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Length-weight relationships for 47 fish species from Izmir Bay (eastern Aegean Sea, Turkey)

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Length-weight relationships were calculated for 47 fish species from the Izmir Bay in the Aegean Sea, Turkey. A total of 13243 fish specimens were sampled with several fishing gears in 1998-2001. The sample size ranged from 11 individuals for Nerophis ophidion *to 1197 for* Boops boops*. The* r^2 *values ranged from 0.82 for* Nerophis ophidion *to 0.99 for* Scorpaena scrofa, *and all regressions were highly significant (p<0.001). Values of the exponent b in the length-weight regression (*$W = aL^b$*) ranged 1.970-3.727. The median was 3.042 and over 50% of the values were within 2.937-3.186. Information from the present survey may be used for fisheries management or other practical purposes.*

Key words: Length-weight relationship, Aegean Sea, Izmir Bay

INTRODUCTION

Izmir Bay provides a significant proportion of the overall marine fish production in Turkey and is considered one of the most important fishery grounds of the Aegean region of Turkey (UÇKUN *et al*., 2000). Izmir Bay is also known as an important spawning and nursery ground for several fish species, mainly because of lagoons which serve as sheltered habitats and the input of nutrients from the Gediz River. Information about the length-weight relationships of fish species in Izmir Bay is scarce and incomplete. The few studies in Turkish seas that focused on length-weight relationships dealt with 18 Lessepsian immigrant species from the eastern Mediterranean (TASKAVAK & BILECENOGLU, 2001), 13 species of Iskenderun Bay in the eastern Mediterranean (CAN *et al*., 2002), and 24 species of the north Aegean Sea (FILIZ & BILGE, 2004).

Length and weight data are a useful and standard result of fish sampling programs. These data are needed to estimate growth rates, length and age structures, and other components of fish population dynamics (KOLHER *et al*., 1995). Length-weight relationships allow fisheries scientists to convert growth-in-length equations to growth-in-weight in stock assessment models (DULČIĆ & KRALJEVIĆ, 1996; GONÇALVES *et al*., 1997; MORATO *et al*., 2001; STERGIOU & MOUTOPOULOS, 2001), estimate biomass from length frequency distributions (ANDERSON & GUTREUTER, 1983; PETRAKIS & STERGIOU, 1995; DULČIĆ &

KRALJEVIĆ, 1996), and calculate fish condition (PETRAKIS & STERGIOU, 1995). Length-weight relationships are also useful for comparing life history and morphological aspects of populations inhabiting different regions (GONÇALVES *et al*., 1997; STERGIOU & MOUTOPOULOS, 2001).

In this study, we report the length-weight relationships for 47 fish species collected from Izmir Bay in the eastern Aegean Sea.

MATERIALS AND METHODS

A total of 13243 fish specimens were sampled in Izmir Bay (Fig. 1) during 1998-2001 by the research vessels Egesüf and Hippocampus (boat lengths 27 and 13.5 m, engine horsepower 500 and 135 hp, respectively). Fishing gears used for sampling included beach seines (stretched cod-end mesh sizes 16 and 18 mm), gill nets (mesh sizes in bar length 20, 22, 24, and 26 mm), trammel nets (mesh sizes in bar length 22, 24, 26 and 28 mm), and bottom trawls (mesh sizes 22 and 24 mm at stretched cod-end). Two fish species (*Syngnathus acus* and *Syngnathus typhle*) were collected with hand nets. The lengths of the gill and trammel nets ranged 80-100 m.

After hauling, the catch was removed and analyses were carried out on the deck of the research vessel and, later, in the laboratory. Total or fork lengths were measured to the nearest cm and individuals were weighed on

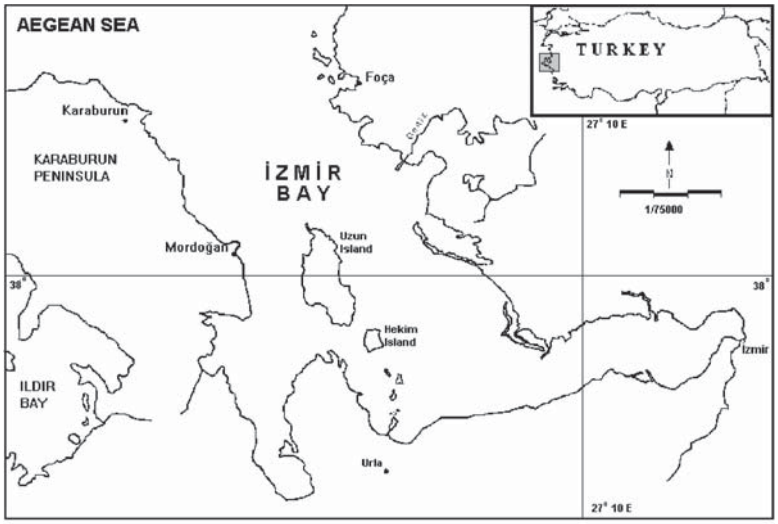

Fig. 1. Sampling area

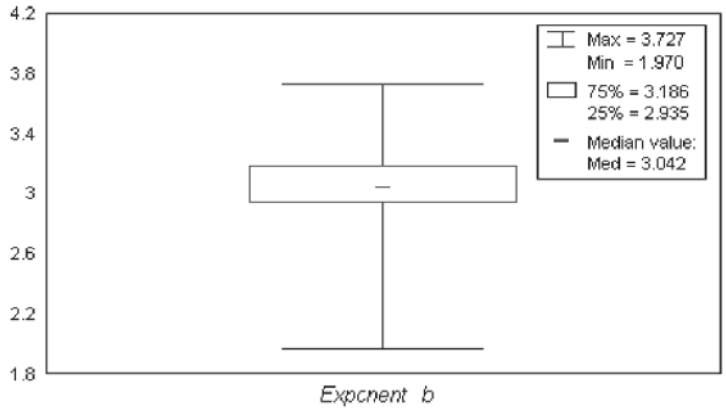

Fig. 2. Box-Whiskers plots of the exponent b of length-weight relationships (W=aLb) for 47 fish species caught in Izmir Bay. The central box covers 53.19% of data values, the vertical line indicates the range of the values, and the horizontal line represents the median

Table 1. Mean length (MeanL; cm) and weight (MeanW; g) and parameters of the length-weight relationship for 47 species from the Bay of Izmir on the Aegean coast of Turkey*

		Length characteristics				Weight characteristics			Parameters of relationship			
Species	Length	N	MeanL	± SE	Range	MeanW	± SE	Range	*a*	*b*	SE (*b*)	r^2
Aphanius fasciatus	TL	143	4,29	0,86	2,7 – 7,1	1,23	0,95	0,19 - 6,2	0,0060	3,532	0,0496	0,97
Arnoglossus laterna	TL	721	10,28	2,44	6,8 – 21,9	10,41	11,1	2,3 - 79,4	0,0052	3,168	0,0236	0,96
Atherina boyeri	FL	138	6,92	1,29	4,8 – 9,8	2,15	1,06	0,6 - 4,86	0,0048	3,165	0,0818	0,98
Belone belone	TL	416	39,07	5,64	26,0 - 60,5	82,74	42,99	16,51 - 303,55	0,0003	3,365	0,0448	0,93
Boops boops	FL	1197	14,63	1,53	10,7 - 23,5	45,18	18,61	14,27 - 252,6	0,0127	3,033	0,0261	0,92
Cepola macrophthalma	TL	254	31,69	7,55	12,2 – 50,6	19,4	8,9	1,93 – 46,15	0,0203	1,970	0,0182	0,98
Chelon labrosus	FL	94	17,91	3,19	13,5 – 24,9	82,42	40,81	35,5 – 192,0	0,0533	2,523	0,0484	0,97
Citharus linguatula	TL	409	12,10	2,83	8,4 – 22,7	19,11	13,41	5,88 – 89,5	0,0540	2,314	0,0330	0,92
Dentex macrophthalmus	FL	51	14,24	2,65	9,9 – 19,5	65,16	37,28	20,0 – 154,0	0,0178	3,051	0,0723	0,97
Diplodus annularis	FL	929	11,08	1,48	7,9 – 16,8	33,04	14,21	11,21 – 102,0	0,0245	2,973	0,0248	0,94
Diplodus vulgaris	FL	63	10,91	1,88	8,0 – 15,4	32,99	17,85	12,33 – 80,0	0,0184	3,094	0,0639	0,98
Engraulis engrasicolus	FL	513	12,09	0,91	10,5 – 14,9	13,91	3,15	9,09 – 23,62	0,0116	2,840	0,0318	0,94
Gobius niger	FL	727	10,01	1,76	6,0 – 15,6	12,07	6,37	2,4 – 40,10	0,0134	2,914	0,0272	0,94
Lapidotrigla cavillone	FL	31	11,77	2,07	8,0 – 21,1	25,81	18,4	5,82 – 116,54	0,0101	3,143	0,1323	0,95
Lithognathus mormyrus	FL	35	18,89	1,76	15,5 – 22,0	111,49	33,3	60,0 –182,0	0,0094	3,181	0,1184	0,96
Liza aurata	FL	81	22,51	1,88	15,7 – 27,8	138,38	36,29	53,5 – 266,0	0,0113	3,016	0,0944	0,93
Liza saliens	FL	329	20,84	3,26	15,8 – 35,0	113,11	54,99	41,4 – 446,5	0,0120	2,990	0,0370	0,95
Lophius piscatorius	TL	94	28,54	8,65	8,0 – 48,0	331,32	238,39	6,4 – 1152,1	0,0146	2,931	0,0577	0,97
Merlangius m. euxinus	TL	100	20,66	2,92	16,0 – 31,7	72,73	36,9	30,27 – 229,37	0,0092	2,944	0,0583	0,96
Merluccius merluccius	TL	501	27,22	5,13	12,3 – 47,0	189,67	109,73	13,1 – 810,0	0,0050	3,154	0,0219	0,98
Mullus barbatus	FL	479	12,76	1,81	7,5 – 20,0	35,75	16,86	5,57 – 123,0	0,0102	3,176	0,0306	0,96
Mullus surmuletus	FL	51	11,88	1,63	8,4 – 17,0	30,61	13,93	11,0 – 84,0	0,0167	3,011	0,0843	0,96
Nerophis ophidion	TL	11	12,54	2,40	10,3 – 18,2	0,21	0,09	0,12 – 0,46	0,0009	2,127	0,3338	0,82
Pagellus acarne	FL	335	11,15	1,14	8,6 – 14,5	23,37	8,38	9,8 – 52,2	0,0064	3,383	0,0416	0,95
Pagellus erythrinus	FL	226	15,31	2,93	9,0 – 25,2	72,6	43,51	12,0 – 285,0	0,0193	2,979	0,0235	0,99
Sarpa salpa	FL	93	19,15	3,19	13,9 – 27,5	148,05	83,79	48,1 – 401,16	0,0063	3,373	0,0429	0,99
Sardina pilchardus	FL	388	11,82	1,02	9,2 – 14,0	20,74	5,74	10,0 – 34,0	0,0076	3,190	0.0590	0,89
Sardinella aurita	FL	677	18,88	1,90	13,0 - 24,2	87,16	24,39	30,06 – 170,7	0,0248	2,769	0,0349	0,90
Scomber japonicus	FL	129	17,68	3,45	12,5 – 26,0	59,47	34,73	17,57 – 157,00	0,0115	2,940	0,0396	0,98
Scomber scombrus	FL	50	25,52	1,88	19,0 – 28,5	180,76	46,65	64,0 – 271,0	0,0010	3,727	0,1690	0,91
Scorpaena porcus	TL	50	18,90	2,77	14,1 – 25,6	149,12	68,06	52,9 – 350,30	0,0201	3,004	0,0825	0,96
Scorpaena scrofa	TL	129	17,30	5,63	8,2 – 30,1	107,96	94,54	10,0 – 439,0	0,0291	2,796	0,0288	0,99
Scorpaena notata	TL	52	13,62	3,80	7,9 – 24,3	55,61	50,93	4,2 – 250,0	0,014	3,085	0,0796	0,97
Serranus cabrilla	TL	200	17,11	1,75	11,9 – 21,8	61,58	19,44	19,53 – 127,8	0,0122	2,990	0,0545	0,94
Serranus hepatus	TL	143	8,49	1,28	5,7 – 11,1	10,6	4,66	2,9 – 23,79	0,0162	2,999	0,0351	0,98
Spicara flexuosa	FL	765	12,50	1,51	8,3 – 18,0	28,62	10,04	8,78 – 74,6	0,0250	2,773	0,0339	0,90
Solea solea	TL	74	25,46	3,37	20,4 – 37,0	134,47	68,17	53,0 – 395,0	0,0022	3,386	0,0782	0,96
Sparus aurata	FL	72	18,92	2,42	15,3 – 28,0	127,26	57,88	60,45 – 365,0	0,0110	3,164	0,0627	0,97
Spicara maena	FL	194	14,05	3,20	8,7 – 19,5	42,5	25,25	10,9 – 92,72	0,0251	2,767	0,0218	0,99
Spicara smaris	FL	163	12,06	1,52	8,3 – 16,8	24,1	9,55	6,78 – 62,93	0,0154	2,935	0,0479	0,96
Syngnathus acus	TL	202	10,01	2,28	6,1 – 20,7	0,53	0,52	0,07 – 4,49	0,0001	3,630	0,0494	0,97
Syngnathus typhle	TL	14	13,73	4,14	7,5 – 20,3	1,23	1,04	0,15 – 2,96	0,0002	3,217	0,2421	0,94
Trachurus mediterraneus	FL	549	14,33	2,53	9,3 – 22,6	35,35	21,48	8,07- 136,2	0,0051	3,275	0,0225	0,98
Trachurus trachurus	FL	575	15,39	3,41	10,3 – 25,6	48,28	31,82	12,3 – 175,4	0,0139	2,938	0,0212	0,97
Trigla lucerna	FL	470	19,84	3,66	12,7 – 34,4	94,23	62,98	20,58 – 491,49	0,0051	3,248	0,0222	0,98
Trisopterus minitus capelanus	TL	158	15,00	1,69	12,1 – 19,9	38,47	15,05	17,4 – 86,2	0,0067	3,177	0,0665	0,94
Zosterisessor ophiocephalus	TL	168	14,48	2,89	9,3 – 20,5	35,37	24,18	7,0 – 111,0	0,0044	3,306	0,0329	0,98

* Length-weight relationships determined according to the equation: $\log W = \log a + b \log TL$

TL = total length; FL = fork length; N = sample size; SE = standard error; r^2 = coefficient of determination

a digital balance with a precision of 0.01 g. Length-weight relationships were calculated by adjustment of an exponential curve to the data ($W = aL^b$). This can be expressed in linear form after logarithmic transformation by log W = log a +b log TL, where W is weight and TL is total length, a is intercept, and b is slope. The degree of association between the variables was computed by the determination coefficient, r^2.

RESULTS AND DISCUSSION

The values for a and b, the standard error of b, and r^2 in length-weight relationships of 47 fish species belonging to 35 genera and 23 families are given in Table 1. The sample size ranged from 11 individuals for *Nerophis ophidion* to 1197 for *Boops boops*. The r^2 values ranged from 0.82 for *N. ophidion* to 0.99 for *Scorpaena scrofa*, and all regressions were highly significant (p<0.001). Values of b ranged from 1.970 for *C. macrophthalma* to 3.727 for *S. scombrus* (Fig. 2). The mean value of the parameter b was 3.042 (SD = 0.048) for the complete data set and 3.055 (SD = 0.045) excluding *N. ophidion,* which had the lowest r^2 value. The length-weight relationships for *S. acus, S. typhle,* and *N. ophidion* have not previously been reported for Turkish seas.

Most of the species were collected over an extended period of time and the data are not representative of a particular season or time of year. Consequently, the estimated parameters should be considered mean annual values. Various factors may be responsible for differences in parameters of the length-weight relationships between seasons and years, such as stage of maturity, sex, temperature, salinity, and food quality, quantity, and size (SHEPHERD & GRIMES, 1983; PAULY, 1984; WEATHERLEY & GILL, 1987; DULČIĆ & KRALJEVIĆ, 1996). According to BAGENAL & TESCH (1978), GONÇALVES *et al.* (1997), and TASKAVAK & BILECENOGLU (2001), the parameter b, unlike the parameter a, may vary seasonally, and even daily, and between habitats. Thus, the length-weight relationship in fish is affected by a number of factors including gonad maturity, sex, diet, stomach fullness, health, and preservation techniques as well as season and habitat, none of which were taken into consideration in the present study.

The information gained in the present survey can enable fish biologists to derive weight estimates for Izmir Bay fishes that are measured but not weighed. The length-weight parameters hereby reported may be of considerable use in ongoing studies of catches in Turkish commercial fisheries.

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Dužinsko-maseni odnos 47 ribljih vrsta iz Izmirskog zaljeva (istočni dio Egejskog mora, Turska)

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SAŽETAK

Istraživan je dužinsko-maseni odnos za 47 vrsta u Egejskom moru (Izmirski zaljev). Ukupno je obrađeno 13243 jedinki uzorkovanim s nekoliko različitih ribarstvenih alata u razdoblju od 1998. do 2001. godine. Broj jedinki kolebao je od 11 za šilce gretenkljuno *Nerophis ophidian* do 1197 za bukvu, *Boops boops.* Vrijednosti koeficijenta determinacije r^2 su kolebale u rasponu od 0.82 za šilce gretenkljuno *N. ophidian* do 0.99 za škrpinu, *Scorpaena scrofa*, dok su regresije bile statistički vrlo značajne ($P<0.001$). Vrijednosti eksponenata b kod dužinsko-masenih odnosa ($W = aL^b$) su kolebale između 1.970-3.727. Srednja vrijednost je iznosila 3.042, dok se 50% svih vrijednosti kretalo u rasponu između 2.937 i 3.186.
Dobiveni podatci iz ove studije mogu poslužiti svsishodno za potrebe gospodarenja ribljim bogatstvima kao i za neke drgue praktične primjene.

Ključne riječi: dužinsko-maseni odnos, Egejsko more, Izmirski zaljev