

Some biological properties of different populations of the Atlantic horse mackerel *Trachurus trachurus* (L.) in Turkish Seas

Zeliha ERDOĞAN¹, Hatice TORCU KOÇ¹, Gülçin ULUNEHİR¹ and
Aleksandar JOKSIMOVIĆ^{2*}

¹Department of Biology, Faculty of Science and Technology, University of Balıkesir,
Çağış Campus, Balıkesir 10145, Balıkesir, Turkey

²University of Montenegro, Institute of Marine Biology, Dobrota bb, 85330, Kotor, Montenegro

*Corresponding author, e-mail: acojo@ac.me

Age, growth, sex, and condition of different populations of the Atlantic horse mackerel, *Trachurus trachurus* (L.) in the Turkish seas were determined from 300 specimens between November 2010 and March 2011. Fork length and total weight of the specimens ranged from 10.0 to 18.9 cm and from 12.81 to 81.71 g, respectively. Maximum age group was determined as IV, and sex ratio in samples did not differ significantly from a 1:1 ratio for all locations except for Bandırma, where it was skewed towards males (χ^2 test, $p > 0.005$). Weight increased allometrically for [Zonguldak (BS), Bandırma (MS1), Edremit (AS1), İzmir (AS2), Marmaris (AS3)] populations together with $b=2.881$, $b=2.973$, $b=3.210$, $b=3.120$, $b=2.820$ respectively except for $b=3.004$ for Sarköy (MS2) as isometry.

Key words: Carangidae, *Trachurus trachurus*, Turkish Seas, Age, Growth

INTRODUCTION

The Atlantic horse mackerel, *Trachurus trachurus*, is distributed throughout the eastern Atlantic, the Mediterranean and Black Sea (WHITEHEAD *et al.* 1986; FISCHER *et al.* 1987). In the Turkish Seas, the genus *Trachurus* is represented by three species: Atlantic horse mackerel, *T. trachurus*, Mediterranean horse mackerel, *T. mediterraneus* and blue jack mackerel, *T. picturatus* (BILECENOĞLU *et al.* 2002). In the Turkish Seas, the first two species are commercially valuable and very abundant, while the third is very scarce (AKSIRAY, 1987; TURAN, 2004). Atlantic horse mackerel is the third most important resource (after anchovy and sardine) for the

Turkish fishing industry with the mean annual catch value of 18.072 tons (ANONYMUS, 2011) because of improvements in fishery technology (ERKOYUNCU, 1995):

The biology of this species has been well documented by numerous studies in the Atlantic (EATON, 1989; BORGES & GORDOA, 1991) in the Mediterranean Sea (ARRUDA, 1984; PETRAKIS & STERGIO, 1995; KARLOU-RIGA & SINIS, 1997; VILLAMOR *et al.* 1997; MURTA, 2000; KOUTRAKIS & TSIKLIRAS, 2003; ABAUNZA *et al.* 2003; CABRAL & MURTA, 2002; MOUTOPOULOS & STERGIU, 2002; MACKENZIE *et al.* 2008) and in the Adriatic Sea (ALEGRIA-HERNANDEZ, 1984; DULČIĆ & KRALJEVIĆ, 1996) in the Black Sea (DEMİR, 1961; YANKOVA, 2010). There are some studies of the

biology of the Atlantic horse mackerel population in the Black Sea and the Sea of Marmara (SAHINOGLU, 1996; YUCEL & ERKOYUNCU, 2000; KURTOGLU *et al.* 2010; AYDIN & KARADURMUŞ, 2012). The present work investigates some aspects of the growth of Atlantic horse mackerel at different localities off Turkey.

MATERIAL AND METHODS

Fifty Atlantic horse mackerel specimens per sampling were obtained directly from fishermen at six different stations between November 2010 and March 2011. Fishermen provided the information on fishing methods (Table 1).

Specimens were measured to the nearest 1 cm below (Fork length) and weighted to the nearest 0.01 g and their sagittal otoliths were removed immediately and stored dry in properly labeled envelopes. All 300 specimens were used for the age and growth analysis. The ages were determined using the methods by CHUGUNOVA (1963). Sagittal otoliths were viewed under a binocular microscope at 20 times magnification using reflected light and a dark background. The number of opaque zones (summer rings, appearing dark under reflected light) was checked by two readers. To avoid subjectivity effect on age estimation, as much as possible, there was an

interval of 1 month between readings. Translucent bands that continued around the entire circumference of the otolith were considered to be annuli and the total number of these bands was recorded as the age. Age-classes were assigned based on the number of annuli and the month fish was collected. Length-at-age data were used to estimate the parameters of the VON BERTALANFFY (1938) growth function $VBGF: L_t = L_\infty [1 - e^{-k(t-t_0)}]$ (SPARRE & VENEMA, 1992). where L_t is the total length of the fish at time t , L_∞ is the ultimate length an average fish could achieve, k is the growth constant which determines how fast the fish approach L_∞ and t_0 is the hypothetical time at which the length of the fish is zero.

Length-weight relationships were calculated by applying an exponential regression $W = aL^b$, Where, W =weight, L =Fork length, a and b are constants (RICKER, 1975; SPARRE & VENEMA, 1992). The gonads were examined on fresh specimens to determine sex macroscopically. Sex ratio was analyzed in each population (AVSAR, 2005).

Deviations from 1:1 sex ratio null hypothesis was statistically tested by χ^2 analysis. All statistical analyses and graphics were prepared using Quattro Pro Windows and Microsoft Excel.

Table 1. Sampling details of *Trachurus trachurus* used in this study. The age structure, parameters of length–weight relationship (a and b), growth (L_∞ , K , t_0) fork length (FL).

Stations	Abbrev.	Coordinates	Date of capture	Sampling gear	Mesh size (mm)	FL (cm)	W (g)	L_∞	K	t_0	a	b	R^2
Black Sea (Zonguldak)	BS	41°27'23" N, 31°47'55" E	10 November 2010	Purse seiners	7	11.0-11.9	20.00-24.99	23.47	0.26	-1.61	0.016	2.881	0.983
Marmara Sea (Bandırma)	MS1	40°21'34" N, 27°58'45" E	25 March 2011	Gill nets	16	16.0-16.9	50.00-69.99	21.63	0.31	-1.62	0.012	2.973	0.967
Marmara Sea (Şarköy)	MS2	40°36'48" N, 27°6'48" E	15 November 2010	Purse seiners	7	11.0-11.9	15.00-19.99	14.73	0.27	-4.48	0.012	3.004	0.888
Aegean Sea (Edremit)	AS1	39°35'56" N, 27°1'19" E	1 January 2011	Purse seiners	7	12.0-12.9	20.00-29.99	15.49	0.29	-3.77	0.007	3.210	0.862
Aegean Sea (İzmir)	AS2	38° 32' 09" N, 26° 45' 18" E	20 January 2011	Purse seiners	7	12.0-12.9	15.00-19.99	17.19	0.21	-4.17	0.009	3.121	0.856
Aegean Sea (Marmaris)	AS3	36°51'48" N, 28°16'30" E	1 February 2011	Gill nets	16	13.0-13.9	10.00-19.99	15.07	0.40	-4.09	0.017	2.820	0.832

RESULTS

Length-weight frequency distribution

Fork length of Atlantic horse mackerels ranged from 10.0-18.9 cm. The most abundantly captured specimen ranged from 11.0-11.9 cm (36%) in BS; 16.0-16.9 cm (36%) in MS1; 11.0-11.9 (66%) in MS2; 12.0-12.9 cm (40%) in AS1; 12-12.9 cm (40%) in AS2; 13.0-13.9 cm (54%) in AS3 in length groups respectively (Fig. 1).

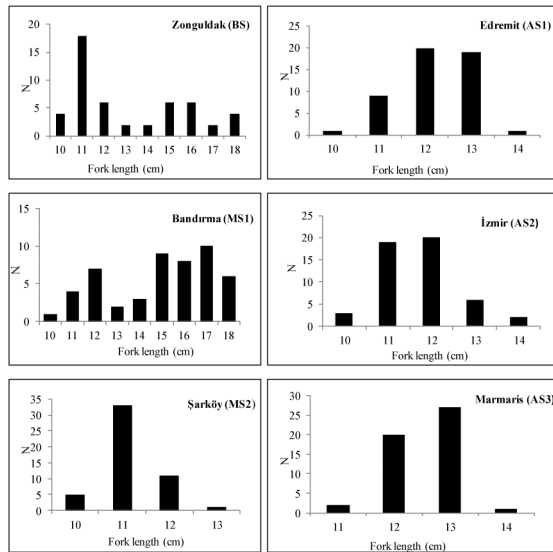


Fig1. Length frequency distribution of *Trachurus trachurus* in different populations of Turkish Seas.

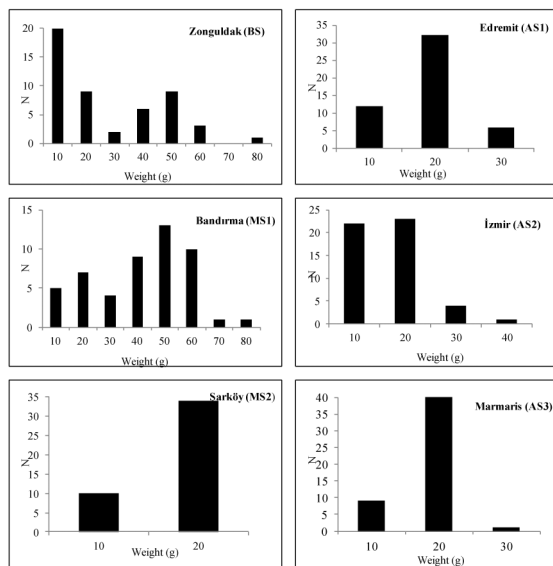


Fig. 2. Weight frequency distribution of *Trachurus trachurus* in different populations of Turkish Seas.

Weight of mackerels ranged from 12.81-81.71 g. The most abundantly captured specimen ranged from 20.00-24.99 g.(38%) in BS; 50.00-69.99g (46%) in MS1; 15.00-19.99 g (62%) in MS2; 20.00-29.99 g (80%) in AS1; 15.00-19.99 g.(40%) in AS2; 10.00-19.99g (40%) in AS3 in weight groups (Fig. 2), respectively.

Age and sex ratio

According to the age determinations, the specimens ranged from age group I to age group IV. Age groups I and II were the most abundant age groups in the samples taken at all localities except for Bandırma where age groups III and IV were the most abundant (Fig. 3).

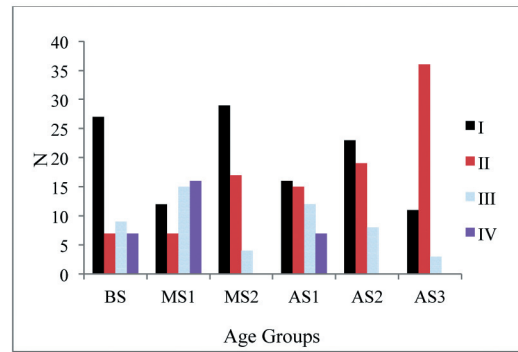


Fig.3. Age groups of *Trachurus trachurus* in different populations of Turkish Seas.

The sex ratios in samples from BS (Zonguldak), MS2 (Şarköy), AS1 (Edremit), AS2 (İzmir), and AS3 (Marmaris) did not differ significantly from a 1:1 ratio (χ^2 test, $p>0.005$). The sex ratio in the sample from MS1 (Bandırma) was skewed in favor of males and was significantly different from 1:1 ratio (χ^2 test $p<0.005$) (Fig. 4).

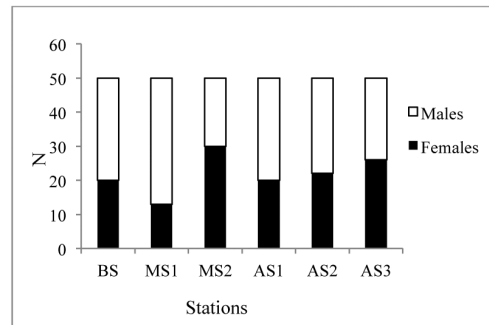


Fig. 4. - Sexes of *Trachurus trachurus* in different populations of Turkish Seas.

Growth

The von Bertalanffy growth equations (age-length relationships) calculated with mean lengths at different ages in AS1, MS1, MS2, AS3, AS2, and BS, respectively were found as follows:

$$L_t = 15.49 [1 - e^{-0.29(t+3.77)}], L_t = 21.63 [1 - e^{-0.31(t+1.62)}], L_t = 14.73 [1 - e^{-0.27(t+4.48)}],$$

$$L_t = 15.07 [1 - e^{-0.40(t+4.09)}], L_t = 17.19 [1 - e^{-0.21(t+4.17)}], L_t = 23.47 [1 - e^{-0.26(t+1.61)}]$$

Length-weight relationships

The values of length-weight relationships are:

$W = 0.0016L^{2.881}$ $R^2 = 0.983$ in BS (Zonguldak),

$W = 0.012L^{2.973}$ $R^2 = 0.967$ in MS1 (Bandırma),

$W = 0.00067L^{3.2109}$ $R^2 = 0.9621$ in AS1 (Edremit),

$W = 0.009L^{3.1207}$ $R^2 = 0.9341$ in AS2 (İzmir),

$W = 0.017L^{2.819}$ $R^2 = 0.832$ in AS3 (Marmaris),

Weight increased allometrically ($b > 3$ or $b > 3$) above, showing isometry as

$W = 0.0121L^{3.0042}$ $R^2 = 0.8905$ in MS2 (Şarköy).

The correlation coefficients computed for the length-weight relationships suggested that the growths in the populations were harmonious and balanced (Fig. 5).

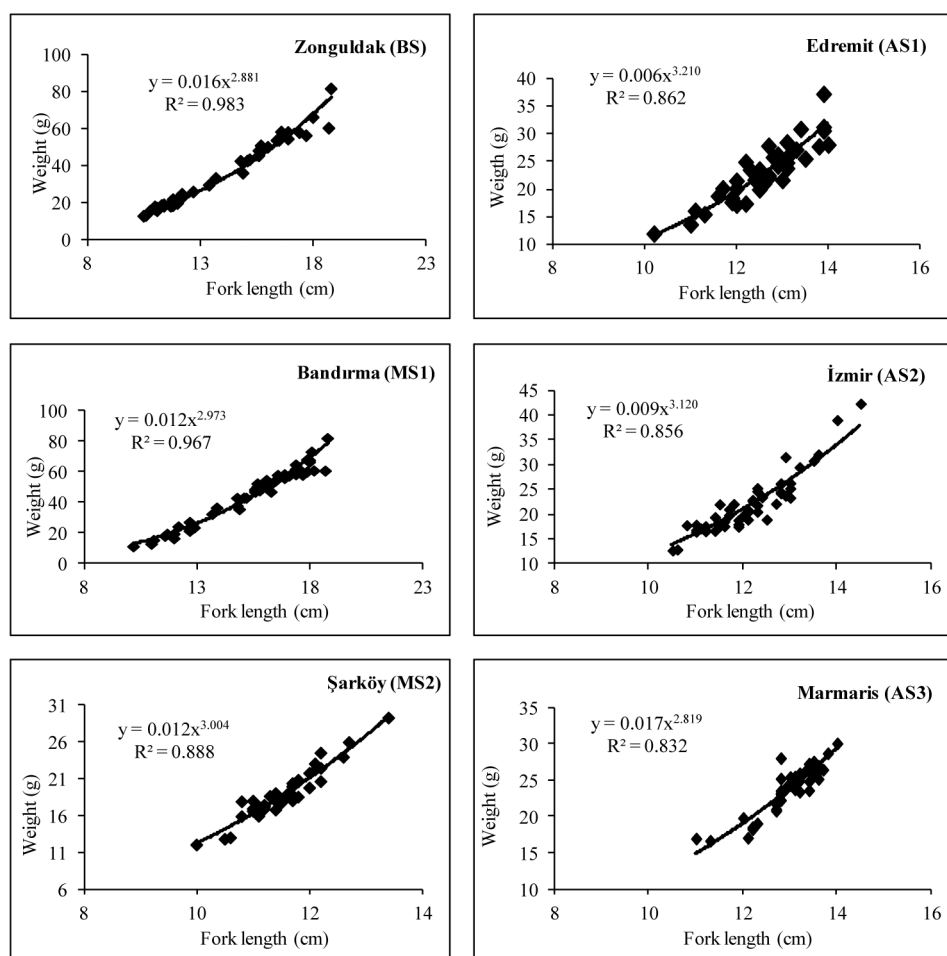


Fig. 5.- Length-weight relationship of *Trachurus trachurus* in different populations of Turkish Seas.

DISCUSSION

The fork length of Atlantic horse mackerel in the coastal waters of Turkey ranged from 10.0 to 18.9 cm. This range was compared with the given results as 6.0-16.0 cm, 10.1-34.0, 13.0-39.0 cm, 10.1-39.0, and 25.0-35.0 cm, for the Atlantic horse mackerel populations of coastal waters of Adriatic and British waters by KARLOVAC & KARLOVAC (1971), JUKIĆ & PICCINETTI (1981), ALEGRIA-HERNANDEZ (1984), respectively. The range values in our samples are different from the relevant literature probably due to dif-

ferences in ontogenetic development, condition, sex, maturity as well as variations in geographic location, seasonality and small sample size. The fork length of Atlantic horse mackerel specimens ranged between 10.0-18.9 cm, the dominant ones between 11.0-13.0 cm, except for MS1 (Fig. 1). Regarding the Turkish Seas, total length values in the Black Sea (6.9-19.2 and 9.4-16.8 cm) by AYDIN & KARADURMUS (2012), and the Sea of Marmara (10.0-17.8 cm) by KURTOGLU *et al.* (2010) are different to those calculated by us in the Turkish Seas (Table 2).

Table 2. The age structure, parameters of length-weight relationship (*a* and *b*), growth (L_{∞} , *K*, t_0) and CF of *Trachurus trachurus* in this and previous studies (- indicates absence of data)

References	L_{∞}	Age	N	a	b	R ²	K	t_0	CF	Weight range (g)	Length range (cm)	Area
Farina Perez 1983	-	-	1238	0.0129	2,854	-	-	-	-	-	7.4-51.0	NW Spain
Hernandez-Allegria. 1984	37.55	9	-	-	-	-	0.218	-1.28	-	-	10.1-34.0	Adriatic Sea
Arruda 1984	-	-	1519	0.0199	2.885	-	-	-	-	-	17.2-25.5	Portugese
Kerstan 1985	-	-	-	0.0043	3.125	-	-	-	-	-	-	Irland -UK
Coull <i>et al.</i> 1989			283	0.0034	3.294						16.0-41.0	North Sea
Akyol 1995	19.28											İzmir Bay
Sahinoglu 1996	24.82											Black Sea
Karlou and Sinis 1997	30.27											Saronikos
Prodonov <i>et al.</i> , 1997	24.52						0.172					Black Sea
Kayalı 1998	38.85						0.100					Eastern Black Sea
Genç <i>et al.</i> 1999	19.88						0.396					Eastern Black Sea
Olaso <i>et al.</i> 1999											25-30	Northern Spain
Yücel and Erkoyuncu, 2000	16.92	7	720	0.0075	3.05		0.353	-2.79	0.843	9.4-16.8	5.27-43.95	Black Sea
Santic <i>et al.</i> 2002	37.68		2304	0.0080	3.019		0.23	-0.30		6.04-437.5	10.3-37.3	Adriatic
Jardas <i>et al.</i> 2004			1200								10.5-37.6	Adriatic
Santic <i>et al.</i> 2005			1200								12.9-17.6	Adriatic Sea
Kalaycı 2006	24.12						0.170					Black Sea
Samsun <i>et al.</i> 2006	26.74						0.138					Black Sea
Kasapoglu 2006	26.09						0.125					Black Sea
Güroy <i>et al.</i> 2006	30.34	3	459	0.006	3.1234		0.255	-2.48		8.50-171.7	8.80-25.90	Dardanelles
Garrido <i>et al.</i> 2008		15	1626								12-42	Portugal

Özdemir et al 2009	22.54		946				0.16			5.0-17.5	Black Sea	
Kurtoglu et al. 2010	23.64	5	256	0.002	3,45		0.13	-4.59	0,873	8.94-58.64	10.40-17.80	Marmara Sea
Santic et al. 2011			1384	0.0081	3,001		0.064		0.060-0.09	7.0-430.3	9.1-37.8	Adriatic Sea
Aydın and Karadurmuş 2012	20.5	7	1307	0.0049	3,17		0.96	0.231	-2.96	2.32-59.98	6.9-19.02	Black Sea
This study (2010-2011)	14.73-23.47	I-IV	300	0.007-0.017	2.82-3.21		0.89-0.98	0.21-0.40	-1.61-4.48	12.81-81.71	10.0-18.9	Turkish Seas

The weight of Atlantic horse mackerel in the coastal waters of Turkey ranged from 12.81 to 81.71 g. (Fig. 2). Regarding Turkish Seas, weight values in Black Sea (9.4-16.8 and 2.32-59.98 g.) by YUCEL & ERKOYUNCU (2000) and AYDIN & KARADURMUS (2012), and Adriatic Sea (7.0-430.3 g) by ŠANTIĆ *et al.* (2011) are different to those calculated for all Turkish Seas (Table 2).

Our values of b (2.881, 2.973, 3.004, 3.210, 3.120, 2.820) (Fig. 5) are similar to the ones estimated in Izmir Bay, Çanakkale Boğazı, Mid and Eastern Black Sea, ($b=3.21$, $b=3.22$, $b=3.017$, $b=3.05$, $b=3.12$, $b=3.09$, $b=2.98$, $b=3.15$, $b=3.17$.) by AKYOL (1995), GENÇ *et al.* (1999), YUCEL & ERKOYUNCU (2000), GUROY *et al.* (2006), SAMSUN *et al.* (2006), KALAYCI (2006), AYDIN & KARADURMUS (2012), except in the result from the Sea of Marmara ($b=3.45$) by KURTOGLU *et al.* (2010). It is thought that this difference can be the result of the assessment methodologies in sampling. KARLOU-RIGA & SINIS (1997), ŠANTIĆ *et al.* (2002), and CHERIF *et al.* (2006), SANTOS *et al.* (2002), estimated $b=3.07$, $b=3.01$, $b=2.98$, $b=3.02$ for the Saronikos Bay, Middle Adriatic, Tunisian coasts, Portuguese Waters, respectively which are close to the values we calculated while MENDES *et al.* (2004) found b value as a highly contradict to the findings in this study. These differences between the values of b may be the result of several ecological factors, such as the characteristics of the biotope, temperature, spawning conditions, feeding, length, age, and gonad maturity as reported by RICKER (1975) and SAMSUN *et al.* (2006). SINOVIĆ reported that the coefficient of the length-weight relationship changed according to the time of year, the physiological state of the fish, and length range analyzed (SINOVIĆ, 2003).

The age of the mackerel caught in Turkish Seas between ages I and IV (Fig. 3). While the I and II age groups of the mackerel were dominant in total samples, the age groups III and IV were the most abundant in MS1 (Marmaris). As seen in Table 2, age distribution was reported to be I-IV in Dardanelles (GUROY *et al.* 2006), while some populations showed the age groups until XXXV in Britain, Atlantic, Adriatic Sea, Middle Black Sea, Portugal, the Sea of Marmara (MACER, 1977; KAMPOWSKI, 1981; ALEGRIA-HERNANDEZ, 1984; YUCEL & ERKOYUNCU, 2000; GARRIDO *et al.* 2008; KURTOGLU *et al.* 2010). These differences in the age distribution of the populations may be due to gill net selectivity, fishing activity, feeding habits and the ecological characteristics of the lakes and reservoirs (NIKOLSKY, 1963; WOOTON, 1998). As to the theoretical maximum lengths, the values of Atlantic horse mackerel populations in Turkish Seas were found to be close to estimates by AKYOL (1995), GENÇ *et al.* (1999), YUCEL & ERKOYUNCU (2000), KALAYCI (2006), OZDEMIR *et al.* (2009), KURTOGLU *et al.* (2010), AYDIN & KARADURMUS (2012) (Table 2).

The sex ratio for Atlantic horse mackerel is 1:1 in general in the Black Sea (DUZGUNES & KARACAM, 1991; GENÇ *et al.* 1999) and Adriatic (ALEGRIA-HERNANDEZ, 1984). Sex ratio value of specimens in MS₁ (Bandırma) population was skewed in favor of males with 26% females and 74% males ($p>0.005$) that may be due, in part, to the greater catchability of males with random sampling. ABAUNZA *et al.* (2003) found that the sex ratio of the Atlantic horse mackerel was close to 1:1 for the whole area, similar to our samples, except for those in MS1 (Bandırma) for Turkish Seas (Fig. 4).

Atlantic horse mackerel is the most important species after anchovy and sardine. The

present study contributes to the body of information regarding growth, age, and length-weight

composition of Atlantic horse mackerel at different localities off Turkey.

REFERENCES

- ABAUNZA, P., L. GORDO, C. KARLOU-RIGA, A. MURTA, A.T.G.W. ELTINK, M.T. GARCIA SANTAMARIA, C. ZIMMERMANN, C. HAMMER, P. LUCIO, S.A. IVERSEN, J. MOLLAY & E. GOLLA. 2003. Growth and reproduction of horse mackerel, *Trachurus trachurus* (Carangidae). *Reviews in Fish Biol. and Fish.*, 13: 27-61.
- AKSIRAY, F. 1987. Marine fishes of Turkey with Pictorial Keys to the Species (Turkish edition). Istanbul Univ. Press, 811 pp.
- AKYOL, O., 1995. Some biological parameters of the Atlantic horse mackerel (*Trachurus trachurus* L., 1758) distributing at Izmir Bay (Aegean Sea). M.S. Thesis, Izmir, 59 pp.
- ALEGRIA-HERNANDEZ, V. 1984. Some aspect of horse mackerel (*Trachurus trachurus* L.) biology in the middle Adriatic. *FAO Fish Rep.* 290: 123-125.
- ANONYMUS, 2011. Year Book of Turkish Fisheries Statistics. Turkish Statistics Association, Prime Ministry, Ankara.
- ARRUDA, L.M. 1984. Sexual maturation and growth of *Trachurus trachurus* (L.) along the Portuguese coast. *Inv. Pesq.*, 48: 419-430.
- AVSAR, D. 2005. Fishery biology and population dynamics, Univ. of Cukurova, Handbook 5. Baki Press, Adana, 303 pp.
- AYDIN, M. & U. KARADURMUS. 2012. Age, growth, length-weight relationship and reproduction of the Atlantic mackerel (*Trachurus trachurus* Linnaeus, 1758) in Ordu (Black Sea). *Ordu Univ. J. Sci. Tech.* 2 (2): 68-77.
- BILECENOGLU, M., E. TASKAVAK, S. MATER & M. KAYA. 2002. Checklist of the marine fishes of Turkey. *Zootaxa*, Auckland, New Zealand: Magnolia Press. 113: 194 pp.
- BORGES, M.F. & L.S. GORDO. 1991. Spatial distribution by season and some biologic parameters of the Atlantic mackerel (*Trachurus trachurus* L. 1758) in the Portuguese Continental Waters, (Division IXa). *ICES. Pel. Fish. Comm.*, C.M/H, 54: 1-17.
- CABRAL, H. N. & A.G. MURTA. 2002. The diet of blue whiting, hake, horse mackerel and mackerel off Portugal. *J. Appl. Ichthyol.* 18: 14-23.
- CHERIF, M., R. ZARRAD, H. GHARBI, H. MISSAOURI & O. JARBOUI. 2006. Length-weight Relationships for 11 Fish Species from the Gulf of Tunis (SW Mediterranean Sea, Tunisia). *Pan-American J. of Aqua. Sci.*, 3 (1): 1-5.
- CHUGUNOVA, N. I. 1963. Age and growth studies in fish. National Science Foundation, Washington, DC. 132 pp.
- COULL K. A., A.S. JERMYN, A.W. NEWTON, G.I. HENDERSON & W.B. HALL. 1989. Length-weight relationship from 88 species of fish encountered in the North Atlantic. *Scott. Fish. Res. Rep.* 43: 1-52.
- DEMIR, M. 1961. On the eggs and larvae of the *Trachurus trachurus* (L.) and *Trachurus mediterraneus* (Stdhnr) from the Sea of Marmara and the Black Sea. *CIESM*, 16: 317-320.
- DULČIĆ, J. & M. KRALJEVIĆ. 1996. Weight-length relationship for 40 fish species in the Eastern Adriatic (Croatian waters). *Fish. Res.*, 28: 243-251.
- DUZGUNEŞ, E. & H. KARAÇAM. 1991. Some population aspects, meat yield and biochemical composition of Mediterranean horse mackerel (*Trachurus mediterraneus* Steindachner, 1868) in the Black Sea. *Doga Tr. J. of Zool.*, 15: 195-201.
- EATON, D.R. 1989. Spawning-stock biomass of scad of to the west of the British Isles, as indicated by egg surveys. *J. Cons. int. Explor. Mer.*, 45: 231-247.
- ERKOYUNCU, I. 1995. Fisheries biology and Population Dynamics. O.M.U. Publications, Sinop, 265 pp.
- FARINA PEREZ, A.C. 1983. Age and growth of the Galician Shelf horse mackerel (*Trachurus trachurus* L.). *Count. Meet. ICES G*, 26: 10-11.

- FISCHER, W., M. SCHEINDER & M.L. BAUCHOT. 1987. Mediterranee et mer Noire. Zone de Peche 37, Rev. 1, Vol. II, Vertebres, Rome, pp. 1028-1030.
- GARRIDO, S., G. ALBERTO, G. MURTA, A. MOREIRA, M.J. FERREIRA & M.M. ANGELICO. 2008. Horse mackerel (*Trachurus trachurus*) stomach fullness off Portugal: index calibration and spatio-temporal variations in feeding intensity, ICES J of Marine Sci., 65: 1662–1669.
- GENC, Y., M. ZENGİN, S. ENGIN, I. BASAR, A. TABAK & B. CEYLAN. 1999. Investigation of economic seafood, TKB. TAGEM/IY/96/17/3/01 project report, Institute of Fisheries, Trabzon, 156 pp.
- GÜROY, D., G. KAHYAOĞLU, O. OZEN & A. A. TEKİNAY. 2006. Some biological aspects of Atlantic mackerel caught from the Dardanelles and its vicinity (in Turkish), E.U. J of Fish and Water Pro., 23: 91-93.
- HERNANDEZ-ALLEGRIA, V. 1984. Observations on the age and growth of *Trachurus trachurus* (L.) in the middle Adriatic. Bilješke-Notes, Institut za oceanografiju i ribarstvo-Split, SFR Jugoslavija, 58: 1-6.
- JARDAS, I., M. ŠANTIĆ & A. PALLAORO. 2004. Diet composition and feeding intensity of horse mackerel, *Trachurus trachurus* (Osteichthyes: Carangidae) in the eastern Adriatic, Marine Biol., 144: 1051–1056.
- JUKIĆ, S. & C. PICCINETTI. 1981. Quantitative and qualitative characteristics of demersal resources, in the Adriatic Sea, with some population Dynamics estimates. FAO Fish. Rep., 253: 73-91.
- KALAYCI, F. 2006. Determination of reproduction aspects and population parameters of Atlantic mackerel *Trachurus trachurus* (L.) caught in Mid Black Sea, Ph D. Thesis. Ondokuz Mayıs Univ. Institute of Sci. and Tech., Samsun, 119 pp.
- KAMPOWSKI, A. 1981. Ostroboki: *Trachurus trachurus* (L., 1758), *Trachurus trecae* Cadenat, 1949, *Trachurus picturatus* (Bowditch, 1825) Wschodniego Atlantyku, Systematyka i Biologia. RoZJ pr. Akad. Roln. Szczecin, 79: 1-321.
- KARLOVAC, O. & J. KARLOVAC. 1971. Contribution a la connaissance de l'ecologie de *Trachurus trachurus* (L.) au large de l'Adriatique. Izvješća, Ribarstveno-biološka ekspedicija mfb »Hvar«, 1948-1949, 5 (2A): 1-24.
- KARLOU-RIGA, C. & A. SINIS. 1997. Age and growth of horse mackerel *Trachurus trachurus* (L.) in the Saronikos Gulf. Fish. Res. 32: 157-171.
- KASAPOGLU, N. 2006. Stock structure and population parameters of mackerel (*Trachurus mediterraneus*, Steindchner, 1868) in Eastern Black Sea. M.S. Thesis. KTU, Institute of Sci. and Tech., Trabzon. 60 pp.
- KAYALI, E. 1998. Some population parameters and feeding ecology of mackerel (*Trachurus mediterraneus*, Steindchner, 1868) and anchovy (*Engraulis encrasicolus*, Linnaeus, 1758), Ph.D. Thesis, KTU, Institute of Sci. and Tech., Trabzon, 197 pp.
- KERSTAN, M. 1985. Age, growth, maturity and mortality estimates of horse mackerel (*Trachurus trachurus*) from the waters west of Great Britain and Ireland in 1984. Arch. Fischwiss., 36: 115-154.
- KOUTRAKIS, E.T. & A.C. TSIKLIRAS. 2003. Length weight relationship of fishes from three northern Aegean estuarine systems (Greece). J. App. Ichthyol., 19: 258-260.
- KURTOGLU, A.G., U. ERDEM & E.G. ATASOY. 2010. Some Biological characteristics of the Atlantic horse mackerel (*Trachurus trachurus* Linnaeus, 1758) in Marmara Sea. e-Journal of New World Sci. Academy Ecol. Life Sci., 5A0042, 5 (3): 222-230.
- MACER, C. T. 1977. Some aspects of the biology of the horse mackerels (*Trachurus trachurus*, L.) in waters around Britain. J. Fish Biol., 10: 511-562.
- MACKENZIE, K., N. CAMPBELL, S. MATTIUCI, P. RAMOS, A.L. PINTO & P. ABAUNZA. 2008. Parasites as biological tags for stock identification of Atlantic horse mackerel *Trachurus trachurus* L., Fish. Res., 89: 136–145.
- MENDES, B., P. FONSECA & A. CAMPOS. 2004. Weight-length relationships for 46 fish species of the Portuguese west coast. J of Appl. Ichthyol., 20 (5): 355–361.
- MOUTOPOULOS, D.K. & K.I. STERGIU. 2002.

- Length-weight and length-length relationship of fish species of the Aegean Sea (Greece). *J. App. Ichthyol.*, 18: 200-203.
- MURTA, A.G. 2000. Morphological variation of horse mackerel (*Trachurus trachurus*) in the Iberian and North African Atlantic: implications for stock identification. *ICES J. Mar. Sci.*, 27: 1240–1248.
- NIKOLSKY, G.V. 1963. The ecology of fishes (Trans L. Birkett). 1-3. Academic Press, London and New York, 352 pp.
- OLASO, I., O. CENDERO & P. ABAUNZA. 1999. The diet of horse mackerel, *Trachurus trachurus* (Linnaeus, 1758), in the Cantabrian Sea (north Spain). *J. Appl. Ichthyol.*, 15: 193–198.
- OZDEMIR, S., E. ERDEM, Z. B. OZDEMIR & D. SAHIN. 2009. Estimation of Population Parameters from Length Composition of Pelagic Species Caught in the Black Sea: Horse mackerel (*Trachurus trachurus*), Blue fish (*Pomatomus saltatrix*) and Allis shad (*Alosa alosa*). *Firat Univ. J of Sci.*, 21 (1): 1-8.
- PETRAKIS, G. & K.I. STERGIOU. 1995. Weight-length relationship for 33 species in Greek waters. *Fish. Res.* 21: 465-469.
- PRODONOV, K., K. MIKHAILOV, G. DASKLOV, C. MAXIM, A. CHASHCHIN, A. ARKHIPOV, V. SHLYAKHOV & F. OZDAMAR. 1997. Environmental Management of Fish Resources in the Black Sea and their Rational Exploitation. General Fisheries Council for the Mediterranean, FAO studies and reviews, 60: 100-110.
- RICKER, W.E. 1975. Computation and interpretation of Biological Statistics of fish populations. *Bull. Fish. Res. Board Can.*, 191: 1-382.
- TURAN, C. 2004. Stock identification of Mediterranean horse mackerel (*Trachurus mediterraneus*) using morphometric and meristic characters. *ICES J. Mar. Sci.*, 61 (5): 774-781.
- SAMSUN, N., F. KALAYCI, O. SAMSUN & S. BILGIN. 2006. Determination of some biological parameters of Atlantic Mackerel (*Trachurus trachurus*, L., 1758) caught in Samsun Bay, E.U.J of Fish. And Water Prod., 23(1-3): 481-486.
- ŠANTIĆ, M., I. JARDAS & A. PALLAORO. 2002. Age, growth and mortality rate of horse mackerel, *Trachurus trachurus* (L.), living in the eastern central Adriatic. *Periodicum Biol.*, 104 (2): 165-173.
- ŠANTIĆ, M., I. JARDAS & A. PALLAORO. 2005. Feeding habits of horse mackerel, *Trachurus trachurus* (Linnaeus, 1758), from the central Adriatic Sea. *J. Appl. Ichthyol.* 21: 125–130.
- ŠANTIĆ, M., B. RADA & A. PALADIN. 2011. Condition and length-weight relationship of the horse mackerel (*Trachurus trachurus* L.) and the Mediterranean horse mackerel (*Trachurus mediterraneus* L.) from the eastern Adriatic Sea. *Arch. Biol. Sci., Belgrade*, 63 (2): 421-428.
- SANTOS, M.N., M.B. GASPAR, P. VASCONCELOS & C.C. MONTEIRO. 2002. Weight-length relationships for 50 selected fish species of the Algarve coast (southern Portugal), *Fish. Res.*, 59 (1–2): 289–295.
- SAHINOGLU, B. 1996. Investigations on biological parameters of the Atlantic horse mackerel (*Trachurus trachurus* L., 1758) and Mediterranean horse mackerel (*Trachurus mediterraneus* Stein., 1868) in Izmir Bay (Aegean Sea) (In Turkish). M.S. Thesis, Dokuz Eylül Univ. Institute of Sci. and Tech., Izmir, 54 pp.
- SINOVIĆ, G. 2003. The length-weight relationship of anchovy, *Engraulis engrasicolus* (L.), in the eastern Adriatic Sea. *Acta Adriat.*, 44: 1-181.
- SPARRE, P. & S.C. VENEMA. 1992. Introduction to Tropical Fish Stock Assessment. Part 1: Manual, FAO Fish. Techn. Pap., 306/1, Rev. 2. Rome, 376 pp.
- WHITEHEAD, P.J.P., M.L. BAUCHOT, J.C. HUREAU, J.NIELSEN & E. TORTONESE. 1986. Fishes of the North-eastern Atlantic and the Mediterranean. UNESCO, Paris., II: 841-844.
- WOOTON, R.J. 1998. Fish assemblage. In: Ecology of Teleost fishes (2nd Edition). The Netherlands: Kluwer Academic, 285 pp.
- VILLAMOR, B., P. ABAUNZA, L. LUCIO & C. PORTERIO. 1997. Distribution and age structure of mackerel (*Scomber scombrus*, L.) and horse mackerel (*Trachurus trachurus*, L.) in

- the northern coast of Spain, 1989-1994, *Sci. Mar.*, 61(3): 345-366.
- YANKOVA, M. 2010. Some biological aspects of the horse mackerel catch of the Bulgarian Black Sea Coast. *Cercetari marine-Recherches marines*, 39, NIMRD, 239-249.
- YUCEL, S. & I. ERKOYUNCU. 2000. Population dynamics of horse mackerel (*Trachurus trachurus* L., 1758) stocks in the Mid Black Sea, Turkey. (In Turkish). *Tr. J. of Biol.*, 26: 543-552.

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Neka biološka svojstva različitih populacija atlantskog šaruna *Trachurus trachurus* (L.) u turskim morima

Zeliha ERDOĞAN¹, Hatice TORCU KOÇ¹, Gülçin ULUNEHİR¹ i Aleksandar JOKSIMOVIĆ^{2*}

¹Fakultet znanosti i umjetnosti, Odjel za biologiju, Sveučilište u Balikesiru, Cagis Campus, Balikesir 10145, Balikesir, Turska

²Sveučilište u Crnoj Gori, Institut za biologiju mora, Dobrota bb, 85330, Kotor, Crna Gora

*Kontakt adresa, e-mail: acojo@ac.me

SAŽETAK

Starost, rast, spol i stanje različitih populacija atlantskog šaruna *Trachurus trachurus* (L.) u turskim morima procijenjene su kod 300 jedinki u razdoblju od studenog 2010. do ožujka 2011. Dužina do repne peraje i ukupna masa jedinki u rasponu je od 10.0 do 18.9 cm, odnosno od 12.81 do 81.71 g. Najstarija dobna skupina označena je oznakom IV, dok se omjer zastupljenosti spolova nije značajno razlikovao od odnosa 1:1 koji je ustanovljen na svim postajama, osim u Bandirmi gdje je bio u korist mužjaka (χ^2 test, $p > 0.005$). Masa se na sljedećim postajama [Zonguldak (BS) Bandirma (MSI), Edremit (AS1), Izmir (AS2), Marmaris (AS3)], povećavala uz koeficijente alometrije $b=2.881$, $b=2.973$, $b=3.210$, $b=3.120$, $b=2.820$ respektivno, osim za $b=3.004$ u Sarköyu (MS2) koji ukazuje na izometriju.

Ključne riječi: Carangidae (bitnice), *Trachurus trachurus*, turske vode, starost, rast

