Mediterranean Marine Science

Vol. 16, 2015

New Fisheries-related data from the Mediterranean Sea (October 2015)

TSAGARAKIS K.	Institute of Marine Biological Resources and Inland Waters, Hellenic Centre for Marine Research, 46.7 km Athens-Sounio ave., 19013, Anavyssos, Attiki
BAŞUSTA A.	Fisheries Faculty, Firat University, TR-23119, Elazig
BAŞUSTA N.	Fisheries Faculty, Firat University, TR-23119, Elazig
BIANDOLINO F.	CNR-Institute for Coastal Marine Environment U.O.S. Taranto, Via Roma 3, 74100 Taranto
BOSTANCI D.	Faculty of Science and Arts, Department of Biology, Ordu University, Ordu
BUZ K.	Fisheries Faculty, Firat University, TR-23119, Elazig
DJODJO Z.	University of Dubrovnik, Department of Aquaculture, 20000 Dubrovnik
DULČIĆ J.	Institute of Oceanography and Fisheries, POB 500, 21000 Split
GÖKOĞLU M.	Aquaculture Department, Faculty of Fisheries, Akdeniz University, Antalya
GÜCÜ A.C.	Department of Marine and Fisheries, Institute of Marine Sciences, Middle East Technical University, Mersin
MACHIAS A.	Institute of Marine Biological Resources and Inland Waters, Hellenic Centre for Marine Research, 46.7 km Athens-Sounio ave., 19013, Anavyssos, Attiki
MARAVELIAS C.D.	Institute of Marine Biological Resources and Inland Waters, Hellenic Centre for Marine Research, 46.7 km Athens-Sounio ave., 19013, Anavyssos, Attiki

ÖZVAROL Y.	Fisheries Department, Faculty of Fisheries, Akdeniz University, Antalya
POLAT N.	Faculty of Science and Arts, Department of Biology, OMU, Samsun
PRATO E.	CNR-Institute for Coastal Marine Environment U.O.S. Taranto, Via Roma 3, 74100 Taranto
YEDIER S.	Faculty of Science and Arts, Department of Biology, Ordu University, Ordu
VASILAKOPOULOS P.	Institute of Marine Biological Resources and Inland Waters, Hellenic Centre for Marine Research, 46.7 km Athens-Sounio ave., 19013, Anavyssos, Attiki

https://doi.org/10.12681/mms.1396

Collective Aticle B

Mediterranean Marine Science
Indexed in WoS (Web of Science, ISI Thomson) and SCOPUS
The journal is available on line at http://www.medit-mar-sc.net
DOI: http://dx.doi.org/10.12681/mms.1396

New Fisheries-related data from the Mediterranean Sea (October, 2015)

K. TSAGARAKIS[1], N. BAŞUSTA[2], A. BAŞUSTA[2], F. BIANDOLINO[3], D. BOSTANCI[4], K. BUZ[2], Z. DJODJO[5], J. DULČIĆ[6], M. GÖKOĞLU[7], A.C. GÜCÜ[8], A. MACHIAS[1], C. D. MARAVELIAS[1], Y. ÖZVAROL[9], N. POLAT[10], E. PRATO[3], P.VASILAKOPOULOS[1] and S. YEDIER[4]

[1] Institute of Marine Biological Resources and Inland Waters, Hellenic Centre for Marine Research, 46.7 km Athens-Sounio ave., 19013, Anavyssos, Attiki, Greece
[2] Fisheries Faculty, Firat University, TR-23119, Elazig, Turkey
[3] CNR-Institute for Coastal Marine Environment U.O.S. Taranto, Via Roma 3, 74100 Taranto, Italy
[4] Faculty of Science and Arts, Department of Biology, Ordu University, Ordu, Turkey
[5] University of Dubrovnik, Department of Aquaculture, 20000 Dubrovnik, Croatia
[6] Institute of Oceanography and Fisheries, POB 500, 21000 Split, Croatia
[7] Aquaculture Department, Faculty of Fisheries, Akdeniz University, Antalya, Turkey
[8] Department of Marine and Fisheries, Institute of Marine Sciences, Middle East Technical University, Mersin, Turkey
[9] Fisheries Department, Faculty of Fisheries, Akdeniz University, Antalya, Turkey
[10] Faculty of Science and Arts, Department of Biology, OMU, Samsun, Turkey

Abstract

In this third Collective Article, with fisheries-related data from the Mediterranean Sea, we present the historical length distribution of *Lophius budegassa* in the catch of commercial trawlers in the Greek seas; length-weight and length-length relationships of five flatfish species (*Lepidorhombus boscii, L. whiffiagonis*, *Platichthys flesus*, *Pegusa lascaris* and *Solea solea*) from different coastal areas of Turkey (Black Sea and Eastern Mediterranean Sea); growth of settled *Polyprion americanus* and length-weight relationships of this species and of *Deltentosteus quadrimaculatus*, *Capros aper* and three commercially important groupers in the Eastern Mediterranean Sea; the age, growth and mortality of *Zosterisessor ophiocephalus* in the Eastern Adriatic Sea; the length-weight relationship and condition factor of *Atherina boyeri* in a Central Mediterranean semi-isolated lagoon, and also the length-weight and length-length relationships of three *Alburnus* species from different inland waters in Turkey.

Keywords: Weight-length relationships, ichthyology, Aegean Sea, Levantine Sea, fishes, sole, anglerfish, wreckfish.

Introduction

Despite the continuous expansion of fisheries science to new fields and to even more sophisticated techniques, basic biological/ecological information (e.g. length-weight and length-length relationships, growth, mortalities, diets, reproduction) on stocks is always useful and essential for, among other things, population and ecosystem models, stock assessments and stock discrimination. Furthermore, in a changing world (Grafton *et al.*, 2008), the existence of such basic information for different time periods and regions is important for exploring fisheries and environment induced changes (i.e. climate change) on aquatic biological resources. With these in mind, Mediterranean Marine Science facilitates the publishing of fisheries-related data through its Collective Articles.

In this article, we present the length distribution of the black anglerfish *Lophius budegassa* in the catch of commercial trawlers in the Greek seas as well as length-weight and length-length relationships of five flatfish species (four-spotted megrim *Lepidorhombus boscii,* megrim *L. whiffiagonis*, flounder *Platichthys flesus*, sand sole *Pegusa lascaris* and common sole *Solea solea*) from different coastal areas of Turkey (North Aegean Sea, Black Sea and North-eastern Mediterranean) and of three *Alburnus* species from different inland waters in Turkey. We also present the length-weight relationships of the four-spotted goby *Deltentosteus quadrimaculatus* in Mersin Bay, the boarfish *Capros aper* in the Turkish Levantine Sea and of three commercially important groupers (white grouper *Epinephelus aeneus*, dusky grouper *Epinephelus marginatus*, goldblotch grouper *Epinephelus costae*) in the North-eastern Mediterranean Sea (Turkey). Finally, we present the length-weight relationship and condition factor of the big-scale sand smelt *Atherina boyeri* in Lesina lagoon (Italy, Central Mediterranean), the growth and length-weight relationships of the settled wreckfish *Polyprion americanus*, off Crete (Greece), and the age, growth and mortality of the grass goby *Zosterisessor ophiocephalus* in the Novigrad Sea (Croatia, Eastern Adriatic).

1. Length distribution of the black anglerfish *Lophius budegassa* in the catch of commercial trawlers in the Hellenic seas

P. Vasilakopoulos & C. D. Maravelias

The black anglerfish *Lophius budegassa* (Spinola, 1807) is a long-lived demersal fish species distributed in the NE Atlantic and throughout the Mediterranean. *L. budegassa* used to be a low-value by-catch species in the Mediterranean, but the steep increase of its price over the past 15 years has led it to become a target species for Mediterranean mixed demersal fisheries (Maravelias & Papakonstantinou, 2003). Here, we investigate the length distribution of *L. budegassa* in the catch of commercial trawlers in the Hellenic seas.

Sampling took place within the framework of different Greek national projects during the 1980s and 1990s in Thermaikos Gulf and the Thracian Sea (north Aegean Sea), the north Aegean Sea (excl. Thermaikos Gulf & Thracian Sea), Pagassitikos Gulf (western Aegean Sea), the Cyclades and Dodecanese (south Aegean Sea) and Patraikos and Korinthiakos Gulfs (eastern Ionian Sea). *L. budegassa* specimens were caught throughout the year by means of commercial demersal trawlers.

In total, 8848 *L. budegassa* specimens were caught, ranging from 3 cm to 76 cm in total length (TL), with $\overline{TL}$ = 21 cm (Fig. 1). 87% of the specimens caught were below 34 cm, which is the TL at which 50% of the female fish mature (L_{50}) in the Hellenic seas (Tsimenidis, 1980). 81% of the specimens caught were below 30 cm, which is the minimum landing size (MLS) according to European legislation (EC 1626/94). Exploitation of juveniles was more intense in Patraikos and Korinthiakos Gulfs where 92% of the caught *L. budegassa* specimens were below L_{50} and 86% were below MLS (Fig. 1). The lowest proportion of juveniles in the catch was observed in the Cyclades and Dodecanese area, but still more than half (57%) of the fish caught there were below L_{50} and 46% were below MLS.

Our results indicate that catches of *L. budegassa* by demersal trawlers in the Hellenic seas are dominated by juveniles. Overexploitation of *L. budegassa* juveniles is also a feature of demersal mixed fisheries in the western and central Mediterranean (STECF, 2012). Catching fish before they manage to spawn-at-least-once can have detrimental effects on stocks due to the occurrence of both growth and recruitment overfishing (Vasilakopoulos *et al*., 2011). Therefore, increasing size-at-capture of *L. budegassa* is recommended to promote sustainable exploitation of the species in the Hellenic seas. This could be achieved either through gear modifications (e.g. increased mesh size) or by spatio-temporal shifts in fishing effort (e.g. avoidance of nurseries). Also, new sampling projects are needed for an updated picture of the *L. budegassa* commercial catches in the Hellenic seas.

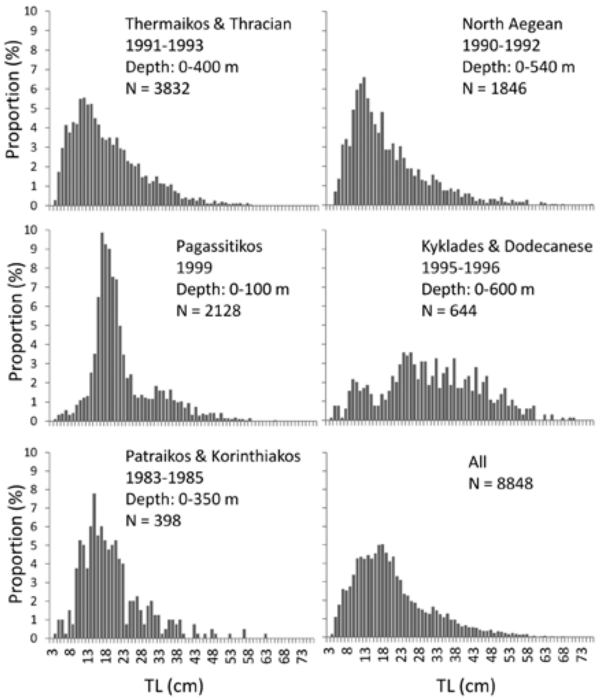

Fig. 1: Length distribution of *Lophius budegassa* in the catch of commercial demersal trawlers in five different marine areas of the Hellenic seas.

2. Length-weight and length-length relationships of five flatfish species from different biogeographic coastal areas of Turkey

D. Bostancı & N. Polat

The knowledge of individual body length-weight relationship (LWR) in a population has been extensively used for: (i) the estimation of weight from length due to technical difficulties and the amount of time required to record weight in the field; (ii) the conversion of growth-in-length equations to growth-in-weight for use in stock assessment models, (iii) the estimation of biomass from length observations, and (iv) the estimation of the condition factors of fish (Gonçalves *et al.,* 1997). Length-weight relationships for fish are originally used to provide information on the condition of fish in order to determine whether somatic growth is isometric or allometric (Ricker, 1975). This study investigates length-weight and length-length relationships for a number of commercial flatfish species, four-spotted megrim *Lepidorhombus boscii,* megrim *L. whiffiagonis*, *the* flounder *Platichthys flesus*, the sand sole *Pegusa lascaris* and the common sole *Solea solea* (Pleuronectiformes), from different coastal areas of Turkey (North Aegean Sea, Black Sea and Northeastern Mediterranean).

Samples were measured for total length (TL) and standard length (SL) to the nearest 0.1 cm and weighed (W) to the nearest 0.01 g. The LWR for total body weight was calculated using the equation $W=aL^b$ (Ricker, 1975). Additionally, the 95% confidence limits of *b* and the coefficient of determination r^2 were estimated. Furthermore, the relationships of total length (TL) and standard length (SL) were calculated using linear regression.

In this study, 5 flatfish species belonging to 3 families with a total of 749 fish specimens were caught and examined. Table 1 shows the length-weight relationships and capture location for different flatfish species. The number of specimens, the length and weight ranges (minimum and maximum), the parameters of the LWRs (*a* and *b*) and the coefficient of determination (r^2) are given. All relationships were highly significant ($P < 0.001$). The relationships of total (TL) and standard length (SL) were calculated as follows and a high correlation was found for all species.

L. boscii	SL=0.813TL+0.12	r^2=0.986
L. whiffiagonis	SL=0.741TL+1.22	r^2=0.987
P. flesus	SL=0.792TL+0.11	r^2=0.994
P. lascaris	SL=0.891TL-0.51	r^2=0.983
S. solea	SL= 0.927TL-0.42	r^2=0.982

All species showed positive allometric growth because the *b*-values were significantly higher than 3 ($P < 0.001$). It is known that geographic location, environmental conditions, stomach fullness, disease and parasite loads can affect the length-weight relationship (Ricker, 1975). For example, for *L. boscii*, Bilge *et al.* (2014) reported *b*=3.199 (n=67) for the Southern Aegean Sea while Cengiz (2011) found *b*=3.25 (n=2242) for the North Aegean Sea (Saroz Bay). Similarly, for *S. solea*, Bayhan *et al.* (2008) calculated *b*=2.73 (n=44) in the Aegean Sea (İzmir Bay), while we calculated *b*=3.11 (n=88) in the Northeastern Mediterranean (Mersin Bay). Observed differences in *b*-values could occur because of differences in sampling (*e.g.* differences in the length ranges and the number of specimens). While estimating the parameters of length-weight relationships, the length range (e.g. minimum and maximum fish length) in different areas may have affected the parameters.

Table 1. Length-weight relationship parameters of five flatfish species from Turkey. n= Sample size; TL=Total length range (cm); W=Weight range (g); *a* and *b* are the parameters of the relationships; r^2= Coefficient of determinat.

Family	Species	Locality	n	TL range (cm)	W range (g)	*a*	*b*	95%CI	r²
Scophthalmidae	*L. boscii*	North Aegean Sea (Saroz Bay)	420	12.2-29.0	11.52-207.21	0.0049	3.146	3.141-3.145	0.9723
	L. whiffiagonis		26	13.4-26.7	14.98-111.05	0.0055	3.036	3.028-3.048	0.9752
Pleuronectidae	*P. flesus*	Black Sea (Samsun)	122	6.5-32.4	12.00-369.00	0.0053	3.230	3.216-3.233	0.9772
Soleidae	*P. lascaris*	Black Sea (Sinop)	93	10.4-22.2	07.01-110.33	0.0024	3.484	3.471-3.487	0.9547
	S. solea	Northeastern Mediterranean (Mersin Bay)	88	17.5-24.5	29.60-98.62	0.0088	3.112	3.104-3.117	0.9612

3. The length-weight relationship and condition factor of *Atherina boyeri* (Pisces, Atherinidae) in a semi-isolated Mediterranean lagoon

E. Prato & F. Biandolino

Atherina boyeri is a resident species of Mediterranean coastal lagoons and because of its low dispersal capability it forms local semi-isolated populations, which may differ from other nearby populations as regards their biology and morphology. This species is an important resource, but stable demand for it could lead to overexploitation of natural stocks in the lagoons (Maci & Basset, 2010). The aim of this study was to determine the length-weight relationships (LWRs) and the Fulton's condition index (K) of this species, which are useful for fishery management.

A survey was conducted in Lesina lagoon (41°88' N and 15°45' E) from June 2007 to May 2008. At the laboratory, *A. boyeri* weigh (W, in g) and total length (TL) (to the nearest mm) were determined, and the *t-test* was used to identify isometric or allometric growth.

A total of 2143 individuals were caught and descriptive statistics as well as the LWR and K estimated parameters are reported in Table 2. The total length of the individuals ranged from 14.0 mm to 110.0 mm in summer and the body weight ranged from 0.02 g in winter to 8.52 g in autumn (Table 2).

The seasonally collected data were pooled and all individuals were described by the general equation: $W=0.0135*TL^{3.05}$ ($R^2=0.85$). Moreover, LWRs determined in each season showed a coefficient of determination (R^2) ranging between 0.65 and 0.90 ($p < 0.05$) (Table 2). The slope values of b ranged from 2.61 in summer to 3.39 in spring. It differed significantly from 3 (t-test; $p < 0.05$), showing a positive allometric growth ($b > 3$) in spring, an isometric growth ($b = 3$) in winter while, in summer and autumn, *A. boyeri* exhibited negative allometric growth ($b < 3$) (t test; $p > 0.05$). This implies that changes in the LWR can be linked to a spawning event. Maci & Basset (2010) indicate spring as the reproductive season for *A. boyeri,* since a great proportion of females with gonads full of ripe eggs were observed in Aquatina lagoon. Moreover, the K values determined in this season were highest (1.91 ± 0.91), even though no significant difference among seasons were observed (ANOVA, $p > 0.05$), indicating a good condition during the entire study period.

A comparison of the parameters obtained in this study also reveals geographical differences between nearby areas (Table 3). It is expected that the results obtained will contribute to the knowledge of *A. boyeri* populations in this lagoon and also assist scientists and fisheries managers, involved in future management programmes, as regasrds the recovery and conservation of this heavily exploited population.

Table 2. Descriptive statistics and estimated parameters of the length-weight relationships. N = sample size; TL: Total Length (mm); WW: Wet weight (g); S.D.: Standard Deviation; Max = Maximum; Min = Minimum; a = Intercept; b = Slope; 95% CI = Confidence Intervals; R^2 = Coefficient of Determination; K = Condition index.

	N	TL (mm)			WW (g)			$W=aTL^b$					K
		Mean ± S.D.	**Min**	**Max**	**Mean ± S.D.**	**Min**	**Max**	***a***	**95% CI of *a***	***b***	**95% CI of *b***	**R^2**	**Mean ± S.D.**
Summer	490	71.8 ± 13.6	14.0	110.0	2.26 ± 1.33	0.29	8.20	0.028	0.018 - 0.038	2.61	2.47 - 2.74	0.70	1.45 ± 0.48
Autumn	382	59.8 ± 11.1	39.0	105.0	4.31 ± 1.66	0.35	8.52	0.033	0.023 - 0.043	2.63	2.49 - 2.76	0.65	1.46 ± 0.79
Winter	528	44.5 ± 9.84	15.0	98.4	1.40 ± 0.88	0.02	5.23	0.018	0.008 - 0.028	2.94	2.80 - 3.07	0.90	1.77 ± 0.57
Spring	743	48.8 ± 9.84	25.0	100.0	2.27 ± 1.22	0.10	8.32	0.038	0.028 - 0.047	3.39	3.25 - 3.52	0.80	1.91 ± 0.91

Table 3. Length-weight relationships of *A. boyeri* from different localities. (TL=Total Length; ST=Standard Length; FL=Fork length).

References	Area	Length range (mm)	Length type	*a*	*b*
Tarkan *et al*. (2006)	Küçükçekmece Lagoon (NW-Turkey)	39 - 111	TL	0.0035	3.31
	Ömerli Dam Lake (NW-Turkey)	77 - 129	TL	0.0159	2.66
Özaydin & Taskavak (2006)	Izmir bay (E-Aegean sea, Turkey)	48 - 98	FL	0.0048	3.16
Dulčić & Glamuzina (2006)	Estuary Mirna (Adriatic, Croatia)	45 - 157	TL	0.0075	2.97
	Estuary Cetina (Adriatic, Croatia)	25 - 106	TL	0.0095	2.85
	Estuary Neretva (Adriatic, Croatia)	36 - 98	TL	0.0070	2.95
Andreu-Soler *et al*. (2006)	Segura River basin (SE-Spain)	39 - 94	FL	0,0055	3.26
Maci & Basset (2010)	Aquatina lagoon (Lecce-Italy)	20 - 90	SL	-11.45	2.95
Liousia *et al*. (2012)	Port of Igoumenitsa (Greece)	27 - 80	SL	0.0084	3.06
	Amvrakikos Gulf (Greece)	16 - 83	SL	0.0117	2.99
Present study	Lesina lagoon (Adriatic sea, Italy)	14 - 110	TL	0.0135	3.05

4. The growth and length-weight relationships of the settled wreckfish (*Polyprion americanus*) from the Eastern Mediterranean Sea

A. Machias & K. Tsagarakis

The wreckfish *Polyprion americanus* (Bloch & Schneider, 1801) has a pelagic juvenile stage associated with FADs and floating objects and settles on the bottom, usually in deep waters, after reaching ~60 cm length (Machias *et al*., 2003). Despite its interesting life history, its high commercial value and its potential for aquaculture

(Papandroulakis *et al.,* 2004), information on its biology is still relatively scarce. In this study, we estimate growth parameters and the length-weight relationship of the species in the Eastern Mediterranean sea.

Fish were collected using bottom longlines on board commercial vessels operating in the fishing grounds around the island of Crete (Greece) in depths ranging from 300 to 1000m (mainly 500 to 850m) from September 1999 to March 2001. Total length in cm (TL) and weight in g (total weight: TW; eviscerated weight: EW) were measured from 225 demersal wreckfish specimens and the length-weight relationships were estimated. In addition, age reading of otoliths (left sagitta) took place for 207 fish. Each sagitta was embedded in a block of clear epoxy resin and sectioned along a dorso-ventral plane through the kernel, using a single high-concentration diamond wheel mounted on an OTO-LABCUT 250 Diamond sectioning machine. Two readers projecting the image onto a TV monitor performed counting. When no agreement could be reached, the otolith was not included in the analysis. The von Bertalanffy growth equation (VBGE; $L_t = L_\infty *(1-e^{-K*(t-to)})$; L = length, t = age in years, K = growth rate) was used to estimate Wreckfish growth.

The parameters of the length-weight relationships were estimated as follows:

$$TW = 0.0162*TL^{2.998},\ r^2 = 0.885$$

$$EW = 0.0149*TL^{3.009},\ r^2= 0.906$$

The estimated von Bertalanffy parameters and their standard errors were: L_∞ = 143.20 ±0.910 cm, K = 0.082 ±0.001 y^{-1} and t_0 = -3.442 ±0.064 y (r^2 = 0.955). The fitted curve is shown in Figure 2.

Slightly lower L_∞ and higher growth rate (K) was estimated for the Italian Ionian sea population (Carbonara *et al*., 2003); however, pelagic phase juveniles were included in that analysis. The contrary - higher L_∞ and lower growth rate but still with comparable values - has been reported for fish from the North Atlantic (L_∞ = 151.7 cm, K = 0.073 y^{-1}; Sedberry *et al.*, 1999). Since the data from the Eastern Mediterranean reported here are quite old (1999-2001), it would be interesting to see if the length-weight and VBGE parameters have changed due to e.g. fishing pressure during the recent period.

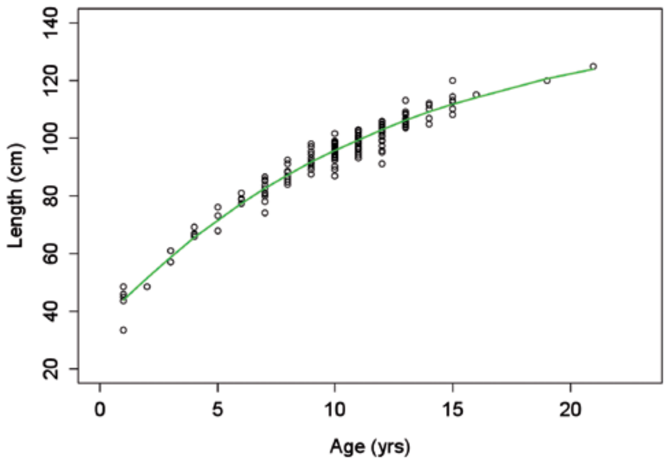

Fig. 2: Wreckfish length per age and fit of the von Bertalanffy growth curve [$TL = 143.2*(1 - e^{-0.082*(t+3.442)})$].

5. The length-Weight relationships of four-spotted goby *Deltentosteus quadrimaculatus* (Valenciennes, 1837) in Mersin Bay, South Turkey

N. Başusta & A. C. Gücü

The four-spotted goby, *Deltentosteus quadrimaculatus* (Valenciennes, 1837), is one of the gobiids inhabiting Mersin Bay. It is an Atlanto-Mediterranean species, distributed throughout the Mediterranean Sea and the eastern Atlantic from the Bay of Biscay to Mauritania (Golani *et al.,* 2006). There is no available information on the fisheries biology of this species in the North-eastern Mediterranean Sea. However, the four-spotted goby has been satisfactorily studied in other areas of the Mediterranean in recent years. The Length-Weight relationships (LWRs) of this species have been reported from the Balearic Islands (Merella *et al*., 1997), from the western Mediterranean (Morey *et al.*, 2003), from the North Aegean (Lamprakis *et al*., 2003) and from the Central Aegean Sea (Metin *et al*., 2011). In this study, the LWRs of the four-spotted goby were examined for the first time in a population of the North-eastern Mediterranean Sea.

D. quadrimaculatus individuals were caught as discards by R/V "Lamas" from depths of 120 and 125 m in Mersin Bay, eastern Mediterranean Turkish coasts (36.506 N / 34.346 E - 36.502 N / 34.318 E) on 24th August 2015. At the laboratory, total length (*TL*) to the nearest 0.1 cm was measured for each fish and they were weighed (wet weight, *W*) using a digital scale to the nearest 0.01 g. A total of 132 specimens were collected. Total length ranged from 4.5 to 8.6 cm and weight ranged from 0.60 to 6.15 g. The samples were composed of 44.70% females, 40.91% males and 14.39% juvenile individuals.

The LWR estimated for combined sexes was $W= 0.0047*TL^{3.3282}$ (R^2=0.975, SE_b =0.070) (Fig. 3). LWR for females (n=59) was $W= 0.0039*TL^{3.4334}$ (R^2=0.960, SE_b =0.093) and for males (n=54) $W= 0.0039*TL^{3.1519}$ (R^2=0.964, SE_b =0.092). The type of growth for both sexes was positive allometric (b >3). As regards other regions, the *b* values calculated for this species were 3.05 in the Balearic Islands (Merella *et al*., 1997), 3.368 in the Thracian Sea (Lamprakis *et al*., 2003), 3.6321 in the Balearic Islands and the Iberian Peninsula (Morey *et al.,* 2003) and 3.45 in Izmir Bay (Aegean Sea) (Metin *et al.,* 2011). These values are similar to those of our study.

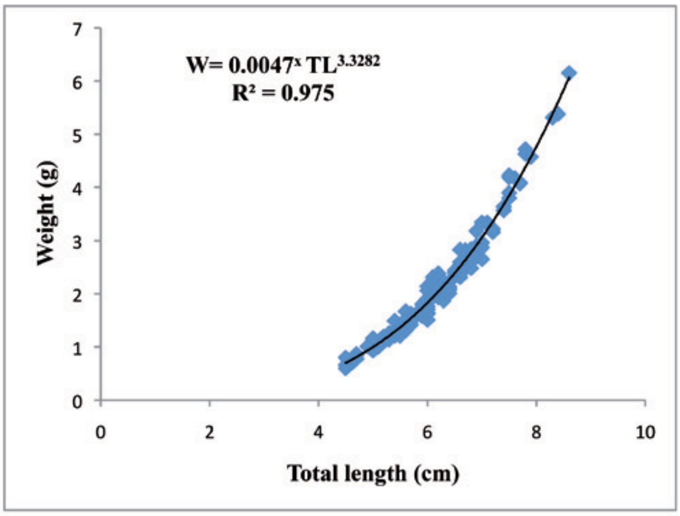

Fig. 3: Overall length-weight relationship of *Deltentosteus quadrimaculatus* in Mersin Bay.

6. The length-weight and length-length relationships of three *Alburnus* species from different inland waters in Turkey

D. Bostancı & S. Yedier

Length-weight relationships (LWRs) have been commonly used in fish biology, ecology, fisheries management, and even fish physiology. In fish biological studies, LWRs have been used for the estimation of fish biomass from lengths as well as for life history and morphological comparisons between different fish species and different populations from different habitats (Gonçalves *et al*., 1997). LWRs also provide crucial information on the condition of a fish, in order to determine whether somatic growth is isometric or allometric (Ricker, 1975). The current study provides length-length and length-weight relationships for three *Alburnus* species, the danube bleak, *A. chalcoides, the* mosul bleak, *A. mossulensis* and the tarek, *A. tarichi,* from different inland waters in Turkey.

All individuals were measured for total length (TL), fork length (FL), and standard length (SL) to the nearest 0.1 cm and total body weight (W) to the nearest 0.01 g. The LWRs were calculated using the equation $W=a*L^b$ (Ricker, 1975), while the TL – SL and TL – FL relationships were calculated for each *Alburnus* species using linear regression.

A total of 261 specimens of the three species were collected with anglers by commercial fishermen in three different inland waters of Turkey, the Curi stream (Ordu), the Munzur river (Tunceli), and Lake Van (Van) (May 2013-January 2014) (Table 4). The length-length relationships were estimated as: SL = 0.8479*TL-0.0178 (R^2 = 0.961), FL = 0.9531*TL-0.5250 (R^2 = 0.975) for *A. chalcoides,* SL = 0.8570*TL-0.1606 (R^2 = 0.960), FL = 0.9040*TL+0.1120 (R^2 = 0.960) for *A. mossulensis,* and SL = 0.8383*TL+0.2526 (R^2 = 0.969), FL = 0.9211*TL+0.0155 (R^2 = 0.967) for *A. tarichi*.

All extracted LWRs (Fig. 4) were highly significant ($p < 0.001$). *A. chalcoides* and *A. mossulensis* exhibited positive allometry ($b > 3$; $p < 0.001$). Negative allometry was estimated for *A. tarichi* ($b < 3$; $p < 0.001$). The coefficient of determination for LWRs was high for the three *Alburnus* species thus indicating that the length increased with increase in fish weight. Several authors have reported negative, isometric, and positive allometric growth for *Alburnus* species from various water bodies. For instance, whereas Esmaeili *et al.* (2014) estimated $b = 3.04$ (n = 475) in the Persian Gulf and $b = 3.00$ (n = 68) in Kor basin (Iran) for *A. mossulensis,* Tarkan *et al.* (2006) indicated $b = 3.56$ (n = 57) for *A. chalcoides* in Lake Sapanca and Sarı (2001) reported $b = 2.276$ for *A. tarichi* in Lake Van.

This study on the three *Alburnus* species would certainly add to the knowledge of LWRs and encourage further studies on the subject involving many other species from different regions of the world.

Table 4. Length-weight relationship parameters of three *Alburnus* species from different inland waters in Turkey. n= Sample size; TL=Total length (cm); W=Weight (g); *a* and *b* the parameters of the log(W)-log(TL) relationship; R^2= Coefficient of determination.

Family	Species	Common name	Locality	n	TL range (cm)	W range (g)	*a*	*b*	95% CI	R^2	Growth Type
Cyprinidae	*A. chalcoides*	Danube bleak	Curi Stream (Ordu-Turkey)	26	11.8-17.8	13.8-52.4	0.0079	3.051	3.042-3.061	0.945	Allometric (+)
	A. mossulensis	Mosul bleak	Munzur River (Tunceli- Turkey)	130	11.3-21.0	10.9-82.7	0.0061	3.060	3.053-3.066	0.915	Allometric (+)
	A. tarichi	Tarek	Lake Van (Van-Turkey)	105	17.8-23.5	44.8-112.2	0.0220	2.653	2.648-2.657	0.839	Allometric (–)

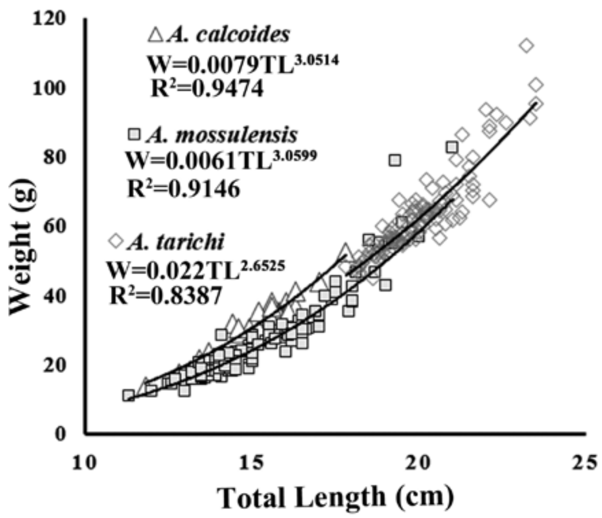

Fig. 4: Weight-length relationship of the three *Alburnus* species.

7. The Length-Weight relationship of three commercially important groupers (Pisces: Serranidae) from Southern Turkey

Y. Özvarol & M. Gökoğlu

The family Serranidae contains about 500 species in more than 60 genera, including sea basses and groupers of the subfamily Epinephelinae Bleeker, 1874. The members of the family are of considerable high economic value, especially for the coastal fisheries of tropical and subtropical areas. Loss or reduction of these species from reefs can therefore adversely affect local biodiversity and ecosystem stability (Dulvy *et al.*, 2004). They are highly prized because of the quality of their flesh, and most species fetch high market prices. *Epinephelus aeneus* (White grouper), *Epinephelus marginatus* (Dusky Grouper), *Epinephelus costae* (Goldblotch grouper) are some of the groupers of commercial fisheries along the southern Mediterranean coast of Turkey.

The relationship between the length and weight of fishes is very important for estimating growth rates, age structures, stock conditions, comparing life histories of fish species between regions, assessing the condition of fish, and other components of fish population dynamics (King, 2007).

Studies of these groupers along the Mediterranean coast of Turkey are still absent. The aim of this study is to determine the length-weight relationships (LWR) for 3 highly commercially important groupers from the Gulf of Antalya, North-eastern Mediterranean Sea.

The *E. aeneus*, *E. marginatus* and *E. costae* individuals were obtained with longlines from the small-scale fishery in the Gulf of Antalya (36.833 N, 30.567 E - 36.75 N, 30.917 E) in January – February 2014. Operations were carried out daily with commercial boats of the local fisheries (15 fishing boats, 6–9 m in length, 9–32 hp engine power). The longline used consisted of 0.7-0.8 mm diameter monofilament and a main line with 1 mm diameter monofilament at a depth from 5 to 150 m. Longlines were left at sea for 1 – 3 hours. Longlines (one basket) were 1 km long and carrying 200 hooks. *Sardinella aurita* Valenciennes, 1847, was used as bait during fishing. All caught fishes were identified to species level upon arrival at the port.

Total length of fishes was measured to the nearest 0.1 cm and weight to the nearest 0.1 g. The LWR parameters of the three groupers were determined using the equation: $W = a L^b$ where W is body wet weight, L is total length, *a* is the intercept, and b is the slope of the regression line (Wootton, 1990). The slope of the length-weight relationship for each species was tested for significant difference from the isometric growth value of 3.0 (Froese, 2006). Significance ($p < 0.001$) between total length and weight was assessed with Student's t-test. SPSS 16 was used for the statistical analysis.

A total of 662 individuals of the 3 species were sampled. The relative abundance of samples was 79% for *E. aeneus*, 12% for *E. marginatus* and 9% for *E. costae*. Total length and weight of the samples varied between 20 – 97.5 cm and 80 – 14550 g, respectively. Length-weight regressions for all 3 groupers were highly significant ($p < 0.001$). Values of the coefficient of determination (r^2) varied from 0.978 (*E. marginatus*) to 0.989 (*E. costae*). The one tailed t-test showed that the length exponents (b values) of all species were significantly different from 3, with all species showing positive allometries (Table 5).

Table 5. Length-weight relationship parameters for fish species from the Gulf of Antalya. N: number of specimens; L: length (cm); W: weight (g); *a* and *b*, relationship parameters; SE(b): standard error of *b*; r^2: coefficient of determination; P: P value for t-test comparing differences for isometric growth (b=3); (A+: Positive allometric growth); GT: Growth type.

Species	N	L range	W range	a	b	SE(b)	r^2	P	GT
Epinephelus aeneus	522	20.5–97.5	80-11400	0.009	3.059	0.615	0.989	P<0.001	A+
Epinephelus marginatus	78	25.8–90.5	254-14550	0.010	3.108	1.539	0.978	P<0.001	A+
Epinephelus costae	62	20–58	90-2460	0.009	3.051	1.058	0.986	P<0.001	A+

8. The length-weight relationships of the boarfish *Capros aper* (Linnaeus, 1758) from the Turkish Levantine Sea

A. Başusta and K. Buz

Caproidae, boarfishes, consists of 12 species with only one found in the Mediterranean. The boarfish *Capros aper* (Linnaeus, 1758) is widespread in the eastern Atlantic Ocean, from Norway to Senegal (Golani *et al.,* 2006). This study was carried out to determine the length-weight parameters of *C. aper* off Iskenderun Bay between June and August 2015. The LWRs of boarfish in the Turkish Levantine Sea were examined for the first time in this study.

Capros aper specimens were caught as bycatch by a commercial bottom trawl fishery at a depth of 200 to 380 m off Iskenderun Bay (36.121 N - 35.311 E, 36.237 N - 35.383 E). Twelve trawl operations were performed along the same trawl line. The trawler was equipped with 44 mm stretched mesh size nets at the cod-end. Trawling lasted 3 hours and trawling speed was 2.5 knots. A total of 208 specimens were collected. All samples were transported to the laboratory on ice, where total length (L) of each fish was measured to the nearest 0.1 cm, weight (W) was measured to the nearest 0.1 g and the sex was determined by macroscopic observation of the gonads.

Minimum and maximum total length and weight were 5.5 - 13.2 (7.5 ± 1.41) cm and 2.3 - 32.5 (7.6 ± 4.0) g, respectively. The exponential total length-weight relationships were described by the equations: $W = 0.02748 * L^{2.752}$ ($R^2 = 0.928$; $SE_b = 0.1305$, t-test: $p < 0.05$) for all specimen, $W = 0.02499 * L^{2.796}$ ($R^2 = 0.919$; $SE_b = 0.1321$, t-test: $p < 0.05$) for females and $W = 0.02954 * L^{2.719}$ ($R^2 = 0.932$; $SE_b = 0.1298$, t-test: $p < 0.05$) for males. The type of growth for all individuals was negative allometric growth (b<3). In this study, the data did not represent a total year; thus, the parameters calculated should be considered as representative for year 2015 only. Similar values were observed in other studies, with the exception of except Lamprakis *et al.* (2003) and Torres *et al.* (2012) (Table 6). The reason for this difference could be the insufficient number of samples.

Table 6. Total length-weight relationships of *Capros aper* in various areas.

Region	a	b	Sex	Lmin-max (cm)	R^2	n	Source
Cantábrico, Spain	0.03050	2.791	all	2.0-16.0	0.980	22	Pereda & Villamor, 1991
South Aegean Sea,	-	2.913	female	-	0.940	170	Kaya &
Turkey	-	2.915	male	-	0.940	165	Ozaydin, 1996
Balearic Islands, Spain	0.02820	2.810	all	3.2-12.2	0.990	104	Merella *et al.*, 1997
North Aegean Sea (Thracian Sea), Greece	0.10390	2.056	all	2.9-12.2	0.868	20	Lamprakis *et al.*, 2003
North Aegean Sea, Turkey	0.02320	2.830	all	2.9-10.1	0.980	455	Filiz & Bilge, 2004
Northeast Atlantic	0.000054	2.91	all	5.0-14.0	0.994	168	White *et al.*, 2011
Gulf of Cadiz, Spain	0.01380	3.106	all	3.5-13.3	0.950	94	Torres *et al.*, 2012
South Aegean Sea, Turkey	0.0353	2.6360	all	2.9-9.7	0.880	602	Bilge *et al.*, 2014
South Aegean Sea,	0.01940	2.934	all	3.5-10.5	0.950	790	Yapici &
Turkey	0.01930	2.937	female	5.2-10.5	0.950	432	Filiz, 2014
	0.01980	2.934	male	5.0-9.2	0.930	318	
North-Eastern	0.02748	2.752	all	5.5-13.2	0.928	208	this
Mediterranean	0.02499	2.795	female	5.5-10.6	0.919	88	study
	0.02954	2.719	male	5.8-13.2	0.932	120	

9. Age, growth and mortality of the grass goby *Zosterisessor ophiocephalus* (Pallas, 1814), in the Novigrad Sea (Eastern Adriatic)

J. Dulčić & Ž. Djodjo

The grass goby, *Zosterisessor ophiocephalus* (Pallas 1814) (Gobiidae), lives in inshore and brackish water estuaries and lagoons of the Mediterranean, the Black Sea, the Adriatic Sea and the Sea of Azov (Jardas, 1996). The main objective of this study was to obtain the first information on age, growth, length-weight relationship (LWR) and mortality of the grass goby in the Novigrad Sea (eastern Adriatic Sea).

Sampling took place in the Novigrad Sea (Eastern Adriatic), (44.184204 N, 15.528724 E and 44.206358 N 15.570395 E), from January 2010 to February 2011 at depths of between 3 and 4 m and a total of 1065 individuals were collected using 6 mm mesh deployed fyke nets. The sex was determined by macroscopic examination of sexually dimorphic urogenital papilla and gonads. The sagittal otoliths of each fish were removed, cleaned, and stored dry for subsequent age determination.

The Von Berntalanffy growth equation (VBGE) was used to describe the growth of *Z. ophiocephalus*. The length-weight relationship of fish was calculated by applying the exponential regression equation $W = aTL^b$ where *a* and *b* are the regression parameters. Estimates of instantaneous total mortality (Z) were obtained using the linearized length-converted catch curve. The instantaneous rate of fishing mortality (F) was rated from the difference between Z and M (estimated using estimates of L_∞, K and annual mean water temperature). The exploitation rate (E) was determined according to the equation: $E = F / Z$.

The total length of 1065 individuals ranged from 5.4 to 20.0 cm (mean 12.64 ± 2.51) and weight from 1.20 to 76.96 g (21.34 ± 12.70) (Table 7). The calculated length-weight equation for all individuals was TW (g) = $0.010TL^{2.90}$, R^2= 0.950; for females TW (g) = $0.012TL^{2.890}$, R^2=0.951 and for males TW (g) = $0.012TL^{2.895}$, R^2= 0.950. There was no statistically significant difference of the length-weight regressions between sexes (ANOVA, $p > 0.05$). The ages ranged from 1 to 5 years. The values of the VBGE parameters pooled for both sexes are $L\infty$ = 21.14 cm, K = 0.35 year^{-1}, t_0= - 0.32 year^{-1}. Total mortality, corresponding to descending limb of the length-converted catch curve, was Z = 0.442 per year for females and Z = 0.510 per year for males (Table 8). The estimate of E should be considered with caution, since mortality rates were estimated from a single sampling season and may be biased due to annual differences in year class strength.

In this study, the values of *b* (in the LWR) showed negative allometry in the growth of females and males. The same result was found for the population of the grass goby along the Tunisian coast (Menif, 2000; Hajji *et al.*, 2013). In the study by Akyol (2003) (Bay of Izmir, Aegean Sea), growth was isometric after spawning and positive allometric in winter and early spring, including during the reproduction period of the fish. The grass goby is a short-lived species. The oldest specimen in this study was 5 years old, which is in agreement with other findings (Akyol, 2003; Miller, 1986; Menif, 2000), but in the study of Hajii *et al*. (2013) 6 years was found to be the maximum age for both sexes. Asymptotic length from our study (21.14 cm) was lower than those estimated by other authors (Hajji *et al*., 2013: 24.49 cm for the Gulf of Gabes; Akyol, 2003: 27.4 cm for the Bay of Izmir). It is known that there is a general trend for fish species with larger asymptotic length, to have lower growth coefficient K values and vice versa. Such differences could also be attributed to the differences in temperature and other ecological conditions.

Table 7. Total number of fish (N), observed mean length (cm) ± SD and weight (g) ± SD per age group, sex and for all fish.

Group	Mean length (cm) ± SD	Weight	n
Age:		Mean weight (g) ± SD	
1	7.87 ± 1.62	5.15 ± 3.35	328
2	12.35 ± 1.02	18.60 ± 4.35	287
3	14.12 ± 1.11	28.12 ± 7.76	189
4	15.83 ± 0.62	38.69 ± 5.91	105
5	17.99 ± 1.05	58.13 ± 13.31	88
Sex:		Range (g):	
females	12.11±2.07	2.1 - 57.8	470
males	13.11±2.75	1.2 - 76.9	595
All fish	12.64±2.51	Range (g): 1.2 - 76.9	1065

Table 8. Values of total mortality rate (Z), natural mortality (M), fishing mortality (F), exploitation rate (E) for females, males and all fish for *Z. ophiocephalus*.

Mortality	Females	Males	All fish
Z	0.442	0.51	0.432
M	0.35	0.388	0.344
F	0.092	0.122	0.088
E	0.208	0.239	0.203

References

Akyol, O., 2003. Age, growth and reproduction period of grass goby (*Zosterisessor ophiocephalus* Pallas, 1811) in the Bay of Izmir (Aegean Sea). *Archive of Fishery and Marine Research*, 50 (2), 220-224.

Andreu-Soler, A., Oliva-Paterna, F.J., Torralva, M., 2006. A review of length–weight relationships of fish from the Segura River basin (SE Iberian Peninsula). *Journal Applied Ichthyology,* 22, 295-296.

Bayhan, B., Sever, T.M., Taşkavak, E., 2008. Length-weight relationships of seven flatfishes (Pisces: Pleuronectiformes) from Aegean Sea. *Turkish Journal of Fisheries and Aquatic Sciences,* 8, 377-379.

Bilge, G., Yapıcı, S., Filiz, H., Cerim, H., 2014. Weight–length relations for 103 fish species from the southern Aegean Sea, Turkey. *Acta Ichthyologica Et Piscatoria*, 44 (3), 263-269.

Carbonara, P., Constantino, G., Giovine, G., Lembo, G., Spedicato, M.T. *et al*., 2003. Some aspects of the life history of *Polyprion americanus* (Schneider, 1801) along the coasts of the north western Ionian Sea. *Biologia Marina Mediterranea*, 10, 102-112.

Cengiz, Ö., 2011. *Determination of population parameters of four-spotted megrim (L. boscii Risso, 1810) from Saroz Bay Northern Aegean Sea*. PhD thesis. ÇOMÜ, Turkey, 82 pp.

Dulčić, J., Glamuzina B. 2006. Length–weight relationships for selected **fish** species from three eastern Adriatic estuarine systems (Croatia). *Journal of Applied Ichthyology*, 22 , 254-256.

Dulvy, N.K., Freckleton, R.P., Polunin, N.V.C., 2004. Coral Reef Cascades and the Indirect Effects of Predator Removal by Exploitation. *Ecology Letters,* 7 (5), 410-416.

Esmaeili, H.R, Gholamifard, A., Vatandoust, S., Sayyadzadeh, G., Zare, R. *et al*., 2014. Length-weight relationships for 37 freshwater fish species of Iran. *Journal of Applied Ichthyology,* 30, 1073-1076.

Filiz, H., Bilge, G., 2004. Length-weight relationships of 24 fish species from the North Aegean Sea, Turkey. *Journal of Applied Ichthyology*, 20, 431-432.

Froese, R., 2006. Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. *Journal of Applied Ichthyology* 22 (4), 241-253.

Golani, D., Ozturk, B., Basusta, N., 2006. *Fishes of the Eastern Mediterranean*. Turkish Marine Research Foundation*,* Istanbul, Turkey, 259 pp.

Gonçalves, J.M.S., Bentes, L., Lino, P.G., Ribeiro, J., Canario, A.V.M. *et al*., 1997. Weight-length relationships for selected fish species of the small-scale demersal fisheries of the south and south-west coast of Portugal. *Fisheries Research*, 30, 253-256.

Grafton, R. Q., Hilborn, R., Ridgeway, L., Squires, D., Williams, M. *et al.*, 2008. Positioning fisheries in a changing world. *Marine Policy*, 32 (4), 630-634.

Hajji, F., Ouannes-Ghorbel, A., Ghorbel, M., Jarboui, O., 2013. Age and growth of the grass goby *Zosterisessor ophiocephalus* Pallas, 1811 in the Gulf of Gabes (Tunisia, Central Mediterranean). *Acta Adriatica*, 54(1), 27-40.

Jardas I., 1996. *Jadranska ihtiofauna*. Školska knjiga, Zagreb, 533 pp.

Kaya, M., Ozaydin, O., 1996. A preliminary investigation on biology of *Capros aper* (L., 1758) (Pisces: Caproidae). *Turkish Journal of Zoology*, 20, 51-55.

King, M.G., 2007. *Fisheries biology, assessment, and management, Second edition*. Blackwell Publishing Ltd., Oxford, 382 pp.

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 Ichthyogica et Piscatoria*, 33 (2), 145-151.

Liousia, V., Batziakas, S., Panagiotou, N., Daouti, I., Koutrakis E. et al., 2012. Length Weight relations of 22 fish species from the littoral zone of the eastern Ionian Sea, Greece. *Acta Ichthyologica et Piscatoria*, 42 (1), 69-72.

Machias, A., Somarakis, S., Papadroulakis, N., Spedicato, M.-T., Suquet, M. *et al.*, 2003. Settlement of the wreckfish (*Polyprion americanus*). *Marine Biology*, 142, 45-52.

Maci, S., Basset, A., 2010. Spatio-temporal patterns of abundance, size structure and body condition of *Atherina boyeri* (Pisces: Atherinidae) in a small non-tidal Mediterranean lagoon. *Estuarine, Coastal and Shelf Science,* 87, 125-134.

Maravelias, C., Papaconstantinou, C., 2003. Size-related habitat use, aggregation patterns and abundance of anglerfish (*Lophius budegassa*) in the Mediterranean Sea determined by generalized additive modelling. *Journal of the Marine Biological Association of the UK*, 83, 11711178.

Menif, D., 2000. *Les Gobiidae des côtes tunisiennes: Morphologie et Biologie de Zosterisessor ophiocephalus (Pallas, 1814) et Gobius niger (Linnaeus, 1758) (The Gobiidae of the Tunisian coasts: Morphology and Biology of Zosterisessor ophiocephalus (Pallas, 1811) and Gobius niger (Linnaeus, 1758).* PhD. thesis, University of Tunis, Tunisia, 232 pp.

Merella, P., Quetglas, A., Alemany, F., Carbonell, A., 1997. Length-weight relationship of fishes and cephalopods fron Balearic Islands (western Mediterranean). *Naga, the ICLARM Quarterly*, 20 (3/4), 66-68.

Metin, G., Ilkyaz, A.T., Soykan, O., Kinacigil, H.T., 2011. Age, Growth and reproduction of four-spotted goby, *Deltentosteus quadrimaculatus* (Valenciennes, 1837), in Izmir Bay (central Aegean Sea). *Turkish Journal of Zoology*, 35 (5), 711-716.

Miller, P. J., 1986. Gobiidae. p. 1019-1085. In: *Fishes of the northern Eastern Atlantic and the Mediterranean*. Whitehead, P.J.P., Bauchot, M.L., Hureau, J.C., Nielsen, J., Tortonese, E. (Eds). Unesco, Paris.

Morey, G., Moranta, J., Massuti, E., Grau, A., Linde, M. *et al.*, 2003. Weight-length relationships of littoral to lower slope fishes from the western Mediterranean. *Fisheries Research*, 62, 89-96.

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.

Papandroulakis, N., Suquet, M., Spedicato, M. T., Machias, A., Fauvel, C. et al., 2004. Feeding rates, growth performance and gametogenesis of wreckfish (*Polyprion americanus*) kept in captivity. *Aquaculture International*, 12(4-5), 395-407.

Pereda, P., Villamor, B., 1991. *Relaciones biometricas en peces de la plataforma Cantabrica*. Informes Tecnicos - Instituto Espanol de Oceanografia No. 92, 39 p.

Ricker, W.E., 1975. Computation and interpretation of biological statistics of fish populations. Department of the Environment. Fisheries and Marine Service, Ottawa, 382 pp.

Sarı, M., 2001. The stock assessment of *Chalcalburnus tarichi* (Pallas 1811) in the Lake Van and the determination of the basis of fishery management. Çekul Bilimsel Dizi, Istanbul, 150 pp. (in Turkish with English abstract).

STECF, 2012. Scientific, Technical and Economic Committee for Fisheries. 2012 Assessment of Mediterranean Sea stocks part I (STECF 12-19). Publications Office of the European Union, Luxembourg, 501 pp.

Sedberry, G. R., Andrade, C. A., Carlin, J. L., Chapman, R. W., Luckhurst, B. E. *et al.*, 1999. Wreckfish *Polyprion americanus* in the North Atlantic: fisheries, biology, and management of a widely distributed and long-lived fish. *American Fisheries Society Symposium*, 23, 27-50.

Tarkan, A.S., Gaygusuz, Ö., Acıpınar, H., Gürsoy, Ç., **Özuluğ** M., 2006. Length–weight relationship of fishes from the Marmara region (NW-Turkey). *Journal of Applied Ichthyology*, 22 (4), 271-273.

Torres, M.A., Ramos, F., Sobrino, I., 2012. Length-weight relationships of 76 fish species from the Gulf of Cadiz (SW Spain). *Fisheries Research,* 127-128, 171-175.

Tsimenidis, N.C., 1980. Contribution to the study of the anglerfishes *Lophius budegassa* Spinola, 1807 and *L. piscatorius* L., 1758 in Greek seas. *Institute of Oceanography Fisheries Research (Athens) Special Publication*, 4, 180-190.

Vasilakopoulos, P., O'Neill, F.G., Marshall, C.T., 2011. Misspent youth: does catching immature fish affect fisheries sustainability? *ICES Journal of Marine Science*, 68, 15251534.

White, E., Minto, C., Nolan, C.P., King, E, Mullins, E., Clarke, M., 2011. First estimates of age, growth and maturity of boarfish (*Capros aper*): a species newly exploited in the Northeast Atlantic. *ICES Journal of Marine Science*, 68, 61-66.

Wootton, R.J., 1990. *Ecology of Teleost Fishes*. Chapman and Hall, New York, 404 pp.

Yapici, S., Filiz, H., 2014. Estimation of age, growth and reproduction of boarfish, *Capros aper*, in the South Aegean Sea. *Pakistan Journal of Zoology*, 46 (4), 1061-1068.