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# Population Age, Sex Structure, Growth and Diet of *Aphanius mento* Heckel in: Russegger, 1843 (Cyprinodontidae: Teleostei), at Kırkgöz Spring, Antalya-Türkiye

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**Abstract**

The population structure of *Aphanius mento* in Kırkgöz Spring (37º06' N; 30°35' E) was studied, using 654 fish monthly in 2002. This study were observed in the number of individuals of each sex, age, weight and size compositions. In addition, the total length-weight relationship was calculated as well as the Von Bertalanffy growth equation. A study of the food uptake throughout the year has been carried out by examination of the content of the digestive track. Males made up 52.29%, females 47.71% of the population. The length-weight relationship and Von Bertalanffy growth equation were $W=0.0626\ L^{2.3348}$, $L_t = 23.51\ (1 - e^{-0.041\ (t+2.904)})$ and $W_t = 786.25\ (1 - e^{-0.002\ (t+0.200)})^{2.3348}$, respectively. *Gammarus* sp. and *Palaemon* sp. are the major food items for *A. mento*.

*Key words*: Kırkgöz Spring (Antalya), *Aphanius mento*, Growth, Diet.

## Introduction

The Cyprinodontiform fish of the genus *Aphanius,* extant as well as fossil, are widely distributed along the late-period Tethys Sea coast lines. Fossil finds are known from many locations between Southern Germany and Kirchisiah. Their present-day distribution has also been influenced by glacial and interglacial period differences in the Mediterranean Sea level (Wildekamp *et al.*, 1999). The genus *Aphanius* consists of 6 species and 4 subspecies comprising two major clades that occur in Anatolia; *A. asquamatus*, *A. mento*, *A. fasciatus A. danfordii*, *A. villwocki*, *A. anatoliae anatoliae*, *A. a. splendens*, *A. a. transgradiens* and *A. a. sureyanus* (Wildekamp, 1993; Wildekamp *et al.*, 1999; Hrbek and Meyer, 2003; Hrbek and Wildekamp, 2003).

*Aphanius mento* (Heckel in: Russegger, 1843) is known from the Arabian Peninsula, Syria and Lebanon, coastal rivers in Israel and in Western Jordan. Within Türkiye, the species is found in the Kırkgöz Spring (Antalya), Ceyhan and Seyhan rivers, Kızılca lake (Bor-Niğde), Yeşilada Lake (Samandağ-Hatay), Tatlısuyu Kanalı (Ereğli-Konya), basin of the lowland Aksu River (Antalya) and the branches of Fırat River in Türkiye (Balık, 1980; Krupp, 1984; Küçük, 1997; Wildekamp, 1993; Wildekamp *et al.*, 1999; Hrbek and Meyer, 2003; Kuru, 2004). Besides Çıldır (2001) reported a form of this species that was introduced into Nemrut Crater Lake in 1980s where it was not found earlier (İnnal and Erk'akan, 2006; Fricke *et al.*, 2007). Inhabits fresh to lightly brackish water, in springs, creeks, rivers and small lakes, commonly near the banks. It is usually found amongst or close to vegetation where males establish territories (Wildekamp, 1993; Wildekamp *et al.*, 1999).

Wildekamp *et al.* (1999) studied the species and subspecies of the genus *Aphanius* in Türkiye. Molecular phylogeny and historical biogeograpy of the *Aphanius* species complex of Central Anatolia have been studied by Hrbek *et al.* (2002). The phylogeny of Eurasian killifish and genetic relationships between Anatolian species and subspecies of *Aphanius* have been studied Bardakçı *et al.* (2004) and Hrbek and Meyer (2003). Güçlü *et al.* (2007) made researches on population structure and growth features of *Aphanius anatoliae sureyanus* in Burdur Lake. Karslı (2007) investigated some biological features of *Aphanius chantrei* population in Sırakaraagaçlar Stream (Sinop-Akliman). So far, most of the researches related to *A. mento* species have focused on molecular phylogeny, taxonomy of species and population features of other *Aphanius* species. In the present study, information on the population structure of *A. mento* in the Kırkgöz Spring is presented.

## Materials and Methods

Kırkgöz Spring (37°06' N; 30°35' E) is a spring flowing towards Antalya Bay which originates from the karstic limestones in the Korkuteli and Kestel plains. Kırkgöz is the major spring in the area and is located at about 30 km Northwest of Antalya (Figure 1). It covers a total wetland area of 7 hectares (Anonymous, 1985; Denizman, 1989). The chemical and physical parameters of the spring are given in Table 1.

Apart from *A. mento*, the ichthyofauna of the spring consists of *Pseudophoxinus antalyae* Bogutsakaya, 1992 (Cyprinidae), *Barbatula* cf. *mediterraneus* (Balitoridae), *Clarias gariepinus*

(Bruchell, 1822) (Clariidae) and *Gambusia affinis* (Baird and Girard, 1853) (Poeciliidae).

Monthly samples were collected from the Kırkgöz Spring between January 2002 and December 2002 with drift nets of tulle of 2 mm mesh size. The fish were preserved in 4% formaldehyde (v/v) and transported to the Fish Biology Laboratory at Eğirdir Fisheries Faculty. In this study, a total of 654 *A. mento* were examined. The total lengths of all fish measured with 0.01 mm sensitive calipers, whereas weights were recorded with an electronic balance at the nearest 0.01 g. The age was determined from scales taken from the left side of the body, between the end of the pectoral fin and the beginning of the dorsal fin. Observations were made using a stereoscope with transmitted light. The overall ratio of males to females was evaluated with $\chi^2$ - test (0.05) (Düzgüneş *et al.*, 1995). The relation of weight to total length was established by the exponential regression equation, $W = a\ TL^b$, where W is the weight in g, TL the total length in cm, a and b the parameters to be established (Ricker, 1975). The growth of the *A.mento* population was estimated with the following Von Bertalanffy growth equations: $L_t = L_\infty (1 - e^{-k(t-to)})$ and $W_t = W_\infty (1 - e^{-k(t-to)})^b$, where $L_t$ is the total length in cm at age "t", $L_\infty$ the average asymptotic length in cm, $W_t$ the weight in g at time "t", $W_\infty$ the average asymptotic weight in g, k the body growth coefficient, "to" the hypothetical age and "a" and "b" constants (Kara, 1992). Fulton's coefficient of condition factor was calculated by $C = (W/TL^3) \times 100$ (Sparre and Venema, 1992). Food selection was expressed as the percent distribution of the monthly consumed food types. Food organisms in the alimentary canal were identified using various textbooks (Demirsoy, 2001, 2003; Smith, 2001; Koca, 2007).

## Results

The age of the fish ranged from 0 to VII years (Table 2). Of the total fish examined, 312 (47.71%) were male and 342 (52.29%) female. The overall ratio of males to females was 1.10 : 1.00 and $\chi^2$ analysis showed this not to be significant (P>0.05) (Table 2). The age distribution shows for age classes (Table 3).

The following Von Bertalaffy growth equation

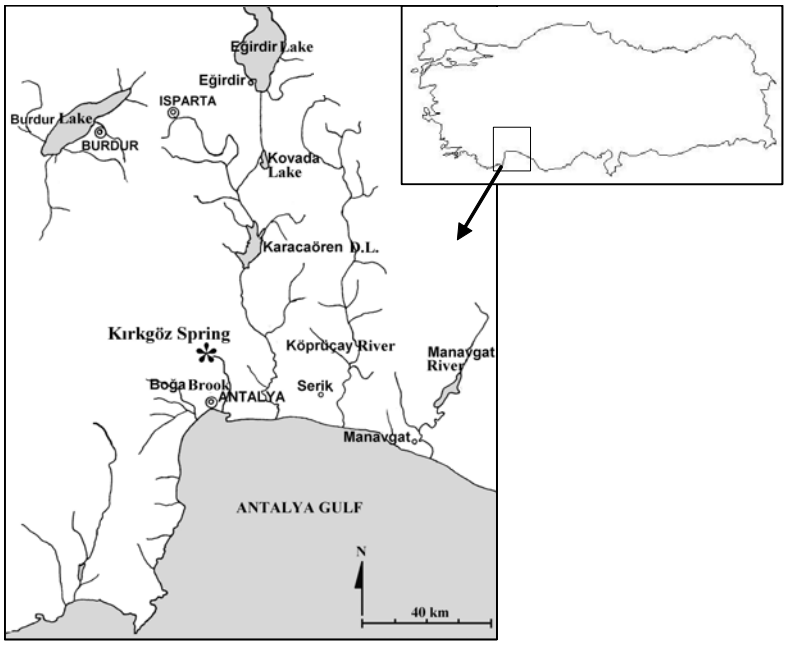


**Figure 1.** Map of the Kırkgöz Spring.

**Table 1.** The mean chemical and physical parameters of Kırkgöz Spring

| | | | |
|---|---|---|---|
| $Ca^{+2}$ (mg/L) | : 133.07 | Total $HCO_3$ alkalinity (mg/L) | : 338 mg/l $CaCO_3$ |
| $Mg^{+2}$ (mg/L) | : 25.27 | Water temperature (°C) | : 14.6-17 (mean 15.8) |
| $Cl^-$ (mg/L) | : 14 | Dissolved oxygen (mg/L) | : 6.64-10 (mean 7.80) |
| $HCO_3^-$ (mg/L) | : 412.36 | Oxygen saturation (%) | : 73-105 (mean 90.91%) |
| $SO_4^=$ (mg/L) | : 10 | pH | : 6.88-7.58 (mean 7.09) |
| Total hardness ($CaCO_3$) (mg/L) | : 436 | Conductivity (25°C) (µS/cm) | : 385-801 (mean 695.5) |

**Table 2.** Age and sex distribution of females (F), males (M) and all *A. mento* from the Kırkgöz Spring

| Age group | Females | | Males | | All | | M:F |
|---|---|---|---|---|---|---|---|
| | N | N% | N | N% | N | N% | |
| 0 | 40 | 6.11 | 100 | 15.29 | 140 | 21.40 | 0.40:1.00 |
| I | 72 | 11.01 | 59 | 9.02 | 131 | 20.03 | 1.22:1.00 |
| II | 76 | 11.62 | 50 | 7.64 | 126 | 19.26 | 1.52:1.00 |
| III | 69 | 10.55 | 56 | 8.56 | 125 | 19.11 | 1.23:1.00 |
| IV | 58 | 8.86 | 23 | 3.51 | 81 | 12.38 | 2.52:1.00 |
| V | 15 | 2.29 | 18 | 2.75 | 33 | 5.04 | 0.83:1.00 |
| VI | 6 | 0.91 | 5 | 0.76 | 11 | 1.68 | 1.20:1.00 |
| VII | 6 | 0.91 | 1 | 0.15 | 7 | 1.07 | 6.00:1.00 |
| Total | 342 | 52.29 | 312 | 47.71 | 654 | 100 | 1.10:1.00 |

N: Number of samples, N%: Percent of samples

**Table 3.** Size and age composition of females (F) and males (M) of *A.mento* from the Kırkgöz Spring (Length in mm)

| Age Class | 0 | | I | | II | | III | | IV | | V | | VI | | VII | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Length (TL) | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | |
| 4-12 | 3 | 4 | | | | | | | | | | | | | | | 7 |
| 12-20 | 7 | 9 | 2 | 1 | | | | | | | | | | | | | 19 |
| 20-28 | 15 | 61 | 17 | 11 | 1 | | | | | | | | | | | | 105 |
| 28-36 | 14 | 21 | 27 | 19 | 14 | 6 | 1 | 1 | | | | | | | | | 103 |
| 36-44 | 1 | 5 | 19 | 21 | 34 | 14 | 21 | 13 | 1 | | 1 | | | | | | 130 |
| 44-52 | | | 7 | 7 | 21 | 17 | 35 | 27 | 14 | 8 | 1 | 1 | | | | | 138 |
| 52-60 | | | | | 6 | 13 | 8 | 13 | 20 | 9 | 5 | 6 | 1 | | | | 81 |
| 60-68 | | | | | | | 4 | 2 | 21 | 6 | 5 | 6 | 3 | 2 | | | 49 |
| 68-76 | | | | | | | | | 2 | | 3 | 5 | 2 | 3 | 4 | 1 | 20 |
| 76-84 | | | | | | | | | | | | | | | 1 | | 1 |
| 84-92 | | | | | | | | | | | | | | | 1 | | 1 |
| ∑ | 40 | 100 | 72 | 59 | 76 | 50 | 69 | 56 | 58 | 23 | 15 | 18 | 6 | 5 | 6 | 1 | 654 |
| TL ± Sd (min.max) | | | | | | | | | | | | | | | | | |
| ♀ | 2.46±0.12 (0.40-4.00) | | 3.36±0.09 (1.91-5.20) | | 4.20±0.07 (2.50-5.60) | | 4.77±0.07 (3.30-6.56) | | 5.69±0.08 (4.31-6.84) | | 6.09±0.22 (4.33-7.41) | | 6.60±0.21 (5.89-7.29) | | 7.80±0.22 (7.40-8.78) | | 5.18±0.11 (0.40-8.78) |
| ♂ | 2.51±0.06 (0.60-3.89) | | 3.47±0.09 (1.63-5.00) | | 4.61±0.10 (3.20-5.87) | | 4.84±0.08 (3.20-6.50) | | 5.56±0.11 (4.49-6.54) | | 6.29±0.15 (5.14-7.44) | | 7.06±0.24 (6.02-7.52) | | 7.30±0 (7.30) | | 5.21±0.10 (0.60-7.52) |

was obtained for all: $L_t = 23.51\ (1 - e^{-0.041\ (t+\ 2.904)})$. The differences between observed and expected total lengths were statistically not significant in all age groups (t – test, P>0.05).

The weight rations based on the Von Bertalanffy growth equation are as follows for all individuals; $W_t = 786.25\ (1 - e^{-0.002\ (t\ +\ 0.2)})^{2.3348}$. The differences between the observed and expected weights were statistically not significant in all age groups (t – test, P>0.05). The total length-weight relationships were calculated for females, males and all of the *A. mento* samples. The length-weight relationships are visually represented in Figure 2, 3 and 4.

Fulton's coefficient of condition factor (C) was established with 623 specimens. The mean condition factor was 2.55±0.18.

The monthly stomach contents are presented as the percent distribution of organisms identified from the alimentary canal (Table 4). *Gammarus* sp. and *Palaemon* sp. are the major food resources for *A. mento*. Gastropods, fish larvae, odonata and nematods contribute to a small extent to the diet. *Gammarus* sp. between March and November, and *Palaemon* sp. throughout the year are consumed by *Aphanius mento*. The nematods (*Raphidascaris* sp.) were only found in January and February.

## Discussion

$Ca^{+2}$, $Mg^{+2}$, $Cl^{-}$ and total hardness values of Kırkgöz Spring are very high rations. The annual average of water temperature in the Kırkgöz Spring is fairly stable (15ºC). These features of the Kırkgöz Spring are in similar with other springs in the Taurus Mountains Chain (Değirmenci, 1989; Savaş and Cengiz, 1994). Kırkgöz Spring is one of the typical habitats in the most of adaptation of genera *Aphanius* and *Pseudophoxinus* that parallel varieted in Anatolia. (Hrbek *et al.*, 2002; 2004)

In this study, the age of *A. mento* from the Kırkgöz Spring ranged from 0 to VII. Nikolsky (1980) suggested that the situation in wide range of age distribution in a population is to be accepted as an indication of enough level in the food of water system. The decrease of individuals in old age groups in the population will cause increase of individuals in young age groups, decreasing the food competition. The individuals in age groups 0, I, II and III consist

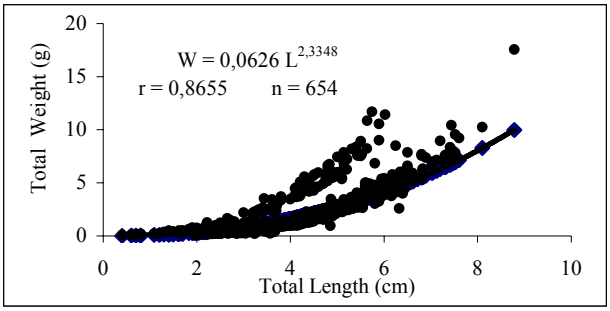


**Figure 2.** The total length–weight relationships of *A. mento* from the Kırkgöz Spring (♀- ♂).

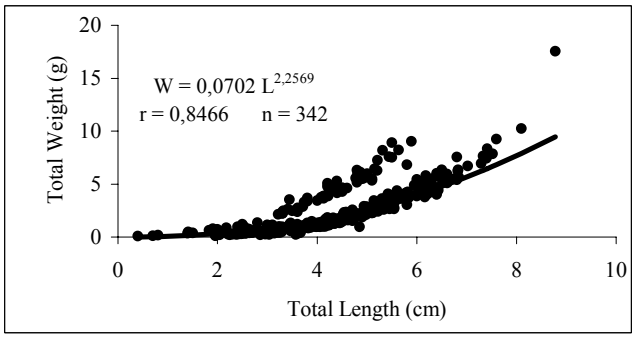


**Figure 3.** The total length–weight relationships of *A. mento* from the Kırkgöz Spring (♀).

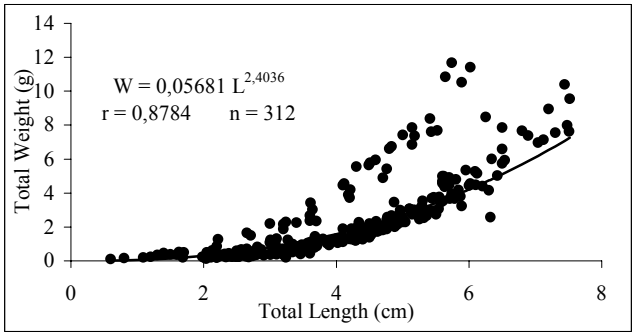


**Figure 4.** The total length–weight relationships of *A. mento* from the Kırkgöz Spring (♂).

**Table 4.** The monthly percent distribution of organisms in the alimentary canal of *A. mento* from the Kırkgöz Spring (%)

| | J | F | M | A | M | J | J | A | S | O | N | D | ∑ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Amphipoda** | | | | | | | | | | | | | |
| *Gammarus* sp. | - | - | 46.52 | 67.37 | 76.06 | 80 | 74.07 | 77.97 | 76.47 | 85 | 56.42 | - | 65.92 |
| Decapoda | | | | | | | | | | | | | |
| *Palaemon* sp. | 15.39 | 30.77 | 37.20 | 25.27 | 22.54 | 12.64 | 24.69 | 16.94 | 23.53 | 15 | 28.20 | 81.81 | 23.60 |
| **Gastropoda** | | | | | | | | | | | | | |
| *İslamia bunarbasa* | 11.53 | - | 2.32 | 4.21 | - | 1.06 | - | 1.69 | - | - | 7.69 | - | 2.13 |
| *Graecoanatolica pamphylica* | - | 11.54 | 4.66 | - | - | 2.10 | - | 1.69 | - | - | 7.69 | - | 1.80 |
| *Bithynia tenteculata* | 3.84 | 3.84 | 9.30 | 3.15 | - | 3.15 | 1.23 | - | - | - | - | 18.19 | 2.46 |
| **Nematoda** | | | | | | | | | | | | | |
| *Raphidascaris* sp | 69.24 | 53.85 | - | - | - | - | - | - | - | - | - | - | 3.60 |
| **Insecta** | | | | | | | | | | | | | |
| Odonata | - | - | - | - | - | 1.05 | - | 1.69 | - | - | - | - | 0.33 |
| **Others** | | | | | | | | | | | | | |
| Larvae of Fishes | - | - | - | - | 1.40 | - | - | - | - | - | - | - | 0.16 |

79.81% of population. The age of *Aphanius fasciatus* from Mesolongi and Etolikon Lagoon (Greece) ranged between 0-VI (Leonardos and Sinis, 1999), *Aphanius vladykovi* in Modar-Dokhtar Spring (Middle Zone of Iran) ranged between 0-II (Keivany and Soofiani, 2004), *Aphanius chantrei* from Sırakaraağaçlar Stream in Türkiye ranged between 0-II (Karslı, 2007) and *Aphanius anatoliae sureyanus* from the Burdur Lake (Mediterranean Zone of Türkiye) ranged from 0 to IV (Güçlü *et al.*, 2007). *A. mento* have a wide age range. The age range of *A. mento* was different from *A. vladykovi* (Keivany and Soofiani, 2004), *A. chantrei* (Karslı, 2007) and *A. a. sureyanus* (Güçlü *et al.*, 2007), but similar to *A.fasciatus* populations (Leonardos and Sinis, 1999).

The sex ratio of females to males of *A.mento* from the Kırkgöz Spring is 1.10 : 1.00 ($\chi^2$, P>0.05). This ration found in the research is similar to ration 1.00:1.00 that gives for a number of species (Nikolsy, 1980). According to Nikolsky (1980), sex ratio varies considerably from species to species; but in the majority of species, it is close to one. Of the total number of (F:M) caught fish, 2795 were female and 1145 were male giving an overall sex ratio of 2.44 : 1.00 of *A. fasciatus* from Mesolongi and Etolikon Lagoon (Leonardos and Sinis, 1997; 1999). The females in population of *A. fasciatus* from Lake of Mariut in Egypt are dominant; the sex ratio of females to males in this population is 2.10:1.00 (Penaz and Zaki, 1985). The sex ratio of females to males of *A. chantrei* is 1.06:1.00 (Karslı, 2007). The overall ratio of females to males is 0.64:1.00 of *A. a. sureyanus* from Burdur Lake (Güçlü *et al.*, 2007). The sex ratio of females to males is similar to *A. chantrei* (Karslı, 2007), but different from *A. fasciatus* (Penaz and Zaki, 1985), *A. fasciatus* (Koutrakis and Tsikliras, 2003) and *A. a. sureyanus* (Güçlü *et al.*, 2007). This situation may be caused by fishing apparatus and genetic structures of populations.

The total length values in the population of *A. mento*, *A. fasciatus* (Koutrakis and Tsikliras, 2003), *A. vladykovi* (Keivany and Soofiani, 2004), *A. iberus* from Mar Menor Coastal Lagoon (Verdiell-Cubedo *et al.*, 2006), *A. iberus* from Segura River Basin (Andreu-Soler *et al.*, 2006) and *A. chantrei* from Sırakaraağaçlar Stream in Türkiye (Karslı, 2007) are similar, but are higher than *A. a. sureyanus* (Güçlü *et al.*, 2007), *A. fasciatus* (Leonardos and Sinis, 1999) and *A. fasciatus* from Küçükçekmece Lagoon in Türkiye (Gaygusuz *et al.*, 2006). The difference may be caused by differences in the morphological features of the species and habitats.

The differences between in the observed and expected weights were statistically not significant (t test, P>0.05) of *A. mento* from Kırkgöz Spring. The average asymptotic total length (mm) values are 94.44 mm for females and 79.22 mm for males, the Brody growth coefficient values are 0.16 for females and 0.22 for males and the hypothetical age (year) values are -1.58 for females and –1.14 for males of *A. fasciatus* from Mesolongi and Etolikon Lagoon (Leonardos and Sinis, 1999). von Bertalanffy growth formula values of *A. mento* differ from those of *A. fasciatus* (Leonardos and Sinis, 1999), *A. chantrei* (Karslı, 2007) and *A. a. sureyanus* (Güçlü *et al.*, 2007). They may be caused by the habitat (Kırkgöz is a freshwater spring, Burdur Lake and Mesolongi-Etolikon Lagoon are brackish water) differences.

The exponents of total length – weight relationships are for combined sexes b= 2.3348 of *A. mento* and this is showed that Kırkgöz Spring has negative allometric growth. The relationship of total length – weight of *A. mento* samples correlation coefficient r= 0.8655 for combined sexes. This situation exhibits unimportant deviation expected regulation increase in relationships of total length – weight. In this study, relationship is similar to *A. vladykovi* (Keivany and Soofiani, 2004), *A.iberus* (Verdiell-Cubedo *et al.*, 2006) and *A.iberus* (Andreu-Soler *et al.*, 2006), but different from *A. fasciatus* (Koutrakis and Tsikliras, 2003), *A. fasciatus* from (Gaygusuz *et al.*, 2006) and *A.a.sureyanus* (Güçlü *et al.*, 2007). These situations may be caused by the habitats and also by morphological differences.

The population of *A. mento* feeds, as carnivore, with *Gammarus* sp. and *Palaemon* sp. that densely inhibits in the habitat. *Gammarus* sp. is consumed between March and November, whereas the uptake of *Palaemon* sp. occurs throughout the year. *Raphidascaris* sp., instead of nematods was only found in January and February. *Arctodiaptomus burduricus* and *Brachionus plicatilis* are the major food items for *Aphanius anatoliae sureyanus* from Burdur Lake (Türkiye). *Hexartha fennica*, nauplius larvae and dipterean larvae contribute to the diet to a small extent, whereas cyclopoid copepods and dipterean imagos are minor food items for *A.a.sureyanus* (Güçlü *et al.*, 2007).

In these results, the population of *A. mento* inhabiting in the Kırkgöz Spring is 0 – VII age groups and contains the individuals from 0, I, II and III age groups (79.81% of population). As a result, it exhibits that the population of *A. mento* is a developing population. It is suggested that the Kırkgöz Spring is an ideal habitat for *A. mento* and should be a conserved area for a survival natural ecosystems.

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## References

Andreu-Soler, A., Oliva-Paterna, F.J. and Torralva, M. 2006. A review of length–weight relationships of fish from the Segura River basin (SE Iberian Peninsula), J. Appl. Ichthyol., 22: 295–296.

Anonymous. 1985. Antalya Kırkgöz Kaynakları ve Traverten Platosu Karst Hidrolojik Etüd Raporu. D.S.İ. Genel Müdürlüğü, Ankara.

Balık, S. 1980. Güney Anadolu Bölgesi İçsularında

Yaşayan Tatlısu Balıklarının Sistematik ve Zoocoğrafik Yönden Araştırılması. AsProf. thesis, İzmir: Aegean University.

Bardakçı, F., Tatar, N. and Hrbek, T. 2004. Genetic Relationships Between Anatolian Species and Subspecies of *Aphanius* Nardo, 1827 (Pisces, Cyprinodontiformes) Based on RAPD Markers, Biologia, 59(5): 559-566.

Değirmenci, M. 1989. Köprüçay Havzası ve Dolayının (Antalya) Karst Hidrojeolojisi İncelemesi. PhD. thesis, Ankara: Hacettepe University, 375 pp.

Demirsoy, A. 2001. Yaşamın Temel Kuralları, Omurgasızlar/İnvertebrata (Böcekler Dışında). Ankara, 1210 pp.

Demirsoy, A. 2003. Yaşamın Temel Kuralları, Omusgasızlar/Böcekler (Entomoloji). Ankara, 940 pp.

Denizman, C. 1989. Kırkgöz Kaynakları ve Antalya Traverten Platosunun Hidrolojik Etüdü. MSc. thesis, Ankara: Hacettepe University.

Düzgüneş, O., Kesici, T. and Gürbüz, F. 1995. İstatistiki Metodlar, (II. Baskı), Ankara Üniversitesi Ziraat Fakültesi Yayınları No: 1291, Publ. No: 369, Ankara, 218 pp.

Fricke, R., Bilecenoglu, M. and Sari, H.M. 2007. Annotated checklist of fish and lamprey species of Turkey, including a Red List of threatened and declining species. Stuttgarter Beitrage zur Naturkunde, (Biologie), 706: 1-169.

Gaygusuz, Ö., Gürsoy, Ç., Özuluğ, M., Tarkan, A.S., Acıpınar, H., Bilge, G. and Filiz, H. 2006. Conversions of Total, Fork and Standard Length Measurements Based on 42 Marine and Freshwater Fish Species (from Turkish Waters). Turkish Journal of Fisheries and Aquatic Sciences, 6: 79-84.

Güçlü, S.S., Turna, İ.İ., Güçlü, Z. and Gülle, İ. 2007. Population Structure and Growth of *Aphanius anatoliae sureyanus* Neu, 1937 (Osteichthyes: Cyprinodontidae), Endemic to Burdur Lake, Turkey. Zoology in the Middle East, 41: 63-69.

Hrbek, T., Küçük, F., Frickey, T., Stölting, K.N., Wildekamp, R.H. and Meyer, A. 2002. Molecular phylogeny and historical biogeography of the *Aphanius* (Pisces, Cyprinodontiformes) species complex of central Anatolia, Turkey. Molecular Phylogenetics and Evolution, 25: 125-137.

Hrbek, T. and Wildekamp, R.H. 2003. *Aphanius villwocki*, a New Species from the Sakarya River Basin of Central Anatolian Plain, Turkey (Teleostei: Cyprinodontiformes), Ichthyol. Explor. Freshwater, 14(2): 137-144.

Hrbek, T. and Meyer, A. 2003. Closing of the Tethys Sea and the Phylogeny of Eurasian Killifishes (Cyprinodontiformes: Cyprinodontidae), J. Evol. Biol., 16: 17-36.

Hrbek, T., Stölting, K.N., Bardakçı, F., Küçük, F., Wildekamp, R.H. and Meyer, A. 2004. Plate Tectonics and Biogeographical Patterns of the Pseudophoxinus (Pisces: Cypriniformes) Species Complex of Central Anatolia, Turkey. Molecular Phylogenetics and Evolution, 32: 297-308.

İnnal, D. and Erk'akan, F. 2006. Effects of Exotic and Translocated Fish Species in the Inland Waters of Turkey, Rev. Fish Biol. Fisheries, 16: 39-50

Kara, F. 1992. Balıkçılık Biyolojisi ve Populasyon Dinamiği. Ege Üniversitesi Su Ürünleri Yüksekokulu Kitapları Serisi No:27, Ege Üniversitesi Basımevi. İzmir, 168 pp.

Karslı, Z. 2007. Sırakaraağaçlar Deresi (Sinop-Akliman) Sivrisinek Balığı, *Aphanius chantrei* Populasyonunun Bazı Biyolojik Özellikleri, MSc. thesis, Sinop: Ondokuz Mayıs University, 53 pp.

Keivany, Y. and Soofiani, N.M. 2004. Contribution to the Biology of Zagros Tooth Carp, *Aphanius vladykovi* (Cyprinodontidae) in Central Iran. Enviromental Biology of Fishes, 71: 165-169.

Koca, S.B. 2007. Determination of Rissoacea (Gastropoda, Prosobranchia) fauna in West Anatolia. PhD. thesis, Isparta, Eğirdir: Süleyman Demirel University. 165 pp.

Koutrakis, E.T. and Tsikliras, A.C. 2003. Length-Weight Relationships of Fishes From Three Northern Aegean Estuarine Systems (Greece). Journal Appl. Ichthyol., 19: 258-260.

Krupp, F. 1984. *Aphanius cypris* (Heckel, 1843) Versus *Aphanius mento* (Heckel, 1843) (Pisces: Cyprinodontidae), Cybium, 8(2): 63–69.

Kuru, M. 2004. Recent Systematic Status of Inland Water Fishes of Turkey. Gazi University, Ankara. Journal of Gazi Education Faculty, 24(3): 1-21.

Küçük, F. 1997. Antalya Körfezi'ne Dökülen Akarsuların Balık Faunası ve Bazı Ekolojik Parametreleri Üzerine Bir Araştırma. PhD. thesis, Isparta, Eğirdir: Süleyman Demirel University. 121 pp.

Leonardos, I. and Sinis, A. 1997. Early Development of *Aphanius fasciatus* (Nardo, 1827) in Mesolongi Lagoon (in Greek). Proceedings of the Fifth Hel. Symp. Oceanogr. and Fish., Greece, 2: 237–240.

Leonardos, I. and Sinis, A. 1999. Population Age and Sex Structure of *Aphanius fasciatus* (Nardo, 1827) (Pisces: Cyprinodontiformes) in the Mesolongi and Etolikon Lagoons (West Greece). Fisheries Research, 40(3): 227–235.

Nikolsky, G.V. 1980. Theory of Fish Poulation Dynamics as the Biological Background for Rational Exploitation and Management of Fishery Resources. Otto Koeltz Science Publishers, Koenigstein, 317 pp.

Penaz, M. and Zaki, M. 1985. Cyprinodont Fishes of Lake Maruit, Egypt Folia. Zoologica, 34: 373–384

Ricker, W.E. 1975. Computation and Interpretation of Biological Statistics of Fish Populations, No: 191, Fish. Res. Board Can. Bull., 382 pp.

Savaş, S. and Cengiz, M. 1994. Köprüçay Irmağının Eğirdir Gölü'ne Dökülen Kolunda Su Kalitesi Değişimi Üzerinde Bir Araştırma., Journal of Fisheries and Aquatic Science, 11: 42-43-44.

Smith, D.G. 2001. Pennak's Freshwater Invertebrates of the United States (Porifera to Crustacea), Fourth Edition. John Wiley & Sons, Inc., USA, 638 pp.

Sparre, P. and Venema, S.C. 1992. Introduction to Tropical Fish Stock Assasment, Part I, FAO Fisheries Technical Paper 306/1, Rome, 376 pp.

Verdiell-Cubedo, D., Oliva-Paterna, F.J. and Torralva, M. 2006. Length–weight relationships for 22 fish species of the Mar Menor coastal lagoon (western Mediterranean Sea), J. Appl. Ichthyol., 22: 293–294.

Wildekamp, R.H. 1993. A World of Killies, Atlas of the Oviparous Cyprinodontiform Fishes of the World, The Genera *Adamas*, *Adinia*, *Aphanius*, *Aphyoplatys* and *Aphyosemion*, American Killifish Association, Inc., U.S.A.

Wildekamp, R.H., Küçük, F., Ünlüsayın, M. and Van Neer, W. 1999. Species and Subspecies of the Genus *Aphanius* Nardo 1897 (Pisces: Cyprinodontidae) in Turkey, Tr. J. of Zoology, 23: 23-44.