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SHORT COMMUNICATION KISA ARAŞTIRMA

Length-weight relationships of fishes caught by stationary uncovered pound nets in the coastal waters of Saros Bay, North Aegean Sea (Turkey)

Saros Körfezi'nin (Kuzey Ege Denizi) kıyısal sularında ağ dalyan ile yakalanan balıkların boy-ağırlık ilişkileri

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Abstract: Stationary uncovered pound nets are passively fishing gears used for fish catching according to traditional methods in the coastal waters of Saros Bay, North Aegean Sea. The purpose of this study was to determine length-weight relations (LWRs) for a wide range of fish species collected from the traps in the coastal waters of Saros Bay. We are studied in the fish species caught by four traps between April and August (fishing season) in 2010 - 2012. A total of 23 fish species belonging to 12 families were caught individual 2.096. The mean value of the growth pattern (*b*) was 3.141±0.042, ranging from 2.711 to 3.577. Whereas they were negative allometric only for two species (*Pomatomus saltatrix* and *Mugil cephalus*), from other fish species were observed to be 13 positive allometric and 8 isometrics. The LWR parameters for the positive allometric and isometric fish species were significant (P<0.05). This study provides some general information about the status of the LWR parameters of the fish species caught from the traps.

***Keywords*:** Length- weight relationship, fish species, stationary uncovered pound net, Saros Bay

Öz: Ağ dalyanlar, Kuzey Ege Denizi'nin Saros Körfezi kıyılarında geleneksel yöntemlere göre balık avlamada kullanılan pasif av araçlarıdır. Bu çalışmanın amacı, Saros Körfezi kıyılarındaki ağ dalyanlardan toplanan çeşitli balık türleri için boy-ağırlık ilişkilerini (LWRs) belirlemektir. 2010 - 2012 yıllarında Nisan ve Ağustos ayları arasında (balık avlama sezonu) dört ağ dalyandan yakalanan balık türlerinde çalışılmıştır. 12 aileye ait toplam 23 balık türünde toplam 2.096 adet birey yakalandı. Büyüme ilişkilerinin (*b*) ortalama değeri 3,141 ± 0,042 iken, 2,711 – 3,577 arasında değişmiştir. Sadece iki tür (*Pomatomus saltatrix* ve *Mugil cephalus*) negatif allometrik iken, diğer balık türlerinden 13 pozitif allometrik ve 8 izometrik olduğu tespit edilmiştir. LWR parametreleri pozitif allometrik ve izometrik balık türleri için anlamlıydı (P <0,05). Bu çalışma, ağ dalyanlardan yakalanan balık türlerinin LWR parametreleri ile ilgili bazı genel bilgiler sunmaktadır.

Anahtar kelimeler: Boy-ağırlık ilişkileri, balık türleri, ağ dalyan, Saros Körfezi

INTRODUCTION

The stationary uncovered pound net fishery is well known to be one of the oldest methods used in different regions of the world. These fishing systems are established in different types and sizes in shallow waters with sandy–muddy substrates at certain periods of the year (Deveciyan, 2011). These traps are used in the coastal areas of the Mediterranean Sea, the Aegean Sea, and the Marmara Sea in Turkey (Çolakoğlu et al., 2015; Biçer et al., 2020). The stationary uncovered pound net fishery on the coast of Saros Bay is used extensively due to the high commercial value of the fish species (Çolakoğlu et al., 2015; Biçer et al., 2020). There are 15 traps in this region and they are limited to this number by the competent authority. This study is important in terms of determination of species diversity, length, and weight distributions of fishes caught by stationary uncovered pound net in the coastal waters of Saros Bay, North Aegean Sea.

The length-weight relationship (LWR) is of great importance in fisheries biology and population dynamics (Silva et al., 2013). This information is useful for the prediction of indications of condition, level of breeding, feeding, and stock assessment of the fish (Yıldız et al., 2018). Also, LWR is used in morphological comparisons of fish species (Gonçalves et al., 1997).

In other studies conducted in Turkey have been made assessment on LWR for fish species caught in the coastal areas of the Black Sea, the Marmara Sea, the Aegean Sea and the Mediterranean Sea (Taskavak & Bilecenoglu, 2001; Filiz & Bilge, 2004; Karakulak et al., 2006; Ozaydin & Taskavak, 2006; Akyol et al., 2007; Demirhan & Can, 2007; Ismen et al., 2007; Ozaydin et al., 2007; Ilkyaz et al., 2008; Ceyhan et al., 2009; Erguden et al., 2009; Keskin & Gaygusuz, 2010, Kasapoglu & Düzgünes, 2014; Yıldız et al., 2018). There is not enough information about species diversity, length and weight distributions of fishes caught by stationary uncovered pound nets in Saros Bay. The present study aimed to characterize the relationship between the length and weight of fish species caught along the sampling period from the stationary uncovered pound net. In addition,

the results will provide information on the sustainability of the fish caught by traps in the region.

MATERIAL AND METHOD

Surveys were regularly recorded the fish caught in one day, twice a week for each trap between April and August (stationary uncovered pound net fishing season) in the years 2010-2012 in four locations along the coastal waters of Saros Bay in the North Aegean Sea, Turkey (Figure 1).

Each fisheries system was constructed over a surface area of approximately 0.5 hectares (70 m width and 70–80 m length) at depths of up to 20–30 m, perpendicular to the shore in Saros Bay (Figure 2). The stationary uncovered pound net was located just above the average low tide line and consisted of a leader net, an entrance, a slope, a bag net, and a final trap, and all of them supported by galvanized pipe poles (Çolakoğlu et al., 2015). At each location, the mesh size of all parts of the traps was usually constructed of a 10.5 mm mesh. Four fishermen recovered the fish caught in the traps by removing the net in both final traps (168 m^2). Stationary uncovered pound nets were checked twice daily (at sunrise and sunset) and usually cleared only during low tide.

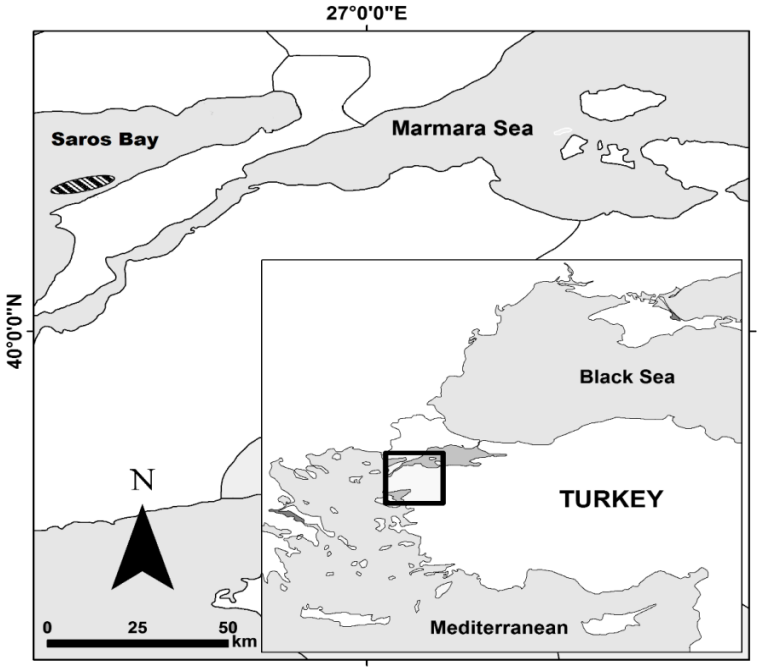

Figure 1. Sampling locations

Figure 2. A typically stationary uncovered pound net in Saros Bay

Samples were packaged in styrofoam boxes and transported with high humidity to the laboratory in 2 hours via an ice-cooled box. All fish species were identified according to Mater et al. (2003), and the scientific name for each species was checked according to the FishBase® (Froese & Pauly, 2013). The fresh samples total length (TL) was recorded to the nearest 0.1 cm.

The total weight (W) of each fish was measured using an electronic balance (0.01 mg accuracy). The fish length and weight relationship were calculated using the exponential relationship: $W = a \times L^b$, where W is total weight (g), L is the total length (all data standardized to cm), *a* is the intercept, and *b* is the slope. Parameters *a* and *b* were estimated by least-squares linear regression on log–log transformed data: ($\ln W = \ln a + b \times \ln L$). The coefficient of determination (R^2) was used as an indicator of the quality of linear regression. To confirm whether the values of *b* obtained in the linear regressions were significantly different from the isometric value (*b*=3) and negative (*b* < 3) or positive (*b* > 3) allometric relationships, t-tests were used. In addition, the functional regression *b* value represents the body shape as related to the weight (Ricker, 1973). A Student's t-test (α=0.05) was employed to test whether the *b* value was significantly different from the isometric (*b*=3) point (Zar, 1999). Student t-tests and ANCOVA were performed using the Statistica® 8.0 software package (StatSoft, 2007). Descriptive statistics were derived using Microsoft Office Excel 2016 software (Seattle, WA, USA).

RESULTS AND DISCUSSION

Stationary uncovered pound nets are one of the most important fishing gears used in fishing in Turkey. The trap fishing in different regions of the country is carried out using artisanal methods along the coast of the Aegean and Marmara Seas (Çolakoğlu et al., 2015). Although the LWRs studies in the fishes caught with different fishing gears were made, there are no studies on the fishes caught with traps. In this study, LWRs were determined for the fishes caught with stationary uncovered pound nets in the coastal waters of Saros Bay, North Aegean Sea.

During the research period, a total of 23 species belonging to 12 families were caught 2.096 individuals in total by the traps. The dominant within the caught fish species were components of *Trachurus mediterraneus* (19.08%), *Sardinella aurita* (15.08%), *Boops boops* (8.54%), *Oblada melanura* (6.92%), and *Sardina pilchardus* (6.54%) and which represented approximately 56.15%. Minimum and maximum lengths, weights, parameters of the LWRs and standard errors of *b* values for 23 species were summarized in Table 1. According to the results of the present study, the slope *b* values ranged between 2.711±0.017 (*Mugil cephalus*) and 3.577±0.008 (*Scomber japonicus*), and *a* values ranged from 0.0004 (*Belone belone*) to 0.0216 (*M. cephalus*) (P<0.05). Whereas they were negative allometric only for two species (*Pomatomus saltatrix* and *M. cephalus*), from other fish species were observed to be 13 positive allometric and 8 isometrics. The LWR parameters for the positive allometric and isometric fish species were significant (P<0.05). The highest *b* value was over the upper limit for only two species *S. japonicus* (3.577) and *Diplodus annularis* (3.417). The LWRs were significant for all species, with R^2 values ranging from 0.823 (*Scomber scombrus*) to 0.993 (*Sarpa salpa*) (P<0.05) (Table 1).

A comparison of the *b* values between the present study and other studies is shown in Table 2.

Table 1. The results of length-weight relationships of fish species caught from the coastal waters of Saros Bay, North Aegean Sea

Family	Species	n	Length		Weight		Relationship parameters				Range of *b*
			Mean (±SD)	Range (cm)	Mean (±SD)	Range (g)	*a*	*b*	SE (b)	R^2	Fishbase
Carangidae	*Trachurus mediterraneus*	400	17.22±1.97	11.0-24.6	45.56±16.26	10.1-121.1	0.0090	2.982	0.004	0.949	2.964-3.573
Clupeidae	*Sardinella aurita*	316	20.65±1.84	15.8-26.2	66.03±18.78	24.0-134.0	0.0069	3.020	0.004	0.907	3.183-3.660
	Sardina pilchardus	137	15.18±1.54	11.5-17.5	28.42±8.36	10.0-43.0	0.0036	3.280	0.007	0.945	3.257-3.621
	Spondyliosoma cantharus	120	17.95±3.07	12.0-30.8	102.96±73.50	21.9-563.0	0.0080	3.238	0.013	0.943	3.123-4.159
	Boops boops	179	17.42±3.24	12.1-25.5	55.95±31.31	15.0-154.0	0.0115	2.936	0.010	0.973	2.961-3.593
	Oblada melanura	145	23.59±3.62	14.7-30.0	179.65±85.73	19.10-360.0	0.0056	3.263	0.015	0.984	2.904-4.081
	Sarpa salpa	52	17.44±4.31	13.7-29.4	80.58±73.89	31.0-310.0	0.0105	3.059	0.025	0.993	3.232-3.839
Sparidae	*Pagellus bogaraveo*	51	14.97±2.28	12.5-21.5	47.96±26.18	26.1-137.5	0.0108	3.076	0.015	0.976	3.222-3.638
	Diplodus annularis	23	15.27±1.69	11.4-19.8	67.76±27.66	23.0-154.0	0.0058	3.417	0.020	0.969	3.478-3.912
	Pagellus acarne	21	18.14±2.89	13.5-24.6	82.56±44.40	29.7-194.0	0.0084	3.142	0.028	0.972	3.309-3.780
	Lithognathus mormyrus	20	23.38±2.92	19.3-28.5	175.50±77.16	86.0-350.0	0.0040	3.373	0.033	0.981	3.800-4.912
	Scomber japonicus	121	23.03±2.16	17.5-30.0	113.72±40.37	38.0-274.0	0.0015	3.577	0.008	0.953	3.852-4.350
Scombridae	*Scomber scombrus*	54	28.01±1.09	23.3-30.0	184.24±24.96	103.0-252.0	0.0041	3.209	0.006	0.823	3.759-4.024
	Sarda sarda	15	47.31±11.61	39.2-67.0	1358.5±1163.51	671.4-3250.2	0.0072	3.102	0.082	0.986	4.164-4.692
Centracanthidae	*Spicara smaris*	86	14.31±1.99	10.7-19.0	28.22±11.28	11.0-55.1	0.0106	2.942	0.010	0.974	2.952-3.285
	Spicara maena	48	16.91±1.46	13.5-19.8	65.90±17.20	31.0-99.0	0.0086	3.154	0.011	0.953	3.319-3.619
Pomatomidae	*Pomatomus saltatrix*	73	26.22±3.85	19.5-33.3	150.8±63.8	61.0-322.0	0.0148	2.807	0.014	0.979	3.204-3.710
Sphyraenidae	*Sphyraena chrysotaenia*	65	30.49±3.27	24.8-38.9	100.66±40.71	51.0-210.0	0.0012	3.308	0.012	0.951	3.781-4.178
Belonidae	*Belone belone*	58	42.69±6.44	29.1-55.0	81.18±42.38	25.0-175.0	0.0004	3.263	0.018	0.945	3.719-4.214
Engraulidae	*Engraulis encrasicholus*	36	14.33±0.91	11.7-15.6	20.47±3.87	11.0-28.0	0.0053	3.096	0.008	0.924	3.162-3.359
Mugilidae	*Mugil cephalus*	25	28.75±2.06	27.0-34.2	197.33±47.42	155.0-350.0	0.0216	2.711	0.017	0.882	3.349-3.630
Atherinidae	*Atherina boyeri*	22	12.28±0.84	11.2-14.0	12.93±3.02	9.0-20.0	0.0066	3.014	0.014	0.839	3.032-3.203
Scorpaenidae	*Scorpaena scrofa*	19	24.81±4.78	18.3-34.0	381.89±244.93	121.0-896.0	0.0094	3.266	0.063	0.972	3.688-4.276

Table 2. Comparison of length-weight relationship parameters for fish species obtained by several researchers

Species	This study (7)			The Dardanelles				Saros Bay and Gökçeada Island				Marmara Sea				Black Sea			
	N	a	b	N	a	*b*	Ref.	N	a	*b*	Ref.	N	a	*b*	Ref.	N	a	*b*	Ref.
Atherina boyeri	22	0.007	3.01	-	-	-	-	-	-	-	-	14	0.002	3.49	4	-	-	-	-
Belone belone	58	0.003	3.26					30	0.001	3.19	1	-	-	-	-	-	-	-	-
Boops boops	179	0.012	2.94	-	-	-	-	189	0.005	3.24	2	-	-	-	-	-	-	-	-
Diplodus annularis	23	0.006	3.42	282	0.015	3.05	1	108	0.016	3.02	2	15	0.022	2.96	4	-	-	-	-
Engraulis encrasicholus	36	0.005	3.10	-	-	-	-	-	-	-	-	-	-	-	-	1588	0.013	2.71	6
Lithognathus mormyrus	20	0.004	3.37	45	0.019	2.86	1	-	-	-	-	-	-	-	-	-	-	-	-
Mugil cephalus	25	0.022	2.71	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oblada melanura	145	0.006	3.26	97	0.018	2.89	1	316	0.003	3.46	3	-	-	-	-	-	-	-	-
Pagellus acarne	21	0.008	3.14	228	0.012	3.03	1	-	-	-	-	-	-	-	-	-	-	-	-
Pagellus bogaraveo	51	0.011	3.08	92	0.024	2.78	1	2355	0.007	3.19	2	-	-	-	-	-	-	-	-
Pomatomus saltatrix	73	0.015	2.81	-	-	-	-	-	-	-	-	290	0.033	2.53	4	25	0.009	3.01	6
Sarda sarda	15	0.007	3.10	-	-	-	-	-	-	-	-	-	-	-	-	36	0.050	2.56	6
Sardinella aurita	316	0.007	3.02	26	0.001	3.28	1	50	0.006	3.07	3	24	0.003	3.44	5	-	-	-	-
Sardina pilchardus	137	0.004	3.28	146	0.006	3.12	1	-	-	-	-	-	-	-	-	-	-	-	-
Sarpa salpa	52	0.011	3.06	99	0.013	3.02	1	-	-	-	-	-	-	-	-	-	-	-	-
Scomber japonicus	121	0.002	3.58	69	0.004	3.23	1	45	0.002	3.52	2	-	-	-	-	-	-	-	-
Scomber scombrus	54	0.004	3.21	58	0.006	3.08	1	100	0.003	3.29	2	-	-	-	-	-	-	-	-
Scorpaena scrofa	19	0.009	3.27	134	0.022	2.96	1	15	0.018	3.00	3	-	-	-	-	-	-	-	-
Spicara maena	48	0.009	3.15	-	-	-	-	353	0.0098	3.01	2	-	-	-	-	-	-	-	-
Spicara smaris	86	0.011	2.94	114	0.011	3.01	1	1449	0.012	2.91	2	403	0.009	3.08	4	103	0.022	2.72	6
Sphyraena chrysotaenia	65	0.001	3.31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spondyliosoma cantharus	120	0.008	3.24	156	0.008	3.26	1	45	0.009	3.17	2	-	-	-	-	-	-	-	-
Trachurus mediterraneus	400	0.009	2.98	489	0.006	3,13	1	446	0.0032	3.37	2	307	0.006	3.13	4	624	0.005	3.14	6

Ref. is the reference of different researchers: 1: Cengiz, (2013); 2: Ismen, A. et al., (2007); 3: Karakulak et al., (2006); 4: Bok et al., (2011); 5: Keskin and Gaygusuz, (2010); 6: Kasapoglu and Duzgunes, (2014); 7: Present study.

Parameter *b* (2.98) for *T. mediterraneus* in this study was lower than the one obtained from the Aegean Sea 3.37 (Ceyhan et al., 2009) and the Black Sea (3.14) (Kasapoglu & Duzgunes, 2014) and (3.17) (Yankova et al., 2011), the Dardanelles (3.13) (Cengiz, 2013), the Saros Bay (3.37) (İşmen et al., 2007), but higher than from the Mediterranean Sea (2.81) (Sangun et al., 2007). The *b* coefficient (3.02) value obtained for *S. aurita* was found to be similar to the values of the same species studied for the North Aegean Sea (3.07) (Karakulak et al., 2006) and smaller than for the Dardanelles (3.28) (Cengiz, 2013). *b* (3.26) for *Oblada melanura* was found to be lower than the findings obtained in the North Aegean Sea (3.46) (Karakulak et al., 2006), but higher than in the Dardanelles (2.89) (Cengiz, 2013). *b* (3.58) for *S. japonicus* was found to be similar to the findings obtained in the Saros Bay (3.52) (İşmen et al., 2007), but higher than in the Dardanelles (3.23) (Cengiz, 2013) and the North Aegean Sea (3.10) (Karakulak et al., 2006). *b* (3.24) for *Spondyliosoma cantharus* was found to be similar to the findings obtained in the Dardanelles (3.26) (Cengiz, 2013) and the Saros Bay (3.17) (İşmen et al., 2007), but higher than in the North Aegean Sea (2.87) (Karakulak et al., 2006). *b* value (2.94) for *B. boops* was found to be lower than the findings obtained in the Saros Bay (3.24) (İşmen et al., 2007). *b* values for *Spicara maena* (3.15) and *D. annularis* (3.42) in the present study were found to be higher than the findings obtained (3.01 and 3.02) in the Saros Bay, respectively (İşmen et al., 2007). The study conducted by İşmen et al. (2007) with this study was observed that of differences in *b* values in some fish species. The reason for this is thought to be due to the low number of samples and the difference of the fishing gear. In addition, the low number of samples in 7 different fish species in the study can decrease the reliability of the results.

The differences in LWR parameters of the fishes investigated in studies could be caused by factors such as lack or abundance of food, specimens age, reproductive stage and sex characteristics (Wootton, 1990), number of specimens analyzed, ecological differences of the sampling areas, sampling duration (Moutopoulos & Stergiou, 2002), fishing gear used and selectivity (İşmen et al., 2007; Cengiz, 2013). The relationship between *a* and *b* is an important factor influencing the body shape of fishes (Froese, 2006) and these factors can be used to assess the 'well-being' of individual fish (Jobling, 2002).

In conclusion, the results of this study could be used as a reference for comparing the findings of other studies. Additionally, results from this study also provide basic information that may facilitate conservation and stock management policies of the impact on fish species of stationary uncovered pound nets fishing conducted in the coastal waters of Saros Bay.

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