RESEARCH ARTICLE   **ARAŞTIRMA MAKALESİ**

Age, growth and mortality rates of discard species (*Uranoscopus scaber, Neogobius melanostomus and Gobius niger)* in the Black Sea

Karadeniz'de ıskarta türlerin (*Uranoscopus scaber, Neogobius melanostomus ve Gobius niger*) yaş, büyüme ve ölüm oranları

Nazlı Kasapoğlu

Central Fisheries Research Institute, Vali Adil Yazar Cad. No: 14, 61250 Trabzon, Turkey
nazliktu@gmail.com

Abstract: *Uranoscopus scaber, Neogobius melanostomus* and *Gobius niger* are called non-commercial fish species and also caught as discarded in Turkish fisheries. Samplings were carried out by bottom trawl, gillnet, purse seine net operations in the Turkish Black Sea coasts. The results of the study showed that age of these species were 0-V ages for *Uranoscopus scaber* and *Gobius niger*, and 0-VII ages for *Neogobius melanostomus* for both sexes. The von Bertalanffy growth parameters, total mortality rate (Z), natural mortality rate (M) and fishing mortality rate (F) were calculated for each species separately.

Keywords: Age, growth, mortality rates, Uranoscopus scaber Neogobius melanostomus, Gobius niger

Öz: *Uranoscopus scaber, Neogobius melanostomus ve Gobius niger* Türkiye balıkçılığında ekonomik olmayan balıklar olarak adlandırılmakta ve ıskarta edilmektedirler. Bu çalışmanın örnekleri Karadeniz kıyısında kullanılan dip trolü, uzatma ağı ve gırgır ağları ile avlanmıştır. Bu çalışmadan elde edilen sonuçlar, *Uranoscopus scaber ve Gobius niger* türünün yaşlarının 0-V arasında, *Neogobius melanostomus* türünün ise 0-VII yaş arasında değiştiğini göstermiştir. Von Bertalanffy büyüme parametreleri, toplam ölüm oranları, doğal ölüm oranları ve balıkçılık ölüm oranları ise her tür için ayrı ayrı hesaplanmıştır.

Anahtar kelimeler: Yaş, büyüme, ölüm oranları, Uranoscopus scaber, Neogobius melanostomus, Gobius niger

INTRODUCTION

Uranoscopidae family contains approximately 50 fish species living mainly in warm-water and temperate zones (Baron, 2009). The teleosts with an electric organ are two genera of the perciform family *Uranoscopidae*: *Astroscopus* and *Uranoscopus*, Linnaeus (Bennett, 1971; Moller, 1995). Electrogenic tissue is derived from sonic muscles in Uranoscopus genus (Moller, 1995). This genus produces pulse type electric organ discharges (EOD) generated mainly during feeding activity or when the fish is disturbed (Pickens and McFarland, 1964). *Uranoscopus scaber* (Linnaeus 1758) is a benthic species living in the littoral waters in sandy or muddy bottoms and distributed along Atlantic coast of Europe and Africa, Mediterranean and Black Seas (Hureau, 1986). It is a non-commercial fish species and is being caught by various fishing gears as discards in Turkey. Therefore, there is no fishing regulation, i.e. no minimum landing size (MLS) or restricted fishing time. Moreover, there is no landing statistics for this species. *U. scaber* notified as 'vulnerable' to a high risk of extinction in the wild for Turkey in the Red Data Book of the

Black Sea (Yankova et al., 2011). There are few research studies on this species in the Black Sea and other seas (Demirhan et al., 2007; Rizkalla and Bakhoum, 2009; Erdogan Saglam and Saglam, 2013).

The family Gobiidae is a large family and distributed in tropical, subtropical areas in shallow coastal marine waters. There are 1578 goby species living in the world. 74 goby species are reported in the Mediterranean and Black Seas, and 33 species of them are found in Turkish waters (Miller, 1986; Nelson, 1994; Froese and Pauly, 2009). *Gobius niger* is widely distributed in Eastern Atlantic, Mediterranean and Black Seas as well as North Africa from Cape Blanc, Mauritania north and eastwards to the Suez Canal; the eastern Atlantic coast and Baltic Sea (Miller, 1986; Fabi and Gianetti, 1985). *G. niger* is known as a common fish species in the Black Sea, but there is no fishing limitation/regulation (no MLS) due to non-commercial value in Turkey. However, this species has an important ecological importance as an indicator species. It plays a significant role in the food chain (Filiz and Toğulga, 2009;

Katalay and Parlak, 2002). Although, the studies were conducted on this species caught from Aegean Sea related to its age, growth, reproduction, biological characteristics, diet, environmental effects and pollution (Katalay and Parlak, 2002; Filiz and Toğulga, 2009). There is only one research conducted about its age and growth parameters in the Black Sea (Van, 2012).

The other goby fish *Neogobius melanostomus* (Pallas, 1811) is an invasive species inhabiting in the Black and Caspian seas and was probably introduced through other seas (the seas of Atlantic, Europa and America) via ballast waters (Skora and Stolarski, 1993). This species is a successful colonist (high fecundity, wide tolerance of abiotic and biotic factors), having a short generation time, fast growth rates (Lodge, 1993). This species is commonly found in the Black Sea without any market value just as *G. niger* which are no management measures on this species in Turkey. There are numerous studies on all these species in Turkish and other seas in the world (Lodge, 1993; Skora and Stolarski, 1993; Macinnis and Corkum, 2000; Simonovic et al., 2001; Corkum et al., 2004; Kurt, 2005; Engin, 2008; Gümüs and Kurt, 2009; Sokolowska and Fey, 2011).

The present study aims to determine age, growth and mortality parameters of *Uranoscopus scaber*, *Gobius niger* and *Neogobius melanostomus* obtained from the Turkish Black Sea coastal waters. These parameters are required for the management of fish stocks and planning of the future for the sustainable fisheries in the framework of the common fisheries policy.

MATERIAL AND METHODS

This study was carried out in sampling stations in Hopa, Rize, Trabzon, Giresun, Ordu, Samsun, Sinop seasonally between 2008–2011 (Figure 1).

Figure 1. Sampling stations

Totally 439 specimens collected, 155 were individuals of *U. scaber*, 112 were indv. of *G. niger* and 172 were indv. of *N. melanostomus.* The samples were caught by bottom trawl nets with 40 mm mesh size in the cod end, purse seine nets with 12 -15 mm mesh size in the bunt and gillnets with 34 - 36 mm mesh size).

Total length and weight of the samples were measured and weighed to within 1 mm and 0.01 g precision, respectively. The sagittal otoliths were removed from each fish, cleaned in alcohol, dried and fixed on ELISA microplate. Age was estimated by stereomicroscope (Leica MZ75); was performed by different researcher. The left or right otolith was used for age estimation depending on the clarification of the annulus.

The length-weight relationship was estimated with the formulae of $W = aL^b$ for both sexes, where a and b are constant, W is the total weight (g), and L is the total length (cm) (Ricker, 1975). The von Bertalanffy growth parameters were calculated for each sex group by using the formulae of $Lt = L_\infty(1 - e^{-k(t-t_0)})$, where L_∞ is asymptotic length (cm), t is age (year), k is the growth rate (year -1), and t_0 is the hypothetical age at zero length (year) (Beverton and Holt, 1957; Pauly, 1983; Sparre and Venema, 1992; King, 1995). The instantaneous total mortality coefficient (Z) was calculated by the formulae of $Z = -lnS$ (Ricker, 1975), where S is the survival rate. Natural mortality rate (M) was determined by $M = 0.8 \times exp(-0.0152 - 0.279\ Ln\ L_\infty + 0.6543\ Ln\ K + 0.463\ LnT)$, where T is the average annual water temperature in the fishing area (°C) (Ricker, 1975; King, 1995). Fishing mortality (F) was estimated from F=M-Z (Gulland, 1971). All statistics (student t test) and graphs were carried out Microsoft Excel software ®.

RESULTS

In this study, 155 *U. scaber* specimens were found in between 5.2 and 23.4 cm. Samples were mainly distributed in the range of 10.0-14.0 cm (57%). Mean length of *U. scaber* was calculated as 14.87±3.436 cm for females, 14.45±3.488 cm for males and 12.44±4.659 cm for overall samples. Mean weight was estimated as 66.68±25.920 g for females, 59.80±23.521 g for males and 47.59±24.370 g for all specimen. No significant differences were identified between the lengths of this species for males and females (P>0.05). Majority of samples were represented by females as 58%. Figure 2 shows the length-weight relationships for females, males and both sexes. The age of *U. scaber* was estimated in the range of 0-V. The maximum age group was determined as V years for both sexes (Table 1).

The age-length and age-weight relationships were given in Figure 3. The Von Bertalanffy growth equation (VBGE) of the *U. scaber* was determined for sexes, females and males as $Lt=32.68(1-e^{-0.16(t+1.71)})$, $Lt=38.82(1-e^{-0.12(t+2.00)})$, $Lt=31.07(1-e^{-0.15(t+1.75)})$, respectively (Table 2). The instantaneous total mortality rate (Z) of *U. scaber* was calculated as 0.40 year⁻¹, natural mortality (M) as 0.33 year⁻¹ and fishing mortality (F) as 0.07 year⁻¹ (Table 2).

Table 1. Age, mean length and weight of species (I: Immature, F: Female, M: Male)

			Uranoscopus scaber			*Gobius niger*			*Neogobius melanostomus*	
Age	Sex	N	L (cm) ± SD	W (g) ± SD	N	L (cm) ± SD	W (g) ± SD	N	L (cm) ± SD	W (g) ± SD
0	I	10	6.72±0.839	6.19±2.096						
	F	10	7.52±0.404	19.06 ± 2.141	4	7.20±0.381	6.76±1.274	9	7.49±0.611	7.01±2.024
	M	8	7.33±0.458	18.22±3.182	1	6.80±0.704	4.09±1.822	9	6.69±0.377	5.00±1.512
	I+F+M	28	**7.13±1.376**	**7.68±4.602**	5	**7.12±0.511**	**6.22±1.467**	18	**7.11±0.544**	**6.74±1.935**
1	F	44	11.86±0.655	27.15±7.392	41	9.83±.0836	13.68±4.633	60	12.88±0.810	26.44±3.714
	M	15	11.72±0.897	25.59±7.072	29	9.88±0.816	13.49±4.227	22	12.20±0.837	24.61± 3.127
	F+M	59	**11.80±0.667**	**26.52±7.206**	70	**9.85±0.822**	**13.74±4.421**	82	**12.54±0.834**	**25.43± 3.534**
2	F	16	13.97±0.451	47.78±5.337	9	11.98±0.365	25.57±2.811	25	14.36±0.497	42.01±3.868
	M	8	13.88±0.544	45.35±9.741	5	11.80±0.318	22.41±2.768	16	14.12±0.471	36.52±3.070
	F+M	24	**13.94±0.474**	**46.97±6.988**	14	**11.92±0.357**	**24.59±2.994**	41	**14.20±0.481**	**38.32±3.446**
3	F	10	15.82±0.679	73.78±9.696	8	13.02±0.298	29.63±4.371	9	16.66±0.935	60.21±7.611
	M	9	15.70±0.508	67.85±8.245	5	12.90±0.285	29.88±4.033	8	16.05±1.094	52.68±7.041
	F+M	19	**15.76±0.591**	**70.97±8.279**	13	**12.97±0.274**	**29.73±4.071**	17	**16.32±0.995**	**56.21±7.215**
4	F	9	18.05±0.837	110.89±10.598	4	14.77±0.741	42.69±7.074	3	17.85±0.703	60.83± 7.804
	M	6	18.25±1.061	101.84±9.041	3	14.37±0.785	42.24±4.447	2	17.55±0.711	55.86±7.052
	F+M	15	**18.09±0.822**	**109.08±9.512**	7	**14.57±0.744**	**42.47±5.894**	5	**17.70±0.703**	**59.29±6.814**
5	F	8	21.44±1.439	165.57±12.741	2	15.60±2.010	50.08±2.757	3	19.67±1.252	111.61±8.984
	M	2	21.01±0.882	159.34±14.375	1	15.50	47.22	1	18.00	98.46
	F+M	10	**21.33±1.217**	**163.08±13.194**	3	**15.57±1.971**	**49.61±2.841**	4	**19.25±1.258**	**108.32±9.014**
6	F							2	24.50±1.110	177.53±9.083
	M							1	23.80	160.59
	F+M							3	**24.15±1.121**	**169.06±9.175**
7	F							1	26.40	269.88
	M							1	25.60	249.66
	F+M							2	**26.00± 0.565**	**259.77±14.298**
Total	F	90	14.87±3.436	66.68±25.920	68	10.86±2.070	19.47±11.094	112	13.48± 3.548	30.38± 11.742
	M	43	14.45±3.488	59.80±23.521	44	10.77±2.006	19.06±11.235	60	12.66± 3.746	29.32± 15.716
	F+M				112	**10.80±2.036**	**19.31±11.100**	172	**12.86± 3.613**	**28.96± 14.607**
	I+F+M	155	**12.44±4.659**	**47.59±24.370**						

Table 2. Von Bertalanffy growth parameters, mortality and survival rates of species

Species	L∞	k	t₀	S	Z	F	M
Uranoscopus scaber	32.68	0.16	-1.71	0.67	0.40	0.07	0.33
Gobius niger	17.95	0.27	-1.50	0.51	0.68	0.14	0.54
Neogobius melanostomus	36.08	0.14	-1.57	0.58	0.54	0.25	0.29

In total, 112 sample units were caught for *G. niger* distributing between 6.80 and 15.8 cm. The majority of specimens were varied in 9.0-11.9 cm (56%). Females were found dominant in this distribution (61%). Mean length and mean weight were estimated for each sex and pooled samples of both sexes. Mean length of *G. niger* was found females, males and both sexes as 10.86±2.070 cm, 10.77±2.006 cm and 10.80±2.036 cm, respectively. Mean weight was also determined for females, males and pooled samples of both sexes as 19.47±11.094 g, 19.06±11.235 g and 19.31±11.100 g, respectively. Differences between the lengths of this species for males and females were not found statistically significant (P>0.05). Length-weight relationships of *G. niger* were

estimated as $W=0.0180L^{2.856}$ for both sexes, $W=0.0152L^{2.964}$ for females and $W=0.0107L^{3.098}$ for males (Figure 2). The age composition of the species was observed between 0-V years. The most dominant age group was determined as I age class (Table 1).

Figure 3 shows the age-length and age-weight relationship for this species. VBGE was computed for females, males and pooled samples as $Lt=18.57(1-e^{-0.26(t+1.78)})$, $Lt=17.81(1-e^{-0.30(t+1.57)})$ and $Lt=17.95(1-e^{-0.27(t+1.50)})$, respectively (Table 2). The instantaneous total mortality rate (Z) of *G. niger* was calculated 0.68 year⁻¹, natural mortality (M) as 0.54 year⁻¹ and fishing mortality (F) as 0.14 year⁻¹ (Table 2).
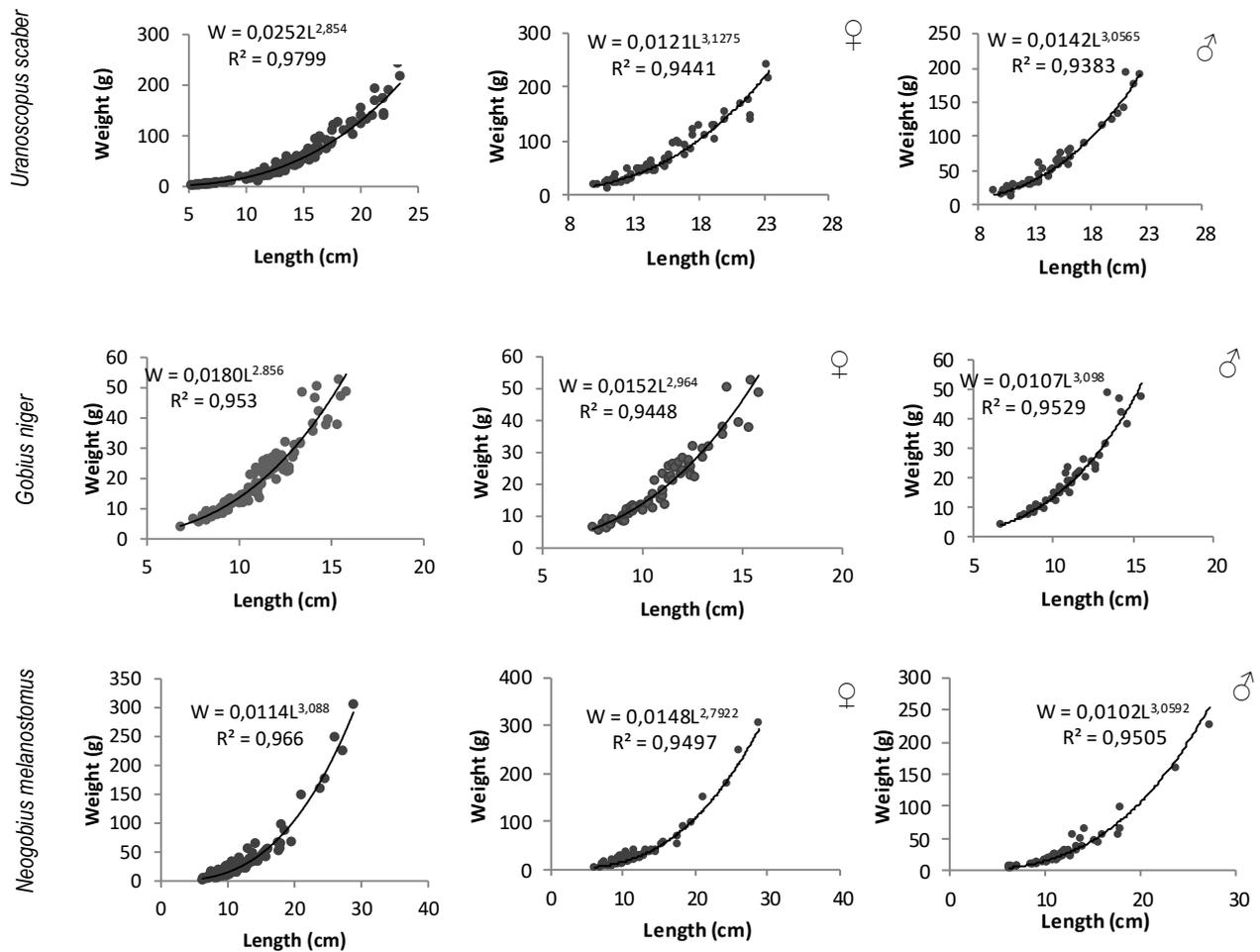
Figure 2. Length-weight relationships of species

In total, 172 *N. melanostomus* samples were examined in this research. The sample lengths were found min. 6.5 cm and max. 26.40 cm. The majority (69%) of them ranged from 8.0-13.0 cm. The mean length of this species was estimated as 12.86± 3.613 cm for sexes, 13.48± 3.548 cm for females and 12.66± 3.746 cm for males. The mean weight of *N. melanostomus* was calculated as 28.96± 14.607 g for pooled samples of both sexes, 30.38± 11.742 g for females and 29.32± 15.716 g for males. Differences between the lengths of this species for males and females were found statistically insignificant (P>0.05). The length-weight relationships of this species were determined as $W=0.0114L^{3.088}$ for both sexes, $W=0.0148L^{2.79}$ for females and $W=0.0102L^{3.06}$ for males (Figure 2). The age composition of *N. melanostomus* varied in 0-VII years old for males and females (Table 1). The most dominant age class was I age class (48%), followed by II age class (37%). VBGE of this species was calculated for both sexes as $Lt=36.08(1-e^{-0.14(t+1.57)})$, for females as $Lt=38.08(1-e^{-0.12(t+1.62)})$ and for males as $Lt=33.87(1-e^{-0.16(t+1.33)})$ (Table 2). The instantaneous total mortality rate (Z) of *N. melanostomus* was calculated as 0.54 year^{-1}, natural mortality (M) as 0.29 year^{-1} and fishing mortality (F) as 0.25 year^{-1} (Table 2).

Table 3. Comparison of the growth parameters and mortality rates of 3 species

| Study	Area	*Uranoscopus scaber*						*Gobius niger*						*Neogobius melanostomus*					
		L_∞	t_0	Z	F	M	Age	L_∞	t_0	Z	F	M	Age	L_∞	t_0	Z	F	M	Age
Demirhan et al. (2007)	Black Sea	26.31	-0.08	-	-	-	I-V												
Rizkalla and Bakhoum (2009)	Mediterranean	35.02	-1.01	0.90	0.35	0.55	0-V												
Erdogan Saglam and Saglam (2013)	Black Sea	44.50	-1.24	1.24	0.98	0.26	0-IV												
Fabi and Gianetti (1985)	Adriatic Sea							18.52♂ 16.86♀	-1.69♂ -2.57♀	-	-	-	0-V						
Silva and Gordo (1997)	Obidos Lagoon							16.66	-1.91	-	-	-	0-III						
Filiz (2007)	İzmir Bay							17.59	-2.17	-	-	-	0-V						
Filiz and Togulga (2009)	Aegean Sea							16.69♂ 14.84♀	-2.21♂ -1.46♀	-	-	-	0-V						
Van (2012)	Black Sea							13.50	-1.61	1.26	0.61	0.36	0-V						
Kurt (2005)	Black Sea													25.29♀ 21.31♂	-5.75♀ -9.70♂	-	-	-	I-V
Engin (2008)	Black Sea													19.7♀ 26.8♂	-0.04♀ -0.03♂	-	-	-	I-VII
This Study	Black Sea	32.68	-1.71	0.40	0.07	0.33	0-V	17.95	-1.50	0.68	0.14	0.54	0-V	36.08	-1.57	0.54	0.25	0.29	0-VII
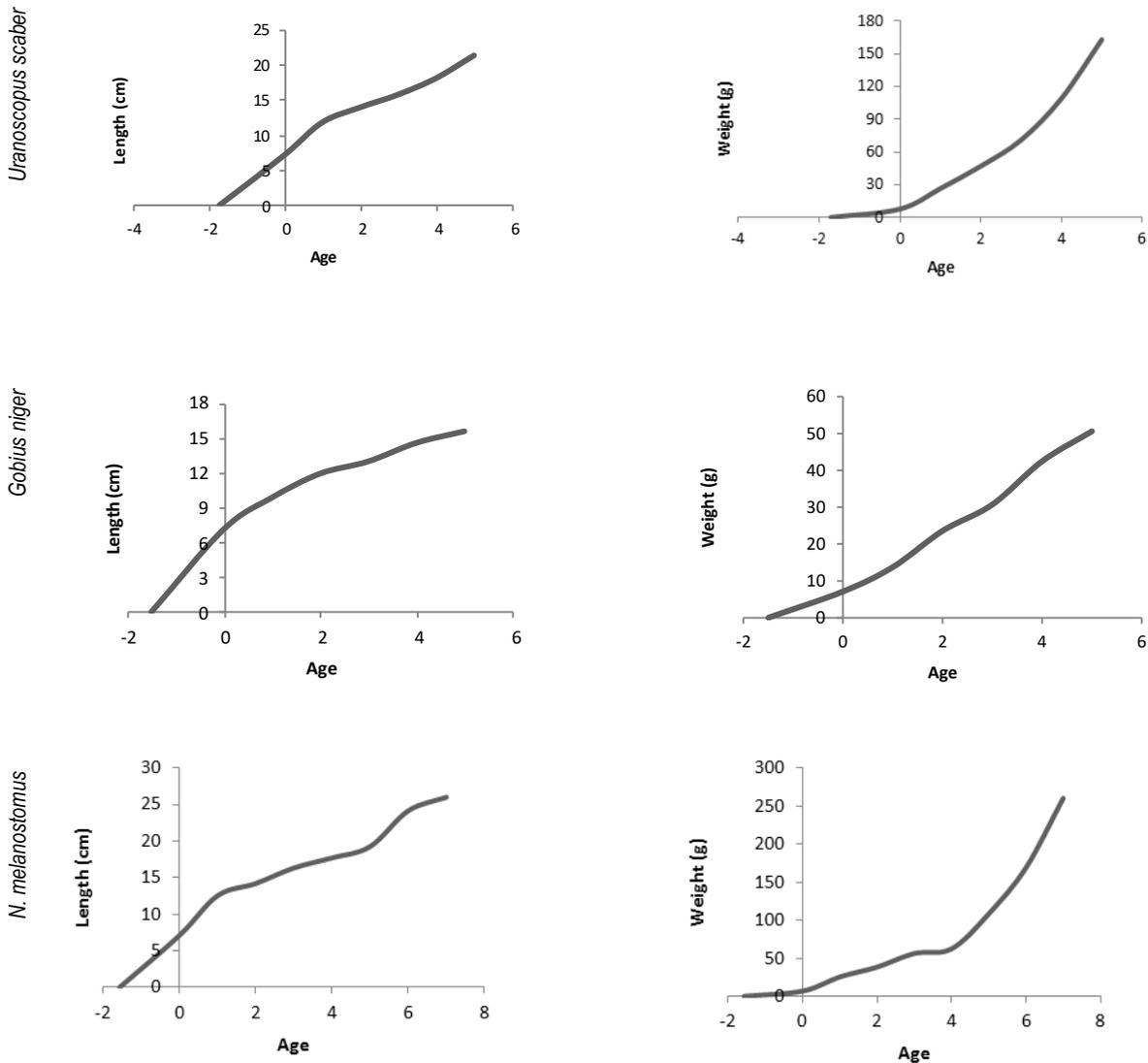
Figure 3. Age-length and age-weight relationships of species

DISCUSSION

The growth parameters and mortality rates of the *U. scaber* supported by results of Rizkalla and Bakhoum (2009). The growth and mortality parameters in this study are generally found different from the past studies carried out for the Black Sea (Erdoğan Sağlam and Sağlam, 2013; Demirhan et al., 2007). The reason for the differences between them may be explained by using the Bhattacharya method in the age determination by Erdoğan Sağlam and Sağlam (2013) and reading of false annulus in the age determination by Demirhan et al. (2007).

The results of this study for growth parameters of *G. niger* supported the findings of Fabi and Gianetti (1985). However, there were lower values were reported by Silva and Gordo (1997), Filiz (2007), Filiz and Toğulga (2009) and Van (2012) for this species. The differences can be understood by the different sampling period and gear. Age determination results of this study was found similar to Filiz (2007), Filiz and Toğulga (2009) and Van (2012), however, the results showed different from the findings of Fabi and Gianetti (1985). Mortality rates were only found similar to Van (2012). The values of growth parameters for *N. melanostomus* are higher than the values observed by Kurt (2005) and Engin (2008). Age analysis of this study was estimated using by otoliths. The differences can be caused due to reading of false rings in otoliths by past studies. This study represents the mortality rates of the relating species for the first time (Table 3).

CONCLUSION

The values of this study might be accepted as a baseline for researchers on these species in the future. These species have not commercial values and are called discard in fishing operations. There are no management measures (i.e MLS, fishing seasons or gear limitations) on these species in Turkey. Authorities should take these measures to regulate for non-commercial fish species in order to provide sustainable fisheries and protect the environment in Turkey.

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