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Length-Weight, Length-Length Relationships and Condition Factor of Grey Mullet Species From Köyceğiz Lagoon in Turkey

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Research Article

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Abstract

The relationships between length-weight, length-length parameters and condition factor were given for four grey mullet species that caught in Köyceğiz Lagoon area between January 2017 and December 2017. Total length and weight ranged from 6.2-39.3 cm and 2.34-508.38 g for *Chelon auratus*, 8.9-47.6 cm and 8.61-1006.5 g for *Mugil cephalus*, 5.0-37.7 cm and 1.62-478.90 g for *Chelon labrosus* and 3.8-35.2 cm and 0.52-462.88 g for *Chelon saliens*. The length-weight relationships were determined for *C. auratus*, *M. cephalus*, *C. labrosus* and *C. saliens* as $W = 0.0087L^{2.96}$, $W = 0.0106L^{2.95}$, $W = 0.0073L^{3.06}$ and $W = 0.0067L^{3.04}$ respectively. All the fish species showed isometric growth (b=3). It was observed that there were strong correlations between total length, fork length and standard length of 4 fish species (P<0.001). Also, the condition factor values range between 0.56-1.30 for *C. auratus*, 0.66-1.22 for *M. cephalus*, 0.64-1.30 for *C. labrosus*, 0.57-1.06 for *C. saliens*.

Keywords: Köyceğiz Lagoon, Fish barrier, grey mullet, growth

Köyceğiz Lagünü'nden (Türkiye) Avlanan Kefal Türlerinin Boy-Ağırlık, Boy-Boy Ilişkileri ve Kondüsyon Faktörü

Özet

Ocak 2017-Aralık 2017 tarihleri arasında Köyceğiz Lagününden avlanan dört farklı kefal türünün boy-ağırlık, boy-boy parametreleri ve kondüsyon faktörü değerleri verilmiştir. Total boy ve ağırlık değerleri *Chelon auratus* için 6,2-39,3 cm ve 2,34-508,38 g, *Mugil cephalus* için 8,9-47,6 cm ve 8,61-1006,5 g, *Chelon labrosus* için 5,0-37,7 cm ve 1,62-478,90 g, *Chelon saliens* için 3,8-35,2 cm ve 0.52-462,88 g olarak değişim göstermiştir. Boy-ağırlık ilişkisi denklemleri *C. auratus*, *M. cephalus*, *C. labrosus* ve *C. saliens* için sırasıyla $W = 0{,}0087L^{2,96}$, $W = 0{,}0106L^{2,95}$, $W = 0{,}0073L^{3,06}$ ve $W = 0{,}0067L^{3,04}$ olarak tespit edilmiştir. Tüm balık türleri izometrik büyüme göstermiştir (b=3). Total boy, çatal boy ve standart boy arasında bu dört balık türü için güçlü bir ilişki olduğu gözlemlenmiştir (P<0,001). Ayrıca, kondüsyon faktörü değerleri *C. auratus* için 0,56-1,30, *M. cephalus* için 0,66-1,22, *C. labrosus* için 0,64-1,30, *C. saliens* için 0,57-1,06 arasında değişim göstermiştir.

Anahtar Kelimeler: Köyceğiz Lagünü, dalyan, kefal, büyüme

INTRODUCTION

Köyceğiz Lagoon system covers 5400 hectares lake area and quagmire outlook 1150 hectares delta area and is connected to the sea via a 14 km long canal. The width of the canal varies between 5-70 meters and the depth between 1-6 meters (Buhan, 1998). Fishing activities are carried by DALKO (Dalyan Fisheries Cooperative) in the lagoon system. The lagoon area consists of four main sections; Lake Köyceğiz, lagoon canal, Lake Sülüngür and Lake İztuzu.

Köyceğiz Lagoon is one of the most important active lagoon fishery areas in Turkey (Sağlam et al., 2015). DALKO operates Turkish wooden dalyan which set up in this area. Besides being an active lagoon fisherycooperative, they also prepare and sell grey mullet caviar.

Due to the high economic value of this product, it increases the significance of this area and grey mullet species. A great economic return comes out with both roe and fresh mullet flesh. These features are enough to think about the sustainability of lagoon fishery. As it is known by all fishery managers, fishery should be managed for food and economic sustainability.

The length-weight relationships (LWR) are one of the most useful parameters for fishery management and have importance in fisheries science. The LWR is used for prediction the weight corresponding to a given length and to allow for the comparison of fish growth in different regions or localities (Bagenal and Tesch, 1978; Moutopoulos and Stergiou, 2002; Tsoumani et al., 2006). LWR may also useful to determine whether somatic growth is isometric or allometric (Ricker, 1975).

Condition factor gives knowledge when comparing two populations in living different regions, climate and other conditions (Weatherly and Gills, 1987). Therefore, condition factor of fish species is important for understanding its life cycle.

This study aims to contribute to the knowledge of LWR, LLR and condition factor data for commercial grey mullet species, *Chelon auratus* (Risso, 1810), *Mugil cephalus* (Linnaeus, 1758), *Chelon labrosus* (Risso, 1827) and *Chelon saliens* (Risso, 1810), in Köyceğiz Lagoon.

MATERIALS and METHODS

Samples were collected monthly periods with Turkish wooden dalyan, trammel net, beach seine and cast-net between January 2017 and December 2017 in the Köyceğiz Lagoon, Turkey (Figure 1). The fish samples were brought to the laboratory and were taxonomically identified according to Thomson (1997); FAO (1999) and Geldiay and Balık (2009). Total length (TL), fork length (FL) and standard length (SL) were recorded to the nearest centimetre (0.1 cm), and bodyweight (W) was measured with precision balance (0.01 g).

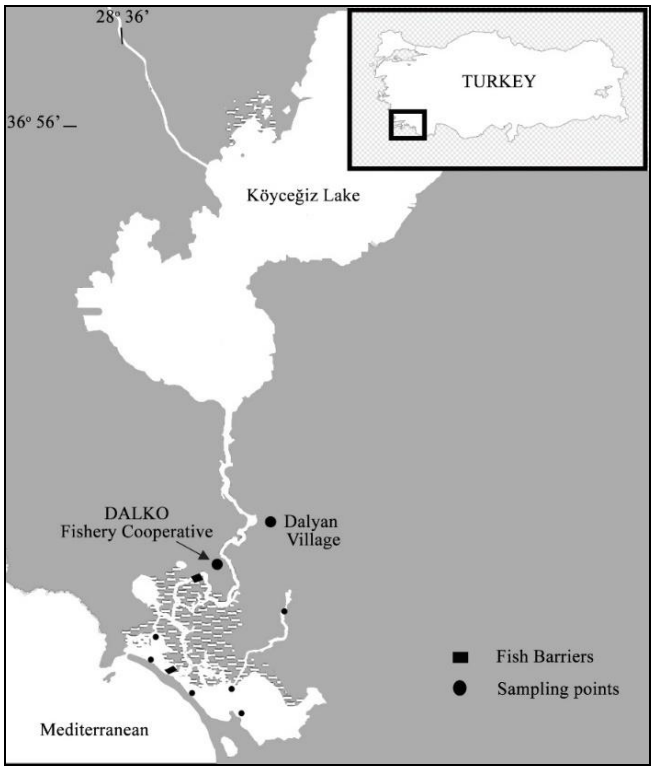

Figure 1. The study area

The length-weight relationships were established using the equation; $W=aL^b$, where W is weight (g), L is length (cm), *a* is the intercept and *b* is the slope of the linear regressions. The significance of the *b*-values for each species was tested by *t*-test to confirm that it was significantly different from the predictions for isometric growth (*b*=3) (Pauly, 1993).

The length–length relationship was estimated by linear regression analysis: TL = *a* + *b*SL; FL = *a* + *b*SL and SL = *a* + *b*FL, where *a* is the intercept and *b* is the slope of the linear regression.

Fulton's condition factor (K) was calculated using the equation; $K=(W/L^3)*100$ where W is the total weight (g), L is the total length (cm).

The Microsoft Office Excel software (version 2016) was used for all calculations.

RESULTS

Overall, 1195 samples from 4 fish species *C. auratus*, *M. cephalus*, *C. labrosus* and *C. saliens* were examined in the Köyceğiz Lagoon in Turkey. *C. auratus* (476) was found the most abundant fish species.

Table 1. Parameters of the LWR and condition factor for four grey mullet species from the Köyceğiz Lagoon (Turkey)

Species	N	K_{min}-K_{max}	L_{min}-L_{max}	W_{min}-W_{max}	Parameters of LWR					
					a	***b***	**SE(*b*)**	**CI(*b*)**	**r^2**	**GT**
C. auratus	476	0.56-1.30	6.2-39.3	2.34-508.38	0.0087	2.96	0.052	2.931-2.988	0.989	Isometric
M. cephalus	291	0.66-1.22	8.9-47.6	8.61-1006.5	0.0106	2.95	0.042	2.914-2.983	0.989	Isometric
C. labrosus	279	0.64-1.30	5.0-37.7	1.62-478.9	0.0073	3.065	0.058	3.027-3.103	0.989	Isometric
C. saliens	149	0.57-1.06	3.8-35.2	0.52-462.88	0.0067	3.045	0.057	2.996-3.094	0.991	Isometric

In this study, *b* values were calculated between 2.95 (*M. cephalus*) and 3.065 (*C. labrosus*) (Table 1). In this experiment when the values of *b* are examined, it was found that an isometric growth for all fish species. The K values significantly ($P<0.001$) range between 0.53-1.01 for *C. auratus*, 0.70-1.05 for *M. cephalus*, 0.73-1.13 for *C. labrosus* and for *L. saliens* 0.57-1.06. The condition factor and LWR parameters of the four grey mullet species are shown in Table 1.

Length - weight relationship of *C. auratus*, *M. cephalus*, *C. labrosus* and *C. saliens* are found $W=0.0087L^{2.96}$, $W=0.0106L^{2.95}$, $W=0.0073L^{3.06}$ and $W=0.0067L^{3.04}$ respectively (Figure 2).

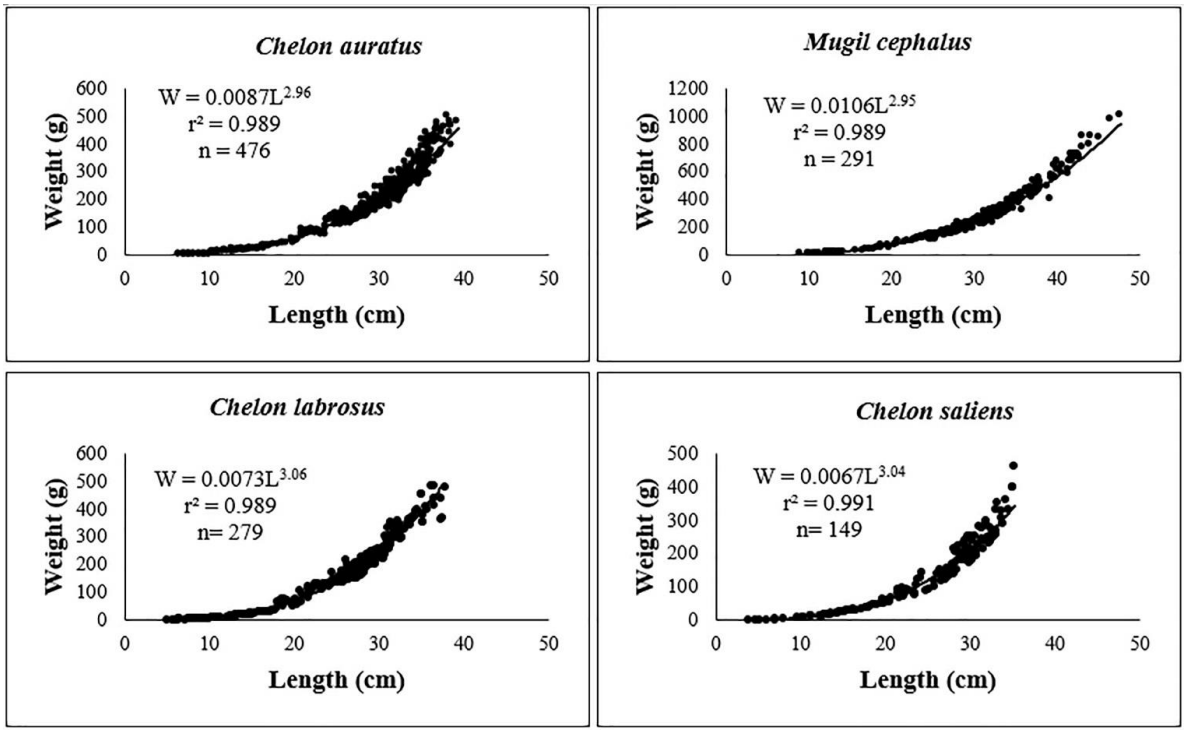

Figure 2. Length–weight relationships ($W=aL^b$) for *C. auratus*, *M. cephalus*, *C. labrosus* and *C. saliens* from the Köyceğiz Lagoon in Turkey.

Relations between TL-FL, FL-SL and SL-TL of *C. auratus*, *M. cephalus*, *C. labrosus* and *C. saliens* living in Köyceğiz lagoon are given in Table 2. Significant relationships were found between different lenghts of each fish species ($P<0.001$).

Table 2. Lenght-lenght relationships parameters of *C. auratus*, *M. cephalus*, *C. labrosus* and *C. saliens* from the Köyceğiz Lagoon in Turkey

Species	N	Equation	*a*	*b*	SE(*b*)	CI(*b*)	r²
		TL = *a* + *b*FL	0.149	0.897	0.292	0.895-0.900	0.998
C. auratus	476	FL = *a* + *b*SL	-0.490	0.870	0.361	0.866-0.874	0.996
		SL = *a* + *b*TL	-0.349	0.780	0.485	0.776-0.785	0.993
		TL = *a* + *b*FL	0.115	0.899	0.314	0.896-0.903	0.999
M. cephalus	291	FL = *a* + *b*SL	-0.283	0.864	0.243	0.861-0.867	0.999
		SL = *a* + *b*TL	-0.182	0.778	0.378	0.773-0.782	0.998
		TL = *a* + *b*FL	0.226	0.888	0.271	0.884-0.892	0.998
C. labrosus	279	FL = *a* + *b*SL	-0.127	0.861	0.307	0.855-0.866	0.997
		SL = *a* + *b*TL	0.061	0.764	0.352	0.759-0.770	0.996
		TL = *a* + *b*FL	0.171	0.892	0.311	0.885-0.899	0.999
C. saliens	149	FL = *a* + *b*SL	-0.157	0.861	0.259	0.854-0.868	0.999
		SL = *a* + *b*TL	-0.012	0.769	0.359	0.760-0.777	0.998

DISCUSSION

The *b* values in LWR identify the growth type of the fish species. In a fish population, $b = 3$ isometric growth and fish transform into more robust with an increase in length (Bagenal and Tesch, 1978), $b \neq 3$ allometric growth and fish becomes thinner with increasing length (King, 1996). The results of this study show that the growth of the *C. auratus*, *M. cephalus*, *C. labrosus* and *C. saliens* was isometric. In this study, the similarity and differences were observed in the length - weight relationship parameters compared to the results of other researchers (Table 3). Nikolsky (1963) stated that the environmental conditions in the fish habitat have positive or negative effects on growth. This may explain that same fish species in different habitats can show different growth types.

In the present research, the condition factor values were similar when compared to the other researcher's results (Egemen et al., 1999; Buhan, 1998; Hoşsucu, 2001). In contrast, Bilgin et al., 2006; Acarlı, 2007; Komolu-Johnson and Ndimele, 2010; Yılmaz and Polat, 2011; Kasımoğlu and Yılmaz, 2011 reported different condition factor values. These differences may be due to the nutrient capacity of the environment, population density, sampling time, sample size and age.

In conclusion, results of the present study provide basic information on the LWR, LLR, and condition of four grey mullet species. These results showed that grey mullet species in Köyceğiz Lagoon are well-developed and nutritional capacity of the environment is sufficient when they are considered in terms of their length-weight and condition. In this respect, we have considered that our results will contribute positively to the management of lagoon fisheries and to related studies to be carried out in the future.

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Table 3. Comparison of growth parameters of grey mullet species reported by different studies

Species	Habitat	n	a	b	r^2	Growth type	References
Chelon auratus	Köyceğiz Lagoon	406	0.005	3.193	0.98	I	Buhan, 1998
	Mar Menor Lagoon	2955	0.0073	3.18	0.99	+A	Verdiel-Cubedo et al., 2006
	Homa Lagoon	119	0.0100	2.99	0.98	I	Acarlı et al., 2014
	Gediz Estuary	81	0.0091	3.035	0.99	+A	Kara et al., 2017
	Middle BlackSea	255	0.044	2.52	0.87	I	Samsun et al., 2017
	Köyceğiz Lagoon	**476**	**0.0087**	**2.96**	**0.99**	**I**	**This study**
Mugil cephalus	Köyceğiz Lagoon	284	0.0012	2.95	0.95	I	Buhan, 1998
	Strymon Lagoon	290	0.0128	2.779	0.81	-A	Koutrakis and Tsikliras, 2003
	Vellar, Pakistan	390	0.0232	2.76	0.99	-A	Murugan et al., 2012
	Persian Gulf	37	0.0234	2.91	0.96	-A	Khayyami et al., 2014
	Okrika Gulfs	30	-	2.86	0.96	I	Ogunola and Onada, 2017
	Köyceğiz Lagoon	**291**	**0.0106**	**2.95**	**0.99**	**I**	**This study**
Chelon labrosus	Köyceğiz Lagoon	65	0.0013	2.931	0.99	I	Buhan, 1998
	Güllük Lagoon		0.0001	3.084	0.98	I	Egemen et al., 1999
	Rihios Lagoon	88	0.0106	2.993	0.96	I	Koutrakis and Tsikliras, 2003
	Homa Lagoon	68	0.0080	3.061	0.83	I	Acarlı et al., 2014
	Gediz Estuary	113	0.0083	3.090	0.99	+A	Kara et al., 2017
	Köyceğiz Lagoon	**279**	**0.0073**	**3.06**	**0.99**	**I**	**This study**
Chelon saliens	Köyceğiz Lagoon	257	0.010	2.95	0.96	I	Buhan, 1998
	Erdek Gulf	57	0.0092	3.008	0.98	I	Keskin and Gaygusuz, 2010
	Beymelek Lagoon	1248	0.0099	2.95	0.97	I	Balık et al., 2011
	Gediz Estuary	91	0.0098	2.988	0.99	I	Kara et al., 2017
	Homa Lagoon	177	0.0018	3.489	0.95	+A	Acarlı et al., 2014
	Köyceğiz Lagoon	**149**	**0.0067**	**3.04**	**0.99**	**I**	**This study**

In conclusion, the results of the present study provide basic information on the LWR, LLR, and condition of four grey mullet species. These results showed that grey mullet species in Köyceğiz Lagoon are well-developed and nutritional capacity of the environment is enough when they are considered in terms of their length-weight and condition. In this respect, we have considered that our results will contribute positively to the management of lagoon fisheries and to related studies to be carried out in the future.

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