www.trjfas.org
ISSN 1303-2712
Turkish Journal of Fisheries and Aquatic Sciences 11: 323-327 (2011) DOI: 10.4194/trjfas.2011.0217

Reproductive Biology of *Aphanius mento* (Heckel in: Russegger, 1843) (Osteichthyes: Cyprinodontidae) in Kırkgöz Spring (Antalya-Turkey)

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Received 02 September 2009
Accepted 25 January 2011

Abstract

The reproduction of *Aphanius mento* is described from the Kırkgöz Spring (Turkey) (37º06' N; 30°35' E) between January 2002 and December 2002. In this study, the sex ratio, age, the relationship between fecundity and fish length, weight and gonad weight, the gonadosomatic index, egg diameter and the first age of maturation were observed. Age range was determined as 0-VII years for 654 individuals. The overall male to female ratio was 1.10 : 1.00. Spawning period was between May and July. The first maturation was found to be at age I. First maturity length (L_m) was estimated at 2.45 cm for females. The mean fecundity per individual was found to be 228.48±28.60. The mean egg diameter was calculated as 1,240.09±53.26 μm.

Keywords: Killifish, Anatolia, GSI, fecundity.

Kırkgöz Kaynağı (Antalya-Türkiye)'nda Yaşayan *Aphanius mento* (Heckel in: Russegger, 1843) (Osteichthyes: Cyprinodontidae)'nun Üreme Biyolojisi

Özet

Bu çalışma Kırkgöz Kaynağı (Türkiye) (37º06' N; 30°35' E)'nda yaşayan *Aphanius mento* populasyonunun üreme özelliklerinin belirlenmesi amacıyla Ocak 2002-Aralık 2002 tarihleri arasında yapılmıştır. Çalışmada, populasyona ait bireylerin eşey ve yaş oranları, balık boyu, vücut ağırlığı ve gonad ağırlığı--yumurta verimliliği ilişkisi, gonadosomatik indeks, yumurta çapı, ilk üreme yaşı incelenmiştir. Populasyonun yaş aralığı 0-VII ve erkek: dişi oranı 1,10 : 1,00 (n=654)'dir. Üreme zamanı Mayıs-Temmuz ayları arasındadır. Populasyonun ilk üreme yaşı I ve dişi bireylerde ilk üreme boyu 2,45 cm olarak hesaplanmıştır. Bireylere ait ortalama yumurta verimliliği 228,48±28,60'dır. Ortalama yumurta çapı ise 1.240,09±53,26 μm olarak bulunmuştur.

Anahtar Kelimeler: Yosun balığı, Anadolu, GSİ, yumurta verimliliği.

Introduction

The Cyprinodontiform fishes of the genus *Aphanius,* extant as well as fossil, are widely distributed along the late-period Tethys Sea coast lines. Their present distribution has also been influenced through glacial and interglacial periods by the changes in the level of Mediterranean Sea (Wildekamp *et al.*, 1999). *Aphanius* is an important genus which reflect the effect on aquatic fauna of geological isolation in Anatolia. Genus of *Aphanius* are given important clues in the zoogeogrophical and bio-ecological studies. *Aphanius mento* (Heckel in: Russegger, 1843) is known from the Arabian Peninsula, Syria, Lebanon, coastal rivers in Israel and in western Jordan. Within Turkey, the species is found in the Kırkgöz Spring (Antalya), Ceyhan and Seyhan rivers, Kızılca (Bor-Niğde), Yeşilada Lake (Samandağ-Hatay), Tatlısuyu Kanalı (Ereğli-Konya), basin of the lowland Aksu River (Antalya) and the branches of Fırat River in Turkey (Krupp, 1984; Wildekamp, 1993; Wildekamp *et al*., 1999). This species usually inhabits fresh to lightly brackish water, springs, creeks, rivers and small lakes. Usually found amongst or close to vegetation where males establish territories (Wildekamp, 1993; Wildekamp *et al*., 1999). Majority of the researches on *A. mento* have been focused on molecular phylogeny and the taxonomy of the species (Wildekamp *et al*., 1999; Hrbek *et al*., 2002; Hrbek and Meyer, 2003; Bardakçı *et al*., 2004).

In the present study, information on the

reproduction characteristics of *A. mento* in the Kırkgöz Spring is presented.

Material and Methods

The Kırkgöz Spring (37°06′ N; 30°35′ E) is a spring flowing towards Antalya Bay originating 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. It covers a total wetland area of 7 hectares. The physical parameters (water temperature, dissolved oxygen, oxygen saturation, pH and conductivity) were measured by multimeter parameters in the field. The chemical parameters (Ca^{+2} and Mg^{+2}, EDTA method; Cl^- and HCO_3^-, titrimetric method with 0.05 N HCl; $SO_4^=$, spectrophotometric method with BaCl) were measured in the laboratory. The total hardness ($CaCO_3$) and total HCO_3 alkalinity values are calculated according to these chemical parameters. 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).

A total of 654 *A. mento* were collected from the Kırkgöz Spring between January 2002 and December 2002 with drift nets of tulle of 2 mm mesh size. The total lengths of all fish specimens preserved in formalin, were measured with 0.01 mm sensitive digital calipers, whereas body and gonad weights were recorded with an electronic balance by the nearest 0.01 g in the laboratory. Sex was determined by visual observation of the sexual dimorphism characteristics (body coloration). The overall ratio of males to females was evaluated with the χ^2 –test (Düzgüneş *et al*., 1995). The age determinations of samples were made from scales. The gonadosomatic index (GSI) was calculated as:

$$GSI = GW / W \times 100$$

where GW was the gonad weight and W, the total body weight of the fish (Gibson and Ezzi, 1980). Spawning period was determined from monthly evaluation of GSI. Fecundity was estimated by gravimetrically from the number of mature oocytes in 115 ripe females (spawning stage). The diameters of eggs were measured by means of a microscobic micrometer (Nikolsky, 1980). The relationship between fecundity and fish body size was expressed by equation:

$$F = a X^b$$

where F is the fecundity, X is the length, body weight and gonad weight, ‘a’ is the constant and ‘b’ is the slope (Bagenal and Braum, 1978; Elliott, 1995). The method used to estimate the maturity level of mature females was based on fitting of the sigmoid, logistic curve. Estimation of the length at first sexual maturity is as follows (De Martini *et al*., 2000): Firstly, it was plotted L against ln [(1-Px)/Px] using simple linear regression to estimate values for a and b. Where Px is the observed proportion of mature at length x. Secondly, the mean lengths at 50% maturity was calculated by Lm = -a/b. Thereafter, the estimated proportions of mature at length L were calculated using the equation

$$PL = 100 / [1+e^{b(L-Lm)}]$$

and give of first sexual maturity was drawn. Where PL is the estimated proportion of mature at length L (De Martini *et al*., 2000).

Results

The age of the fish ranged from 0 to VII years. Of the total fish examined, 312 (47.71%) were males and 342 (52.29%) were females (χ^2, P>0.05) (Table 2). The age composition for male and females and the sex ratio was presented for all age classes (Table 2).

Fecundity-length, fecundity-body weigth and fecundity-gonad weigth relationships of *A. mento* were described as; $F = 39.445 * TL^{0.8604}$ (r = 0.2976), $F = 66.973 * W^{0.7092}$ (r = 0.7009), $F = 500.956 * GW^{0.5511}$ (r = 0.7568), respectively.

Monthly changes in GSI are plotted in Figure 1. Spawning occurred between May and July. The GSI values reached a maximum in May (8.89% in females, 4.24% in males) and declined rapidly thereafter, reaching a minimum in December (0.64% in females, 0.70% in males) (Figure 1). The first maturation was found to be at age I. First maturity length (L_m) was estimated at 2.45 cm for females. Average fecundity per individual was found to be

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

Ca^{+2} (mg/L)	133.07	Total HCO_3 Alkalinity (mg/L $CaCO_3$)	338
Mg^{+2} (mg/L)	25.27	Water Temperature (°C)	15.8 (14.6-17)
Cl^- (mg/L)	14.0	Dissolved Oxygen (mg/L)	7.80 (6.64-10)
HCO_3^-(mg/L)	412.36	Oxygen Saturation (%)	90.91 (73-105)
SO_4^{-2} (mg/L)	10.0	pH	7.09 (6.88-7.58)
total hardness ($CaCO_3$) (mg/L)	436	Conductivity (25°C)(µS/cm)	695.5 (85-801)

Table 2. Age and sex distribution of females (F), males (M) and all *A. mento* individuals 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

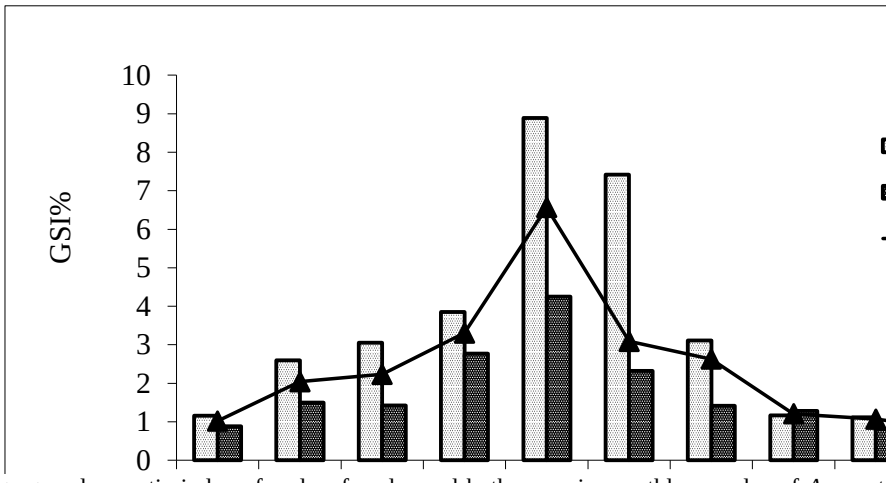

Figure 1. Average gonadosomatic index of males, females and both sexes in monthly samples of *A. mento* from Kırkgöz Spring.

228.48±28.6 number/individual/year (minimum 18 number/individual/year- maximum 474 number/ individual/year). Average egg diameter was calculated as 1240.09±53.26 µm.

Discussion

The annual average of water temperature in the Kırkgöz Spring is fairly stable (15ºC). This features of the Kırkgöz Spring are similar to other springs in the Toros Mountain Chain (Değirmenci, 1989; Savaş and Cengiz, 1994). Kırkgöz Spring is one of the typical habitats of genera *Aphanius*.

In the present 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 are accepted as a indication of sufficient level in the food of water system. The decrease of number of individuals in old age groups in the population would cause increase of individual in young age groups, decreasing the food competition. The individuals in age groups 0, I, II and III contain 79.81% of the population. *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) *A. iberus* (Garcia-Berthou and Moreno-Amich, 1992) (Delgado *et al*., 1988) and *A. a. aureyanus* (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. This ratio found in the research is similar to ratio 1.00:1.00 given 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. The sex ratio of females to males of *A. fasciatus* from Mesolongi and Etolikon Lagoon (Leonardos and Sinis, 1999), from Lake of Mariut in Egypt (Penaz and Zaki, 1985), *A. chantrei* from Sırakaragaçlar Stream in Turkey (Karslı, 2007) and *A. a. sureyanus* from Burdur Lake (Turkey) (Güçlü *et al*., 2007) is; 2.44:1.00, 2.10:1.00, 1.06:1.00 and 0.64:1.00, respectively. The overall sex ratio is similar to *A. chantrei* (Karslı, 2007), but differences from *A. fasciatus* (Penaz and Zaki, 1985) and *A. a. sureyanus* (Güçlü *et al*., 2007). This different situation may be caused by fishing gear and genetics structures of populations.

In the present study, the gonadosomatic index

and ovary condition suggested that the reproductive season of *A. mento* was between April and July with maximal GSI value in May. Based on our observations, eggs are adhesive and are attached to aquatic plants in small patches. Such a longer breeding season is a kind of adaptation of short-lived small fishes to environmental conditions (Miller, 1979). Female *A.dispar* in Suez Canal (Egypt) breed from March to September with maximal GSI value in May (19.4) and male GSI peaked in April (2.5) (Fouda, 1995). The reproduction season of *Aphanius vladykovi* in the Central Iran was between late March and June (Keivany and Soofiani, 2004), *A. fasciatus* in the Mesolongi and Etolikon Lagoons (West Greece) was between April to July (Leonardos and Sinis, 1998), *A.iberus* from Guadalquivir River spawned intermittently during the reproductive period from April to July (Fernandez-Delgado *et al*., 1988) and the reproduction season of the *A. chantrei* in the Sırakaraağaçlar Stream in Turkey was lasts from April to early October (Karslı, 2007). Our data are similar to other *Aphanius* populations.

The relationship between fecundity- total length of *A. mento* is very low levels ratio (r= 0.2976) and differences from other *Aphanius* populations (Fouda, 1995; Leonardos and Sinis, 1998; Fernandez-Delgado *et al*., 1988). The relationship between fecundity-weight and fecundity-gonads weight are similar to other *Aphanius* populations (Fouda, 1995; Leonardos and Sinis, 1998). Fecundity is affected by age, size, species, feeding of fish, season and environmental conditions (Nikolsky, 1980). The diameter of eggs were similar to other *Aphanius* populations egg diameters (Fouda, 1995; Leonardos and Sinis, 1998). One of the most important parameters used for determination of the reproductive potential is the variation of egg diameter in ovarian. The egg diameter is may be related to the amount of that females can metabolize (Nikolsky, 1963).

Acknowledgements

We wish to thank the Research Grant Council of Süleyman Demirel University for financial support, Dr İskender Gülle for great help in the field and Prof. Dr. İsmet Balık for contributions to the revision of the manuscript.

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