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Some population features of the tub gurnard (*Chelidonichthys lucerna* L. 1758) distributed in the Southwestern Black Sea Shores

Güney-Batı Karadeniz kıyılarında dağılım gösteren kırlangıç balığı (*Chelidonichthys lucerna* L. 1758)'nın bazı populasyon özellikleri

Türk Denizcilik ve Deniz Bilimleri Dergisi

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ABSTRACT

Some population features (length, weight, LWR, sex ratio and condition factor) were determined for tub gurnard (*Chelidonichthys lucerna* L. 1758) distributed in the Black Sea coast of Türkiye in the study. The study was conducted between 2018 and 2021 fishing seasons. Fish samples were obtained from the commercial fisheries (demersal trawls and set nets) in the region. Mean, maximum and minimum total length were calculated as 38.9±0.99 cm, 73.8 cm and 13.4 cm respectively. Length-weight relationship (LWR) of examined fishes was founded as $W=0.0112L^{2.9425}$ for all individuals. The "b" parameter was defined as negative allometry growth for females (2.9345), isometry growth for males (2.9535). Fulton's condition factor were calculated as 0.926±0.009 for all individuals. The calculated sex ratio was 1 female: 0.67 male in the examined fishes.

Keywords: Tub gurnard, length-weight relationships, biological characteristics, Black Sea

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ÖZET

Bu araştırmada Türkiye'nin Karadeniz kıyılarında dağılım gösteren kırlangıç balığının (*Chelidonichthys lucerna* L. 1758) bazı populasyon özellikleri (boy, ağırlık, boy-ağırlık ilişkisi, cinsiyet oranı ve kondisyon faktörü) belirlenmiştir. Çalışma 2018-2021 avcılık sezonları arasında yapılmıştır. Balık örnekleri bölgede yapılan ticari balıkçılıktan (demersal trol ve uzatma ağları) elde edilmiştir. Türün ortalama, maksimum ve minimum toplam boyu sırasıyla 38.9±0.99 cm, 73.8 cm ve 13.4 cm olarak hesaplanmıştır. İncelenen balıkların boy-ağırlık ilişkisi (LWR) tüm bireyler için $W=0.0112L^{2.9425}$ olarak saptanmıştır. "b" parametresi, dişiler balıklar için negatif allometrik büyüme (2.9345), erkekler balıklar için izometrik büyüme (2.9535) olarak tanımlanmıştır. Fulton'nun kondisyon faktörü tüm bireyler için 0.926±0.009 olarak belirlenmiştir. İncelenen balıkların dişi erkek oranı ise 1:0.67 şeklinde tespit edilmiştir.

Anahtar Kelimeler: Kırlangıç balığı, boy-ağırlık ilişkisi, biyolojik özellik, Karadeniz

1. INTRODUCTION

The Black Sea is an important sea area where pelagic fish species are caught the most The Black Sea is the most important area for landing pelagic fish species with a 75% of contribution (TurkStat, 2022). Although pelagic fish such as anchovy (*Engraulis encrasicolus*), bluefish (*Pomatomus saltatrix*), horse mackerel (*Trachurus mediterraneus*), bonito (*Sarda sarda*) and sprat (*Sprattus sprattus*) attract attention in the Black Sea, a significant amount of demersal fish are captured such as red mullet (*Mullus barbatus ponticus*), whiting (*Merlangius merlangus*) and turbot (*Scophthalmus maximus*). While these demersal fish are intensively caught by demersal trawl. But they are the target species for gillnets and trammel nets, which are the most important fishing gear of coastal fisheries. The Tub gurnard (*Chelidonichthys lucerna*), is one of the other economical fish species, also caught with these fishing gears Tub gurnard is mainly captured as none-target together with flatfish and demersal fishes in fishing with demersal trawls, gillnets and trammel nets, (ICES, 2010; Kasapoğlu and Düzgüneş, 2017; Özdemir *et al*., 2019; Rodrigues *et al*., 2019; Campos *et al*., 2022; Ünal *et al*., 2022).

Tub gurnard, is a member of the family Triglidae, are distributed throughout tropical and temperate marine areas globally (Stewart *et al*., 2022). Tub gurnard is one of the three species of Triglidae family distribution in the Black Sea (Bat *et al*., 2008; Bilecenoğlu *et al*., 2014; Yankova *et al*., 2014). Tub gurnard was categorized as least concern in International Union for Conservation of Nature-IUCN Red List (Nunoo *et al*., 2015).

There are many studies on some biological and population features of tub gurnard in the Marmara Sea, Aegean Sea, Mediterranean Sea and Atlantic coasts, (Colloca *et al*., 1994; Abdallah, 2002; Santos *et al*., 2002; Borges *et al*., 2003; Mendes *et al*., 2004; İşmen *et al*., 2004; Uçkun, 2005; Eryılmaz and Meriç, 2005; İlhan and Toğulga, 2007; Deval *et al*., 2007; Boudaya *et al*., 2008; Çiçek *et al*., 2008; Vallisneri *et al*., 2011; Stagioni *et al*., 2012; Demirel and Dalkara, 2012; Akyol, 2013; Rodrigues *et al*., 2019; Campos *et al*., 2022) but research in the southern Black Sea coats are limited (Haşimoğlu *et al*., 2016; Özdemir *et al*., 2019).

Reasons such as climate change and global warming cause changes in the Black Sea ecosystem. Accordingly, it is expected that the stocks of some species in the Black Sea will decrease or even disappear with the increasing pollution and hunting pressure. However, it seems likely that new species will enter the Black Sea and become dominant in the ecosystem (Bat *et al*., 2007). The availability and dominancy of non-resident fish species also cause negative effects such as habitat losses stemmed from food competition.

Scientific research on aquatic species are very essential for sustainable fishery activities and achievement of the fishery authorities. Accordingly, aquatic organisms (target catch, by-catch and discard) of the estimation of population parameters and biological features can be defined as one of the most important

studies (Özdemir *et al*., 2019).
Tub gurnard is one of the important species that are impacted by various negative effects such as pollution, overfishing pressure and climate change in the Black Sea. For this reason, in addition to detailed studies on the species, it is necessary to reach information that will guide fisheries management.
Length-weight relationships (LWRs) and some population characteristics in terms of fisheries biology of tub gurnard were evaluated which captured as by-catch by the trammel nets, gillnets and demersal trawls used in southwestern shores of Black Sea, in the study.

2. MATERIAL AND METHOD

The study was conducted in the Southwestern Black Sea shores of Türkiye at monthly by using a traditional bottom trawl and set nets (trammel nets, gillnets) between 01 September 2018 and 15 June 2021. The sampling area (Sinop-Samsun region) embodies lots of pelagic and demersal fish due to located on migration route in the Southern Black Sea shores of Türkiye. Fish samples were obtained with commercial fishing vessels at water depths ranging from 15 m to 120 m. The map of the study field is shown in Figure 1.

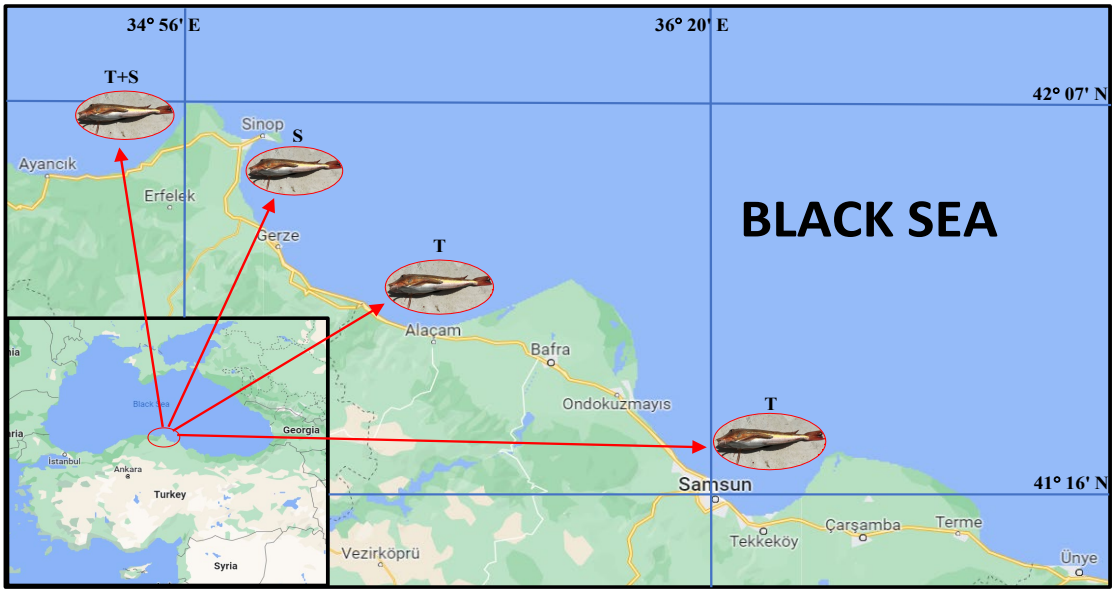

Figure 1. Study area and fishing gears type (T: otter demersal trawl, S: trammel nets and gillnets)

The most of tub gurnard was captured by using a conventional demersal trawl with Equipped with 42 mm and 44 mm condend mesh size, with a 45-90 minutes towing duration. A 24 set of trammel nets and gillnets were used for sampling. The whiting and red mullet trammel nets were donated with 32 mm, 36 mm, 40 mm, 44 mm, 48 mm and 54 mm mesh sizes, whereas whiting, red mullet and turbot gillnets were donated with 32 mm, 34 mm, 36 mm, 44 mm, 48 mm, 320 mm, 340 mm and 400 mm mesh sizes.
A total of 60 and 90 sea survey were realised for trammel-gillnet sampling and demersal trawl sampling, respectively (Table 1).

Table 1. Sampling time, used fishing gears, period and trial number in the study (*Chelidonichthys lucerna* L. 1758)

Sampling Time	Fishing gear type	Period	Trial Number	Total
01 Sep 2018-15 Mar 2019	Demersal Trawl	Monthly	6	42
01 Sep 2019-15 April 2020	Demersal Trawl	Monthly	4	32
01 Sep 2020-15 April 2021	Demersal Trawl	Monthly	2	16
01 Sep 2018-15 June 2019	Gillnets, Trammel Nets	Monthly	2	20
01 Sep 2019-15 June 2020	Gillnets, Trammel Nets	Monthly	2	20
01 Sep 2020-15 June 2021	Gillnets, Trammel Nets	Monthly	2	20

Fish samples were measured to total length (nearest 0.1 cm) and wet weight (nearest 0.01 g) (Figure 2). The sex of the fishes were determined by the macroscopic investigate of the gonads (King, 2007, Follesa and Carbonara, 2019). Female/male ratio of fish was analyzed by Chi-square test (X^2).

Figure 2. Tub gurnard (*Chelidonichthys lucerna*)

Fulton's condition factors (K) were fixed by the formula; $K=WL^3100$

LWRs were predicted by fitting an exponential curve ($W=aL^b$) to the data (Pauly, 1984).

Parameters a and b of the exponential curve were estimated by linear regression analysis over log-transformed data; LogW = Loga + bLogL.

In equations: the total weight (W) is g, the total length (L) is cm, "b" is the slope and "a" is the intercept, using the least-squares method.

The association-degree between variables of W and L were determined by the specification coefficient (R). Further, 95% confidence limits of the parameter "b" was established.

Pauly's t-test was performed (Pauly, 1984). Pauly's t-test statistic was calculated as below:

$$t = \frac{Sd_{logL}}{Sd_{logW}} \frac{|b-3|}{\sqrt{1-r^2}} \sqrt{n-2} \quad (1)$$

Where SdlogTL is the standard deviation of the log TL values, SdlogW is the standard deviation of the log W values, n is the number of specimens used in the computation. The value of b is different from b = 3 if calculated t value is greater than the tabled t values for n-2 degrees of freedom (Pauly, 1984).

If the value of "b" is equal to 3, the growth is expressed as isometric. But the "b" parameter is statistically less than 3, growth is called negative allometric and when the "b" value is greater than 3, growth is called positive allometric (Dutta *et al*., 2012).

3. RESULTS

Totally, 203 specimen of tub gurnard with a 154 788 kg were caught with gillnets and trawl nets during the study. The caught fish consists of 60% (121) female and 40% (82) male. Sex ratio was 1 female: 0.67 male in the examined fishes. Statistical analysis using the Chi-square test (X^2) is significant for the species ($p < 0.05$). Total length of males ranged between 13.4 and 66.1 cm. The range was greater for females between 14.0 and 73.8 cm. The mean total length and weight of all fish were determined as 38.9±0.99 cm and 762.50±56.01 g, respectively. The mean length and weight of the males were found as 37.01±1.51 cm and 656.75±71.44 g, whereas 40.12±1.33 cm and 831.71±80.16 g for females. The size class ranged between 25.1-35 cm and 35.1-45 cm represented with highest individual number, with a 49.75% of total individual. For all sexes, the highest individual number was found for 25.1-35 cm TL (25.62 %) length group, whereas lowest individual number was found for 5.1-15 cm TL (4.93 %) size group. Similar results are valid for the size class distributions of female and male fishes (Figure 3).

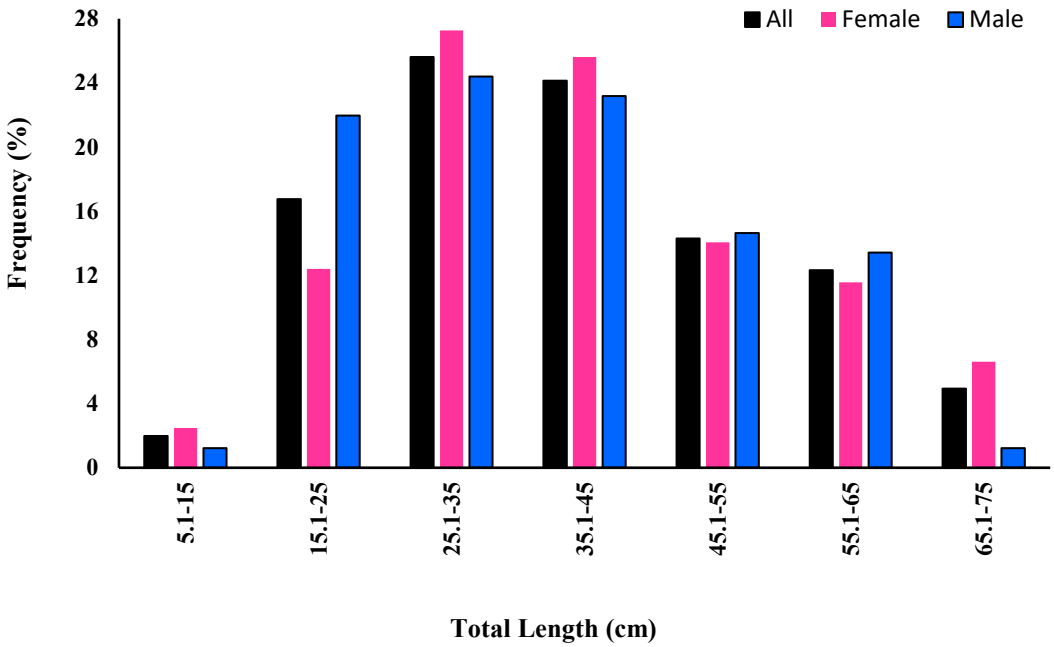

Figure 3. The total length-frequency distribution of tub gurnard

The length-weight relationships (LWRs) of tub gurnard were calculated as $W=0.0115L^{2.9345}$, $W=0.0108L^{2.9535}$ and $W=0.0112L^{2.9425}$ for females, males and all individuals, respectively (Figure 4).

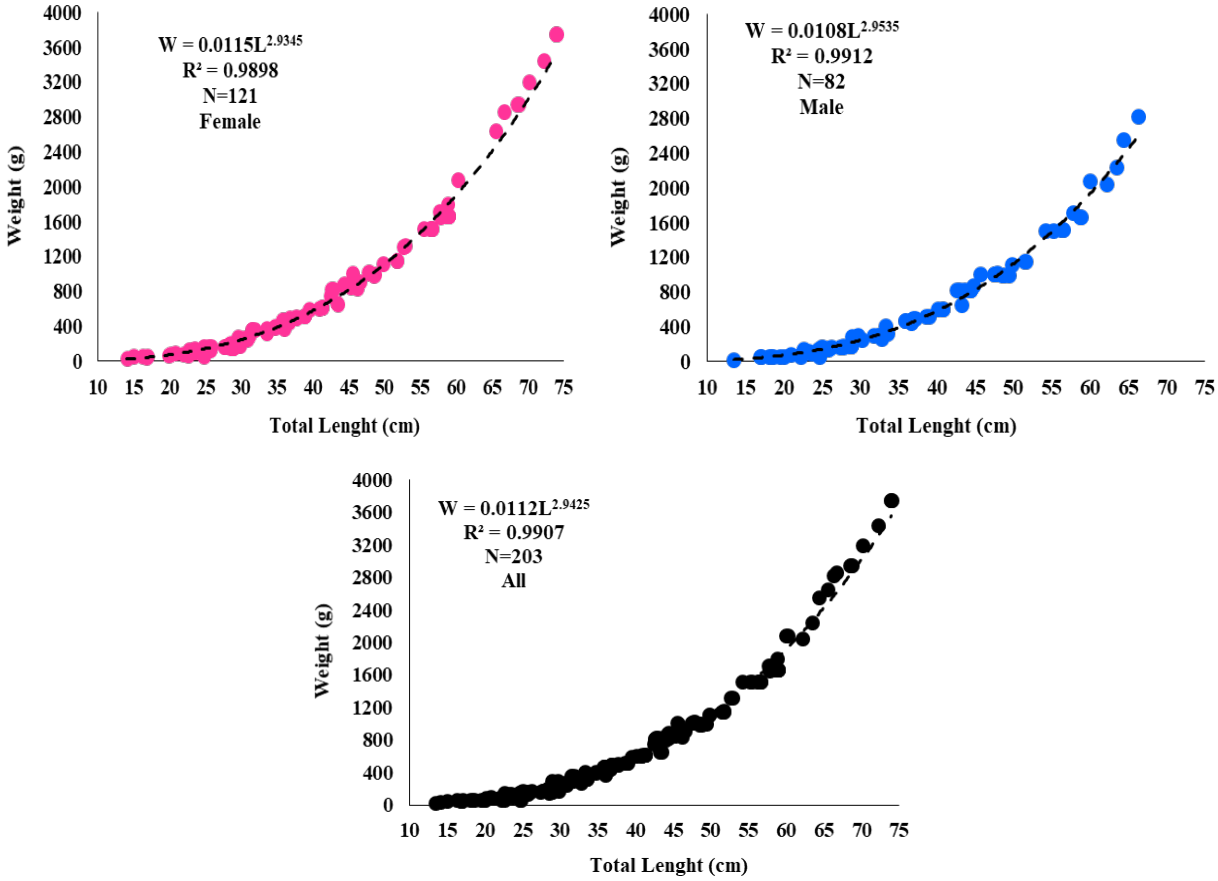

Figure 4. The length-weight relationships (LWRs) graphics of tub gurnard

Fulton's condition factors were founded as 0.926±0.009 for all individuals. Mean condition factor of male was higher than female individuals (0.923±0.013 and 0.929±0.014). Maximum and minimum values were found as 1.035 (September) and 0.968 (June) for females, and 1.021 (October) and 0.975 (June) for males. Mean condition factors were calculated for months and the results are given in Figure 5.

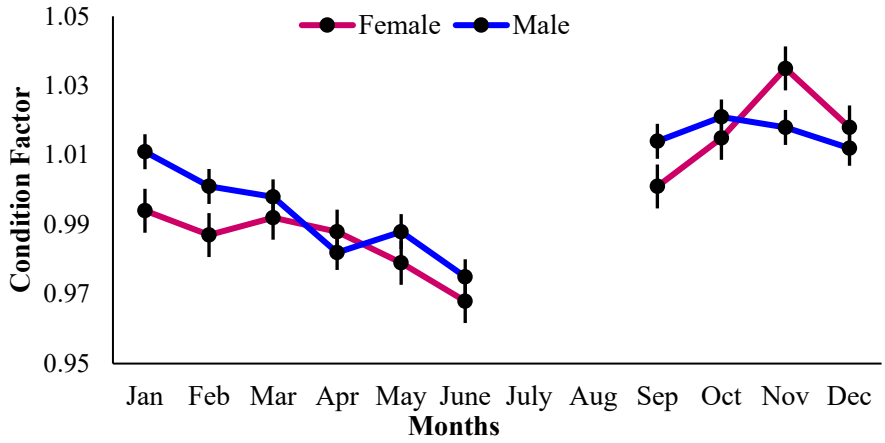

Figure 5. Monthly variation of condition factors of female and male tub gurnard

The values of parameter "b" were determined as 2.9535 (for males), 2.9345 (for females) and 2.9425 (for all fishes). While negative allometry growth were for female and all fishes, isometry growth was defined for males. Data and statistics analyze on the length-weight relationship (LWR) are shown in Table 2.

Table 2. Length-weight relationship (LWR) parameters for tub gurnard

Parameters of LWR	Female (♀)	Male (♂)	All (♀ - ♂)
N	121	82	203
a	0.01155	0.01084	0.01124
95 % Confident of a	0.00874-0.01527	0.00794-0.01481	0.00917-0.01378
b	2.9345	2.9535	2.9425
b (SE)	0.0612	0.0681	0.0449
95 % Confident of b	2.8579-3.0012	2.8659-3.0411	2.8861-2.9991
R	0.9898	0.9912	0.9907
Growth	−Allometry	Isometry	−Allometry
P (t-test)	0.05<	0.05>	0.05<

N is number of specimens; a is intercept of the relationship; b is slope of the relationship; R is coefficient of determination; b (SE) is the standard error of b.

4. DISCUSSION

As in the whole world, many fish species are caught as by-catch on fishing gear in the fishing in the coasts of Turkey (Kasapoğlu and Düzgüneş, 2021). One of these species is the tub gurnard. This fish species is of economic importance, especially for small-scale fisheries. Tub gurnards are caught by trammel nets, gillnets, and demersal trawls, have stated in the most studies (Ceylan *et al*., 2014; Kasapoğlu and Düzgüneş, 2017; McCartey and Marriott, 2018; Özdemir *et al*., 2019; Stewart *et al*., 2022).

In the study, it was determined that individuals with larger sizes and weights groups were captured for tub gurnard compared to studies conducted in other seas (Figure 3). The present study established which mean total length and weight of all fishes are 38.9±0.99 cm and 762.5±63.85 g, respectively. The maximum, minimum size and weight established for tub gurnard were 73.8 cm, 13.4 cm and 3753.5 g, 25.1 g respectively. Uçkun and Toğulga (2007) reported that most abundantly captured specimens ranged from 18.0 to 20.0 cm and 16.0-18.0 cm for females and males, respectively in the Aegean Sea. Moreover, Eryılmaz and Meriç (2005) reported that more individuals were caught in the 21ve 23 cm length groups in the study in the Marmara Sea. On the other hand, İşmen and İşmen (2004) reported that in their study conducted in the Eastern Mediterranean, tub gurnard was caught in smaller size groups (12-13 cm).

The maximum and minimum length were defined as 88.2 cm for Southeastern Black Sea coasts (Haşimoğlu *et al*., 2016) and as 2.2 cm for Eastern Mediterranean (Çiçek *et al*., 2006) in Türkiye seas. Other maximum sizes were measured in North Aegean Sea and Sea of Marmara, 76 cm and 64 cm respectively (İşmen *et al*., 2007; Bök *et al*., 2011). The maximum and minimum size were determined 57.5 cm and 6 cm respectively in the different countries (Papacostantinou *et al*., 1994; McCartey and Marriot, 2018).

The fishes in stocks exposed to extreme degrees fishery pressure will react by spawning at smaller mean lengths and ages. As a result, maximum size reached fishes will be smaller length in the populations (Filiz, 2011). Furthermore, some factors that might probability impress growth has been shown to have an impact, inclusive food presence, diet regime, light density, dissolved oxygen, temperature, salinity, pollution, currents, bait concentration, rate of predator,

intra-specific social connections, genetic differences (Helfman *et al*., 2009; Acarlı *et al*., 2018).

Length-weight relationship was calculated as $W=0.01124L^{2.943}$ (R=0.989) for all tub gurnard (b<3, negative allometric growth). The "b" value was founded to be 2.935 (b<3, negative allometric growth) for female and 2.954 (isometric growth b=3) for male in the study. It was detected that b values of fish varied from 2.630 to 3.265 by many scientists (Table 3).

The changes in b-values may be attributed to one or most reasons: changes of salinity, temperature, oxygen, differences of seasonal and regions, pollution of environment, nutrient presence, food abundance and bait quality, sex of fishes, variety in the number of examined individuals, as well as in the observed size ranges of the analyzed fishes (Gonçalves *et al*., 1997; Froese *et al*., 2011; Özdemir *et al*., 2018).

Fifteen of twenty-seven studies had significantly different "b" for tub gurnard, which defined positive allometric growth in 6 scientific studies and isometric growth in 9 scientific studies for tub gurnard. This study has shown that the b-value have generally been in conformity (negative allometric growth for 12 studies) with results in the twelve studies (Table 3).

Also, in the study similar results were obtained with values of condition factor of tub gurnard founded from studies in Marmara and Aegean Sea. In the Aegean Sea, the minimum and maximum values of condition factor were reported for females and males as 0.594, 1.443 and 0.776, 1.330, respectively (İlhan and Toğulga, 2007). Eryılmaz and Meriç (2005) notified the condition factors as 0.990 for all individuals of tub gurnard in Sea of Marmara. However, Altun *et al*. (1997) mean condition factor of tub gurnard were established (0.8634) lower than other study of Türkiye seas.

Besides, fishes were captured usually small length in the many studies. First size of maturity (FSM) of male and female are 17-18 cm and 19-20 cm for Türkiye shores (İşmen *et al*., 2004; Eryılmaz and Meriç, 2005, Ilhan and Toğulga, 2007). The sizes are range 20 cm and 40 cm in some research of other Mediterranean countries (Baron, 1985; McCarty and Marriott, 2018; Rodrigues *et al*., 2019; Suarez *et al*., 2021; Campos *et al*., 2022). The minimum landing size (MLS) was indicated 18 cm for tub gurnard captured in Türkiye seas (Anonymous, 2020). But it is not adequate once for spawning of fish. The current catch length has to certainly raised for the recovering and sustainable of tub gurnard stocks in Türkiye coasts.

Table 3. Previously research on length-weight relationship parameters of tub gurnard

Authors	Sex	L_{Max}-L_{Min}	N	a	b	R	Growth
Papaconstantinou *et al*., 1994[a]	All	6.0-35.0	563	0.009846	3.011	0.93	-A
Serene *et al*., 1998[a]	All	11.7-45.5	538	0.013900	2.859	0.99	-A
Abdallah, 2002[a]	All	4.7-24.9	196	0.029000	2.630	0.97	-A
Santos *et al*., 2002[a]	All	14.0-34.4	75	0.018000	2.978	0.98	-A
Borges *et al*., 2003[a]	All	13.6-29.2	10	0.001296	2.956	0.99	I
İşmen *et al*., 2004[a]	♀	8.0-30.3	199	0.095000	3.010	0.98	I
	♂	8.3-21.2	143	0.089000	3.010	0.99	I
	All	8.0-30.3	342	0.009300	2.990	0.98	I
Eryılmaz and Meriç, 2005[c]	All	12.3-41.5	224	0.009200	3.019	0.98	I
Çiçek *et al*., 2006[a]	All	2.2-30.3	137	0.013500	2.851	0.99	-A
Olim and Borges, 2006[a]	All	7.5-27.7	21	0.011000	2.720	0.99	-A
İşmen *et al*., 2007[b]	All	12.5-76.0	829	0.009600	2.928	0.99	-A
*İlhan and Toğulga, 2007[b]	♀	12.7-34.4	360	0.005100	3.245	0.98	+A
	♂	14.1-29.9	186	0.005300	3.237	0.98	+A
	All	12.7-34.4	546	0.005200	3.240	0.98	+A
Sangun *et al*., 2007[a]	All	6.7-24.5	474	0.016600	2.743	0.97	-A
Boudaya *et al*., 2008[a]	♀	16.0-36.0	160	0.015500	2.826	0.95	-A
	♂	17.0-26.0	126	0.007300	3.037	0.93	I
İlkyaz *et al*., 2008[b]	All	12.1-42.3	121	0.004300	3.240	0.97	+A
Çiçek *et al*., 2008[a]	♀	6.1-30.3	113	0.011400	2.918	0.99	-A
	♂	6.5-29.3	106	0.009400	2.988	0.99	I
	All	2.2-30.3	228	0.012900	2.874	0.99	-A
Keskin and Gaygusuz, 2010[c]	All	6.3-15.1	17	0.011300	2.902	0.98	I
Bök *et al*., 2011[c]	All	8.0-64.0	90	0.010000	2.982	0.98	I
Vallisneri *et al*., 2011[a]	♀	11.3-41.5	484	0.000001	3.038	0.98	I
	♂	12.8-34.2	396	0.000001	2.952	0.97	I
Demirel and Dalkıran, 2012[c]	All	10.5-56.0	352	0.009000	3.000	0.98	I
Bilge *et al*., 2014[b]	All	16.6-40.7	81	0.005200	3.222	0.98	+A
El-Serafy *et al*., 2015[a]	♀	11.8-28.2	511	0.004200	3.265	0.98	+A
	♂	12.6-23.3	315	0.004300	3.264	0.97	+A
İşmen *et al*., 2018[c]	All	9.2-37.0	204	0.027000	2.676	0.98	-A
McCarthy and Marriot, 2018[d]	All	10.4-57.5	804	0.067000	3.103	0.98	+A
Özdemir *et al*., 2019[e]	All	12.8-74.2	117	0.010300	2.988	0.98	I
Rodrigues *et al*., 2019[f]	♀	13.3-30.3	174	0.088900	3.020	0.99	I
	♂	12.4-46.2	64	0.063900	3.130	0.99	+A
	All	12.4-46.2	238	0.062100	3.140	0.99	+A
Duyar and Özdemir, 2022[e]	All	15.2-55.5	54	0.012320	2.975	0.98	-A
Compas *et al*., 2022[f]	All	4.7-31.8	480	0.010500	2.980	0.99	I
Present Study 2023[e]	**♀**	**14.0-74.0**	**121**	**0.011556**	**2.935**	**0.99**	**-A**
	♂	**13.4-66.3**	**82**	**0.010843**	**2.954**	**0.99**	**I**
	All	**13.4-73.8**	**203**	**0.011246**	**2.943**	**0.99**	**-A**

*♂: male, ♀: female, A: ♂+♀, a: Mediterranean Sea, b: Aegean Sea, c: Marmara Sea, d: North Sea, e: Black Sea, f: North Atlantic, * fork length, I: isometry, +A: positive allometry; -A: negative allometry.*

5. CONCLUSION

In the present study, some biological data and LWRs were determined for tub gurnard caught from the Black Sea coast of Türkiye. Also, some biological features and LWRs of tub gurnard in other seas were compared. The results obtained throughout this study are in agreement with many of the results get in another past research. Furthermore, these major reports and data are frequently used by fisheries authorities, scientists and research institutions. For this reason, in times to come, the related studies on stocks, population dynamic and fisheries biology of fishes caught in the Black Sea should be advanced and evaluated. Last of all, the tub gurnard is an economically

valuable fish for coastal fishery, even though the fish is captured as none-target by the small-scale fishermen in Türkiye shores. Tub gurnard fishery was getting decrease in the Türkiye seas for several years. However, the tub gurnard began to again show in the fishing gears of coastal fisheries in recent years. Therefore, tub gurnard has to not catch by the fishermen before reaching the first size of maturity (FSM 20-40 cm; according to many scientific reports and study). Further, minimum landing size (MLS) for tub gurnard should be revised and it has not to be less than 30 cm for species. Here, not only the first size of maturity (FSM) of the fish, but also the length at which the spawning rate reaches 50% must be taken into account. Tub gurnard caught smaller than 30 cm should be released absolutely into the sea for at least once breeding.

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AUTHORSHIP CONTRIBUTION STATEMENT

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CONFLICT OF INTERESTS

The author(s) declare that for this article they have no actual, potential or perceived conflict of interests.

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