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Research article

Some biological parameters of silverstripe blaasop, *Lagocephalus sceleratus* (Gmelin, 1789) from the Mersin Bay, the Eastern Mediterranean of Turkey

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Abstract: A total of 208 individuals of silverstripe blaasop, *Lagocephalus sceleratus* were caught by trawl hauls from Mersin Bay in the years of September 2014 and April 2015. The samples ranged from 14.9 cm to 67.6 cm in fork length and 32.0 g to 4540.0 g in total weight. The ages of silverstripe blaasop population were determined between 1-6 using vertebra. As the silverstripe blaasop population in Mersin Bay consisted of 98 females and 110 males, the sex ratio was calculated as 0.88: 1(F:M) with 52.88% of the population were males and 47.12% of the population were females (p>0.05, t-test). The length-weight relationship of all individuals was calculated as $L_t=118.71(1-e^{-0.115(t-0.178)})$. According to the length-weight relationships, an isometric growth was confirmed for both sexes, except for those estimated in female and male. The monthly values of gonadosomatic index (GSI) of females indicated that spawning occurred mainly between March and April. Gastrosomatic Index (GaSI) was found to be the highest in December and the least in October that is before and after the spawning season. Analysis of the diet composition showed that silverstripe blaaosop is carnivorous and the food spectrum of *L. sceleratus* consists of fishes 41%, molluscs 19%, crustacea 12% digested items 26%, and others 2% (parts of fish line and nematodes).

Keywords: Silverstripe Blaasop, *Lagocephalus sceleratus*, Mersin Bay, age, sex ratio, gonadosomatic index

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Introduction

The silverstripe blaasop, *Lagocephalus sceleratus* (Gmelin, 1789). belongs to the Tetraodontidae. Distributed in the Indo-West Pacific Ocean (Smith and Heemstra, 1986). primarily at depths ranging from 18 to 100 m. it is also a reef inhabitant (Randall, 1995). This fish is known to carry tetrodotoxin (Sabrah et al., 2006; Kasapidis et al., 2007; Bentur et al., 2008; Katikou et al., 2009).

Lagocephalus sceleratus is a Indo-Pasific fish and was first identified from Gökova Bay (Akyol et al., 2005). Bilecenoğlu et al. (2006) reported the species in the bays of Izmir and Antalya. *Lagocephalus sceleratus* was reported from Jaffa along the Israel Coast in 2004 (Golani and Levy, 2005). The species was also recorded in the waters of Libya, Crete, Rhodes, and Adriatic Sea in 2003. 2005. and 2014 (Corsini et al., 2006; Kasapidis et al., 2007; Jribi and Bradai, 2012; Milazzo et al., 2012; Sulić Šprem et al., 2014). Recent records from the Edremit Bay. Behramkale coast (Türker-Çakır et al., 2009). and İskenderun Bay (Torcu Koç et al., 2011) confirmed the distribution of the species northward along the coasts of eastern Mediterranean of Turkey in the northern Aegean Sea. There are some publications concerning various aspects of ongoing invasion, biology, ecology, and stock of silverstripe blaasop throughtout Mediterranean Sea (Sabrah et al., 2006; Aydın, 2011; Başusta et al., 2013; Farrag et al., 2015; Akbora et al., 2017; Aydın et al., 2017;

Zengin and Türker, 2020; Rousso et al., 2014; Coro et al., 2018).

The fact that the silver stripe blaasop populations have been evaluated as poisonous all over the world (Sabrah et al. (2006); Uygur and Turan (2017) needs the more information about the biology of *L. sceleratus* populations to know its stocks and control *L. sceleratus* wild populations through increased fishing pressure in Turkish Seas. The population structure of *L. sceleratus* should be examined and controlled regularly due to capability of rapidly adaptation to a new environment and the public concerning its lethal effects (presence of tetrodotoxin) should be aware of.

The aim of this paper was to examine the population structure of *L. sceleratus* in order to provide better knowledge and to compare with the relevant studies and catagorize it as a pest for fisheries and a potential threat for biodiversity.

Material and Methods

The study was carried out to catch the materials by using commercial gear vessels with trammel nets between Erdemli and Taşucu from Mersin Bay (36° 48' 43.574" N 34° 38' 29.332"E) during years of 2014 and 2015. In this study, all samplings were conducted under the permission of the Ministry of Agricultural and Forestry (67852565/140.03.03-3591). After capture, the fishes were placed in plastic bags individually. labeled and placed inside coolers with ice pads for transport to the laboratory where they were stored in the freezer at-20ºC for further analysis. All fish was measured in fork length (FL) (from snout to distal edge of the caudal fin) to the nearest 0.1 cm, weighed to the nearest 0.01 g using balance. The commonly used length-weight relationship $W=a*L^b$ was applied. where *W* is the weight (g). *L* is the total length (TL: cm) and *a* and *b* are constants (Avşar, 2016).

For age determination, after removal of the internal organs, all vertebrae between the fifth to tenth were taken out, immersed in boiling water for 3 minutes, cleaned from tissue remains and fixed in 10% formalin solution for 24 hours, then washed in running water for one hour, later decalcified with 10% nitric acid. The opaque rings on the vertebral centrum were counted independently by two readers without prior information of body length and weight. One growth band was defined as an opaque and translucent band pair (Chugunova 1963; Casselman, 1987; DeVries and Frie, 1996; Polat et al., 2004; Saylar, 2009; Uzunova et al., 2020). For the estimation of individual growth rate. the von Bertalanffy growth equation for length was used: $Lt=L\infty\ [1-e^{-k}(t-t_o)]$, where *Lt* is the total length at age *t*. *L*∞ the asymptotic total length. *k* the growth curvature parameter and t_o the theoretical age when fish would have been at zero total length (Sparre and Venema, 1998; Avşar, 2016). The growth performance index (φ'. phiprime) was employed to compare growth rates. with the Formula: $\varphi'=\log k + 2\log L\infty$ (Pauly and Munro, 1984). The length-weight relationship was calculated by applying an exponential regression equation $W=aL^b$ where. *W* is the weight (g). *L* is the total lenght (cm). and *a* and *b* are constants.

During the reproductive cycle. physiological condition and fish stoutness were determined monthly from the hepatosomatic index (HSI%) and the condition factor (CF%). Condition factor (CF%) was calculated as $CF=(W/L^3)*100$ for each sex to assess the maturity. condition of specimens and an overall measurement of robustness of the fish (Avşar, 2016). Hepatosomatic index (HSI=(liver weight/gutted weight)×100): this estimates the relative size of the liver to body weight (Garcia-Diaz et al., 2006).

For calculations of gastro-somatic Index (GaSI%), each gut was removed and weighed in an ± 0.001g, using electronic precision balance and placed in sterile containers with 5% formol. It was kept under running water for 24 hours (Hellawell, 1971; Mahaseth, 2007).

Calculation of gastro-somatic index (GaSI%) is a useful and an efficient way for comparing the scale of feeding (food consumption) during various months and for determining the environmental and physiological effects on feeding habits. Gastro-somatic index (GaSI%)=Weight of gut (g)/Weight of fish (g) * 100 (Desai, 1970).

For the ratio of stomach to body weight, stomach weights of 208 individuals are proportioned to the total body weight and calculated how much of the stomach constitutes% of its total weight. For the determination of stomach contents. The percentage frequency of occurrence (F%) was calculated in the based on the number of stomachs in which a food item was found, expressed as the percentage of total number of non-empty stomachs (Hyslop,1980).

Total mortality rate (Z) was estimated using following equation (Beverton and Holt, 1957); $Z=1/(\bar{t}-t')$ where $\bar{t}$:

average age of the samples and t':age at which a smallest length of the fish. Natural mortality (M) was estimated for shoaling fish using Pauly's empirical Formula: $M=0.8*\exp(-0.0152-0.279 LnL_\infty+0.6543 LnK+0.4634 LnT°C)$, where L_∞ and K are the parameters derived from Von Bertalanffy equation and T the mean annual environmental temperature at the surface of the study area (10 ℃). Following estimation of Z and M. the fishing mortality rate (F) was estimated from: F=Z-M. and the exploitation rate was estimated using this equation E=F/Z (Pauly and Munro, 1984).

Results

Length and weight frequency distributions

Of 208 specimens measured, FL of 98 females ranging from 14.9 to 67.5 cm while the weight varied from 32 to 4538 g FL of 110 males ranging from 20.4 to 67.6 cm while the weight varied from 120 to 4540 g (Figures 1-4, Table 1).

Table1. Mean fork length (cm). mean weight (g). relative growth rate (RGR). mean condition factor (CF). standard error (SE) for different ages of *Lagocephalus sceleratus* from Mersin Bay.

Age	N	FL±SE (min-max.)	RGR in length	W±SE (min-max.)	RGR in weight	CF±SE (min-max.)
1	2	15.5±0.15 (14.9-16.1)		37.44±0.16 (32-42)		0.987±0.02 (0.967-1.006)
			9.18		177.96	
2	80	24.7±0.03 (20.3-31.8)		215±0.55 (103-533)		1.37±0.02 (1.113-2.014)
			13.12		615.92	
3	24	37.8±0.03 (31.8-43.1)		830.9±0.34 (405-1747)		1.48±0.03 (1.23-2.04)
			9.67		633.54	
4	50	47.4±0.02 (43.7-50.8)		1464±0.30 (971-2115)		1.35±0.03 (1.039-1.618)
			5.02		587.08	
5	24	52.5±0.03 (51.1-55.1)		2250±0.26 (1637-2850)		1.416±0.06 (1.19-2.015)
			8.47		1142.3	
6	28	61.0±0.2 (54.1-67.6)		3193.8±0.46 (2006-4540)		1.385±0.02 (1.266-1.545)

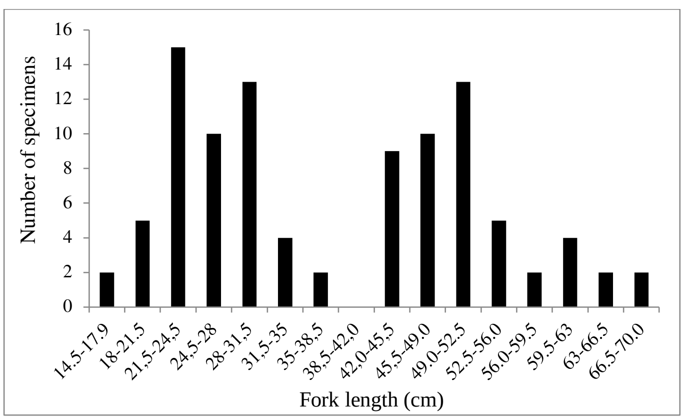

Figure 1. Length-frequency distribution of *Lagocephalus sceleratus* for females from Mersin Bay

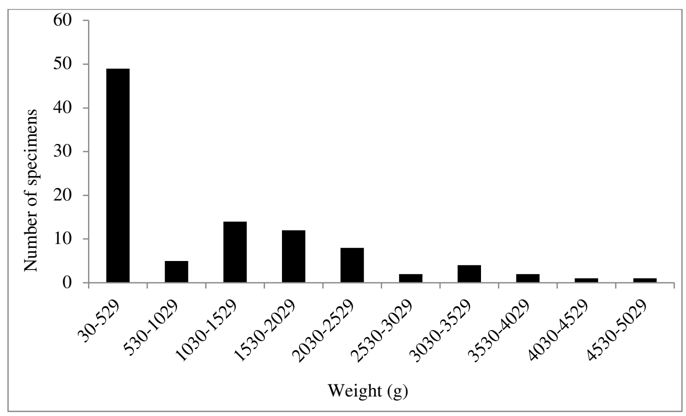

Figure 3. Weight-frequency distribution of *Lagocephalus sceleratus* for females from Mersin Bay

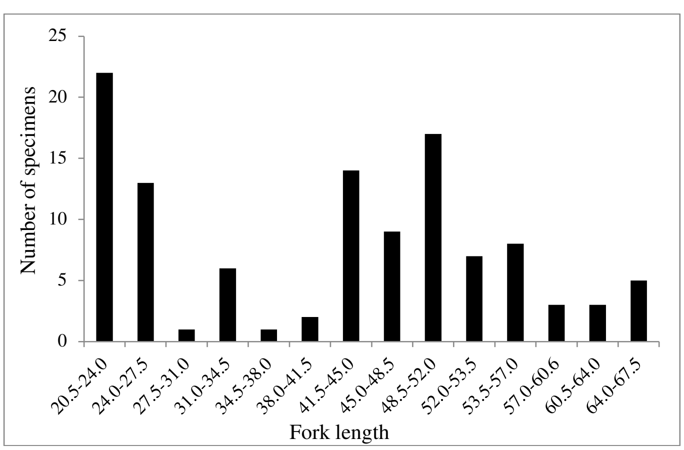

Figure 2. Length-frequency distribution of *Lagocephalus sceleratus* for males from Mersin Bay

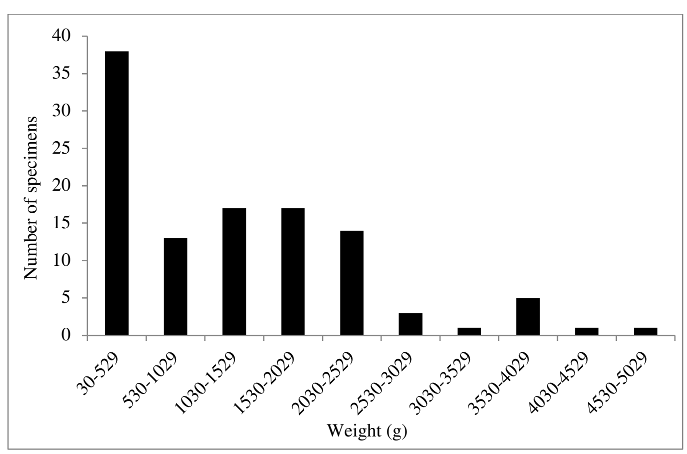

Figure 4. Weight-frequency distribution of *Lagocephalus sceleratus* for males from Mersin Bay

Age composition and sex ratio

Ages resulting from vertabral bones of 208 specimens are summarized are given in Table 1 and Figure 5. Ages ranged from 1 to 6 years with a predominance of age 2 in each sex of the all catches. Because of selectivity of the nets, the 0 age was could not be represented in the samples.

Sex ratio of the population consisted of about 52.88% males with 110 specimens and 47.12% females with 98 ones, and difference between sexes was not statistically significant (t-test, P>0.05) with the sex ratio (F:M=0.88:1) (t test. P>0.05).

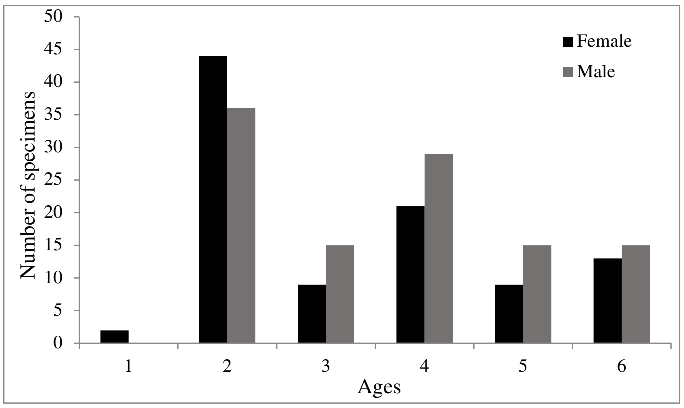

Figure 5. Age-frequency distribution of *Lagocephalus sceleratus* in each sex from Mersin Bay

Growth

The von Bertalanffy growth equations (age-length. age-weight relationships) calculated with mean lengths and weights at different ages were found as:

$L_t=118.71\ (1-e^{-0.115(t+0.178)})$.

The asymptotic length 118.71 cm is realistic since the largest specimen sampled were of 67.6 cm. The phi-prime (ø') value was estimated as 3.209.

Relative growth in length and weight

To determine the growth speed of age groups in Mersin Bay the increase in length between age groups and the increase in ratio and growth characteristics were calculated and are shown in Table 1. As seen, individuals in length and weight were more likely up to age 3 in the population.

Length-weight relationships

The length-weight relationship of all individuals was calculated. $W=0.012*L^{3.02}$. The slope b was not significantly different from 3.0 (t-test. P > 0.05). indicating isometric growth (Figure 6. 7)

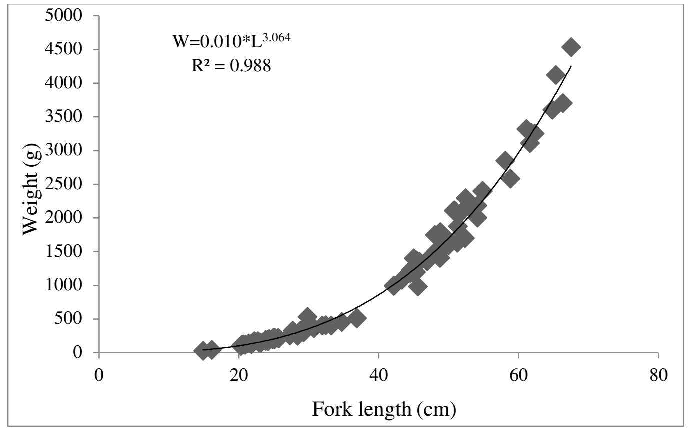

Figure 6. Length-weight relationship of *Lagocephalus sceleratus* for females from Mersin Bay

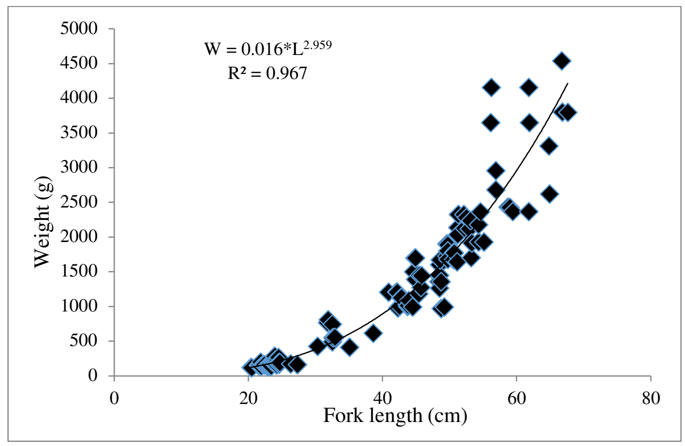

Figure 7. Length-weight relationship of *Lagocephalus sceleratus* for males from Mersin Bay

Condition factor

The seasonal variations in the condition coefficients were determined for all the individuals (Figure 8). In general, monthly conditions exhibited a similiar pattern for all individuals, showing a peak in September but indicating somewhat lower values after the spawning period.

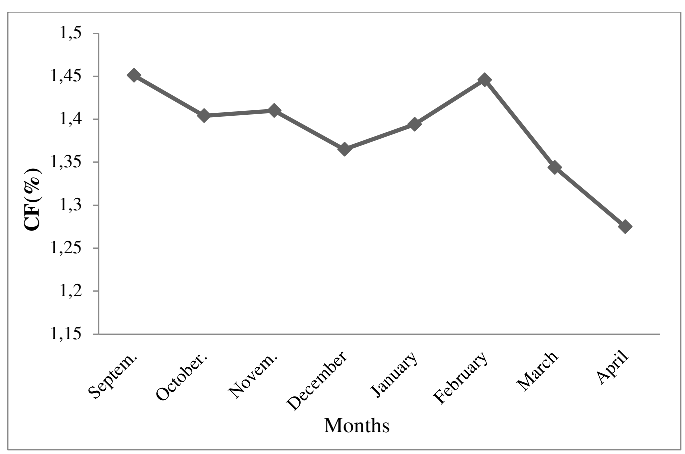

Figure 8. Monthly variations in condition factor of *Lagocephalus sceleratus* specimens from Mersin Bay.

Gonad development and spawning period

Gonad development was followed using the GSI. Monthly changes are plotted in Figure 9. Spawning occurred between March and April.

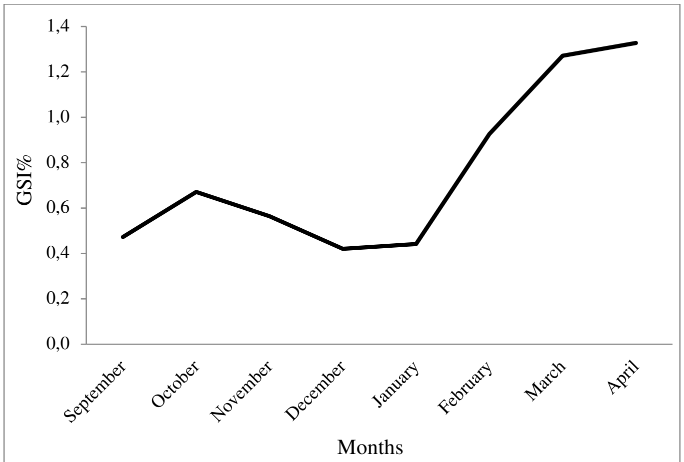

Figure 9. Monthly gonadosomatic index (GSI) of *Lagocephalus sceleratus* for combined sexes from Mersin Bay

Hepatosomatic index (HSI%)

In general, monthly HSI values showed a peak in March for both sexes (Figure 10).

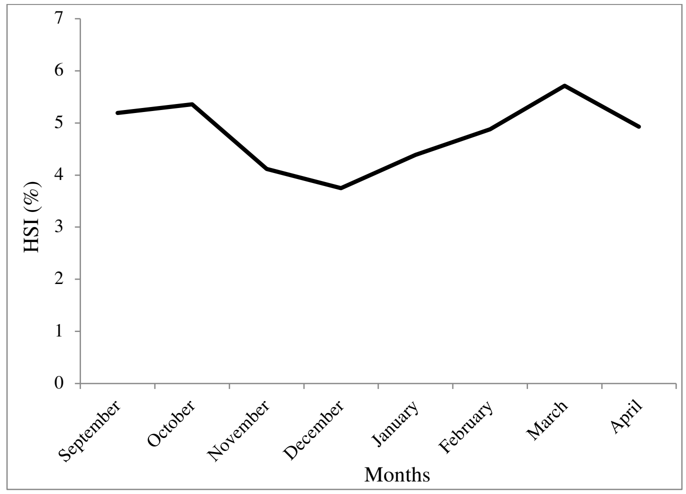

Figure 10. Monthly hepatosomatic index (HSI%) of *Lagocephalus sceleratus* from Mersin Bay

Table 2. The ratio of stomach to body weights of *Lagocephalus sceleratus* population to according to months and seasons.

Seasons	Months	N	Min	Max.	Average	Seasonal average.
Autumn	September	19	1.391	7.697	3.466	3.455
	October	37	1.474	8.329	3.367	
	November	37	1.061	7.236	3.531	
Winter	December	34	0.649	7.322	3.462	3.799
	January	23	1.266	7.568	4.214	
	February	16	0.883	5.822	3.722	
Spring	March	18	1.235	4.517	2.647	2.847
	April	24	0.884	8.361	3.047	

Gastro-somatic index (GaS%)

Gastro-somatic index ranged from 1.26 to 5.355 monthly and higher values were recorded in December (Figure 11, Table 2).

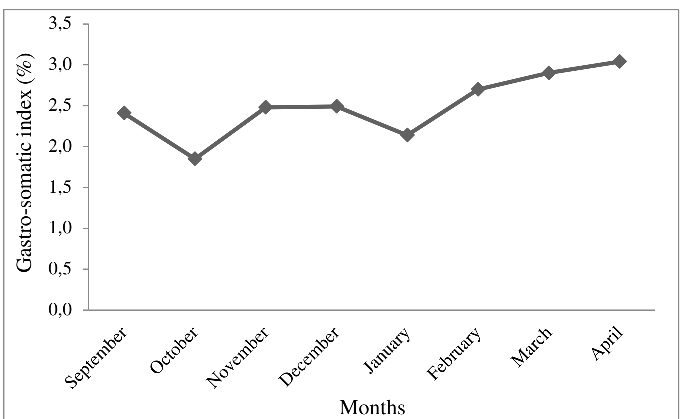

Figure 11. Monthly gastro-somatic index (GaSI%) of *Lagocephalus sceleratus* from Mersin Bay

Our observations showed that stomach contents of *L. sceleratus* included preys from3 major taxonomical groups (Osteichthyes, Mollusca, and Crustacea) in Figure 12.

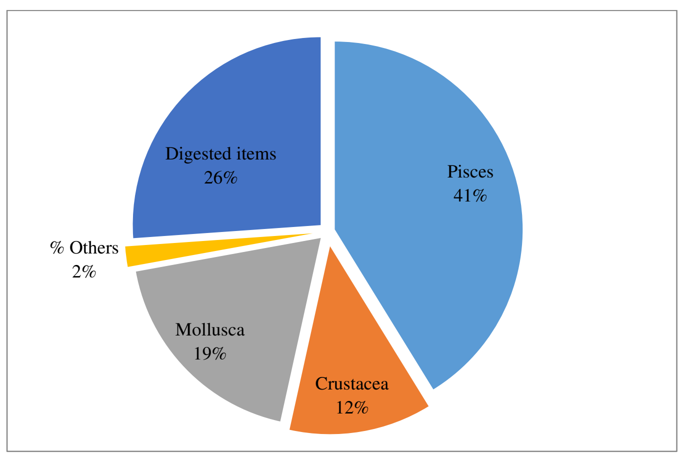

Figure 12. Food composition of *Lagocephalus sceleratus* from Mersin Bay.

Percentage frequency of occurrence (F%), based on the number of stomachs in which a food item was found, expressed as the percentage of total number of non-empty stomachs; the ratios of stomach to body weights and the percentages of occurence frequency (F%) are shown in Table 3.

Table 3. Monthly percentages occurence for prey group (F%) of *Lagocephalus sceleratus* from Mersin Bay

		Prey Groups				
Months	N	Pisces	Crustacea	Mollusca	Others	Digested foods
September October	19	29.53	11.63	17.64	1.15	40.05
November	37	45.34	8.33	19.5	0.8	26.03
December	34	46.38	9.97	15.46	3.42	24.76
January	23	52.68	12.27	18.48	1.48	15.1
February	16	35.66	16.88	20.57	2.09	24.8
March	18	34.37	12.45	22.61	0.47	30.1
April	24	42.84	17.95	16.63	2.47	20.12
Total	**208**	**41.21**	**12.25**	**18.68**	**1.75**	**26.11**

Food compositions found in the stomachs according to seasons (Autumn, Winter, and Spring) in Figures 13-15.

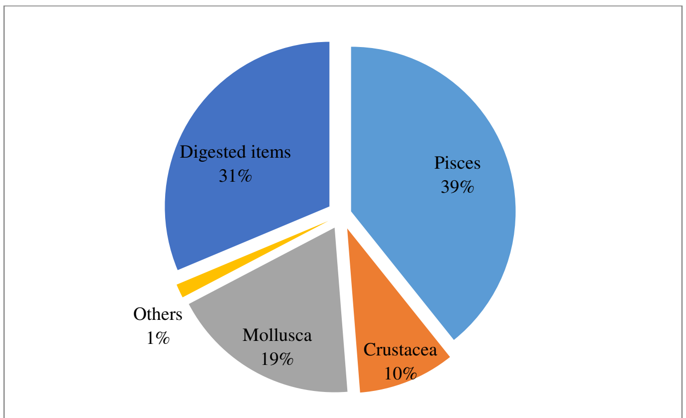

Figure 13. Food composition of *Lagocephalus sceleratus* specimens in Autumn from Mersin Bay

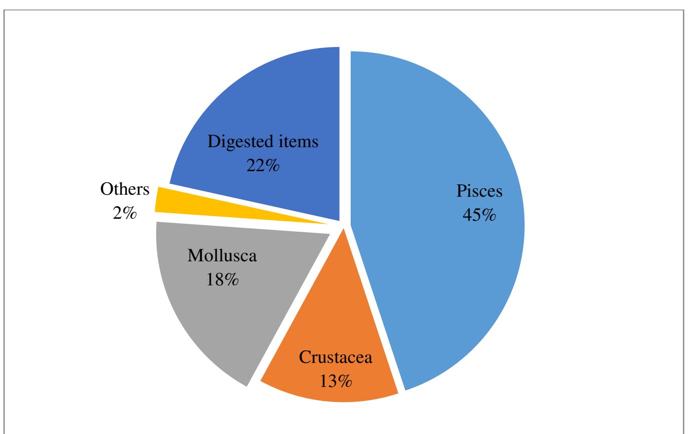

Figure 14. Food composition of *Lagocephalus sceleratus* specimens in winter from Mersin Bay.

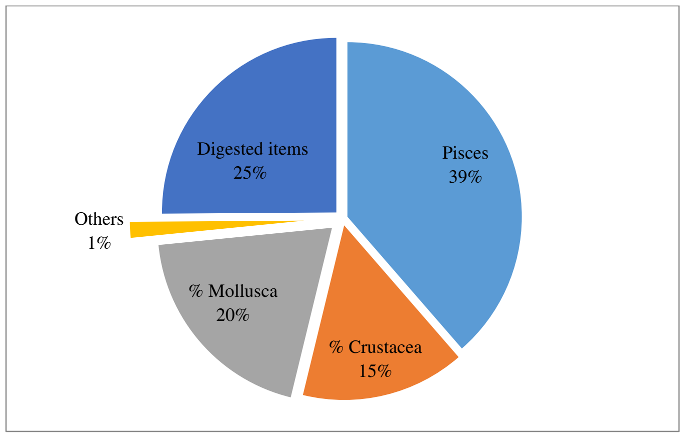

Figure 15. Food composition of *Lagocephalus sceleratus* specimens in spring from Mersin Bay.

Mortality

Total mortality for combined sexes was Z=0.4 year^{-1}. The natural mortality was found to be M=0.25 year^{-1}. Then the calculation of the fishing mortality gave F=0.15 year^{-1}. The exploitation rate which was computed as E=0.38 represents that the population of was not under overfishing.

Discussion

In silverstripe blaasop population in Mersin Bay, vertebrae age-readings indicate that the silverstripe blaasop population ranged between 1 and 6. The fact that 2 age was dominant for population indicated that the population consisted of mostly young individuals (Figure 1). The ages of the *L. sceleratus* population are similar to those recorded in Cyprus and Antalya Bay (Sabrah et al., 2006; Michaidilis, 2010; Aydın, 2011; Yıldırım, 2011; Tüzün, 2012), except for that estimated from Antalya Bay (Zengin and Türker, 2020) as seen in Table 4.

Table 4. The growth parameter (L∞, k, t_0, Φ) of *Lagocephalus sceleratus*

Age	L∞	k	t_0	Φ´	Study Area	Author/s
1-6	81.1	0.26	-0.17	3.099	Suez Gulf	Sabrah et al. (2006)
1-6	82.0	0.5	-0.606	3.527	Cyprus	Michaidilis. (2010)
1-6	126.1	0.099	-1.435	3.197	Antalya Bay	Aydın (2011)
1-6	48.2	0.52	-0.27	3.082	AntalyaBay	Tüzün (2012)
	106.3	0.17	-0.0228	3.289	Egyptian Coasts	Farrag et al. (2015)
	109.7	0.22	-0.4544	-	Finike Bay	Ersönmez et al. (2017)
1-5	79.5	0.18537	-0.611791	3.069	Antalya Bay	Zengin and Türker (2020)
1-6	118.71	0.115	-0.178	3.209	Mersin Bay	This study

The ability to perform age determinations based on the examination of hard anatomical parts is of fundamental importance in understanding fish biology and population status (Goldman et al., 2012). Age determination in fish is a basic step in understanding fish biology and population status (De Vries and Frie, 1996) so it is quite important for fisheries management. Although there are many methods in age determination (Uzunova et al., 2020), the counting of annual zones on vertebra is the preferred one in this study because of having minute otoliths. The population consisted of 52.88% males and 47.12% females. showing the sex ratio as 0.88: 1 (F: M) (>0.05. t-test). Although the sex ratio in most of the species was close to 1. This may vary from species to species. differing from one population to another of the same species and may vary year after year within the same population (Nikolsky, 1980). The most of researchers are agreement with this study (Aydın, 2011; Yıldırım, 2011; Tüzün, 2012; Başusta et al., 2013; Zengin and Türker, 2020). except for Suez Gulf population (Sabrah et al., 2006).

The maximum observed fork length (67.6 cm) in the silverstripe blaasop population from Mersin Bay (Table 1 and Table 5) confirmed those reported in Mediterranean Coasts of Turkey (Aydın, 2011; Başusta et al. 2013, Bilge et al., 2017), except for New Caledonia (Letourneur et al., 1998), Japanese Archipelago populations (Masuda et al., 1984), and Antalya Bay (Zengin and Türker, 2020). This variation may be due to different stages in ontogenetic development as well as differences in condition, length, age, sex, gear selectivity, gonadal development, organic matter, and geographical variations (Ricker, 1975; Wooton, 1992). The von Bertalanffy growth equation was estimated as (Relative infinity) of L_∞=118.71 cm, k=0.115 t_o=-0.178 for Mersin Bay that it was higher than those estimated for Antalya Bay, Suez Gulf, and Cyprus (Tab. 4), except for the other population in Antalya (Aydın, 2011). The theoretical maximum length of 118.71 is realistic because of the largest specimen sampled during the survey was 67.6 cm. A trade-off between growth rate (k) and maximum size (L_∞) is often found. The trade off is influenced by several factors such as temperature, mortality or food availability. quality of food (Bagenal and Tesch., 1978). Temperature, and the water system in which the fish live (Wootton, 1992). Increased food availability causes a shift towards larger maximum size. But may not increase the growth rate (Tserpes and Tsimenides, 2001). Geographic location and some environmental conditions such as temperature, organic matter, quality of food, time of capture, stomach fullness, disease, parasitic loads (Bagenal and Tesch, 1978), and the water system in which the fish live (Wootton, 1992) can also affect weight at-age estimates. The Phi prime index of the silverstripe blaasop population in Mersin Bay is found higher than ones obtained with data from other localities (Sabrah et al., 2006; Aydın, 2011; Tüzün, 2012; Zengin and Türker, 2020) but smaller to those in Cyprus and Egyptian Coasts (Michaidilis, 2010; Farrag et al., 2015) as seen in Table 5. These data confirm the reliability of silverstripe blaasop growth curve. as the overall growth performance (Φ') has minimum variance within the same species because it is independent of growth rates (Moreau et al., 1986).

Fish condition reflects the state of well-being of a fish or population (Welcomme, 2001); Koops et al. (2004) define condition as a measure of the energy available for allocation to life-history "decisions‟. such as growth. reproduction or migration. Condition factor indices are also an indicator of the changes in the food reserves stored in muscle (Htun-Hun, 1978). For a better evidence of the natural life conditions of the silverstripe blaosop in Mersin Bay, the values of condition factor were also calculated according to seasons. The reason may largely be attributed to filling gonads and feeding opportunities. Maximum condition factor was found in February being generally higher just prior to spawning season (Figure 8). It was observed that the average condition factor values increased inversely with the gonadosomatic index values. According to the results obtained in this study, there is a monthly negative linear correlation between gonadosomatic index and condition factor values in females and males (Martinez and Vazquez, 2001). Our findings in CF which are similiar to those estimated in the Antalya Bay by Aydın (2011).

Length-weight relationships (LWRs) have been used as a tool in fisheries research and management since the 1920's (Froese, 2006). Length and weight information give data at the foundation of fishery management and research providing insight into reproductive characteristics, ecology, and sexual dimorphism (Gonçalves et al., 1996; Moutopoulos and Stergiou. 2002; Uchiyama and Boggs, 2006; Cherif et al., 2007). Both of b values were different from "3" for male and female samples reflecting negative and positive allometric growth. In fact, the length-weight relationships given in this study do not confirm several authors in the Mediterranean Sea, (Table 5). The values b in fish differs according to species, sex, age, seasons, feeding, time of year, stage of maturity, growth increment or break, numbers individuals and the size range of used in growth (Bagenal and Tesch, 1978; Moutopoulos and Stergiou, 2002; Froese, 2006).

In the present study, spawning occurred with the highest value in April for Mersin Bay population (Figure 9). Spawning season in Mersin Bay is similar to the relevant study in Mediterranean Sea (Sabrah et al., 2006; Aydın, 2011; Yıldırım, 2011; Tüzün, 2012), except for that from Cyprus (Rousou et al., 2014) (Table 6). Due to different ecological and climate conditions, the starting and finishing time of reproduction may include different months (Nikolsky, 1980).

Table 5. Length-weight relationships of *Lagocephalus sceleratus*

N	Sex	*a*	*b*	L min-max (cm)	Lenght	R^2	Study Area	Author/s
176	-	0.0104	2.8676	18.5-72.5	TL	0.98	Gulf of Suez	Sabrah et al.(2006)
-	-	-	-	11.2-18.3	-	-	-	Simon et al. (2009)
6656	-	0.0116	3.018	6.0-77.0	TL	-	Cyprus	Michailidis (2010)
-	-	0.0197	2.966	-	-	0.9978	Ioanian Sea	Corsini Foka, et al. (2010)
656	-	0.012	2.979	12.5-65.0	TL	0.995	Antalya Bay	Aydın (2011)
-	-	0.0277	2.8462		TL	0.9849	Antalya Bay	Tüzün (2012)
-	C	0. 0225	2. 820	5-56. 5	-	0.991	Israel Coast	Edelist et al. (2012)
28	F	0.0138	2.915	15.4-52.3	TL	0.973	İskenderun Bay	Başusta et al. (2013)
49	M	0.0381	2.6446	8.9-68.4	TL	0.9392	İskenderun Bay	Başusta et al. (2013)
-	-	0.0164	2.89	-	-	0.99	Rhodes Island	Kalogirou (2013)
132	C	0.143	2.99	20.5-73.5	-	0.975	Lebanon Coast	Boustany et al. (2015)
795	C	0.013	2.938	5.0-83.0	-	0.996	Egyptian Coasts	Farrag et al. (2015)
125	C	0.0164	2.92	16.7-63.8	TL	0.97	Coast of Muğla	Bilge et al. (2017)
165	F	-	2.9919	-	-	-	Finike Bay	Ersönmez et al. (2017)
235	M	-	2.9913	-	-	-	Finike Bay	Ersönmez et al. (2017)
69	C	0.0172	2.8921	5.4-62.5	TL	-	Antalya Bay	Mutlu et al. (2017)
100		0.0102	3.0118	13.2-57.6	TL	0.99	Antalya Bay	Zengin and Türker (2020)
98	F	0.0110	3.064	14.9-67.5	FL	0.988	Mersin Bay	This study
110	M	0.016	2.956	20.4-67.6	FL	0.967	Mersin Bay	This study

Table 6. Spawning periods of *Lagocephalus sceleratus*

Months												Study Area	Author/s
J	F	M	A	M	J	J	A	S	O	N	D		
			■	■	■							Gulf of Suez	Sabrah et al. (2006)
		■	■	■	■	■						Finike and Antalya Bays	Yıldırım (2011)
			■	■	■	■						Antalya Bay	Aydın (2011)
				■	■	■						SE. Mediterranean Sea	Rousou et al. (2014)
		■	■									Mersin Bay	This study

As seen the values of hepatosomatic index in Figure 10, the hepatosomatic index shows the highest value in March. The hepatosomatic index is an indicator of feeding activity of fish (Tyler and Dunn, 1976). The hepatosomatic index shows an allocation of energy to the liver during every period except reproduction, when part of the energy is used for gonad maturation (Koops et al., 2004; Chellapa et al., 1995; Nunes and Hartz, 2001). In this study, the values of hepatosomatic index are found to be parallel with the values of gonadosomatic index (Figure 9, 10). This is accordance with the different species studied by Delahunty and De Vlaming, (1980), Awaji and Hanyu (1987), Asahina et al. (1990), Çek et al. (2001), and Kingdom and Allison, (2011). Since fish length and weight are included in the calculation of GSI and HSI, they present an auto-corelation (Çek et al., 2001).

The selectivity and preference of the fish to different food items in different habitats give indicators on the flexibility of the species to adjust to diverse environmental conditions. Calculation of gastrosomatic index (GaSI%) is a useful and an efficient way for comparing the scale of feeding (food consumption) during various months and for determining the environmental and physiological effects on feeding habits. The maximum GaSI recorded (3.04) in the month of April (Figure11). The trophic spectrum in *L. sceleratus* population consisted of almost exclusively pisces 41%, molluscs 19%, crustacea 12% and digested items 26%, and others 2% (parts of fish line and nematodes) (Figure 12) and pisces was determined to be dominant food group in the view of according to frequency of occurrence (F%), according to months and seasons (Table 3, Figures 13-15), confirming the data by Sabrah et al. (2006), Aydın (2011), Kalogirou (2013), and Zengin and Türker (2020). The silverstripe blaasop might be thought of a host of some nematodes (Moravec and Justine, 2008). Taxonomic evaluation of these nematodes can be put forward with the host specifity on *L. sceleratus* in the future. The limited information on feeding habits of *L. sceleratus* populations signifies the importance ofcarrying out detail investigations in the future.

All mortality rates of the silverstriped blaasop population in Mersin Bay have been found lower than the estimated values in along the Egyptian Coast (Farrag et al., 2015). The exploitation rate for the study period (E=0.38) which is lower than the expected optimal exploitation level (E=0.50) revaled light to moderate exploitation of stocks in the studied area. Thus, the population exhibits a natural developmental process.

The opening of the Suez Canal in 1869, which connected the Red Sea with the less salty Mediterranean Sea, resulted in the migration of numerous tropical Indo-Pacific species into the Mediterranean Sea, establishing reproducing populations and often associated with adverse economic and ecological impacts (Golani, 1998; Kasapidis et al., 2007). This species is highly invasive and has been listed among the 100 "worst invasives" in the Mediterranean Sea with profound social and ecological impacts due to the presence of tetrodotoxin, a source of food poisoning (Streftaris and Zenetos, 2006; Eisenman et al., 2008; Bentur et al., 2008; Milazzo et al., 2012). In the Mediterranean, *L. sceleratus* is being caught as by-catch in relatively significant numbers without actual economic value and is therefore directly discarded at sea (Nader et al., 2012). Recently. several studies around the Mediterranean have been targeting this species given negative impacts on the fisheries sector it was found that it represented 4% of the weight of the total artisanal catches (TUIK, 2019). It was concluded that this fish has been able to successfully establish itself due to its rapid growth, reproduction at an early age, adaptation ability, absence of predators and competitors and the fact that it is not a targeted species.

Conclusions

Lagocephalus sceleratus has shown a rapid expansion with a successful adaptation throughout the eastern Mediterranean Sea reaching to Adriatic Sea, Tunusian Coasts, Cyprus, and the northern most parts of the Aegean Sea in the view of the gradual warming of the seas. Awareness of this highly toxic fish, *L. sceleratus* should be urgently provided for both fishermen and consumers. Nevertheless, tetrodotoxin poisoning is quite common in Japan and South-East Asia (secondary to consuming of meals prepared from puffer fish or "fugu" fish) (Kheifets et al., 2012). Additionally, some amateur fishermen unwittingly consume its flesh and inner organs containing tetrodotoxin (liver, gonads, intestines, and skin), leading to hospital and death (Milazzo et al., 2012). The importance of notifying local authorities about the presence of newly captured fish and raising awareness of the dangers to human health and and to avoid its consumption (Azzurro, 2010) lead to fisheries ban on the pufferfishes by the Fisheries Bulletin of Ministry of Agriculture and Rural Affairs. Distributions of brochures with photographic images and information of this poisonous fish should be made as a local precaution.

Ethical Approval

The authors don't declare ethical approval.

Conflicts of Interest

The authors declare that they have no conflict of interest.

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