Present study
A. hepsetus	Erdek Bay	65	TL	2.7	14.8			0.0037	3.236	0.979	(17)

(*Contd*.)

Table 2 — Summary of estimated length-weight parameters for *Atherina* species in Turkish waters — (*Contd.*)

Species	Localite	N	Lenght	Lenght range (cm)		Weigth range (g)		a	b	r^2	Reference
			Type	Min	Max	Min	Max				
Freshwater populations											
A. boyeri	Ömerli Dam Lake	442	TL	7.7	12.9			0.0159	2.66	0.826	(14)
A. boyeri	Eğirdir Lake	114	TL	3.9	6.6	0.27	1.45	0.006	2.781	0.83	Present study
A. boyeri	Gölmarmara Lake	20	TL	3.8	4.7	0.36	0.64	0.001	2.58	0.88	Present study
A. boyeri	Eğirdir Lake	182	TL	5.9	9.5	1.35	5.39	2.00E-06	3.2549	0.8929	(7)
A. boyeri	Eğirdir Lake	152	FL	2.47	9.41	0.4	6.7	0.1188	1.6124	0.9011	(21)
A. boyeri	Hirfanlı Reservoir	323	TL	4.98	11.25			-2.4023	3.2376	0.97	(22)
A. boyeri	Marmara Lake	101	TL	3.7	8.7	0.4	5.4	0.0084	2.908	0.971	(23)
A. boyeri (J)	Hirfanlı Reservoir	69	TL	0.58	11.6	0.01	10.48	$2x10^{-6}$	3.5001	0.9726	(8)
A. boyeri	Hirfanlı Dam Lake	1449	TL	2.9	9.5	0.14	6.42	0.01399	2.7385	0.973	(9)
A. boyeri (F)	Hirfanlı Reservoir	288	TL	3.4	11.6	0.23	10.48	$2x10^{-6}$	3.2929	0.9763	(8)
A. boyeri	İznik Lake	922	TL	0.8	11.5	0.001	11	0.004	3.209	0.978	(3)
A. boyeri (M)	Hirfanlı Reservoir	264	TL	2.9	8.9	0.12	5.42	$2x10^{-6}$	3.2313	0.9783	(8)
A. boyeri	Demirköprü Dam Lake	41	TL	3.9	13.6	0.4	16.5	0.008	2.949	0.99	Present study
A. boyeri	Büyükçekmece Reservoir	22	SL	3.1	6.1	0.295	2.36				(24)

were not representative for all the months. Thus, these estimated parameters should be considered to represent only a particular season. In addition to seasonality and habitat conditions, the observed differences could be due to the sample size, type of gear, preservation technique, sex ratio and length range.

This study provides valuable information on length-weight relationship of two *Atherina* species from Turkey. The findings of this study could also be beneficial for fishery biologists considered to initiate the researches on stock assessment and growth properties of these *Atherina* species in Turkey and in neighbouring countries.

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Conflict of Interest

The authors have no conflicts of interest to declare.

Author Contributions

Both the authors equally contributed for field and laboratory studies. Statistical analyses and length-weight relationships were performed by Dİ.

References

1 Bilecenoğlu M, Kaya M, Cihangir B & Çiçek E, An updated checklist of the marine fishes of Turkey, *Turk J Zool*, 38 (2014) 901-929.

2 Innal D & Erk'akan F, Effects of exotic and translocated fish species in the inland waters of Turkey, *Rev Fish Biol Fisher*, 6 (2006) 39-50.

3 Özeren S C, Age, growth and reproductive biology of the sand smelt *Atherina boyeri*, Risso 1810 (Pisces: Atherinidae) in Lake Iznik, Turkey, *J Fish Int*, 4 (2009) 34-39.

4 Küçük F, Güçlü S S, Gülle İ, Güçlü Z, Çiçek N L, *et al.*, Reproductive Features of Big Scale-Sand Smelt, *Atherina boyeri* (Risso, 1810), an Exotic Fish in Lake Eğirdir (Isparta, Turkey), *Türk J Fish Aquat Sc*, 12 (2012) 729-733.

5 Taşkavak E, Gürkan Ş & Bayhan B, İzmir Körfezi (Ege Denizi) 'nde Gümüş Balığı *Atherina boyeri* Risso, 1810 'nın Biyometrik Özellikleri, *Journal of FisheriesSciences.com*, 6 (2012) 18-25.

6 Çolak S Ö, The helminth community of the sand smelt (*Atherina boyeri* Risso, 1810) from Lake Iznik, Turkey, *J Helminthol*, 87 (2013) 129-134.

7 Bostancı D, Apaydın Yağcı M, Kontaş S, Kurucu G & Polat N, İstilacı Bir Tür *Atherina boyeri* Risso, 1810 'nin Eğirdir Gölü Popülasyonunda Morfometrikve Bazı Kemiksi Yapıların Biyometrik Özellikleri, *Eğirdir Su Ürünleri Fakültesi Dergisi*, 10 (2014) 1-11.

8 Gençoğlu L & Ekmekçi F G, Growth and reproduction of a marine fish, *Atherina boyeri* Risso 1810, in a freshwater ecosystem, *Turk J Zool*, 40 (2016) 534-542.

9 Benzer S & Benzer R, Comparative growth models of big-scale sand smelt (*Atherina boyeri* Risso, 1810) sampled from Hirfanlı Dam Lake, Kırşehir, Ankara, Turkey, *Computational Ecology and Software*, 7 (2017) 82-90.

10 Whitehead P J P, Bauchot M L, Hureau J C, Nielsen J & Tortonese E, Fishes of the North-eastern Atlantic and the Mediterranean, Vol III (Unesco, U. K), 1986.

11 Ricker W E, Computation and interpretation of biological statistics of fish populations, *Bull Fish Res Board Can*, 191, 1975, 382 p.

12 Acarlı D, Kara A & Bayhan B, Length–weight relations for 29 fish species from Homa Lagoon, Aegean Sea, Turkey,

Acta Ichthyol Piscat, 44 (2014) 249-257.

13 Kara A, Sağlam C, Acarlı D & Cengiz Ö, Length-weight relationships for 48 fish species of the Gediz estuary, in Izmir Bay (Central Aegean Sea, Turkey), *J Mar Biol Assoc UK*, (2017) 1-6.

14 Tarkan A S, Gaygusuz Ö, Acıpınar H, Gürsoy Ç & Özuluğ M, Length–weight relationship of fishes from the Marmara region (NW-Turkey), *J Appl Ichthyol*, 22 (2006) 271-273.

15 Yardım Ö, A Study on Fish Species of Sarıkum Lake in Sinop Province in the Black Sea Region, *J Anatolian Environ Ani Sci*, 2 (2017) 72-74.

16 Gürkan S, Bayhan B, Akcinar S C & Taşkavak E, Length-Weight Relationship of Fish from Shallow Waters of Candarlı Bay (North Aegean Sea, Turkey*)*, *Pakistan J Zool*, 42 (2010) 495-498.

17 Keskin Ç & Gaygusuz Ö, Length-Weight Relationships of Fishes in Shallow Waters of Erdek Bay (Sea of Marmara, Turkey), *IUFS J Biol*, 69 (2010) 25-32.

18 Altın A, Ayyıldız H, Kale S & Alver C, Length–weight relationships of forty-nine fish species from shallow waters of Gökçeada Island, northern Aegean Sea, *Turk J Zool*, 39 (2015) 971-975.

19 Özaydın O & Taşkavak E, Length-weight relationships for 47 fish species from Izmir Bay (eastern Aegean Sea, Turkey), *Acta Adriat*, 47 (2006) 211-216.

20 Bök Deniz T, Gökturk D, Kahraman A E & Alıclı T Z, Length-Weight Relationships of 34 Fish Species from the Sea of Marmara, Turkey, *J Anim Vet Adv*, 10 (2011) 3037-3042.

21 Küçük F, Gülle İ, Güçlü S S, Gümüş E & Demir O, Eğirdir Gölü'ne Sonradan Giren Gümüşbalığı (*Atherina boyeri* Risso, 1810) 'nın Göl Ekosistemineve Balıkçılığa Etkisi. *I. Balıklandırmave Rezervuar Yönetimi Sempozyumu* 07-09 Şubat, Antalya, 2006.

22 Kırankaya Ş G, Ekmekçi F G, Yalçın-Özdilek Ş, Yoğurtçuoğlu B & Gençoğlu L, Condition, Length-Weight and Length-length Relationships for Five Fish Species from Hirfanli Reservoir, Turkey, *Journal of FisheriesSciences.com*, 8 (2010) 208-213.

23 İlhan A & Sarı H M, Length-Weight Relationshıps of Fish Species in Marmara Lake, West Anatolıa, Turkey, *Croat J Fish*, 73 (2015) 30-32.

24 Saç G, Aydoğan K, Özuluğ O & Özuluğ M, Resettlement of *Atherina boyeri* Risso, 1810 in Büyükçekmece Reservoir (İstanbul, Turkey), *Fish Taxa*, 1 (2016) 27-28.

25 Moutopoulos D K & Stergiou K I, Length-weight and length-length relationships of fish species from the Aegean Sea (Greece), *J Appl Ichthyol*, 18 (2002) 200-203.

26 Tesch F W, Age and growth. In: *Methods for assessment of fish production in fresh waters*, edited by W E Ricker, (Blackwell Scientific Publications, Oxford) 1971, pp. 98-130.

27 Froese R, Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations, *J Appl Ichthyol*, 22 (2006) 241-253.