

Determination of Entrance Seasons of Elvers (*Anguilla anguilla* L., 1766) in Gözlen Creek and Assessment of Different Catching Methods

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Abstract: This study was carried out in Gözlen Creek, located on the Fethiye-Muğla boundary Turkey, between March to July, 1998, and January to July, 1999. Elvers were collected using trap-nets, drift nets, hand scoop nets and electrofishing equipment. Examination indicated that the highest yield was obtained using hand scoop nets ($P < 0.05$) and electrofishing equipment. Elvers entered Gözlen Creek between February and July. A total of 214 specimens entering the creek were examined and 3 different groups were established according to their morphological characteristics: average weight (W) group I; 0.166 ± 0.007 g, group II; 0.392 ± 0.02 g, group III; 0.800 ± 0.06 g and average total length (L) group I; 56.16 ± 0.06 mm; group II; 64.39 ± 0.11 mm and group III; 82.02 ± 0.18 mm. The length-weight relation of elvers was calculated using regression analysis and was determined as follows: group I; $W = 0.0020 * L^{2.5327}$, group II; $W = 0.0015 * L^{2.9516}$, and group III; $W = 0.0023 * L^{2.7090}$. The condition factor (C) was determined as 0.209 ± 0.009 for group I; 0.154 ± 0.004 for group II and 0.251 ± 0.009 for group III.

Key Words: Eel, elver, catching methods, Gözlen Creek, Turkey

Gözlen Çayı'na Giren Yılan Balığı (*Anguilla anguilla* L., 1766) Elverlerinin Giriş Mevsimlerinin Tespiti ve Yakalama Yöntemlerinin Belirlenmesi

Özet: Bu çalışma, Fethiye İlçesi (Muğla-Türkiye) sınırları içerisindeki Gözlen Çayı'nda Mart-Temmuz 1998 ve Ocak-Temmuz 1999 tarihleri arasında yapılmıştır. Elverlerin avcılığında pinter, pencere tülünden yapılmış sürütme ağları, kepçe ve elektroşok kullanılmıştır. Denenen bu avcılık yöntemleri arasında en yoğun elver, kepçe ($P < 0.05$) ve elektroşok yöntemiyle yakalanmıştır. Yapılan araştırmada elverlerin Gözlen Çayı'na Şubat-Temmuz ayları arasında girdikleri belirlenmiştir. Yakalanan 214 örneğin incelenmesi sonucunda, elverlerin akarsuyun nehir ağzı bölgesinde morfolojik yapıları farklı üç grup halinde (ortalama ağırlık (W) I. grup; $0,166 \pm 0,007$ g, II. grup; $0,392 \pm 0,02$ g, III. grup; $0,800 \pm 0,06$ g ve ortalama toplam boy (L) I. grup; $56,16 \pm 0,06$ mm, II. grup; $64,39 \pm 0,11$ mm, III. grup; $82,02 \pm 0,18$ mm) buldukları tespit edilmiştir. Elverlerin boy-ağırlık ilişkisi regresyon analiz yöntemine göre değerlendirilerek I. grup; $W = 0,0020 * L^{2,5327}$, II. grup; $W = 0,0015 * L^{2,9516}$ ve III. grup; $W = 0,0023 * L^{2,7090}$ olarak hesaplanmış, kondisyon faktörü (C) ise I. grup; $0,209 \pm 0,009$, II. grup; $0,154 \pm 0,004$ ve III. grup; $0,251 \pm 0,009$ olarak belirlenmiştir.

Anahtar Sözcükler: Yılan balığı, elver, yakalama metotları, Gözlen Çayı, Türkiye

Introduction

The annual production of European eel *Anguilla anguilla* (Linnaeus, 1758) in Turkey was 224-588 t between 1973 and 1981 (1,2). Generally, yellow and silver eels are caught all over the freshwaters and along the Mediterranean, Aegean and Marmara coasts. However, most eel fishing takes place in the Adana, Adıyaman, Muğla, Aydın, and Antalya regions (Figure 1), and is especially intense in the Karataş (Adana) and Köyceğiz (Muğla) estuaries. Because eel is not locally consumed, it is all exported to European countries such as

France, the Netherlands and Italy. The amount of exported eel has decreased since 1997 (2) and it is in the light of this recent decline in productivity that the present research was carried out. This study documents the timing of elver arrival in a basin of south-western Turkey (Gözlen Creek near Fethiye, Muğla) and describes the condition of the specimens. These data are compared to existing information in the literature on elvers from rivers in the Antalya region, further east. In addition, the efficiency of various catching methods for elvers was tested in order to define the best suited equipment for

the local aquatic environment. These data should contribute to the basic knowledge necessary for local capture of young eels that could be ultimately used in eel culture.

European eels migrate along the rivers and streams of the Mediterranean, the Aegean and, partially, the Black Sea coastline of Turkey in search of food. This intense migratory behaviour has been described for a number of Turkish basins emptying into the Mediterranean (Asi, Ceyhan, Seyhan, Köprüçay and Manavgat rivers) and into the Aegean Sea (Eşen and Dalaman creeks; Büyük Menderes, Küçük Menderes, Gediz and Meriç rivers) (3,4). The migration patterns of eels in rivers emptying into the Black Sea, however, are poorly documented (5). Although a few studies exist on eel systematics, distribution and nutritional values (1,4), information on seasonal eel migration or on the size of migrating stocks in Turkey is limited. The first detailed study on the entrance of elvers into freshwater bodies along the Mediterranean coasts of Turkey was conducted by İyiz et

al. (4) between 1997 and 1998, and included the Köprüçay, Manavgat, Aksu and Alara rivers, which all empty into Antalya Bay.

The aim of the current study was to determine the entrance seasons of elvers, with their interesting life cycles in Gözlen Creek, to assess the most efficient catching methods for the local aquatic environment, and to contribute to the determination and protection of natural reservoirs.

Materials and Methods

The results presented here are based on sampling carried out in March-July, 1998, and January-July, 1999, in Gözlen Creek (Fethiye/Muğla) on the south-west Mediterranean coast of Turkey. This creek, with a total length of approximately 5 km, starts from a rocky area located 30 km east of Fethiye and ends at the Mediterranean Sea (Figure 1). Some physical and chemical characteristics of Gözlen Creek were measured

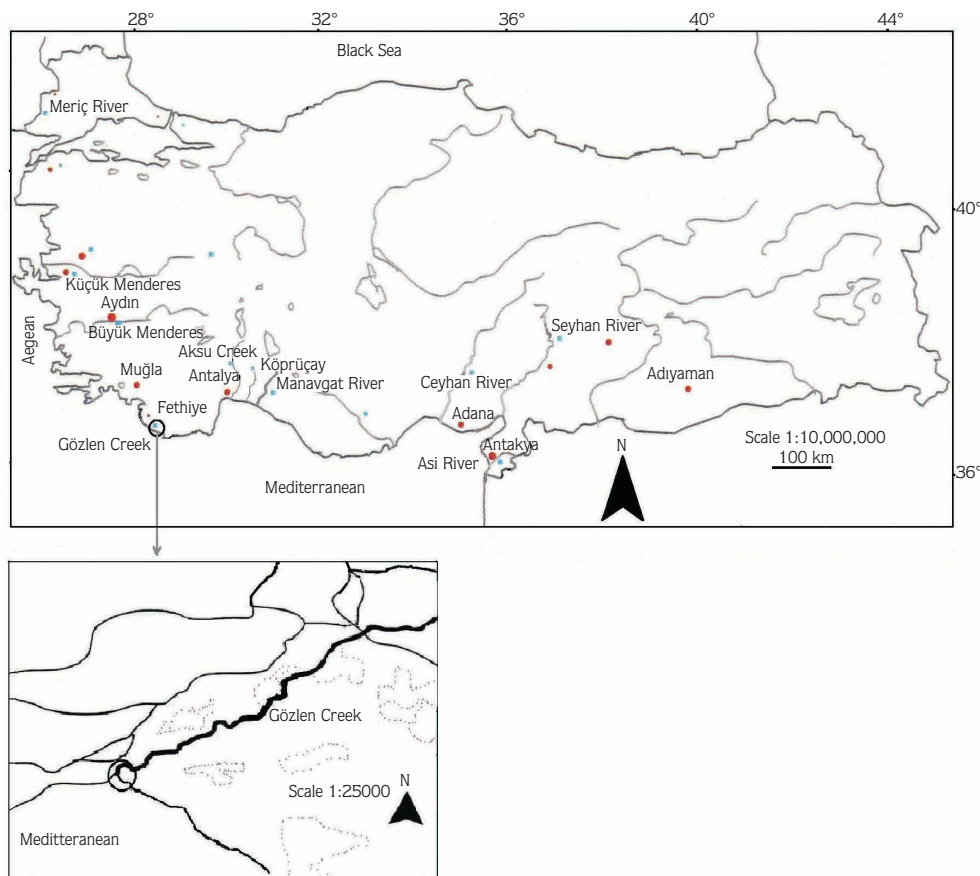


Figure 1. Map showing Gözlen Creek and some rivers and localities mentioned in the text.

using the following procedures: water depth and volume by metric method; water velocity by flowmeter (hydro-bios brand); temperature, salinity and conductivity by SCT meter; pH by pH meter; and dissolved oxygen and oxygen saturation by oxygen meter.

Elvers were collected with electrofishing equipment (AC/DC 220/12 v, 2 HP portable electrical generator fuelled by gasoline and with 2 circular 10 cm diameter electrodes), drift nets (vertical mouth opening 60 cm, total wing length 5 m and mesh size 1 mm), trap nets made out of window screens and fabric fly nets (1 mm mesh net, mouth opening 10 cm, 3 sections and total wing length 3 m) and with hand scoop nets (mouth opening, 40 cm) (Figure 2) (6). Traps were placed near the banks of the creek against the direction of the water flow, and the number of elvers collected during a known time period (overnight) was assessed.

Total length (L in cm) and fresh body weight (W in g) were measured for subsamples and the condition factor was calculated as $C = W/L^b$, where C is the condition factor and b is the coefficient. The length-weight relationship was calculated separately for each morphological group according to $W = a \cdot L^b$. The length-weight data were log-transformed and the factor b determined by regression analysis (7). Results are expressed as mean \pm SE. Differences between both catching methods and entrance seasons were determined by analysis of variance. The differences between means were calculated using Duncan's multiple range test at a significance level of $P < 0.05$. All statistical tests were performed using SPSS (8).

Results

Throughout the research periods, the creek experienced no significant changes in its physical or chemical characteristics ($P > 0.05$) (Table 1).

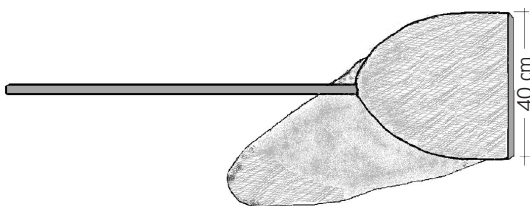


Figure 2. The hand scoop nets used as catching equipment.

Table 1. Average physical or chemical characteristics of Gözlen Creek.

| Parameter | Determined value |
|----------------------------|------------------|
| Temperature (°C) | 16.9 |
| Dissolved oxygen (mg/l) | 10.0 |
| Oxygen saturation (%) | 103.0 |
| Conductivity (μ S/cm) | 2330.0 |
| pH | 7.73 |
| Salinity (ppt) | 1.2 |
| Water velocity (m/s) | 0.35-0.40 |

During periods of heavy elver entrance in the creek, the number of elvers in a known area was assessed using hand scoop nets and stationary nets of known size and mesh size. Most of the elvers were collected with hand scoop nets ($P < 0.05$) and electrofishing equipment from slow running waters where the water velocity was about 0.4 m/s, and where green filamentous algae were abundant (Table 2). They were most abundant at a depth of 20-150 cm in waters located about 50-100 m inland. The types and number of elvers collected with hand scoop nets, and the most efficient catching method for the area examined are given in Table 3 and Figure 3.

The length-weight relationship for each of the 3 groups from Gözlen Creek is shown in Figures 4a-c.

Discussion

There appear to be several factors affecting the entrance of elvers into Gözlen Creek. It is probable that the entrance levels of elvers into this creek are stimulated by a combination of different environmental factors. During this study, observations indicated that the water depth and velocity had an effect on the entrance of eels because nearly all of the elvers were collected near the banks of the creek and in slow running water columns, except for a deep and fast running water column. Our experiments with various other eel catching gear used in north-western Europe and in western Mediterranean countries (9) show that these are not very efficient for the capture of elvers in river mouths of south-western Turkey. In the rivers examined thus far by the authors and by İkiçiz et al. (4), hand scoop nets ($P < 0.05$), and, to some degree, electrofishing equipment, are the most efficient for elver fishing in slow running waters (Table 2). Our field work has shown that elvers start entering

Table 2. Average number of elvers collected with different catching methods in 1998-1999.

| Different catching Methods | Hand scoop nets | Electrofishing quipment | Drift nets | Trap nets |
|----------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Mean ± SE | 21.4 ± 4.73 ^a | 0.70 ± 0.33 ^b | 0.30 ± 0.21 ^b | 0.10 ± 0.10 ^b |

Values in a row with different superscripts are significantly different from each other (P < 0.05).

Table 3. Types and number of elvers collected with hand scoop nets in 1998-1999 in Gözlen Creek.

| Fishing date | Individuals/m ² (mean ± SE) | Collected total elvers | Percent distribution of elvers based on groups | | |
|--------------|--|------------------------|--|----------|-----------|
| | | | Group I | Group II | Group III |
| 24.03.98 | 4.00 ± 1.00 ^{ab} | 22 | 63.6 | 27.3 | 9.1 |
| 23.04.98 | 1.25 ± 0.75 ^b | 9 | 55.6 | 44.4 | 0 |
| 8-9.05.98 | 9.00 ± 5.00 ^a | 56 | 36.3 | 26.3 | 36.3 |
| 18-20.06.98 | 3.00 ± 1.00 ^{ab} | 20 | 55.0 | 10.0 | 35.0 |
| 05.07.98 | 1.25 ± 0.75 ^b | 33 | 21.2 | 51.5 | 27.3 |
| 09.01.99 | 0.75 ± 0.25 ^b | 11 | 0 | 0 | 100.0 |
| 20-21.02.99 | 5.50 ± 1.50 ^{ab} | 30 | 40.0 | 30.0 | 30.0 |
| 23.04.99 | 0.75 ± 0.25 ^b | 13 | 23.1 | 53.8 | 23.1 |
| 2-3.06.99 | 1.50 ± 0.50 ^b | 13 | 23.1 | 15.4 | 61.5 |
| 10.07.99 | 3.00 ± 1.00 ^{ab} | 7 | 0 | 0 | 100.0 |

Values in the same column not sharing the same superscripts are significantly different (P < 0.05).

Gözlen Creek in the last week of February and that they consist of 3 distinct morphological groups (10) until June-July (Table 3 and Figure 3). Research conducted earlier by İlziz et al. (4) in the Antalya Bay rivers showed that the first elvers entered the rivers during the last week of March and that recruitment continued until June. Antalya Bay is located east of our study area and the elvers in Antalya Bay also showed a preference for slow running waters with green filamentous algae. The transparent and non-pigmented elvers decreased from April onwards, whereas the second group increased until June and the third group was captured only in June. The distance between Antalya Bay and the Fethiye area along with the hydrological and physical factors between river mouths may explain the difference in the timing of elver entrance.

Length and weight data of the 3 groups of elvers for Gözlen Creek and the previously sampled Ilıca Creek near Antalya are shown in Table 4.

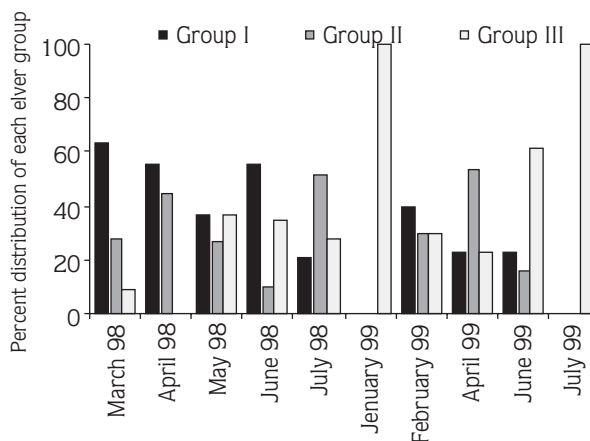


Figure 3. Percent distribution of elvers based on groups in fishing periods.

The length-weight relationship for each of the 3 groups from Gözlen Creek (Figure 4a,b,c) shows that groups I and III are negative log-transformed and that group II approaches isometric growth. The condition factor C was similar for groups I and III (0.209 and

0.251, respectively), but much lower for group II (0.154). Comparison of our data to those of Weber (9) indicates that coefficient b for Gözlen Creek was low, but that the condition factor, C, was high. This could be due to the fact that the study carried out by Weber (9) did not separate the population into groups, as was done in this study.

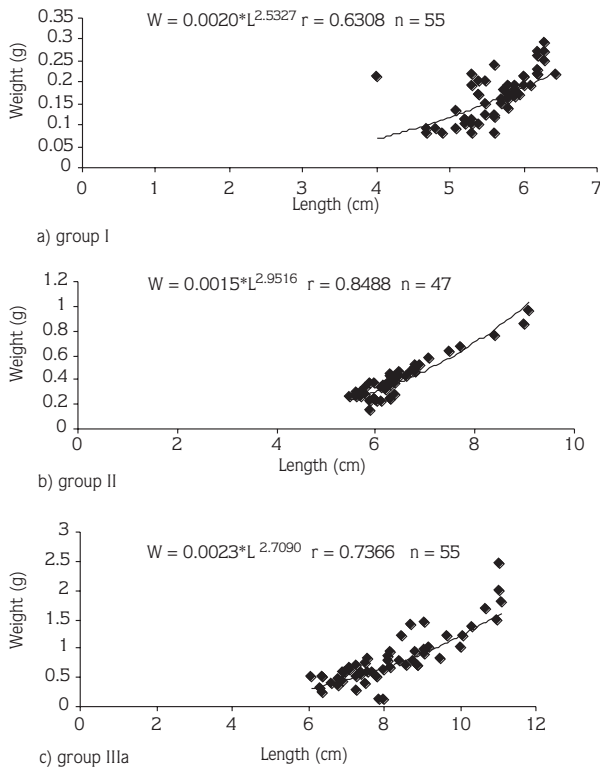


Figure 4 a-c. The length-weight relationship for a) group I, b) group II, c) group III.

Our length-weight data (Table 4) show that group I from Gözlen Creek contains many more individuals per kilogram than those in Golfe of Lion, France (11), or in the Rio Minho river, Portugal-Spain (10), which is due to weight loss during migration along the Mediterranean coasts. The previously published data on Ilica Creek do not seem consistent with our data, and it would appear that the specimens classified as group I and group II in the study by İkiz et al. (4) in fact correspond to our groups II and III.

In the present study, the most efficient catching method was hand scoop nets, depending on the geographical and hydrobiological features of the locality examined. We determined that the entrance season of elvers is the last week of February. Our finding differs from the suggestion made by İkiz et al. (4). The migratory behaviour of eel in fresh water is prevented by hydro-electric power dams and irrigation regulators. Thus, elvers are forced to live downstream. If eel is added upstream of rivers and dam lakes, natural fish stocks will be supported. We also think that these data could represent basic knowledge to plan and support eel culture.

This research is one of the first detailed studies on the entrance of elvers to the freshwater bodies on the south-

Table 4. Average lengths and weights of the 3 groups of elvers collected from Gözlen Creek (Fethiye-Muğla) compared to the data from Ilica Creek (Manavgat- Antalya).

| | Length (mm) | Weight (g) | Individuals/kg |
|-------------------------------------|-------------|--------------|----------------|
| Gözlen Creek | | | |
| Group I; Transparent, non-pigmented | 57.0 ± 0.12 | 0.174 ± 0.60 | 5747 |
| Group II; Transparent, pigmented | 64.2 ± 0.3 | 0.370 ± 0.12 | 2702 |
| Group III; Opaque, pigmented | 80.4 ± 0.41 | 0.750 ± 0.15 | 1333 |
| Ilica Creek | | | |
| Group I; Transparent, non-pigmented | 67.80 | 0.449 | 2227 |
| Group II; Transparent, pigmented | 80.65 | 0.830 | 1204 |
| Group III; Opaque, pigmented | 97.90 | 1.690 | 591 |

western Mediterranean coast of Turkey. Gözlen Creek is a natural and ecological preserve and this may have a positive effect on the entrance of elvers. However, if overall habitat is taken into account, it can be concluded that the entrance of elvers into the Gözlen Creek is not heavy. One reason for this low level of entry could be low tides, because tides are considered to influence the entrance of elvers to creeks. Additionally, the overall entrance levels of elvers into the Mediterranean may play a significant role in this phenomenon. Detailed studies utilising other technologies, such as Geographical Information Systems (GIS) along with more accumulated

entry data in the near future may shed more light on the entrance of elvers into creeks in different localities.

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