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LENGTH–WEIGHT RELATIONS FOR 29 FISH SPECIES FROM HOMA LAGOON, AEGEAN SEA, TURKEY

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Abstract. In the course of the presently reported study, covering the Homa Lagoon, Izmir Bay, Turkey, we collected a total of 2690 fish specimens belonging to 15 families and representing 29 species: *Anguilla anguilla* (Linnaeus, 1758); *Atherina hepsetus* Linnaeus, 1758; *Atherina boyeri* Risso, 1810; *Belone belone* (Linnaeus, 1761); *Blennius ocellaris* Linnaeus, 1758; *Sardina pilchardus* (Walbaum, 1792); *Aphanius fasciatus* (Valenciennes, 1821); *Engraulis encrasicolus* (Linnaeus, 1758); *Gobius niger* Linnaeus, 1758; *Pomatoschistus marmoratus* (Risso, 1810); *Pomatoschistus minutus* (Pallas, 1770); *Zosterisessor ophiocephalus* (Pallas, 1814); *Dicentrarchus labrax* (Linnaeus, 1758); *Chelon labrasus* (Risso, 1827); *Liza aurata* (Risso, 1810); *Liza ramada* (Risso, 1827); *Liza saliens* (Risso, 1810); *Mugil cephalus* Linnaeus, 1758; *Mullus barbatus* Linnaeus, 1758; *Mullus surmuletus* Linnaeus, 1758; *Syngnathus acus* Linnaeus, 1758; *Syngnathus typhle* Linnaeus, 1758; *Diplodus annularis* (Linnaeus, 1758); *Diplodus vulgaris* (Geoffroy Saint-Hilaire, 1817); *Lithognathus mormyrus* (Linnaeus, 1758); *Sarpa salpa* (Linnaeus, 1758); *Sparus aurata* Linnaeus, 1758; *Platichthys flesus* (Linnaeus, 1758); *Solea solea* (Linnaeus, 1758). The fish were weighed, and measured and their length–weight relations were determined. Samples were collected during 2009–2010 using four different types of fishing gear (beach seine, fyke nets, barrier trap, and trammel nets; mesh size: 25, 28, and 30 mm) that allowed both adult and juvenile specimens to be captured. Significant length–weight relations were found for all species. The exponent *b* varied between 2.753 for *Pomatoschistus marmoratus* and 3.650 for *Aphanius fasciatus* (mean value = 3.115). The length–weight parameters of the same species may be different in the population because of feeding, reproduction activities and fishing etc. Therefore, we need to know length–weight relations of fish, which are captured in a given place in a certain period of time. Length–weight relations for 5 out of the 29 fish species are presented for the first time from Homa Lagoon in the Turkish Aegean Sea.

Keywords: LWR, fishing gear, coastal lagoon, Izmir Bay, Mediterranean Sea

Length–weight (LW) relations for fish were originally used to provide information on the condition of fish and determine whether somatic growth was isometric or allometric (Le Cren 1951, Tesch 1971, Ricker 1975). LW relations of fish are important because they allow:

- to estimate the condition of fish,
- to calculate biomass from the length values,
- to determine weight-at-age and convert growth-in-length equations to growth-in-weight ones, and
- to make interregional comparisons of life histories of certain species (Gonçalves et al. 1997, Froese and Pauly 1998, Moutopoulos and Stergiou 2002, Dulčić and Glamuzina 2006).

This study reports the parameters of the length–weight relations for 29 fish species collected from Homa Lagoon, Izmir Bay, Aegean Sea of Turkey: *Anguilla anguilla* (Linnaeus, 1758); *Atherina hepsetus* Linnaeus, 1758; *Atherina boyeri* Risso, 1810; *Belone belone* (Linnaeus, 1761); *Blennius ocellaris* Linnaeus, 1758; *Sardina pilchardus* (Walbaum, 1792); *Aphanius fasciatus* (Valenciennes, 1821); *Engraulis encrasicolus* (Linnaeus, 1758); *Gobius niger* Linnaeus, 1758; *Pomatoschistus marmoratus* (Risso, 1810); *Pomatoschistus minutus* (Pallas, 1770); *Zosterisessor ophiocephalus* (Pallas, 1814); *Dicentrarchus labrax* (Linnaeus, 1758); *Chelon labrasus* (Risso, 1827); *Liza aurata* (Risso, 1810); *Liza ramada*

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(Risso, 1827); *Liza saliens* (Risso, 1810); *Mugil cephalus* Linnaeus, 1758; *Mullus barbatus* Linnaeus, 1758; *Mullus surmuletus* Linnaeus, 1758; *Syngnathus acus* Linnaeus, 1758; *Syngnathus typhle* Linnaeus, 1758; *Diplodus annularis* (Linnaeus, 1758); *Diplodus vulgaris* (Geoffroy Saint-Hilaire, 1817); *Lithognathus mormyrus* (Linnaeus, 1758); *Sarpa salpa* (Linnaeus, 1758); *Sparus aurata* Linnaeus, 1758; *Platichthys flesus* (Linnaeus, 1758); *Solea solea* (Linnaeus, 1758). Also length–weight relations for five fish species (*Anguilla anguilla, Atherina hepsetus*, *Pomatoschistus marmoratus*, *Pomatoschistus minutus*, and *Platichthys flesus*) are presented for the first time from Homa Lagoon in the Turkish Aegean Sea. We believe that the results of the presently reported study can be applied to fisheries management of the Homa Lagoon and also Izmir Bay.

Study area. The Homa Lagoon (38º30′–38º35′N, 26º48′–26º53′E) is situated in the north-eastern part of Izmir Bay, in the Menemen District 42 km away from the centre of the Izmir Metropolitan Municipality. The lagoon covers an area of 1200 ha, being 7.4 km long and 3 km wide. Its maximum depth is 1.8 m, but many areas are shallow (0.5–1 m). The lagoon is separated from the see by a narrow sandspit. There are 6 canals allowing the water exchange between the sea and the lagoon. The widest canal is outfitted with a barrier trap designed to catch fish. For a detailed map of the lagoon see Bayhan and Acarli (2006). Surface water temperature varies from 28ºC in September to –2 ºC in December with a yearly mean of 16ºC. Mean annual salinity is 31.9‰ with the highest of 44.4‰ and the lowest of 27‰ in November and April, respectively. The lagoon supports important commercial fisheries, including mullets (especially *Liza saliens* and *Mugil cephalus*), gilthead sea bream (*Sparus aurata*), sea bass (*Dicentrarchus labrax*), ell (*Anguilla anguilla*), and sole (*Solea solea*) in particular (Alpbaz and Kınacıgil 1988, Bayhan and Acarli 2006, Acarlı et al. 2009).

Data collection. Monthly field studies were performed between February 2009 and March 2010. Samplings were made using four different fishing gears: beach seine, fyke nets, barrier trap, and trammel nets of different mesh size (Table 1). The beach seine was used at day light with 6–7 hauls a day (monthly for a year). Fyke nets were set at dusk and picked up at dawn with a soak time of 10–14 h a day of every month. Barrier trap is generally set between the lagoon and the sea with a rectangular trap chamber composed of reed fences including the closure of canal with reed fences on both sides. Fish swim through a V-shape entrance into the trap and pass through a few sections as far as the final chambers, from where they are taken our with dip nets. As Katselis et al. (2003) reported, one of the most important types of exploitation is to use of barrier traps to catch fish during their seasonal or ontogenic offshore migration. The lagoon is an important nursery area and constitutes the fish feeding ground and therefore the local fishery benefits from fish migration related to feeding and reproduction. The sampling, using the barrier trap, was occasional and was performed either in the day light or overnight, between December and June (The trap was opened in December and closed in early June). Trammel nets were used overnight for a day, monthly. Fish were scared back into the nets and collected after being entangled.

Data analysis. Specimens caught were identified to species level, measured to the nearest 0.1 cm (total length, TL), and wet-weighed (total weight, TW) to the nearest 1 g. The relation was established using linear regression analysis, TW vs. TL (log-transformed):

$$\mathrm{Log(TW)} = \log(a) + (b)\log(\mathrm{TL})$$

where a is the intercept of the regression curve (coefficient related to body form) and b is the regression coefficient (exponent indicating isometric growth when equal to 3). The significance of the regression was assessed by ANOVA and the b-value for each species was tested to be significantly different from the isometric growth ($b = 3$) (Sokal and Rohlf 1981, Verdiell-Cubedo et al. 2006). All statistical analyses were evaluated at $P < 0.05$ significance level.

A total of 2690 individuals was sampled during the study period. The LW relations of 29 fish species of 15 families are given in Table 2. Mugilidae and Sparidae were the most abundant families. Linear regressions were significant for all studied species ($P < 0.05$). The sample size ranged from 178 *Aphanius fasciatus* to 37 individuals for *Syngnathus typhle*.

Table 1

Fishing gear used in the presently reported study and their technical properties

Fishing gear	Description
Beach seine	Wings length 25 m, wing height 1.5 m, bag length 5 m, mouth width 3 m, mouth height 1.5 m
Fyke nets	Equipped with 3 funnels and 7 hoops, the first of which is D-shape; Every operation included 50 fyke nets of the same characteristics which were tied to one another used in a serial line; Mesh size of 12 mm were used to construct the netting; The leading net was 3 m long between the two fyke nets with a 12 mm mesh size
Barrier trap	Trap entrance with V-shape passage; Composed of few small chambers tied to each other with V-shape passages; In Homa lagoon, the barrier trap is opened in December and closed in early June
Trammel nets	Each 300-m long; with 3 different mesh sizes (25, 28, and 30 mm) with variable bar lengths inside nets; Hanging ratio (E) was 0.50 for 100 m length of net

Table 2

Length–weight relations of fish species from Homa lagoon

Family	Species	*N*	Total length [cm]		Total weight [g]		Relation parameters				
			Range	Mean ± SD	Range	Mean ± SD	*a*	*b*	SE of *b*	r^2	*t*-test
Anguillidae	*Anguilla anguilla*	103	27.0–60.3	43.75 ± 7.42	26.50–370.00	142.51 ± 75.58	0.0006	3.266	0.015	0.997	$P \leq 0.05$
Atherinidae	*Atherina hepsetus*	66	5.0–10.6	6.61 ± 1.40	0.79–8.10	2.24 ± 1.72	0.0059	3.060	0.013	0.998	$P \leq 0.05$
	Atherina boyeri	103	3.4–10.6	5.97 ± 2.07	0.29–8.40	2.10 ± 2.14	0.0070	2.963	0.005	0.999	$P \leq 0.05$
Belonidae	*Belone belone*	105	15.0–31.4	22.66 ± 4.61	3.45–35.07	14.42 ± 8.58	0.0008	3.114	0.002	0.999	$P \leq 0.05$
Blennidae	*Blennius ocellaris*	69	6.0–11.0	8.47 ± 1.13	2.90–18.00	8.83 ± 0.49	0.0120	3.043	0.034	0.991	$P > 0.05^{\$}$
Clupeidae	*Sardina pilchardus*	77	6.0–12.5	9.39 ± 1.84	1.68–15.90	7.84 ± 4.07	0.0070	3.053	0.004	0.999	$P \leq 0.05$
Cyprinodontidae	*Aphanius fasciatus*	178	1.6–4.0	2.55 ± 0.38	0.03–1.01	0.22 ± 0.02	0.0060	3.650	0.064	0.948	$P \leq 0.05$
Engraulidae	*Engraulis encrasicolus*	68	7.0–11.3	8.95 ± 0.98	2.32–9.35	4.90 ± 1.61	0.0070	2.917	0.007	0.999	$P \leq 0.05$
Gobiidae	*Gobius niger*	73	4.0–10.7	6.58 ± 1.86	0.66–14.40	4.02 ± 3.61	0.0080	3.125	0.006	0.999	$P \leq 0.05$
	Pomatoschistus marmoratus	128	2.5–5.1	3.22 ± 0.42	0.12–1.16	0.30 ± 0.13	0.0110	2.753	0.080	0.890	$P \leq 0.05$
	Pomatoschistus minutus	47	7.2–9.4	7.99 ± 0.68	5.39–11.93	7.55 ± 2.03	0.0140	3.005	0.024	0.997	$P > 0.05^{\$}$
	Z. ophiocephalus	56	7.4–14.6	10.60 ± 1.46	4.12–31.38	12.70 ± 5.40	0.0100	2.984	0.007	0.996	$P \leq 0.05$
Moronidae	*Dicentrarchus labrax*	111	8.5–33.9	20.71 ± 6.49	8.00–470.00	140.61 ± 112.04	0.0150	2.947	0.005	0.999	$P \leq 0.05$
Mugilidae	*Chelon labrasus*	68	27.2–33.3	30.27 ± 1.05	219.97–394.00	300.28 ± 35.04	0.0080	3.061	0.160	0.831	$P > 0.05^{\$}$
	Liza aurata	119	15.4–25.5	18.86 ± 2.54	39.00–173.90	74.19 ± 33.11	0.0100	2.997	0.392	0.980	$P > 0.05^{\$}$
	Liza ramada	81	25.5–39.6	32.64 ± 3.25	170.10–640.20	368.30 ± 110.71	0.0100	3.003	0.008	0.999	$P > 0.05^{\$}$
	Liza saliens	177	21.7–33.0	26.27 ± 1.99	81.00–369.00	163.27 ± 46.09	0.0018	3.489	0.055	0.958	$P \leq 0.05$
	Mugil cephalus	133	19.8–67.0	34.30 ± 9.88	98.94–2997.00	529.86 ± 52.05	0.0190	2.820	0.021	0.992	$P \leq 0.05$
Mullidae	*Mullus barbatus*	90	5.1–11.1	7.13 ± 1.38	1.15–13.82	3.82 ± 2.54	0.0060	3.180	0.010	0.991	$P \leq 0.05$
	Mullus surmuletus^{+}	105	4.7–10.2	6.53 ± 1.15	0.81–10.56	2.72 ± 1.94	0.0040	3.372	0.016	0.997	$P \leq 0.05$
Syngnathidae	*Syngnathus acus*	67	6.0–20.0	12.49 ± 3.28	0.11–6.62	1.72 ± 1.54	0.0002	3.408	0.004	0.999	$P \leq 0.05$
	Syngnathus typhle	37	6.5–14.2	9.85 ± 2.04	0.06–0.73	0.27 ± 0.17	0.0020	3.141	0.006	0.998	$P \leq 0.05$
Sparidae	*Diplodus annularis*	121	3.9–15.5	10.55 ± 2.59	0.90–68.00	22.61 ± 13.00	0.0100	3.190	0.020	0.994	$P \leq 0.05$
	Diplodus vulgaris	81	8.7–15.2	12.57 ± 1.68	8.90–52.90	30.60 ± 11.80	0.0080	3.198	0.003	0.999	$P \leq 0.05$
	Lithognathus mormyrus	105	10.0–20.5	15.14 ± 2.71	10.80–103.50	43.49 ± 23.41	0.0070	3.159	0.180	0.955	$P > 0.05^{\$}$
	Sarpa salpa^{+}	67	6.7–12.4	9.05 ± 1.48	2.65–18.40	7.45 ± 3.96	0.0060	3.142	0.014	0.998	$P \leq 0.05$
	Sparus aurata^{+}	105	13.5–18.3	15.98 ± 1.24	34.30–90.10	59.75 ± 14.31	0.0090	3.150	0.009	0.999	$P \leq 0.05$
Pleuronectidae	*Platichthys flesus* $^{+}$	77	10.3–15.4	12.39 ± 1.52	9.60–33.50	17.84 ± 6.82	0.0070	3.080	0.011	0.998	$P \leq 0.05$
Soleidae	*Solea solea*	73	8.7–20.5	13.15 ± 3.09	6.30–88.50	26.59 ± 20.80	0.0070	3.053	0.003	0.999	$P \leq 0.05$

$^{\$}$Statistically significant; $^{+}$juveniles; *N* = sample size, *a* = intercept, *b* = regression coefficient, SD = standard deviation, SE = standard error, r^2 = coefficient of determination.

Table 3

Length–weight relations of fish species from Aegean Sea

Family	Species	*N*	*a*	*b*	r^2	Location	Reference
Anguillidae	*Anguilla anguilla*	103	0.0006	3.266	0.997	Turkey, Izmir Bay, Homa Lagoon	This study
Atherinidae	*Atherina hepsetus*	66	0.0059	3.066	0.998	Turkey, Izmir Bay, Homa Lagoon	This study
	Atherina boyeri	103	0.0070	2.963	0.999	Turkey, Izmir Bay, Homa Lagoon	This study
	Atherina boyeri[$]	138	0.0048	3.165	0.980	Turkey, Izmir Bay (Aegean Sea)	Özaydin and Taskavak 2006
Belonidae	*Belone belone*	105	0.0008	3.114	0.999	Turkey, Izmir Bay, Homa Lagoon	This study
	Belone belone	416	0.0003	3.365	0.930	Turkey, Izmir Bay	Özaydin and Taskavak 2006
Blennidae	*Blennius ocellaris*	69	0.0120	3.043	0.991	Turkey, Izmir Bay, Homa Lagoon	This study
	Blennius ocellaris	117	0.0161	2.956	0.970	Greece, Thracian Sea	Lamprakis et al. 2003
	Blennius ocellaris	23	0.0183	2.913	0.970	Turkey, Izmir Bay	Ozaydın et al. 2007
	Blennius ocellaris	36	0.0170	2.930	0.933	Turkey, Saros Bay	Ismen et al. 2007
Clupeidae	*Sardina pilchardus*	77	0.0070	3.053	0.999	Turkey, Izmir Bay, Homa Lagoon	This study
	Sardina pilchardus[$]	388	0.0076	3.190	0.890	Turkey, Izmir Bay	Özaydin and Taskavak 2006
	Sardina pilchardus[$]	82	0.00003	2.754	0.820	Greece, South Euboikos Gulf	Petrakis and Stergiou 1995
Cyprinodontidae	*Aphanius fasciatus*	178	0.0060	3.650	0.948	Turkey, Izmir Bay, Homa Lagoon	This study
	Aphanius fasciatus	143	0.0060	3.532	0.970	Turkey, Izmir Bay	Özaydin and Taskavak 2006
Engraulidae	*Engraulis encrasicolus*	68	0.0070	2.917	0.999	Turkey, Izmir Bay, Homa Lagoon	This study
	Engraulis encrasicolus[$]	513	0.0116	2.840	0.940	Turkey, Izmir Bay (Aegean Sea)	Özaydin and Taskavak 2006
	Engraulis encrasicolus	212	0.0050	2.970	0.872	Turkey, Saros Bay	Ismen et al. 2007
Gobiidae	*Gobius niger*	73	0.0080	3.125	0.999	Turkey, Izmir Bay, Homa Lagoon	This study
	Gobius niger	727	0.0134	2.914	0.940	Turkey, Izmir Bay	Özaydin and Taskavak 2006
	Gobius niger	447	0.0075	3.153	0.970	Turkey, Izmir Bay	Özaydin et al. 2007
	Pomatoschistus marmoratus	128	0.0110	2.753	0.890	Turkey, Izmir Bay, Homa Lagoon	This study
	Pomatoschistus minutus	47	0.0140	3.005	0.997	Turkey, Izmir Bay, Homa Lagoon	This study
	Zosterisessor ophiocephalus	56	0.0100	2.984	0.996	Turkey, Izmir Bay, Homa Lagoon	This study
	Zosterisessor ophiocephalus	168	0.0044	3.306	0.980	Turkey Izmir Bay (Aegean Sea)	Özaydin and Taskavak 2006
Moronidae	*Dicentrarchus labrax*	111	0.0150	2.947	0.999	Turkey, Izmir Bay, Homa Lagoon	This study
	Dicentrarchus labrax	28	0.0359	2.676	0.960	Turkey, Gökova Bay	Ceyhan et al. 2009
	Dicentrarchus labrax	43	0.0156	2.874	0.996	Turkey, Izmir Bay, Homa Lagoon	Acarlı et al. 2009
	Dicentrarchus labrax[$]	316	0.0082	3.074	0.983	Greece, Klisova Lagoon	Moutopoulos et al. 2011

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Table 3 cont.

Family	Species	*N*	*a*	*b*	r^2	Location	Reference
	Dicentrarchus labrax[$]	171	0.0077	3.076	0.993	Greece, Papas Lagoon	Moutopoulos et al. 2011
Mugilidae	*Chelon labrasus*	68	0.0080	3.061	0.831	Turkey, Izmir Bay, Homa Lagoon	This study
	Chelon labrasus	45	0.0075	3.067	0.980	Turkey, Gulluk Lagoon	Hoşsucu 2001
	Chelon labrasus[$]	94	0.0533	2.523	0.970	Turkey, Izmir Bay	Özaydin and Taskavak 2006
	Chelon labrasus	84	0.0134	2.937	0.831	Turkey, Izmir Bay, Homa Lagoon	Acarlı et al. 2009
	Chelon labrasus[$]	183	0.0058	3.242	0.920	Greece, Klisova Lagoon	Moutopoulos et al. 2011
	Chelon labrasus[$]	114	0.0034	3.407	0.967	Greece, Papas Lagoon	Moutopoulos et al. 2011
	Liza aurata	119	0.0150	2.997	0.980	Turkey, Izmir Bay, Homa Lagoon	This study
	Liza aurata[$]	81	0.0113	3.016	0.930	Turkey Izmir Bay (Aegean Sea)	Özaydin and Taskavak 2006
	Liza aurata	6	0.0121	2.893	0.991	Turkey, Izmir Bay, Homa Lagoon	Acarlı et al. 2009
	Liza aurata[$]	530	0.0049	3.255	0.930	Greece, Klisova Lagoon	Moutopoulos et al. 2011
	Liza aurata[$]	404	0.0022	3.536	0.978	Greece, Papas Lagoon	Moutopoulos et al. 2011
	Liza ramada	81	0.0100	3.003	0.999	Turkey, Izmir Bay, Homa Lagoon	This study
	Liza ramada	86	0.0066	3.052	0.970	Turkey, Gulluk Lagoon	Hoşsucu 2001
	Liza ramada	26	0.0051	3.155	0.922	Turkey, Izmir Bay, Homa Lagoon	Acarlı et al. 2009
	Liza ramada[$]	124	0.0031	3.376	0.971	Greece, Klisova Lagoon	Moutopoulos et al. 2011
	Liza ramada[$]	180	0.0020	3.504	0.940	Greece, Papas Lagoon	Moutopoulos et al. 2011
	Liza saliens	177	0.0018	3.489	0.958	Turkey, Izmir Bay, Homa Lagoon	This study
	Liza saliens	47	0.0088	2.997	0.980	Turkey, Gulluk Lagoon	Hoşsucu 2001
	Liza saliens[$]	329	0.0120	2.990	0.950	Turkey, Izmir Bay	Özaydin and Taskavak 2006
	Liza saliens	664	0.0043	3.218	0.984	Turkey, Izmir Bay, Homa Lagoon	Acarlı et al. 2009
	Liza saliens[$]	84	0.0078	3.086	0.950	Greece, Klisova Lagoon	Moutopoulos et al. 2011
	Liza saliens[$]	101	0.0096	3.031	0.915	Greece, Papas Lagoon	Moutopoulos et al. 2011
	Mugil cephalus	133	0.0190	2.820	0.992	Turkey, Izmir Bay, Homa Lagoon	This study
	Mugil cephalus	132	0.0081	3.048	0.990	Turkey, Gulluk Lagoon	Hoşsucu 2001
	Mugil cephalus	288	0.0190	2.829	0.990	Turkey, Izmir Bay, Homa Lagoon	Acarlı et al. 2009
	Mugil cephalus[$]	73	0.0189	2.955	0.947	Greece, Klisova Lagoon	Moutopoulos et al. 2011
	Mugil cephalus[$]	48	0.0127	3.081	0.950	Greece, Papas Lagoon	Moutopoulos et al. 2011
Mullidae	*Mullus barbatus*	90	0.0060	3.180	0.991	Turkey, Izmir Bay, Homa Lagoon	This study
	Mullus barbatus	76	0.0049	3.273	0.941	Turkey Gökceada Island	Karakulak et al. 2006

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Table 3 cont.

Family	Species	*N*	*a*	*b*	r^2	Location	Reference
	Mullus barbatus[$]	479	0.0102	3.176	0.960	Turkey Izmir Bay	Özaydin and Taskavak 2006
	Mullus barbatus[$]	1910	0.0089	3.233	0.980	Turkey Izmir Bay	Özaydın et al. 2007
	Mullus barbatus	3386	0.0070	3.095	0.963	Turkey. Saros Bay	Ismen et al. 2007
	Mullus surmuletus	105	0.0040	3.372	0.997	Turkey, Izmir Bay, Homa Lagoon	This study
	Mullus surmuletus[$]	597	0.000009	3.085	0.870	Greece, South Euboikos Gulf	Petrakis and Stergiou 1995
	Mullus surmuletus	257	0.01404	2.954	0.940	Greece, Cyclades	Moutopoulos and Stergiou 2002
	Mullus surmuletus	601	0.0068	3.192	0.976	Turkey, Gökceada Island	Karakulak et al. 2006
	Mullus surmuletus[$]	51	0.0167	3.011	0.960	Turkey, Izmir Bay	Özaydin and Taskavak 2006
	Mullus surmuletus[$]	117	0.0106	3.202	0.990	Turkey Izmir Bay	Özaydın et al. 2007
	Mullus surmuletus	120	0.0069	3.214	0.979	Turkey, Gökova Bay	Ceyhan et al. 2009
Syngnathidae	*Syngnathus acus*	67	0.0002	3.408	0.999	Turkey, Izmir Bay, Homa Lagoon	This study
	Syngnathus acus	202	0.0001	3.630	0.970	Turkey, Izmir Bay	Özaydin and Taskavak 2006
	Syngnathus typhle	37	0.0020	3.141	0.998	Turkey, Izmir Bay, Homa Lagoon	This study
	Syngnathus typhle	14	0.00023	3.217	0.994	Turkey, Izmir Bay	Özaydin and Taskavak 2006
Sparidae	*Diplodus annularis*	121	0.0100	3.190	0.994	Turkey, Izmir Bay, Homa Lagoon	This study
	Diplodus annularis	7	0.0085	3.319	0.976	Turkey, Izmir Bay, Homa Lagoon	Acarlı et al. 2009
	Diplodus annularis[$]	313	0.00002	3.002	0.870	Greece South Euboikos Gulf	Petrakis and Stergiou 1995
	Diplodus annularis	2517	0.01862	2.951	0.940	Greece, Cyclades	Moutopoulos and Stergiou 2002
	Diplodus annularis	372	0.0068	3.315	0.975	Turkey, Gökceada, Island	Karakulak et al. 2006
	Diplodus annularis[$]	284	0.0245	2.973	0.940	Turkey, Izmir Bay	Özaydin and Taskavak 2006
	Diplodus annularis[$]	929	0.0190	3.046	0.930	Turkey, Izmir Bay	Özaydın et al. 2007
	Diplodus annularis	159	0.0179	2.985	0.971	Turkey, Gökova Bay	Ceyhan et al. 2009
	Diplodus annularis[$]	376	0.0167	3.102	0.960	Greece, Klisova Lagoon	Moutopoulos et al. 2011
	Diplodus annularis[$]	110	0.0108	3.257	0.980	Greece, Papas Lagoon	Moutopoulos et al. 2011
	Diplodus vulgaris	81	0.0100	3.198	0.999	Turkey, Izmir Bay, Homa Lagoon	This study
	Diplodus vulgaris	68	0.0286	2.790	0.937	Turkey, Izmir Bay, Homa Lagoon	Acarlı et al. 2009
	Diplodus vulgaris[$]	28	0.00009	2.710	0.980	Greece, South Euboikos Gulf	Petrakis and Stergiou 1995
	Diplodus vulgaris	122	0.01306	3.055	0.980	Greece, Cyclades	Moutopoulos and Stergiou 2002
	Diplodus vulgaris	93	0.0858	2.431	0.647	Turkey, Gökceada Island	Karakulak et al. 2006
	Diplodus vulgaris[$]	63	0.0184	3.094	0.980	Turkey, Izmir Bay	Özaydin and Taskavak 2006

Table continues on next page

Table 3 cont.

Family	Species	*N*	*a*	*b*	r^2	Location	Reference
	Diplodus vulgaris[$]	1615	0.0344	2.841	0.950	Turkey, Izmir Bay	Özaydın et al. 2007
	Diplodus vulgaris	69	0.0145	3.034	0.988	Turkey, Gökova Bay	Ceyhan et al. 2009
	Lithognathus mormyrus	105	0.0070	3.159	0.995	Turkey, Izmir Bay, Homa Lagoon	This study
	Lithognathus mormyrus[$]	35	0.0094	3.181	0.960	Turkey, Izmir Bay	Özaydin and Taskavak 2006
	Lithognathus mormyrus	141	0.0122	3.034	0.967	Turkey, Gökova Bay	Ceyhan et al. 2009
	Sarpa salpa	67	0.0060	3.142	0.998	Turkey, Izmir Bay, Homa Lagoon	This study
	Sarpa salpa	48	0.01445	2.946	0.980	Greece, Cyclades	Moutopoulos and Stergiou 2002
	Sarpa salpa	80	0.0087	3.134	0.979	Turkey, Gökceada	Karakulak et al. 2006
	Sarpa salpa[$]	93	0.0063	3.373	0.990	Turkey, Izmir Bay (Aegean Sea)	Özaydin and Taskavak 2006
	Sarpa salpa	49	0.0260	2.789	0.772	Turkey, Izmir Bay, Homa Lagoon	Acarlı et al. 2009
	Sarpa salpa[$]	77	0.0102	3.209	0.929	Turkey, Gökova Bay	Ceyhan et al. 2009
	Sparus aurata	105	0.0090	3.150	0.999	Turkey, Izmir Bay, Homa Lagoon	This study
	Sparus aurata[$]	72	0.0110	3.164	0.970	Turkey, Izmir Bay	Özaydin and Taskavak 2006
	Sparus aurata[$]	10	0.0159	3.039	0.980	Turkey, Izmir Bay	Özaydın et al. 2007
	Sparus aurata	1158	0.0035	3.497	0.965	Turkey, Izmir Bay, Homa Lagoon	Acarlı et al. 2009
	Sparus aurata	59	0.0266	2.736	0.966	Turkey, Gökova Bay	Ceyhan et al. 2009
	Sparus aurata[$]	396	0.0065	3.334	0.975	Greece, Klisova Lagoon	Moutopoulos et al. 2011
	Sparus aurata[$]	1047	0.0197	2.990	0.910	Greece, Papas Lagoon	Moutopoulos et al. 2011
Pleuronectidae	*Platichthys flesus*	77	0.0070	3.080	0.998	Turkey, Izmir Bay, Homa Lagoon	This study
Soleidae	*Solea solea*	73	0.0070	3.053	0.999	Turkey, Izmir Bay, Homa Lagoon	This study
	Solea solea	74	0.0022	3.386	0.960	Turkey, Izmir Bay	Özaydin and Taskavak 2006
	Solea solea	110	0.0021	3.201	0.950	Turkey, Izmir Bay	Özaydın et al. 2007
	Solea solea	141	0.0111	2.966	0.823	Turkey, Izmir Bay, Homa Lagoon	Acarlı et al. 2009

[$]Fork length was used instead f total length; *N* = sample size, *a* = intercept, *b* = regression coefficient.

All allometric coefficients (*b*) were within the expected *range* from 2 to 4 (Bagenal and Tesch 1978, Koutrakis and Tsikliras 2003). Values of $b = 3$ indicate that the fish grow isometrically; values under or over 3 show an allometric growth. The exponent *b* varied between 2.753 for *Pomatoschistus marmoratus* and 3.650 for *Aphanius fasciatus* with a mean value *b* of 3.115 (±0.068 SE). Four species showed isometric growth: *Sardina pilchardus*, *Chelon labrasus*, *Atherina hepsetus*, and *Solea solea*; 11 species presented negative allometric growth ($b < 3$): *Engraulis encrasicolus*, *Dicentrarchus labrax*, *Lithognathus mormyrus*, *Pomatoschistus marmoratus*, *Pomatoschistus minutus*, *Zosterisessor ophiocephalus*, *Blennius ocellaris*, *Liza aurata*, *Liza ramada*, *Mugil cephalus*, and *Atherina boyeri*; and the remaining fish indicated positive allometric growth ($b > 3$): *Anguilla anguilla*, *Belone belone*, *Aphanius fasciatus*, *Syngnathus acus*, *Syngnathus typhle*, *Mullus barbatus*, *Mullus surmuletus*, *Diplodus annularis*, *Diplodus vulgaris*, *Sarpa salpa*, *Sparus aurata*, *Gobius niger*, *Liza saliens*, and *Platichthys flesus*.

The coefficients of determination (r^2) ranged between 0.831 for *Chelon labrasus* and 0.999 for eleven species (Table 2), corresponding to a mean value of 0.930 (±0.017 SE).

L–W relations in fish are influenced by various parameters such as habitat, season, degree of stomach fullness, gonad maturity, sex, health, preservation techniques, and differences (Tesch 1971, Dulčić and Kraljević 1996, Wootton 1998, Verdiell-Cubedo 2006). Therefore, fish species of *b* value in the same area can change at different year or period. In this study, L–W parameters of five species (i.e., *Anguilla anguilla*, *Atherina hepsetus*, *Pomatoschistus marmoratus*, *Pomatoschistus minutus*, and *Platichthys flesus* were determined for the first time in the Aegean Sea (Table 3). In addition, the *b* value of *Blennius ocellaris*, *Aphanius fasciatus*, *Engraulis encrasicolus*, *Dicentrarchus labrax*, *Liza aurata*, *Liza saliens Mullus surmuletus*, *Diplodus vulgaris*, and *Lithognathus mormyrus* were estimated higher than in other studies for Aegean Sea. Similar or lower results for *b* value were found for other species in Table 3. Overall, the LW relations of the fish caught in lagoons are different between the Mediterranean and the Aegean Sea. The reason for this is the diversity of the fishing methods. In the Mediterranean lagoons such as Klisova and Papas in western Greece (Moutopoulos et al. 2011), Mar Menor Lagoon in Spain (Verdiell-Cubedo et al. 2006), the only one type of the fishing gear used was beach seine. In the presently reported study, four different fishing gear types were used (fyke nets, three trammel nets with different mesh sizes, barrier trap with V shape entrance, and beach seine). When *b* value is compared between Greek lagoons and Homa Lagoon, the *b* values of Mugilidae species in Klisova and Papas lagoons are higher than those reported presently by us. On the other hand, in both above-mentioned lagoons the *b* value for *Diplodus annularis* was lower than the one form the presently reported study. The *b* values of some fish species from the Mar Menor Lagoon (*Engraulis encrasicolus*, *Gobius niger*, *Liza aurata*, *Liza ramada*, *Liza saliens*, *Lithognathus mormyrus*, and *Sarpa salpa*), reported by Verdiell-Cubedo et al. (2006) were lower than our respective results. However some of the fish species as *Pomatoschistus marmoratus*, *Chelon labrasus*, *Mugil cephalus*, and *Sparus aurata* in Mar Menor Lagoon were higher than those presently reported from Homa Lagoon. Such differences in *b* values can be associated with one or a combination of factors such as: the differences in the number of specimens examined, the area or/and season effects, the distinctions in the observed length ranges of the specimens caught, as well as the duration of the sampling periods (Moutopoulos and Stergiou 2002).

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REFERENCES

Acarlı D., Kara A., Bayhan B., Çoker T. 2009. Homa Lagünü'nden (İzmir Körfezi, Ege Denizi) yakalanan türlerin av kompozisyonu ve av verimi. ["Catch composition and catch efficiency of species caught from Homa Lagoon (Izmir Bay, Aegean Sea)."] Ege Journal of Fisheries and Aquatic Sciences **26** (1): 39–47. [In Turkish with English abstract.]

Alpbaz A., Kınacıgil T. 1988. İzmir Homa dalyanı'nın balık verimliliği ve balık faunası üzerine bir çalışma. [Study on fish fauna and fisheries efficiency of Homa Lagoon.] Su Ürünleri Dergisi (Ege Üniversitesi) **5** (17–18): 31–56. [In Turkish with English abstract.]

Bagenal T.B., Tesch F.W. 1978. Age and growth. Pp. 101–136. *In*: Begenal T. (ed.) Methods for assessment of fish production in fresh waters. 3rd edn. IBP Handbook No. 3. Blackwell Scientific Publications, Oxford, UK.

Bayhan B., Acarli D. 2006. Hermaphrodite thinlip mullet *Liza ramada* (Risso, 1810) (Teleostei: Mugilidae) from Homa Lagoon (Izmir Bay-Aegean Sea). Aquaculture Research **37** (10): 1050–1052. DOI: 10.1111/j.1365-2109.2006.01508.x

Ceyhan T., Akyol O., Erdem M. 2009. Length–weight relationships of fishes from Gökova Bay, Turkey (Aegean Sea). Turkish Journal of Zoology **33** (1): 69–72. DOI: 10.3906/zoo-0802-9

Dulčić J., Glamuzina B. 2006. Length–weight relationships for selected fish species from three eastern Adriatic estuarine systems (Croatia). Journal of Applied Ichthyology **22** (4): 254–256. DOI: 10.1111/j.1439-0426.2006.00633.x

Dulčić J., Kraljević M. 1996. Weight–length relationships for 40 fish species in the eastern Adriatic (Croatian waters). Fisheries Research **28** (3): 243–251. DOI: 10.1016/0165-7836(96)00513-9

Froese R., Pauly D. 1998. Fish Base 1998: Concepts, design and data sources. ICLARM, Manila, Philippines.

Gonçalves J.M.S., Bentes L., Lino P.G., Riberio J., Canário A.V.M., Erzini K. 1997. Weight–length relationships for selected fish species of the small-scale demersal fisheries of the south

and south and southwest coast of Portugal. Fisheries Research **30** (3): 253–256. DOI: 10.1016/S0165-7836(96)00569-3

Hoşsucu B. 2001. Güllük Lagünü (Ege Denizi) kefal türlerinin (*Mugil* spp.) bazı büyüme özellikleri. [Some growth parameters of mullet species (*Mugil* spp.) living in Güllük Lagoon (Aegean Sea).] EU Journal of Fisheries and Aquatic Sciences **18** (3–4): 421–435. [In Turkish with English abstract.]

Ismen A., Ozen O., Altinagac U., Ozekinci U., Ayaz A. 2007. Weight–length relationships of 63 fish species in Saros Bay, Turkey. Journal of Applied Ichthyology **23** (6): 707–708. DOI: 10.1111/j.1439-0426.2007.00872.x

Karakulak F.S., Erk H., Bilgin B. 2006. Length–weight relationships for 47 coastal fish species from the northern Aegean Sea, Turkey. Journal of Applied Ichthyology **22** (4): 274–278. DOI: 10.1111/j.1439-0426.2006.00736.x

Katselis G., Koutsikopoulos C., Dimitriou E., Rogdakis Y. 2003. Spatial patterns and temporal trends in the fishery landings of the Messolonghi-Etoliko Lagoon (western Greek coast). Scientia Marina **67** (4): 501–511.

Koutrakis E.T., Tsikliras A.C. 2003. Length–weight relationships of fishes from three northern Aegean estuarine systems (Greece). Journal of Applied Ichthyology **19** (4): 258–260. DOI: 10.1046/j.1439-0426.2003.00456.x

Lamprakis M.K., Kallianiotis A.A., Moutopoulos D.K., Stergiou K.I. 2003. Weight–length relationships of fishes discarded by trawlers in the north Aegean Sea. Acta Ichthyologica et Piscatoria **33** (2): 145–151.

Le Cren E.D. 1951. The length–weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). Journal of Animal Ecology **20** (2): 201–219. DOI: 10.2307/1540

Moutopoulos D.K., Koukou K., Vavarouta V., Ramfos A., Katselis G. 2011. Investigation of length–weight relationships for 10 commercial fish species as a possible trophic state index of coastal lagoons. Acta Adriatica **52** (2): 261–268.

Moutopoulos D.K., Stergiou K.I. 2002. Length–weight and length–length relationships of fish species of the Aegean Sea (Greece). Journal of Applied Ichthyology **18** (3): 200–203. DOI: 10.1046/j.1439-0426.2002.00281.x

Petrakis G., Stergiou K.I. 1995. Weight–length relationship for 33 fish species in Greek waters. Fisheries Research **21** (3–4): 465–469. DOI: 10.1016/0165-7836(94)00294-7

Ricker W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bulletin of the Fisheries Research Board of Canada No. 191.

Özaydin O., Taskavak E. 2006. Length–weight relationships for 47 fish species from Izmir Bay (eastern Aegean Sea, Turkey). Acta Adriatica **47** (2): 211–216.

Özaydın O., Uçkun D., Akalın S., Leblebici S., Tosunoğlu Z. 2007. Length–weight relationships of fishes captured from Izmir Bay, central Aegean Sea. Journal of Applied Ichthyology **23** (6): 695–696. DOI: 10.1111/j.1439-0426.2007.00853.x

Sokal R.R., Rohlf F.J. 1981. Biometry. 2nd edn. Freeman, San Francisco, CA, USA.

Tesch W. 1971. Age and growth. Pp. 97–130. *In*: Ricker W.E. (ed.) Methods for assessment of fish production in fresh waters. 2nd edn. International Biological Programme, and Blackwell Scientific Publications, Oxford and Edinburgh, UK.

Verdiell-Cubedo D., Oliva-Paterna F.J., Torralva M. 2006. Length weight relationships for 22 fish species of the Mar Menor coastal lagoon (western Mediterranean Sea). Journal of Applied Ichthyology **22** (4): 293–294. DOI: 10.1111/j.1439-0426.2006.00738.x

Wootton R.J. 1998. Ecology of teleost fishes. Kluwer Academic Publishers, Dordrecht, the Netherlands.

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