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RESEARCH ARTICLE ARAŞTIRMA MAKALESİ

PRELIMINARY INVESTIGATION ON MORPHOMETRIC AND BIOMETRIC CHARACTERISTICS OF FEMALE SILVER AND YELLOW, *Anguilla anguilla*, FROM EASTERN MEDITERRANEAN (GÖKSU DELTA/TURKEY)

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Abstract: This preliminary study was conducted to shed light on characterization of migrating female silver and sedentary yellow eels from Göksu Delta (Eastern Mediterranean) by providing some basic morphometric and biometric parameters and indices. Mean body weight and total length of migrating female silver eels were found to be 72.90 cm and 890.27 g respectively. In female yellow eels mean total body length was measured as 57.45 cm and mean body weight was found to be 384.86 g. The mean values of total length, body weigh, gonad weigh, liver weight, eye index, gonado-somatic index, and condition factor of migrating silver were significantly higher than those of yellow eels ($P<0.001$). However; the differences between mean values of fin index and hepato-somatic index in silver and yellow eels were not statistically significant ($P>0.05$). Gonado-somatic index was not found to be correlated to total length and eye index in female silver eels.

Keywords: Female European silver eel, Morphometric/biometric indices, Göksu Delta, Turkey

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Özet: **Doğu Akdeniz (Göksu Deltası/Türkiye) Dişi Gümüşi ve Sarı Avrupa Yılan Balıklarının (*Anguilla anguilla*) Morfometrik ve Biyometrik Özelliklerinin Ön Araştırması**

Göksu Deltasında (Doğu Akdeniz) yürütülen bu ön çalışmada bazı morfometrik ve biyometrik parametreler ile indeksler yardımıyla üreme göçüne başlayan dişi gümüşi ve yerleşik sarı yılan balıklarının tanımlanmasına ışık tutulması amaçlanmıştır. Üreme göçüne başlayan dişi gümüşi yılan balıklarında ortalama total boy ve vücut ağırlığı sırasıyla 72.90 cm ve 890.27 g olarak bulunmuştur. Dişi sarı yılan balıklarında ortalama total boy 57.45 cm, ortalama vücut ağırlığı ise 384.86 olarak ölçülmüştür. Göçe başlayan dişi gümüşi yılan balıklarında total boy, vücut ağırlığı, gonad ağırlığı, karaciğer ağırlığı, göz indeksi, gonadosomatik indeks ve kondisyon faktörünün ortalama değerleri dişi sarı yıllan balıklarına ait ortalama değerlerden istatistiksel olarak önemli derecede yüksek bulunmuştur ($P<0.001$). Buna karşın ortalama yüzgeç indeksi ve hepatosomatik indeksi değerleri arasında istatistiksel olarak önemli bir farklılık saptanmamıştır ($P>0.05$). Dişi gümüşi yılan balıklarında gonadosomtik indeks ile total boy ve göz indeksi arasında bir korelasyon bulunmamıştır.

Anahtar Kelimeler: Dişi gümüşi Avrupa yılan balığı, Morfometrik/biyometrik indeksler, Göksu Deltası, Türkiye

Introduction

European eel (*Anguilla anguilla*, Linnaeus 1758) is a catadromous species found in all European rivers draining to the Mediterranean, North and Baltic seas, in the Atlantic south to Canary Islands and parts of Mediterranean north Africa and Asia (Freyhof and Kottelat, 2008). European eel is also found in Turkish rivers and streams draining to Mediterranean, Aegean, Marmara and Black Sea (Kuru, 1996; Geldiay and Balık, 2002).

The European eel population has been declining over the last 30 years. Currently the stock is considered outside safe biological limits and the fishery regarded as not sustainable by International Council for the Exploration of the Seas (ICES) and European Inland Advisory Commission (EIFAC). The International Union for Conservation of the Nature (IUCN) has thereby classified the European eel as "critically endangered" species (Bilotta et al., 2011; Farrugio and Elie, 2011). Mediterranean production of European silver and yellow eel has also followed the worldwide trend where production has decreased from 4000-5000 mt in 1980s to 700 tont in 2007 (Farrugio, 2010; Farrugio and Elie, 2011). Fisheries statistics published by Turkish Institute of Statistics (TURKSTAT) also reveal that capture fisheries production of eel (Yellow and silver stages) in Turkey has also been declining since its peak (756 mt) in 1988. Catch levels have been below 200 mt in the new millennium and was reported as 158 mt for 2009 (TURKSTAT, various years).

In accordance with scientific advice from ICES and to help the recovery of eel population, European Commission (EC) has established legislation (Regulation No. 1100/2007) calling for all member states with natural *A. anguilla* habits to develop "Eel Management Plans". The objective of the plan is to reduce anthropogenic mortalities to allow with high probability the escapement of at least 40% of the silver eel biomass to the sea. The principle idea behind this conservation approach is that escapement of sufficient sock of silver eels for spawning would have a proportional positive contribution to recruitment (Yokouchi, et al., 2009; Farrugio, 2010; Farrugio and Elie, 2011; Bilotta et al., 2011).

Silvering is a complex mechanism and before departure for spawning ground, eels undergo several morphological and physiological changes from yellow non-migratory and sexually immature stage to silver migratory phase where sexual maturation begins (Vettier et al., 2005; Palstra et al., 2010). Investigating morphometric and biometric characteristics of sedentary yellow and migrating silver eel stages and identifying easily measurable and reliable criterion for distinguishing migrating silver eels are fundamental component of assessing silver eel biomass and thereby implementation of "Eel Management Plan".

Even though skin color is generally used as an indication of yellow and silver stages, this criterion is not always reliable and sufficient to distinguish migratory individuals (Durif et al., 2009). Several studies have reported morphologi-

cal transformation indices like eye diameter and pectoral fin length as well as biometric characteristics such as gonad and liver mass shedding light on silvering process (Pankhurst, 1982; Beullens et al., 1997; Marchelidon et al., 1999; Acou et al., 2003; Durif et al., 2005; Ginneken et al., 2007; Durif et al., 2009; Yokouchi, et al., 2009). Some of these studies have further focused on proposing threshold values for ocular and gonadosomatic indices (Acou et al., 2003) or have developed indices (Silver index) based on some easily measurable morphometric characteristics such as body length, body weight, pectoral fin length and eye diameter to identify migrating silver eels from external measurement (Durif et al., 2005; Durif et al., 2009).

Existing morphometric/biometric criterion and threshold values for identifying silvering stage are either from studies on eels kept in captivity (Pankhurst, 1982; Beullens et al., 1997) or are derived from investigations on European eels caught from their natural environments belonging to different locations in Europe e.g. France, Netherland, Poland and Ireland (Marchelidon, et al, 1999; Acou et al., 2003; Robak, 2005; Durif et al., 2005; Ginneken et al., 2007; Durif et al., 2009; Yokouchi, et al., 2009). Farrugio and Elie (2011) underline the spatial diversity of the European eel population and the fact that part of this population may be specific to Mediterranean. They further stress that the biological and ecological characteristics between Northern and Southern parts of the distribution area are very different. And conclude that if any protection measure is to be adapted by the exploiting countries, some preliminary information on European eel population in the Mediterranean hydrosystems need to be collected. Amilhat et al. (2008) also stress that although European eels from Atlantic side have been well studied; only few studies have been conducted on the Mediterranean side.

Turkey is located on the Eastern Mediterranean and is one of the main five producers of European eel in the Mediterranean region along with Italy, France, Tunisia and Albania (Farrugio and Elie, 2011). However; the context of research and information on eel population in Turkey is indeed poor. Studies on growth, feeding habits, hematological parameters and migratory life history of European eel from different habitats in Turkey do exists (Yalçın-Özdilek et al, 2006; Yalçın-Özdilek; Solak, 2007; Şahan et al., 2007; Genç et al., 2008; Lin et al., 2011) but studies on characteristics of migrating silver eels which would contribute to implementation of any conservation measure or management plan are lacking. Göksu delta situated on the Turkish Mediterranean coast is one of the main habitats of European eel in Turkey. This preliminary study was therefore conducted to shed light on characterization of migrating female silver and sedentary yellow eels in Göksu Delta by providing some basic morphometric and biometric parameters indices.

Materials and Methods

Fish Sampling

This study was conducted in Göksu delta (Mersin/Turkey), an important wetland in Eastern Mediterranean region of Turkey (Figure 1) where Göksu River drains into Mediterranean Sea.

Göksu delta (15.000 ha) which extends from 36º 18' North to 33º 58' East, is included in Ramsar List of Wetland of International Importance. The Delta is further classified as a special environmental protection zone by Ministry of Environment and Forest (Anonymous, 2009). The Delta includes the Göksu River, the large lakes of Akgöl and Paradeniz, a small lake called Kuğu Gölü and a network of drainage canals in the surrounding agricultural lands. Paradeniz (492 ha) and smaller Kuğu lakes are open saline lagoons with little vegetation. The maximum water depth in Paradeniz lagoon is 1.5 m. It is connected to the Mediterranean Sea via a canal and to Akgöl via Kuğu lagoon. Two drainage canals run in to Akgöl (820 ha) from east and north of the lake and once a semi-permanent hyper-saline lake with no connection to the sea is now a freshwater to brackish eutrophic lake. The lake is 0.5-1.0 m in depth and with abundant reed beds (Green, 1998; Anonymous, 2009). Water temperatures range between 10-32 ºC and 10-29 ºC for Akgöl and Paradeniz respectively. Salinity values are reported as 1-4 ppt for Akgöl and 12-39 ppt for Paradeniz (Velioğlu et al., 2010).

Eels (Yellow and silver) in the delta are caught either by fyke nets or through traditional wooden "dalyan", which is basically a fishing arrangement composed of fixed barriers and catching chambers installed on canals connecting the lagoons to the sea to trap the fish during their migration (Image 1). Both migrating silver and yellow eel samples were obtained from fishing cooperative running the fishing activities in the delta. Based on observation of fishermen, Novem-

ber-February was believed to be the period of downstream migration for silver eels in Göksu Delta. Therefore; silver eels trapped and collected from catching chamber of the dalyan (installed on the canal between the Mediterranean and the Paradeniz lagoon) during this period were regarded as "migrant" samples. Yellow eels caught by fyke nets from Akgöl Lake during the same sampling period were regarded as resident/sedentary yellow eel samples. Sampling was carried out from 2007 to 2010 during November-February depending on availability.

Morphometric/Biometric Measurements and Indices

Total length (L_T) and body weight (M) of all eel samples arriving at the laboratory were determined to nearest cm and g. respectively. Vertical and horizontal diameters (mm) of both eyes were measured using a digital veriner caliper to calculate eye index (I_E). Length of pectoral fin was also measured to find (I_F). Fish were then dissected to remove gonads and liver (Image 2). Gonads and liver were weighed to calculate biometric indices i.e. gonado-somatic (I_G) and hepato-somatic (I_L) index.

Morphometric indices were calculated as following:

Eye index (I_E) = $[(D_v + D_h / 4)^2 \times \pi / L_T] \times 100$ (Pankurst, 1982: From Ginnneken et al., 2007)

Where;

D_v = Vertical eye diameter (mm)

D_h = Horizontal eye diameter (mm)

L_T = Total length (mm)

Fin index (I_F) = (L_P / L_T) x 100 (From Durif, et al, 2000)

Where;

L_P = Length of pectoral fin (mm)

Fultons's condition factor (K) = $100 \times BW \times L_T^{-3}$

Where;

BW = Body weight (g)

The two biometric indices namely gonado-somatic (I_G) and hepato-somatic index (I_L) were calculated as following:

Gonado-somatic index (I_G) = $(GW\ BW^{-1}) \times 100\%$

Where;

GW = Weight of gonads (g)

Hepato-somatic index (I_L) = $(LW\ BW^{-1}) \times 100\%$

Where;

LW = The weight of liver (g)

Sex Determination

All eel samples arrived at the laboratory were sexed according to Krueger and Oliveira (1997) using the aceto-carmine gonad squash techniques.

Statistical Analysis

Distributions of morphological-biometric parameters/indices for migrating silver and sedentary yellow eels were tested for normality by Shapiro Wilk Test. Student t test was used to compare the mean values of parameters/indicesfor each group. The correlation between body weight, total length, gonad weight, liver weight, eye index (I_E), fin index (I_F), gonado-somatic index (I_G), hepato-somatic index (I_L) and condition factor (K) of silver and yellow eels were assessed by Pearson Correlation Coefficient. Statistical analysis were carried out using SPSS 11.5. for each group. The correlation between body weight, total length, gonad weight, liver weight, eye index (I_E), fin index (I_F), gonado-somatic index (I_G), hepato-somatic index (I_L) and condition factor (K) of silver and yellow eels were assessed by Pearson Correlation Coefficient. Statistical analysis were carried out using SPSS 11.5.

Figure 1. Map of study area.

a. General view of dalyan

b. Catching chamber of dalyan

Image 1. Traditional wooden dalyan used in catching eels during their downstream migration in Göksu Delta.

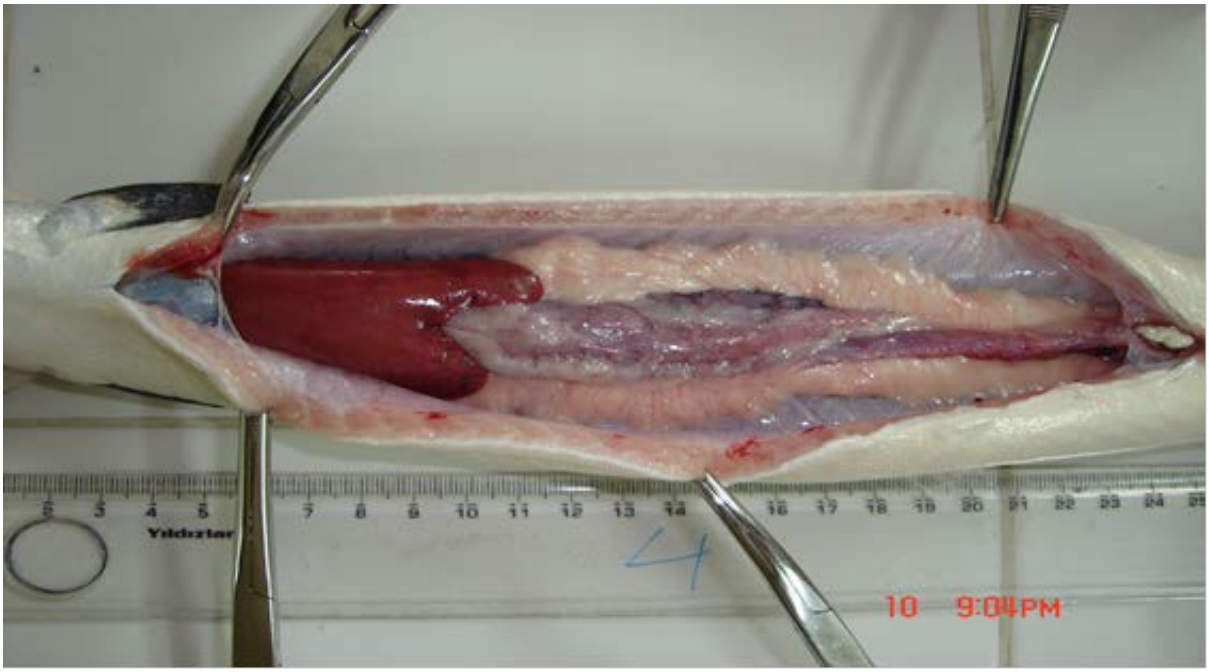

Image 2. A female silver eel from Göksu Delta.

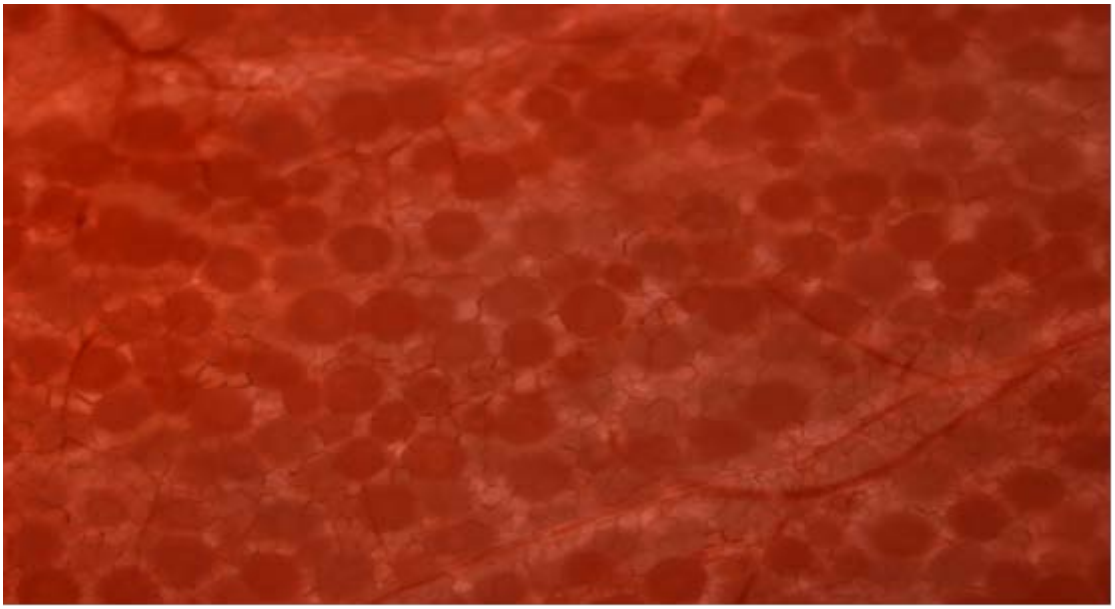

Image 3. Microscopic image of ovary.

Results and Discussion

All silver eels samples (n=18) collected from catching chamber of dalyan (Fixed barriers) were found to be female (Image 3). Out of 48 yellow eel samples caught by fyke nets 38 were determined to be female and were included in the statistical assessments and analysis. Mean values of morphological-biometric parameters and indices of migrating female silver and yellow eels in Göksu delta are presented in Table 1.

Values of mean total length and body weight of migrating silver eels was found to be 72.90 cm and 890.27 g respectively while in female yellow eels, mean total body length was measured as 57.45 cm and mean body weight was found to be 384.86 g. Gonado-somatic (I_G) and eye index (I_E) of migrating silver eels were found as 1.78 ±0.29 and 8.42 ±1.80 respectively. Mean values of total length, body weigh, gonad weigh, liver weight, I_E, I_G and condition factor (K) of migrating silver were significantly higher than those of yellow eels ($P<0.001$). However; the differences between mean values of fin (I_F) and hepato-somatic index (I_L) in silver and yellow eels were not statistically significant ($P>0.05$) (Table 1).

Correlation matrix of morphological-biometric parameters and indices of female yellow and silver eels are presented in Table 2 & 3. Though a number of significant correlations with various degrees of strength were found among/between morphological (total length, body weight) and biometric (gonad and liver weight) parameters, significant correlations between morphological-biometric parameters and indices were few and not always meaningful and informative. In yellow eels total length was positively correlated with body weight ($r^2=0.9247$), gonad weight ($r^2=0.5933$) and liver weight ($r^2=0.7799$). Similar correlations were also found for silver eels. However; in silver eels the positive correlation between total length and body weight was weaker ($r^2=0.7421$). Both in yellow and silver eels body weights were positively correlated with gonad and liver weights. In silver eels gonad weight was positively correlated with liver weight ($r^2=0.6821$) and negatively correlated with I_F ($r^2= -0.6093$). K was found to be positively correlated with I_E ($r^2=0.6892$) and negatively correlated with I_G ($r^2=-0.5526$) and I_L ($r^2=-0.5903$) in silver eels. There was also a negative correlation between I_G and I_F ($r^2= -0.7444$) in silver eels.

Table 1. Mean values (± standard deviations) of morphological-biometric parameters and indices of migrating female silver and yellow eels from Göksu delta.

	Yellow Eels			Migrating Silver Eels			P-value
	N	Mean	S. Deviation	n	Mean	S. Deviation	
Total length, (cm)	38	57.45	5.83	18	72.90	4.88	<0.001
Body weight, (g)	38	384.86	181.65	18	890.27	192.23	<0.001
Gonad weight, (g)	38	2.43	2.81	18	15.82	3.73	<0.001
Liver weight, (g)	38	7.32	5.18	18	12.01	3.17	0.0009
Eye index ,I_E	38	6.07	1.54	18	8.42	1.80	<0.001
Fin index, I_F	38	4.91	0.34	18	5.02	0.90	0.4844
Gonado-somatic index, I_G (%)	38	0.59	0.47	18	1.78	0.29	<0.001
Hepato-somatic index, I_L (%)	38	1.54	0.89	18	1.37	0.27	0.4413
Condition factor, K	38	0.18	0.041	18	0.22	0.032	0.0012

Table 2. Correlation matrix of morphological-biometric parameters and indices of female yellow eels.

	Total length	Body weight	Gonad weight	Liver weight	I_E	I_G	I_L	K	I_F
Total Length	1	0.9247 p<0.001	0.5933 P=0.001	0.7799 P<0.001	-0.0189 P=0.9109	0.2080 P=0.2102	0.3161 P=0.0532	0.5964 P=0.001	-0.0410 P=0.8051
Body Weigh t	-	1	0.6269 P<0.001	0.8460 P<0.001	-0.01152 P=0.9453	0.1793 P=0.2813	0.3050 P=0.0626	0.8256 P<0.001	0.03571 P=0.8315
Gonad weight	-	-	1	0.4471 P=0.0049	0.3335 P=0.0407	0.8024 P<0.001	0.3086 P=0.0596	0.3850 P=0.0170	0.1819 P=0.2743
Liver weight	-	-	-	1	-0.06064 P=0.7176	0.1122 P=0.5025	0.6034 P=0.0001	0.7333 P<0.001	0.09190 P=0.5832
I_E	-	-	-	-	1	0.4719 P=0.0028	0.1096 P=0.5125	-0.1036 P=0.5360	0.4550 P=0.0041
I_G	-	-	-	-	-	1	0.3012 P=0.0061	-0.01030 P=0.9511	0.2471 0.1348
I_L	-	-	-	-	-	-	1	0.2174 P=0.1898	0.2472 P=0.1346
K	-	-	-	-	-	-	-	1-	0.1603 P=0.3362
I_F									1

Table 3. Correlation matrix of morphological-biometric measurements and indices of migrating female silver eels.

	Total length	Body weight	Gonad weight	Liver weight	I_E	I_G	I_L	K	I_F
Total Length	1	0.7421 P=0.0004	0.8118 P<0.001	0.8258 P<0.001	-0.3207 P=0.1944	0.2348 P=0.3484	0.5293 P=0.0239	-0.2057 P=0.4129	-0.3630 P=0.1387
Body Weight	-	1	0.6979 P=0.0013	0.8301 P<0.001	0.1481 P=0.5576	-0.1937 P=0.4413	0.03826 P=0.8802	0.4912 P=0.0385	-0.07230 P=0.7756
Gonad weight	-	-	1	0.6821 P=0.0018	-0.1408 P=0.5774	0.5425 P=0.020	0.2805 P=0.2595	-0.0109 0.9655	-0.6093 P=0.0073
Liver weight	-	-	-	1	-0.1445 P=0.5673	-0.04637 P=0.8550	0.4592 P=0.0553	0.1345 P=0.5948	-0.1873 P=0.4566
I_E	-	-	-	-	1	-0.2534 P=0.3103	-0.3655 P=0.1358	0.6892 P=0.0016	0.2897 P=0.2435
I_G	-	-	-	-	-	1	0.3253 P=0.1878	-0.5526 P=0.0174	-0.7444 P=0.0004
I_L	-	-	-	-	-	-	1	-0.5903 P=0.0099	-0.2438 P=0.3296
K	-	-	-	-	-	-	-	1	0.2957 P=0.2335
I_F	-	-	-	-	-	-	-	-	1

This study is the first attempt on investigation of morphological/biometric characteristics of migrating female silver eels in Göksu delta in Turkey and thereby, has its own shortcomings and limitations in terms of sampling scheme e.g. sample size and use of samples provided by commercial eel fisheries. However; results obtained do shed light on morphological/biometric characteristics of migrating female silver eels from Göksu Delta and as far as literature reviews reveal, findings of this study constitute the first set of data on morphological-biometric parameters and indices of migrating female silver eels from Eastern Mediterranean region.

Accordingly, mean body weight and total length of migrating silver eels from Göksu Delta were found to be 890.27 ±192.23 g and 72.90 ±4.88 cm respectively. Mean body weight and length for female silver eels from Great Mazurian Lakes (Poland) have been reported as 468.0 ±11.371 g and 64.5 ±8.293 cm respectively by (Robak, 2005). For female silver eels from North of France (Somme) values of mean body weight and length have been documented as 277 ±8 g and 54.89 ±0.57 cm respectively by Aroua et al. (2005). Mean body weight and length of female silver eels from Rhine river have been reported as 609 ±35 g and 66.86 ±1.51 cm respectively for samples collected during 1996-1998 and as 560 ±53 g and 65.33 ±1.92 cm for samples collected in 2002 (Aroua et al., 2005). Differences between mean size of silver eels from Göksu Delta and those from other locations is not an extraordinary situation since size (length) of silver eels could vary from one site to another (Durif et al., 2005). Lefebvre et al. (2003) have reported significant differences in size (length) of female silver eels even from two sites in the same delta (Rhone Delta). Likewise, Acou et al. (2003) underline that the ovarian development which is characteristic of metamorphosis to silver stage occur at very variable body lengths varying between 400 and more than 750 mm. Nevertheless; mean body length of migrating female silver eels from Göksu Delta (72.90 ±4.88 cm) is consistent with classification made by Durif et al. (2005) and Durif et al. (2009). Accordingly; a mean

body length of 746 ±110 mm corresponds to FIV stage which characterizes migrant silver European eels.

As far as other parameters are concerned, the higher mean liver weight in silver eels (12.01 ±3.17 g) compared to yellow eels (7.32 ±5.18 g) is also justifiable since one of the important physiological changes that occur during silvering of eel is accumulation of lipid in liver (Durif et al., 2000) and thereby increase in weight of liver. However; due to greater body weight, hepato-somatic index (I_L) turned out to be smaller in silver eels (1.37 ±0.27) but not significantly different from that of yellow eels (1.54 ±0.89). This is consistent with findings of Ginneken et al. (2007) who have reported a hepato-somatic index of 1.34 and 1.35 for silver and yellow eels respectively from Grevelingen Lake (Netherlands) with no significant differences observed between the two groups. Our findings with regard to mean hepato-somatic index of migrating silver eels from Göksu Delta are also within the range of mean I_L (1.40 ±0.17) for FIV stage (migrant female silver) of "silver index" developed by Durif et al. (2009).

The value of mean gonado-somatic index (I_G) estimated for yellow (0.59 ±0.47%) and silver eels (1.78 ±0.29%) from Göksu Delta are in agreement with values of mean gonado-somatic index reported by Durif et al. (2005) and Durif et al. (2009) for FII (0.54%, female resident) and FV (1.71%, female migrant) stages. As far as I_G is concerned our findings with regard to yellow and silver eels from Göksu Delta further support Marchelidon et al. (1999) and Acou et al. (2003) who have reported a threshold value of ≥ 1.4% for gonado-somatic index characterizing the silvering stage.

The mean gonad weight of silver eels from Göksu delta was found to be 15.82±3.73 g which is similar to mean gonad weight of silver eels (16.16 ±5.68 g) from Grevelingen lake (Netherlands) reported by Ginneken et al. (2007). However; the mean gonado-somatic index of silver eels from Grevelingen Lake was found to be 1.40 ±0.28 which is lower than that of silver eels from Göksu Delta. This is probably due to higher mean body weight of silver eels (1132 ±262 g) sampled by Ginneken et al. (2007). With regard to I_G our finding is also in agreement with those reported for silver eels from Rhine River (1.7-1.8%) by Aroua et al. (2005).

Eye index, fin index and condition factor were the three morphometric indices investigated in this study. The mean eye index (I_E) for yellow and silver eels from Göksu Delta was found to be 6.07 ±1.54 and 8.42 ±1.80 respectively. Literature review reveals that as with other biometric and morphometric indices characterizing yellow or silver stages in eels, eye index can also differ from one site to another. For example; mean eye index of female yellow and silver eels from Grevelingen Lake have been reported as 7.14 ±1.31 and 10.17 ±1.04 respectively by (Ginneken et al., 2007). Acou et al. (2003) have investigated morphometric characteristics of eel population from two sites (Fumemrte and Vaccares) in Rhone Delta and have found different values of mean eye index for two sub-populations ranging from 4.20 (Vaccares) to 6.59 (Fumemorte) for female yellow eels and from 8.0 (Vaccares) to 9.71 (Fumemorte) for female silver eels.

The estimated mean eye index of 8.42 ±1.80 for silver eels in this study is higher than Pankhurst's eye index of 6.5, but in agreement with Marchelidon et al. (1999) and Acou et al. (2003) who have found a threshold value of ≥8.0 for eye index discriminating silver eels. As far as I_E is concerned our finding further supports Acou et al.'s (2003) assertion that threshold value of ≥8.0 for eye index in silver eels from Rhone Delta (Northern France) is also applicable to eels in Mediterranean freshwater and lagoon environments.

According to Durif et al. (2005) length of pectoral fin could be a useful indicator for distinguishing migrating silver eels and fin index (I_F) increases significantly when eels start their downstream migration. They have further reported a mean value of 4.3±0.6 for pre-migrant females and a mean value of 5.0±0.7 for migrating female silver eels. We have also found a mean value of 5.02±0.90 for I_F in silver eels from Göksu Delta. But this value was not found to be significantly different ($P<0.4844$) from that of female yellow eels (4.91±0.34). Inter alia similar values of fin index for both groups in our study could be due to measuring errors.

Mean values of condition factor determined for female yellow and silver eels from Göksu delta in our study are consistent with values reported by Ginneken et al (2007) and ranges defined for FII and FIV stages in "silver index" developed by Durif et al. (2009).

Probably due to small sample size, correlation analysis of morphometric and biometric parameters and indices in yellow and silver eels in our study has not yield salient results which could further shed light on silvering process of female European eels or initiate an in depth discussions on the issue. Nevertheless; Durif et al. (2005) have also documented that I_G is not correlated to total length and I_E in female silver eels.

Conclusion

As underlined earlier despite its limitations the findings of this study constitutes the first set of data on some morphometric and biometric parameters and indices of female yellow and silver eel population from Göksu Delta, contributing to existing knowledge and literature on characteristics of female silver eel population from Eastern Mediterranean region. Nevertheless, further studies with modified sampling schemes would be needed to enhance the scope and depth of information and assessments on silvering process of eels from Göksu Delta. This would not only facilitate the studies on estimation of escapement rate of silver eels but would also contribute to formulation of management plan for eel population in Göksu Delta.

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