

The Reproductive Biology of the Tench (*Tinca tinca* L., 1758) in Kayaboğazı (Kütahya, Turkey) Dam Lake

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Abstract: This study was carried out between January 1996 and December 1997 in Kayaboğazı Dam Lake. During this period 424 specimens were examined. The age of females and males ranged from I to VII. The fork length and weight of females and males were 102-277 mm and 15-377.02 g and 125-274 mm and 27-369.02 g, respectively. There was no statistically significant difference between females and males in terms of body length and weight. The sex ratio (male:female) was 0.947:1. Gonadosomatic index values varied from 1.40 to 10.19. The sexual maturity age for males and females was III and IV, respectively. The spawning period was from the beginning of June to the end of July. The average number of eggs was estimated to be $42,724 \pm 5658.93$ for each individual.

In addition, the regression equations were $\text{Log } F = -2.18301 + 2.923 \log L$ ($r = 0.96$) for fecundity and body length (L) and $\text{Log } F = 2.889918 + 0.792 \log W$ ($r = 0.97$) for body weight (W).

Key Words: Kayaboğazı Dam Lake (Turkey), *Tinca tinca*, reproduction biology

Kayaboğazı Baraj Gölü (Kütahya-Türkiye)'nde Yaşayan Kadife Balığı (*Tinca tinca* L., 1758)'nin Üreme Biyolojisi

Özet: Bu çalışma, Ocak-1996, Aralık-1997 tarihleri arasında Kayaboğazı Baraj Gölü'nde yapılmıştır. Bu periyot süresince 424 birey incelenmiştir. İncelenen örneklerde dişi ve erkek bireylerin I-VII yaş arasında dağılım gösterdiği tespit edilmiştir. Çatal boy ve ağırlık dişi ve erkeklerde sırasıyla 102-277 mm, 15-377,02 g ve 125-274 mm, 27-369,02 g'dır. Dişi ve erkek bireylerin boyları ve ağırlıkları arasında istatistiksel açıdan bir fark bulunmadığı saptanmıştır. Eşey oranı (erkek:dişi) 0,947:1 olarak hesaplanmıştır. Gonadosomatik indeks değerleri 1,40-10,19 arasında değişim göstermiştir. Eşeyssel olgunluğa ulaşma yaşı erkek ve dişilerde sırasıyla III ve IV olarak tespit edilmiştir. Üreme periyodunun Haziran'ın başlangıcından Temmuz ayının sonuna kadar gerçekleştiği belirlenmiştir. Ortalama yumurta sayısı her bir birey için $42724 \pm 5658,93$ olarak tahmin edilmiştir.

Ayrıca, fekondite ile vücut uzunluğu (L) ve vücut ağırlığı (W) arasındaki regresyon eşitlikleri sırasıyla, $\text{Log } F = -2,18301 + 2,923 \log L$ ($r = 0,96$) ve $\text{Log } F = 2,889918 + 0,792 \log W$ ($r = 0,97$) olarak bulunmuştur.

Anahtar Sözcükler: Kayaboğazı Baraj Gölü (Türkiye), *Tinca tinca*, üreme biyolojisi

Introduction

The tench (*Tinca tinca*) has been widely cultivated not only in natural ponds but also in small lakes in Spain and it is widespread in Europe. It is also found in the anterior orient and western Siberia (1,2). Recently, it has been introduced into various inland waters in Turkey (3,4).

There have been several studies on the tench in European fresh waters: Horoszewicz (5) has studied its reproductive rhythm, Morawska (6) has advanced the

knowledge on the effects of water temperature elevation on incipient and cumulative fecundity of batch-spawning tench in ponds, and Herzig and Winkler (7) have investigated spawning temperature and the temperature range of optimal embryonic development of tench. Poncin et al. (8) have determined the control of reproduction of tench in heated water and under a natural or controlled photoperiod, and Pimpicka (9,10) has studied formation of fecundity of tench in Drweckie Lake in Poland, and Neophitou (11) has carried out a study on the

reproductive biology of tench in Pamvotida lake (Greece), and Linhard and Billard (12) have researched its reproductive biology in artificial conditions. Perez-Regadera and Gemio (13) have studied the reproduction of tench in spawning ponds in Spain. There are few studies about the tench in Turkey. Göktaş (14) has investigated its bioecological properties in Mogan Lake, Bircan (15) has determined its feeding biology in artificial conditions in the laboratory, and Atasagun and Karabatak (16) have examined its food biology in Mogan Lake. Alaş et al. (17) have investigated the adaptation of this species in Kayaboğazı Dam Lake, and Yılmaz (18) has studied its growth and reproductive biology in Porsuk Dam Lake. According to Yılmaz (18), spawning took place from the beginning of June to the end of July. Altındağ et al. (19,20) have examined growth parameters of this species in Kesikköprü and Bayındır Dam Lakes in Ankara province.

The present study was undertaken to investigate the reproduction of the tench population in Kayaboğazı Dam Lake on Kocasu (Adranos) stream in the Susurluk basin in Kütahya province in western Anatolia.

Materials and Methods

This study was carried out between January 1996 and December 1997 in Kayaboğazı Dam Lake (Figure 1).

During this study, 424 specimens were caught. Sampling was performed with gill nets of various mesh sizes (18 x 18, 24 x 24, 36 x 36, 44 x 44 and 60 x 60 mm). In the laboratory the body and gonad weight and fork length of each individual were measured to the nearest 0.01 g and 1.0 mm, respectively. Only scales were used for the age determination (4). The sexual characteristics were determined by examination of the gonadal tissue (11). In addition, the morphological characteristics of the ventral fin of males were used to determine sex (4,21). The gonado somatic index (GSI) was computed using the following equation (22):

$$GSI = \text{Gonad Weight (GW)} / \text{Body Weight (W)} \times 100$$

The diameter of each ripening ovum was measured. A minimum of 25 ova selected from different parts of the ovary were measured by means of compasses to the nearest 0.01 mm. The number of eggs was estimated by gravimetric methods (23).

Regression analyses were used to determine the relationship between fecundity (F) and body weight (W)

or body length (L). Therefore, the least squares equations are (24)

$$\text{Log F} = \text{log a} + \text{b log W} \text{ and } \text{Log F} = \text{log a} + \text{b log L}$$

The sexual maturity of the fish was determined by exposing the gonads by opening the ventral cavity (23).

The t test was applied to test the hypothesis and the confidence intervals of the parameters were estimated (25,26).

Results

In the samples examined, the age of females and males ranged from I to VII (Table 1). The fork length and weight of females and males were 102-277 mm and 15-377.02 g and 125-274 mm and 27-369.02 g, respectively (Tables 2 and 3).

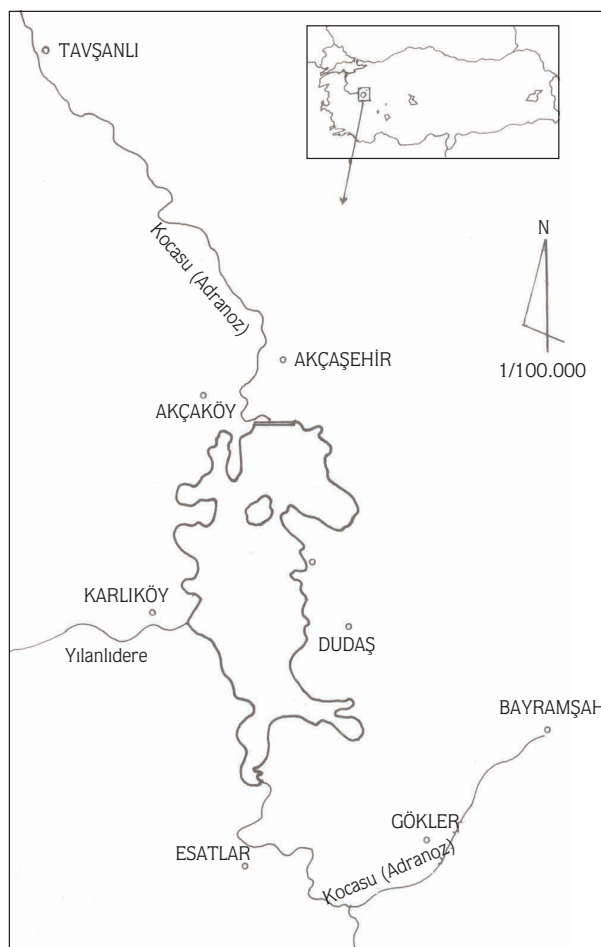


Figure 1. Map of Kayaboğazı Dam Lake.

Table 1. Sex ratio according to age of tench inhabiting Kayaboğazı Dam Lake.

| AGE | FEMALE | | MALE | | FEMALE + MALE | |
|-------|--------|-------|------|-------|---------------|--------|
| | N | % | N | % | N | % |
| I | - | - | - | - | 19 | 4.48 |
| II | 51 | 12.03 | 55 | 12.97 | 106 | 25.00 |
| III | 60 | 14.15 | 65 | 15.33 | 125 | 29.48 |
| IV | 50 | 11.79 | 38 | 8.96 | 88 | 20.75 |
| V | 21 | 4.95 | 16 | 3.77 | 37 | 8.73 |
| VI | 14 | 3.30 | 12 | 2.83 | 26 | 6.13 |
| VII | 12 | 2.83 | 11 | 2.59 | 23 | 5.42 |
| Total | 208 | 49.05 | 197 | 46.45 | 424 | 100.00 |

Table 2. Length range according to age and sex of tench inhabiting Kayaboğazı Dam Lake.

| AGE | FEMALE | | MALE | | t value | FEMALE + MALE | |
|-----|--------|--------------------------------------|------|--------------------------------------|---------|---------------|--------------------------------------|
| | N | L(mm) \pm S \bar{x} (Min-Max) | N | L(mm) \pm S \bar{x} (Min-Max) | | N | L(mm) \pm S \bar{x} (Min-Max) |
| I | - | - | - | - | - | 19 | 113.53 \pm 3.80 (91-135) |
| II | 51 | 142.24 \pm 1.98 (102-172) | 55 | 144.71 \pm 1.49 (125-163) | 1.00 | 106 | 143.52 \pm 1.23 (102-172) |
| III | 60 | 175.33 \pm 0.90 (159-190) | 65 | 174.84 \pm 0.86 (152-189) | 0.40 | 125 | 175.11 \pm 0.62 (152-190) |
| IV | 50 | 205.20 \pm 1.52 (183-226) | 38 | 205.13 \pm 1.94 (185-225) | 0.03 | 88 | 205.17 \pm 1.19 (183-226) |
| V | 21 | 232.29 \pm 2.71 (214-249) | 16 | 238.25 \pm 2.87 (224-262) | 1.51 | 37 | 234.86 \pm 2.01 (214-262) |
| VI | 14 | 249.21 \pm 1.90 (230-254) | 12 | 248.42 \pm 2.13 (229-253) | 0.28 | 26 | 248.85 \pm 1.39 (229-254) |
| VII | 12 | 264.58 \pm 3.67 (240-277) | 11 | 261.60 \pm 3.27 (236-274) | 0.61 | 23 | 263.16 \pm 2.44 (236-277) |

* : P < 0.05 ** : P < 0.01

The assessment of the main spawning season of this species in the dam lake was based on the GSI and analyses of seasonal development in mean egg diameter (Table 4).

Figure 2 shows the relationship between mean water temperature in the lake and seasonal development of the GSI of the tench.

According to Table 4 and Figure 2, the highest GSI values of specimens were observed in June. There was a decrease in GSI to the minimum value in August.

Spawning took place from the beginning of June to the end of July in almost all individuals. During the spawning period, mean water temperature was 16.1 \pm 2 °C and 19.2 \pm 2 °C in June and July, respectively (Table 4, Figure 2).

Table 4 shows that we were unable to measure mean egg diameter in August and September because there were not enough eggs. The largest mean egg diameter was in June and July (Table 4, Figure 3). When GSI values

Table 3. Weight range according to age and sex of tench inhabiting Kayaboğazı Dam Lake.

| AGE | FEMALE | | MALE | | | FEMALE + MALE | |
|-----|--------|--|------|--|---------|---------------|--|
| | N | L(mm) ± S _{\bar{x}} (Min-Max) | N | L(mm) ± S _{\bar{x}} (Min-Max) | t value | N | L(mm) ± S _{\bar{x}} (Min-Max) |
| I | - | - | - | - | - | 19 | 22.19 ± 2.02 (11.02-33.40) |
| II | 51 | 43.33 ± 1.58 (15.00-65.04) | 55 | 45.47 ± 1.24 (27.00-66.50) | 1.07 | 106 | 44.44 ± 1.00 (15.00-66.50) |
| III | 60 | 79.91 ± 1.35 (60.00-99.70) | 65 | 82.36 ± 1.25 (50.00-98.00) | 1.33 | 125 | 80.99 ± 0.92 (50.00-99.70) |
| IV | 50 | 133.50 ± 2.65 (101.90-165.50) | 38 | 132.66 ± 3.27 (108.80-170.10) | 0.20 | 88 | 133.14 ± 2.05 (101.90-170.10) |
| V | 21 | 210.90 ± 7.39 (165.00-263.50) | 16 | 208.37 ± 8.42 (174.00-281.60) | 0.23 | 37 | 209.80 ± 5.48 (165.00-281.60) |
| VI | 14 | 274.99 ± 6.27 (222.70-289.20) | 12 | 270.69 ± 6.26 (220.20-285.60) | 0.49 | 26 | 273.00 ± 4.38 (220.20-289.20) |
| VII | 12 | 334.39 ± 13.78 (242.75-377.02) | 11 | 320.14 ± 11.23 (240.00-369.02) | 0.80 | 23 | 327.58 ± 8.90 (240.00-377.02) |

* : P < 0.05, ** : P < 0.01

Table 4. The means with the standard error of gonadosomatic index values, mean egg diameter and number of *Tinca tinca* living in Kayaboğazı dam and mean water temperature in the lake.

| | GSI ($\bar{X} \pm S\bar{x}$) | 95% Confidence Interval | Egg diameter (mm) ($\bar{X} \pm S\bar{x}$) | 95% Confidence interval | Egg number/g ($\bar{X} \pm S\bar{x}$) | 95% Confidence interval | Water temperature (° C) | |
|---|-----------------------------------|-------------------------------|--|-------------------------------|---|-------------------------------|---------------------------------|------|
| J | 6.09 ± 0.07 | 5.95-6.23 | 0.748 ± 0.010 | 0.728 - 0.768 | 3613 ± 110.48 | 3396 - 3830 | 6.0 | |
| F | 6.56 ± 0.35 | 5.87-7.25 | 0.784 ± 0.012 | 0.759 - 0.809 | 3490 ± 176.82 | 3413 - 3837 | 2.1 | |
| M | 6.63 ± 0.03 | 6.57-6.63 | 0.817 ± 0.011 | 0.795 - 0.839 | 2682 ± 13.77 | 2655 - 2709 | 4.7 | |
| M | A | 8.64 ± 0.19 | 8.26-9.02 | 0.845 ± 0.013 | 0.820 - 0.870 | 2429 ± 34.15 | 2362 - 2496 | 5.4 |
| O | M | 9.74 ± 0.06 | 9.62-9.86 | 0.911 ± 0.007 | 0.897 - 0.925 | 2078 ± 38.49 | 2003 - 2153 | 12.5 |
| N | J | 10.19 ± 0.66 | 8.90-11.48 | 0.966 ± 0.035 | 0.898 - 1.034 | 1877 ± 161.15 | 1561 - 2193 | 16.1 |
| T | J | 7.81 ± 1.39 | 5.09-10.53 | 1.078 ± 0.014 | 1.051 - 1.105 | 1835 ± 87.89 | 1663 - 2007 | 19.2 |
| H | A | 1.40 ± 0.26 | 0.89-1.91 | * | * | * | * | 20.6 |
| S | S | 1.88 ± 0.21 | 1.47-2.29 | * | * | * | * | 18.7 |
| O | | 3.67 ± 0.39 | 2.92-4.42 | 0.532 ± 0.013 | 0.506 - 0.558 | 4924 ± 57.65 | 4811-5037 | 16.8 |
| N | | 4.74 ± 0.34 | 4.08-5.40 | 0.618 ± 0.007 | 0.604 - 0.632 | 4002 ± 44.31 | 3915 - 4089 | 11.0 |
| D | | 6.01 ± 0.19 | 5.65-6.37 | 0.719 ± 0.006 | 0.705 - 0.733 | 3985 ± 76.32 | 3835 - 4135 | 7.1 |

*could not be measured

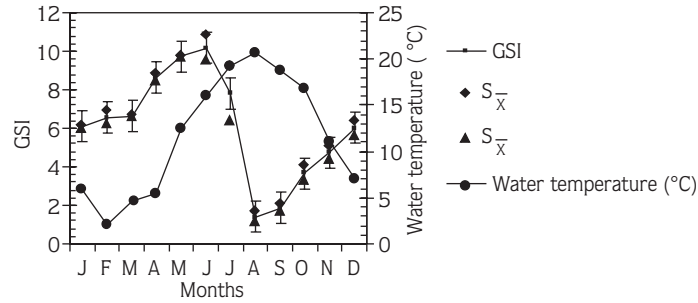


Figure 2. Seasonal changes in GSI of tench and mean water temperature in Kayaboğazı Dam Lake

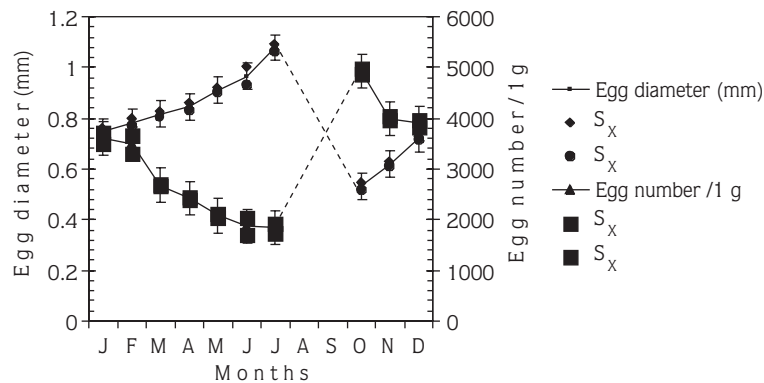


Figure 3. Seasonal changes in egg diameter and egg number of tench living in Kayaboğazı Dam Lake.

and mean egg diameters in Table 4 and Figures 2 and 3 are examined, the spawning period of the tench living in Kayaboğazı Dam Lake appears to be June and July (Table 4 and Figure 2).

The number of eggs ranged from $27,460 \pm 1486.67$ to $74,042 \pm 5975.50$. Mean number of eggs was $42,724 \pm 5658.93$ as well (Table 5).

The gonads of male and female specimens were observed in order to determine the age of attaining sexual maturity. Male and female specimens attained sexual maturity in the third and fourth year of life, respectively. The shortest fork length of tench attaining sexual maturity was 169 mm in males and 198 mm in females.

The regression equations were $\log F = -2.18301 + 2.923 \log L$ ($r = 0.96$) for fecundity and body length (L) and $\log F = 2.889918 + 0.792 \log W$ ($r = 0.97$) for fecundity and body weight (W). The statistical results of these relations are given in Table 6.

Discussion

The age distribution of the tench population for both sexes in Kayaboğazı Dam Lake ranged from I to VII. It was ranged from I to V in Kesikköprü Dam Lake (19). This distribution was I to VI in Bayındır Dam Lake (20). This age distribution was I-VIII in Porsuk Dam Lake in Kütahya (18). These results differ from our findings. This may be due to differences in genetics and ecological factors. Maximum life span is affected by water temperature, fishing and other ecological conditions (27).

According to Table 4 and Figures 2 and 3, spawning took place from the beginning of June to the end of July in almost all individuals. It was reported that spawning of the tench took place in June and July (7,8), and also in June and July in Porsuk Dam Lake (18).

On the other hand, in Lake Pamvotida (Greece), spawning of the tench took place during May and June at 18-20 °C water temperature (11). It was determined

Table 5. Changes in mean with standard errors for fork length (mm), body weight (g) and egg number according to the age of tench inhabiting Kayaboğazı Dam Lake.

| Age | N | L (mm) ($\bar{X} \pm S\bar{x}$) | W (g) ($\bar{X} \pm S\bar{x}$) | Mean egg number ($\bar{X} \pm S\bar{x}$) | 95 % Confidenc interval |
|------|----|--------------------------------------|-------------------------------------|---|-------------------------|
| IV | 50 | 205.20 ± 1.52 | 133.50 ± 2.65 | 27,460 ± 1486.67 | 24,546 - 30374 |
| V | 21 | 232.29 ± 2.71 | 210.90 ± 7.39 | 39,265 ± 3202.98 | 32,991 - 45547 |
| VI | 14 | 249.21 ± 1.90 | 274.99 ± 6.27 | 51,288 ± 2937.19 | 45,531 - 57045 |
| VII | 12 | 264.58 ± 3.67 | 334.39 ± 13.78 | 74,042 ± 5975.50 | 62,330 - 85754 |
| Mean | | | | 42,724 ± 5658.93 | 37,651 - 47796 |

Table 6. The results of correlation between fecundity and fish weight and length of tench inhabiting Kayaboğazı Dam Lake.

| | Fecundity |
|-----------------|-----------|
| Fork length (L) | 0.96** |
| Body weight (W) | 0.96** |

* : P < 0.05 ** : P < 0.01

that it took place from July to September in Mogan Lake (14) and from May to July in ponds in Spain (13). These differences between the results of various researchers may have resulted from different abiotic and biotic factors in each habitat. Since there are inadequate climatic or ecological data, it is not possible to make further comment.

The age of attaining sexual maturity of the tench living in Kayaboğazı Dam Lake was similar to the results of Göktaş (14) and Yılmaz (18). However, both sexes attained sexual maturity in the third year in Pamvotida Lake in Greece (11). This physicochemical situation can be caused by climatic and abiotic factors. Many factors such as physicochemical, biological and climatic factors may have direct and indirect effects on fish attaining sexual

maturity (28). In addition, the sexual maturity age of fish can change in different localities. This may be related to seasonal factors, feeding and water temperature.

A positive correlation between fecundity and fish weight and length has been described in most freshwater fish populations (24). In this study, a high correlation was calculated between fecundity and fish weight and length. However, as no data have been reported from Turkey, we are unable to comment on our results. According to Pimpicka (10), absolute fecundity varied from 18.4 to 416.1 thousand eggs, and relative fecundity from 85.7 to 543.9 thousand eggs per 1000 g of fish body weight in Drweckie Lake in Poland. The number of eggs is 42,724 ± 5658.93 in our findings for each specimen. Temperature patterns over the prespawning and spawning period exerted a determining effect on the number and fecundity of successive batches and cumulative fecundity during the season (6).

In conclusion, the tench was able to adapt well in Kayaboğazı Dam Lake because of its good reproduction ability. Therefore we suggest that specimens should not be caught before they reach sexual maturity age (III for males and IV for females) and from the beginning of June and the end of July to be able to preserve the tench population in this lake.

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