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## Length–weight relationships of 14 fish species from the Gulf of Antalya (northeastern Mediterranean Sea, Turkey)

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**Abstract:** Length–weight relationships (LWRs) were determined for 14 fish species from the Gulf Antalya along the northeastern Mediterranean Sea coast of Turkey. Samples were collected using bottom trawl at depths varying from 25 to 150 m. The parameters  $a$  and  $b$  from the LWR formula  $W = aL^b$  were estimated. The values of the exponent  $b$  of the length–weight relationships ranged from 2.513 to 3.465. Seven species (*Pagrus pagrus*, *Pagellus erythrinus*, *Nemipterus randalli*, *Merluccius merluccius*, *Citharus linguatula*, *Chelidonichthys lastoviza*, *Spicara flexuosa*) indicated negative allometries, 5 species (*Serranus cabrilla*, *Mullus surmuletus*, *Mullus barbatus barbatus*, *Upeneus moluccensis*, *Saurida undosquamis*) indicated positive allometries, and 2 species (*Boops boops*, *Serranus hepatus*) indicated isometries.

**Key words:** Fish growth, marine fish, Gulf of Antalya, northeastern Mediterranean Sea

### 1. Introduction

The relation between length (L) and weight (W) of fish is very important for estimating growth rates, age structures, and stock conditions; comparing life histories of fish species between regions; and assessing the condition of fish and other components of fish population dynamics (Petraakis and Stergiou, 1995; Binohlan and Pauly, 2000; King, 2007). This relationship is generally expressed by the equation  $W = aL^b$ . In this formula, coefficient  $a$  describes body shape and coefficient  $b$  gives information about the balance of the dimensions. Values of  $b$  can be smaller than 3 (negative allometry = the fish grows faster in weight than in length), bigger than 3 (positive allometry = the fish grows faster in length than in weight), or equal to 3 (isometry) (Froese, 2006).

There are many studies on the length–weight relationship (LWR) of fish along the coasts of Turkey, such as in the Marmara region (Tarkan et al., 2006; Keskin and Gaygusuz, 2010; Bök et al., 2011), the Black Sea (Demirhan and Can, 2007; Kalaycı et al., 2007; Ak et al., 2009; Yankova et al., 2011), the Aegean Sea (Moutopoulos and Stergiou, 2002; Koutrakis and Tsikliras, 2003; Filiz and Bilge, 2004; Karakulak et al., 2006; Özyaydın and Taşkavak, 2006; Akyol et al., 2007; İşmen et al., 2007; Özyaydın et al., 2007), and the Mediterranean Sea (Taşkavak and Bilecenoğlu, 2001; Çiçek et al., 2006; Sangun et al., 2007; Özcan, 2008), but there are no studies concerning the LWRs of the fish species of the

Gulf of Antalya. In the present study, the LWRs of 14 fish species from the Gulf of Antalya were determined.

### 2. Materials and methods

The data from 14 species were collected monthly from the Gulf of Antalya (Figure) between September 2012 and June 2013. Samplings of fishes were made by a bottom trawl net having 44 mm mesh size (22 mm mesh size in the cod end). Trawl shots (1 haul per month) were performed at depths varying from 25 to 150 m for 2 h each time. Fish species were identified according to Whitehead et al. (1986) and Mater et al. (2003). All individuals were weighed (total wet weight) to the nearest 0.1 g and measured to the nearest cm in the laboratory of the research vessel.

The relationship between length and weight were calculated using the formula  $W = aL^b$ , in which W is the total weight (g) and L is the total length (cm). The parameters  $a$  and  $b$  were calculated by functional regression. The  $b$  value for each species was tested by t-test at the 0.05 significance level to verify that it was significantly different from isometric growth (Beverton and Holt, 1996; Çetinkaya et al., 2005; Froese, 2006).

### 3. Results and discussion

A total of 3090 individuals of 14 fish species belonging to 9 families were sampled. The main abundance of samples belonged to the families Mullidae (55.1%),

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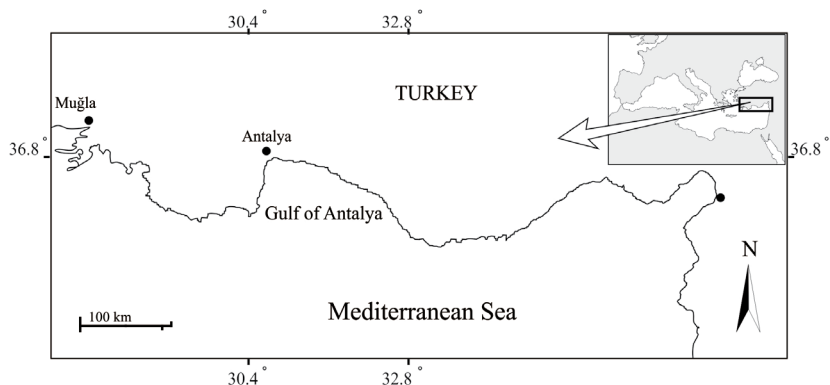


Figure. Map of the study area.

Centracanthidae (14.2%), Sparidae (10.9%), Synodontidae (6.8%), Serranidae (5%), Nemipteridae (4.7%), Citharidae (1.4%), Gadidae (1%), and Triglidae (1%). The best-represented families were Mullidae and Sparidae with 3 species; Nemipteridae, Gadidae, Citharidae, Triglidae, Synodontidae, and Centracanthidae were represented only by 1 species each.

The estimated parameters of LWR are given in Table 1. Values of the coefficient of determination ( $r^2$ ) varied from 0.810 [*Upeneus moluccensis* (Bleeker, 1855)] to 0.973 [*Chelidonichthys lastoviza* (Bonnaterre, 1788)]. The values of the exponent  $b$  of the LWRs ranged from 2.513 [*Pagellus erythrinus* (Linnaeus, 1758)] to 3.465 (*Mullus surmuletus* Linnaeus, 1758). The sample size ranged from

28 individuals for *Chelidonichthys lastoviza* to 1565 for *Mullus barbatus barbatus* Linnaeus, 1758.

In this study, the growth type of 7 species [*Pagrus pagrus* (Linnaeus, 1758), *Pagellus erythrinus*, *Nemipterus randalli* (Russell, 1986), *Merluccius merluccius* (Linnaeus, 1758), *Citharus linguatula* (Linnaeus, 1758), *Chelidonichthys lastoviza*, *Spicara flexuosa* (Linnaeus, 1758)] indicated negative allometries ( $b < 3$ ,  $P < 0.05$ ), 5 species [*Serranus cabrilla* (Linnaeus, 1758), *Mullus surmuletus*, *Mullus barbatus barbatus*, *Upeneus moluccensis*, *Saurida undosquamis* (Richardson, 1848)] indicated positive allometries ( $b > 3$ ,  $P < 0.05$ ), and 2 species [*Boops boops* (Linnaeus, 1758), *Serranus hepatus* (Linnaeus, 1758)] indicated isometries ( $b = 3$ ,  $P > 0.05$ ).

Table 1. Length-weight relationship parameters for fish species from the Gulf of Antalya.

Family	Species	N	L range	a	b	SE(b)	$r^2$	P	GT
Sparidae	<i>Pagrus pagrus</i>	127	9.5–19	0.0186	2.922	4.936	0.943	$P < 0.05$	A-
	<i>Pagellus erythrinus</i>	87	11.6–21.5	0.0511	2.513	5.036	0.946	$P < 0.05$	A-
	<i>Boops boops</i>	124	10–20.2	0.0139	2.821	3.300	0.876	$P > 0.05$	I
Nemipteridae	<i>Nemipterus randalli</i>	143	9.5–22	0.0120	2.975	4.457	0.937	$P < 0.05$	A-
Gadidae	<i>Merluccius merluccius</i>	31	16–28.7	0.0096	2.899	7.012	0.946	$P < 0.05$	A-
	<i>Serranus cabrilla</i>	52	9–18.5	0.0091	3.048	3.246	0.960	$P < 0.05$	A+
Serranidae	<i>Serranus hepatus</i>	100	5.8–13.9	0.0288	2.732	2.272	0.728	$P > 0.05$	I
Citharidae	<i>Citharus linguatula</i>	44	8–19.2	0.0133	2.780	4.151	0.920	$P < 0.05$	A-
Triglidae	<i>Chelidonichthys lastoviza</i>	28	10.1–20.0	0.0272	2.638	3.521	0.973	$P < 0.05$	A-
	<i>Mullus surmuletus</i>	45	13.7–24.5	0.0029	3.465	7.915	0.948	$P < 0.05$	A+
Mullidae	<i>Mullus barbatus barbatus</i>	1565	8.7–21.5	0.0071	3.165	6.302	0.894	$P < 0.05$	A+
	<i>Upeneus moluccensis</i>	93	9.5–19.2	0.0053	3.231	3.913	0.810	$P < 0.05$	A+
Synodontidae	<i>Saurida undosquamis</i>	211	11.5–35.5	0.0037	3.190	22.71	0.968	$P < 0.05$	A+
Centracanthidae	<i>Spicara flexuosa</i>	440	9.0–17.3	0.0260	2.655	3.531	0.816	$P < 0.05$	A-

N: Number of specimens; L: total length (cm);  $a$  and  $b$ , relationship parameters; SD: standard deviation; SE(b): standard error of  $b$ ;  $r^2$ : coefficient of determination; P: P-value for t-test comparing differences for isometric growth ( $b = 3$ ); GT: growth type; I: isometric, A+: positive allometric, A-: negative allometric.

The functional regression *b* value represents the body form, and it is directly related to the weight, affected by ecological factors (temperature, food supply, and spawning conditions) and other factors (sex, age, fishing time, area, and fishing vessels) (Ricker, 1973). Other studies have conducted research on the LWRs of identical species in different localities (Table 2). Growth types were found to be different for *Pagrus pagrus*, *Pagellus erythrinus*, *Boops boops*, *Nemipterus randalli*, *Merluccius merluccius*,

*Serranus cabrilla*, *Citharus linguatula*, *Chelidonichthys lastoviza*, *Mullus surmuletus*, *Mullus barbatus barbatus*, and *Spicara flexuosa*. The differences of growth type and *b* values for the same species from different areas may be attributed to one or more factors: the season and effects of different areas, changes in water temperature and salinity, sex, degree of stomach fullness, gonad maturity, health, habitat, nutrition, food reserves, environmental factors, pollution, and differences in the number of specimens

**Table 2.** Different growth types of the same fish species in other studies.

Family	Species	Growth type		
		A-	A+	I
Sparidae	<i>Pagrus pagrus</i>			Moutopoulos and Stergiou, 2002
	<i>Pagellus erythrinus</i>	Cherif et al., 2007 Ceyhan et al., 2009 Çakır et al., 2008 Moutopoulos and Stergiou, 2002 Cengiz, 2013		Sangun et al., 2007 Karakulak et al., 2006 Merella et al., 1997
	<i>Boops boops</i>	Moutopoulos and Stergiou, 2002	Karakulak et al., 2006	Sangun et al., 2007 Ceyhan et al., 2009 Merella et al., 1997 Cherif et al., 2007
Nemipteridae	<i>Nemipterus randalli</i>			Erguden et al., 2010
Gadidae	<i>Merluccius merluccius</i>	Sangun et al., 2007	Bök et al., 2011 Karakulak et al., 2006 Moutopoulos and Stergiou, 2002 Cherif et al., 2007	Ceyhan et al., 2009 Merella et al., 1997 Çakır et al., 2008
Serranidae	<i>Serranus cabrilla</i>	Çakır et al., 2008 Merella et al., 1997 Moutopoulos and Stergiou, 2002	Sangun et al., 2007	Bök et al., 2011 Karakulak et al., 2006 Cengiz, 2013
	<i>Serranus hepatus</i>	Çakır et al., 2008	Merella et al., 1997	Keskin and Gaygusuz, 2010 Sangun et al., 2007
Citharidae	<i>Citharus linguatula</i>	Sangun et al., 2007 Moutopoulos and Stergiou, 2002	Karakulak et al., 2006 Çakır et al., 2008 Merella et al., 1997	
Triglidae	<i>Chelidonichthys lastoviza</i>	Moutopoulos and Stergiou, 2002		Sangun et al., 2007
	<i>Mullus surmuletus</i>	Bök et al., 2011	Maci et al., 2009 Karakulak et al., 2006	Keskin and Gaygusuz, 2010 Merella et al., 1997 Moutopoulos and Stergiou, 2002
Mullidae	<i>Mullus barbatus barbatus</i>	Merella et al., 1997 Moutopoulos and Stergiou, 2002	Cherif et al., 2007 Çakır et al., 2008 Karakulak et al., 2006 Çakır et al., 2008 Cengiz, 2013	
Synodontidae	<i>Upeneus moluccensis</i>		Sangun et al., 2007	
	<i>Saurida undosquamis</i>		Sangun et al., 2007 Ceyhan et al., 2009	
Centracanthidae	<i>Spicara flexuosa</i>			Soykan et al., 2010

I: Isometric, A+: positive allometric, A-: negative allometric growth.

examined, as well as in the observed length ranges of the species caught (Tesch, 1971; Moutopoulos and Stergiou, 2002). Only the growth types of *Saurida undosquamis* and *Upeneus moluccensis* were similar to those of other studies.

Fish samples in this study were caught over the course of 10 months. Because of this, these species are represented across all seasons. In this study, maximum length of some species (*Boops boops*, *Pagrus pagrus*, *Pagellus erythrinus*, *Merluccius merluccius*, *Mullus barbatus barbatus*, *Mullus surmuletus*, *Serranus cabrilla*) were smaller than in other studies along the Mediterranean coast of Turkey (Karakulak et al., 2006; İşmen et al., 2007; Ceyhan et al., 2009). This can be explained by the choice of fishing

gear, nets, and intense fishing in the Gulf of Antalya. The information in this study could be used as a reference for fisheries and stock management of fish populations in the Gulf of Antalya.

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### References

- Ak O, Kutlu S, Aydın I (2009). Length-weight relationship for 16 fish species from the Eastern Black Sea, Turkey. *Turk J Fish Aquat Sci* 9: 125-126.
- Akyol O, Kınacıgil HT, Şevik R (2007). Longline fishery and length-weight relationships for selected fish species in Gökova Bay (Aegean Sea, Turkey). *Int J Nat Eng Sci* 1: 1-4.
- Beverton RJH, Holt SJ (1957). *On the Dynamics of Exploited Fish Populations*. London, UK: Chapman and Hall.
- Binohlan C, Pauly D (2000). The length-weight table. In: Froese R, Pauly D, editors. *FishBase 2000: Concepts, Design and Data Sources*. Manila, Philippines: ICLARM, pp. 131-134.
- Bök DT, Göktürk D, Kahraman A, Alıçlı T, Acun T, Ateş C (2011). Length-weight relationships of 34 fish species from the Sea of Marmara, Turkey. *J Anim Vet Adv* 10: 3037-3042.
- Çakır DT, Koç HT, Başusta A, Başusta N (2008). Length-weight relationships of 24 fish species from Edremit Bay, Aegean Sea. *E-journal of New World Sciences Academy* 3: 47-51.
- Cengiz Ö (2013). Length-weight relationships of 22 fish species from the Gallipoli Peninsula and Dardanelles (northeastern Mediterranean, Turkey). *Turk J Zool* 37: 419-422.
- Çetinkaya O, Şen F, Elp M (2005). Balıklarda büyüme ve büyüme analizleri. In: Karataş M, editor. *Balık Biyolojisi Araştırma Yöntemleri*. Ankara, Turkey: Nobel Kitap Dağıtım A.Ş., pp. 93-120 (in Turkish).
- Ceyhan T, Akyol O, Erdem M (2009). Length-weight relationships of fishes from Gökova Bay, Turkey (Aegean Sea). *Turk J Zool* 33: 69-72.
- Cherif M, Zarrad R, Gharbi H, Missaouf H, Jarboui O (2007). Some biological parameters of the red mullet, *Mullus barbatus* L., 1758, from the Gulf of Tunis. *Acta Adriatica* 48: 131-144.
- Çiçek E, Avşar D, Yeldan H, Özütoğ M (2006). Length-weight relationships for 31 teleost fishes caught by bottom trawl net in the Babadillimani Bight (northeastern Mediterranean). *J Appl Ichthyol* 22: 290-292.
- Demirhan SA, Can MF (2007). Length-weight relationships for seven fish species from the southeastern Black Sea. *J Appl Ichthyol* 23: 282-283.
- Erguden D, Turan C, Gurlek M, Yagliglu D, Gungor M (2010). Age and growth of the Randall's threadfin bream *Nemipterus randalli* (Russell, 1986) a recent lessepsian migrant in Iskenderun Bay, Northeastern Mediterranean. *J Appl Ichthyol* 26: 441-444.
- Filiz H, Bilge G (2004). Length-weight relationships of 24 fish species from North Aegean Sea, Turkey. *J Appl Ichthyol* 20: 431-432.
- Froese R (2006). Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. *J Appl Ichthyol* 22: 241-253.
- İşmen A, Özen Ö, Altınağaç U, Özekinci U, Ayaz A (2007). Weight-length relationships of 63 fish species in Saros Bay, Turkey. *J Appl Ichthyol* 23: 707-708.
- Kalaycı F, Samsun N, Bilgin S, Samsun O (2007). Length-weight relationship of 10 fish species caught by bottom trawl and midwater trawl from the Middle Black Sea, Turkey. *Turk J Fish Aquat Sci* 7: 33-36.
- Karakulak FS, Erk H, Bilgin B (2006). Length-weight relationships for 47 coastal species from the Northern Aegean Sea, Turkey. *J Appl Ichthyol* 22: 274-278.
- Keskin Ç, Gaygusuz Ö (2010). Length-weight relationships of fishes in shallow waters of Erdek Bay (Sea of Marmara, Turkey). *IUFS J Biol* 69: 25-32.
- King MG (2007). *Fisheries Biology, Assessment, and Management*. 2nd ed. Oxford, UK: Blackwell.
- Koutrakis ET, Tsikliras AC (2003). Length-weight relationships of fishes from three northern Aegean estuarine systems (Greece). *J Appl Ichthyol* 19: 258-260.
- Maci S, Longo E, Basset A (2009). Length-weight relationships for 24 selected fish species from a non-tidal lagoon of the southern Adriatic Sea (Italy). *Transit Waters Bull* 3: 1-9.
- Mater S, Kaya M, Bilecenoğlu M (2003). *Türkiye Deniz Balıkları Atlası*. 3rd ed. İzmir, Turkey: Ege Üniversitesi Su Ürünleri Fakültesi Yayınları (in Turkish).
- Merella P, Quetglas A, Alemany F, Corbonell A (1997). Length-weight relationship of fishes and cephalopods from the Balearic Islands (western Mediterranean). *Naga ICLARM Q* 20: 66-68.

- Moutopoulos DK, Stergiou KI (2002). Length-weight and length-length relationships of fish species from the Aegean Sea (Greece). *J Appl Ichthyol* 18: 200–203.
- Özaydın O, Taşkavak E (2006). Length-weight relationships for 47 fish species from Izmir Bay (eastern Aegean Sea, Turkey). *Acta Adriatica* 47: 211–216.
- Özaydın O, Uçkun D, Akalın S, Leblebici S, Tosunoğlu Z (2007). Length-weight relationships of fishes captured from İzmir Bay, Central Aegean Sea. *J Appl Ichthyol* 23: 695–696.
- Özcan G (2008). Length-weight relationships for seven freshwater fishes caught in Kemer reservoir, Turkey. *J Appl Ichthyol* 24: 337–338.
- Petrakis G, Stergiou KI (1995). Weight-length relationships for 33 fish species in Greek waters. *Fish Res* 21: 465–469.
- Ricker WE (1973). Linear regressions in fishery research. *J Fish Res Board Can* 30: 409–434.
- Sangun L, Akamca E, Akar M (2007). Weight-length relationships for 39 fish species from the north-eastern Mediterranean coast of Turkey. *Turk J Fish Aquat Sci* 7: 37–40.
- Soykan O, İlkyaz AT, Metin G, Kınacıgil HT (2010). Growth and reproduction of blotched picarel (*Spicara maena* Linnaeus, 1758) in the central Aegean Sea, Turkey. *Turk J Zool* 34: 453–459.
- Tarkan AS, Gaygusuz Ö, Acıpınar H, Gürsoy Ç, Özuluğ M (2006). Length-weight relationship of fishes from the Marmara Region (NW-Turkey). *J Appl Ichthyol* 22: 271–273.
- Taşkavak E, Bilecenoğlu M (2001). Length-weight relationships for 18 Lessepsian (Red Sea) immigrant fish species from the Mediterranean coast of Turkey. *J Mar Biol Assoc UK* 81: 895–896.
- Tesch FW (1971). Age and growth. In: Ricker WE, editor. *Methods for Assessment of Fish Production in Fresh Water*. Oxford, UK: Blackwell Scientific Publications, pp. 98–103.
- Whitehead PJP, Bauchot ML, Hureau JC, Nielsen J, Tortonese E (1986). *Fishes of the North-eastern Atlantic and the Mediterranean*. Vols. I–II. Paris, France: UNESCO.
- Yankova M, Pavlov D, Raykov V, Mihneva V, Radu G (2011). Length-weight relationships of ten fish species from the Bulgarian Black Sea waters. *Turk J Zool* 35: 265–270.