Turk J Zool
25 (2001) 127-133

Age, Growth and Reproduction of *Acanthalburnus microlepis*, Filippi 1863 from the Yağan Region of the Aras River, Turkey

Mustafa TÜRKMEN
Faculty of Fisheries, Mustafa Kemal University, İskenderun, Hatay - TURKEY
Orhan ERDOĞAN, H. İbrahim HALİLOĞLU
Department of Fisheries, Faculty of Agriculture, Atatürk University, Erzurum - TURKEY
Ayhan YILDIRIM
Department of Fisheries, Vocational School, Atatürk University, İspir, Erzurum - TURKEY

Received: 17.01.2000

Abstract: The age, growth and reproduction characteristics of 1105 *Acanthalburnus microlepis* from the Yağan region of the Aras River, Turkey, were determined from monthly samples. Ages ranged from 1 to 7 years. The sex ratio was approximately 1.0 (51.49 % males, 48.51 % females). Females attained greater size and age than males. Von Bertalanffy growth parameters were: L_∞= 29.87 cm, K= 0.1049, t_0= -1.92. The length-weight relationships for males and females were found to be $W=0.0099L^{3.098}$ and $W=0.0118L^{3.052}$ respectively. The condition coefficients of males and females were calculated as 1.192 and 1.209 respectively. Both sexes matured at the age of 2 years. Spawning started in early May and continued to the end of July. Fecundity ranged from 2830 to 9705 eggs/female and correlated significantly with fish length, weight, age and gonad weight.

Key Words: Age, Growth, Reproduction, *Acanthalburnus microlepis*, Aras River.

Aras Nehri'nde (Yağan Mevkii) Yaşayan *Acanthalburnus microlepis*, Filippi 1863 Türünün Büyüme ve Üreme Özellikleri

Özet: Bu araştırmada, Temmuz 1996 ve Haziran 1998 tarihleri arasında Aras Nehri'nin Yağan bölgesinden aylık olarak yakalanan 1105 adet *Acanthalburnus microlepis* türü incelenmiştir. Örnekler 1-7 yaşlar arasında dağılım göstermiş olup, %51.49'u erkekler, %48.51'i dişilerden oluşmaktadır. Dişiler, erkelerden daha büyük boy ve yaşlara ulaşmış olup, Von Bertalanffy büyüme parametreleri L_∞= 29.87 cm, K= 0.1049, t_0= -1.92 olarak hesaplanmıştır. Boy-ağırlık ilişkileri erkek ve dişiler için sırasıyla; $W=0.0099L^{3.098}$ ve $W=0.0118L^{3.052}$ olarak hesaplanmıştır. Her iki cinsiyette de 2 yaşında cinsi olgunluğa ulaşan bireylerde üreme Mayısın ilk haftasında başlayıp, Temmuzun sonuna kadar devam etmiştir. Fekondite 2830-9705 adet/dişi arasında değişmiş olup, balığın boyu, yaşı, gonad ve toplam ağırlığı ile birlikte artmıştır.

Anahtar Sözcükler: Yaş, Büyüme, Üreme, *Acanthalburnus microlepis*, Aras Nehri

Introduction

Acanthalburnus microlepis, Filippi 1863 is widely distributed throughout the rivers Aras and Kura in Eastern Anatolia, Turkey (1), but there is no information about its age, growth, population structure and reproduction. This study is the first to describe these basic biological characteristics of this species inhabiting the Aras River, and the results of this study will provide basic information for other studies on this species.

Study Area, Materials and Methods

The study was conducted in the Yağan region of the Aras River in the Eastern Anatolia Region, Turkey (Figure 1). This area was about 20 km long, 10-40 m wide and 50-200 cm deep. This region has terrestrial climate. During the study, air and water temperatures varied from -35 to 30ºC and from 1.0 to 26ºC respectively. The Aras River starts to freeze in early December and becomes ice-free by the end of February or early March. The dominant fish species in this study area are *Capoeta capoeta capoeta*

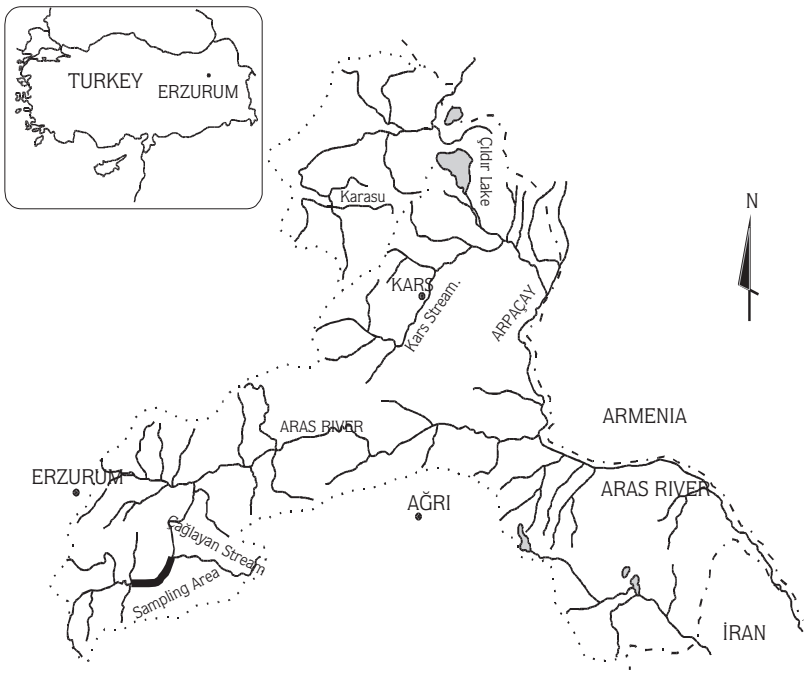

Figure 1. Study Area.

Guldenstaedt 1773, *A. microlepis*, and *Leuciscus cephalus orientalis* Nordmann 1840 (1).

Specimens were captured monthly between July 1996 and June 1998 using nets (12-22 mm mesh sizes). They were frozen immediately and transported to the laboratory where, once thawed, fork length (L), total weight (W), gonad weight (W_g) and sex were recorded. Age was determined from microscopic examination of scales. Ten to fifteen scales from the left side of the body between the lateral line and dorsal fin were removed and mounted dry between two slides for binocular microscopic study (2). The Von Bertalanffy growth equation was calculated according to $L_t = L_\infty(1-e^{-K(t-t0)})$. The commonly used length-weight relationship ($W = aL^b$) was applied. Condition coefficients were calculated using the formula, $CF=(W/L^3)100$ (3).

Sex was determined by examination of the gonad tissue either with the naked eye for larger fish or with a microscope for smaller fish. The sexual maturity and spawning period were estimated from the gonad-somatic index (GSI), direct observation of the gonads and monthly variations in egg sizes of samples. Gonads were removed, weighed to the nearest 0.01 g and the ovaries were preserved in Gilson's fluid. GSI was calculated from the equation, $GSI=(W_g/W_t)100$. Fecundity was estimated by the gravimetric method (4). The sizes of eggs taken out from the front, middle and back parts of ovaries which were in females of various size captured just prior to the spawning period were measured by compass (1/20). The relationships between fecundity and fork length ($F = aL^b$), total weight ($F = aW^b$), ovary weight ($F = aW_o^b$), age ($F = at^b$) and other statistical calculations were made according to Yıldız and Bircan (5).

Results

Age and Sex Distribution

The ages of captured fish were between one and seven years, with three-year-old fish being the most numerous. The numbers of males (569-51.49 %) and females (536-48.51 %) gave an overall sex ratio that was not significantly different from 1:1 ($p>0.05$). However, males were relatively more numerous at ages 1 to 3 whereas females predominated at older ages (Table 1). In the population, males by age 3 were dominant and after this age females were dominant. No seven-year-old male fish captured (Table 1).

Growth

The length differences between males and females were not statistically significant at ages 1 and 2. The differences at ages at 3 and 4 were statistically significant but they are small differences; the difference at age 6 is

Table 1. The age and sex distribution of samples (N: The number of fish).

Age	Male+Female		Male		Female		p=0.05
	N	%	N	%	N	%	
1	100	9.05	61	5.52	39	3.53	p>0.05
2	220	19.91	125	11.31	95	8.60	p>0.05
3	355	32.13	194	17.56	161	14.57	p>0.05
4	294	26.61	139	12.58	155	14.03	p>0.05
5	103	9.32	43	3.89	60	5.43	p>0.05
6	28	2.53	7	0.63	21	1.90	p>0.05
7	5	0.45	-	-	5	0.45	-
Total	1105	100.00	569	51.49	536	48.51	p>0.05

less convincing because of the small sample (N=7) of males (Table 2). The Von Bertalanffy growth equation calculated for this species by using mean fork lengths at ages was found to be $L_t = 29.87(1-e^{-0.10409(t+1.92)})$ (Figure 2).

Males were heavier until age 2, but after then females were heavier in the population (Table 1). Differences between sexes for total weight were statistically significant only at ages 4 and 5.

Length-weight relationship

The length-weight relationships calculated by using the lengths and weights of the samples were found to be $W=0.0099L^{3.098}$ for males and $W=0.0118L^{3.052}$ for females, and were plotted in Figure 3. The slopes (b) of the fork length-weight regressions, which were not different significantly between sexes ($p > 0.05$), indicated

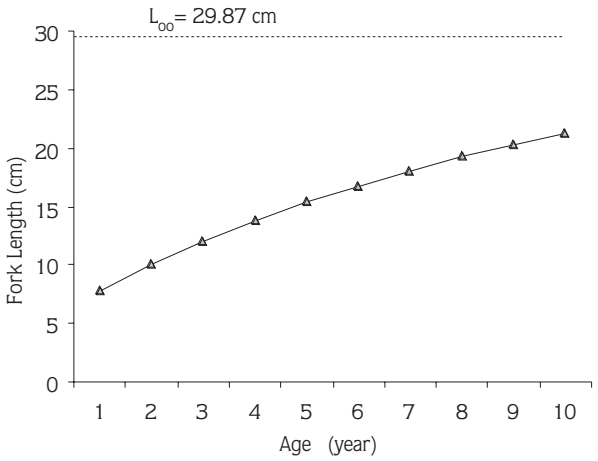

Figure 2. Von Bertalanffy's growth curve fitted to mean length-at-age values of *A. microlepis*.

Table 2. The mean fork length (L) and mean weight (W) with standard error (SE) of different age groups of *A. microlepis* (N: The number of fish).

Age	Male+Female (Total N: 1105)		Male (Total N: 569)		Female (Total N: 536)	
	$\bar{L}$ ± SE (cm)	$\bar{W}$ ± SE (g)	$\bar{L}$ ± SE (cm)	$\bar{W}$ ± SE (g)	$\bar{L}$ ± SE (cm)	$\bar{W}$ ± SE (g)
1	7.78 ± 0.08	5.74 ± 0.22	7.81 ± 0.12	5.82 ± 0.29	7.73 ± 0.11	5.61 ± 0.33
2	10.20 ± 0.07	12.97 ± 0.33	10.24 ± 0.08	12.84 ± 0.39	10.15 ± 0.13	13.15 ± 0.57
3	11.97 ± 0.05	20.68 ± 0.35	11.86 ± 0.06	20.21 ± 0.44	12.11 ± 0.09	21.25 ± 0.55
4	13.67 ± 0.05	31.74 ± 0.48	13.48 ± 0.07	29.99 ± 0.60	13.84 ± 0.07	33.30 ± 0.70
5	15.13 ± 0.09	44.04 ± 1.01	14.87 ± 0.11	41.09 ± 1.60	15.31 ± 0.12	46.15 ± 1.24
6	16.68 ± 0.25	62.22 ± 3.25	16.27 ± 0.54	57.70 ± 5.42	16.81 ± 0.28	63.72 ± 3.95
7	18.12 ± 0.92	77.85 ± 8.32	-	-	18.12 ± 0.92	77.85 ± 8.32

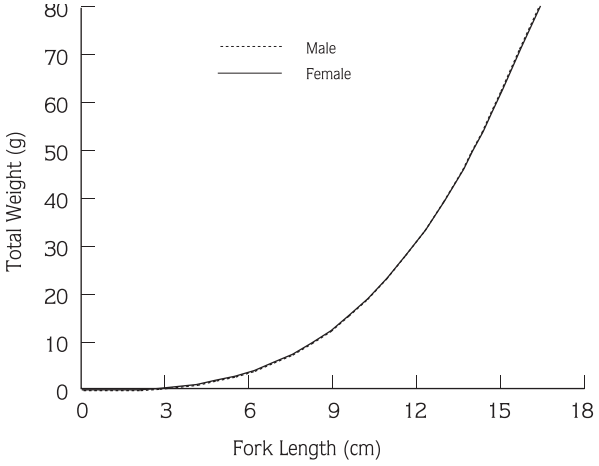

Figure 3. Length-weight curves of *A. microlepis*.

isometric growth (b ranged between 3.052 and 3.098). These values for each sex were not significantly different from 3.0.

Condition coefficient

Although the mean condition coefficient of females (1.209) was higher than that of males (1.192), the differences between sexes were not statistically significant ($p>0.05$) (Table 3, Figure 4). Table 3 and Figure 4 show that the condition coefficient increases when age increases.

Seasonal variations in condition coefficients were also determined for both sexes (Figure 5). Monthly examination of condition showed a generally similar pattern in both sexes, with two maxima, one in May 1997 (at the beginning of spawning) and another in June 1998 (in the spawning season) in both sexes, and with one minimum in February 1997 in both sexes.

Reproduction

Age at spawning was studied in 375 females and 387 males. Males and females matured at 2 years old. There were no differences between sexes in length and age at first spawning. The maturity according to ages was determined and the results were summarized as: 53 % of males were mature at age 2, 95 % at age 3 and 100 % at > 4; 22 % of females were mature at age 2, 83 % at age 3 and 100 % at > 4.

Gonad development was studied by using the monthly changes in the GSI of 496 males and 469 females (Figure 6). Spawning in both years of the study started in early May and continued to the end of July, when water temperatures were between 14 and 24ºC. In the first year, after spawning, there seemed to be a eight-month quiescent period (August 1996-March 1997), and during spring (April-May) a rapid growth of the gonads occured before the next spawning. Also, in the second year of the

Table 3. The mean condition coefficients (CF), standard error (SE) of different age groups of *A. microlepis*.

Age	Male+Female $\overline{CF}$±SE (Min-Max)	Male $\overline{CF}$±SE (Min-Max)	Female $\overline{CF}$±SE (Min-Max)	p=0.05
1	1.165± 0.023 (0.714-1.679)	1.161 ± 0.028 (0.854-1.679)	1.170 ± 0.040 (0.714-1.613)	p>0.05
2	1.182± 0.014 (0.588-1.941)	1.165 ± 0.020 (0.588-1.800)	1.203 ± 0.021 (0.746-1.941)	p>0.05
3	1.178± 0.010 (0.743-1.695)	1.190 ± 0.014 (0.853-1.695)	1.163 ± 0.013 (0.743-1.631)	p>0.05
4	1.223± 0.009 (0.798-1.747)	1.211 ± 0.015 (0.798-1.711)	1.233 ± 0.012 (0.859-1.747)	p>0.05
5	1.255± 0.017 (0.814-1.669)	1.232 ± 0.030 (0.814-1.669)	1.272 ± 0.019 (1.032-1.578)	p>0.05
6	1.319± 0.037 (1.064-1.692)	1.331 ± 0.071 (1.111-1.643)	1.315 ± 0.044 (1.064-1.692)	p>0.05
7	1.317± 0.100 (0.951-1.540)	-	1.317 ± 0.100 (0.951-1.540)	p>0.05
Total	1.201± 0.004 (0.588-1.941)	1.192 ± 0.008 (0.588-1.800)	1.209 ± 0.008 (0.714-1.941)	p>0.05

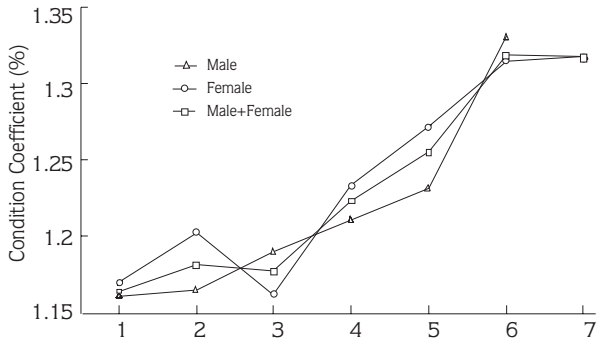

Figure 4. Condition coefficient at ages and sexes of *A. microlepis*.

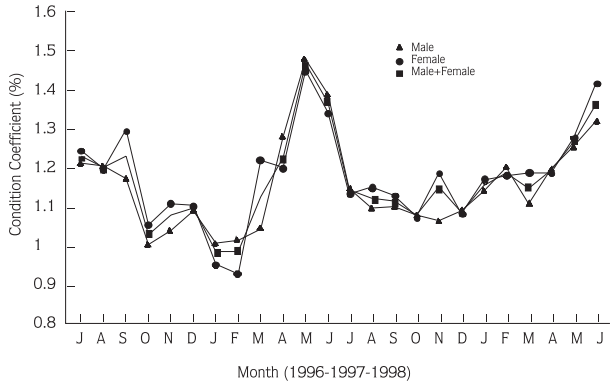

Figure 5. Seasonal variations in condition coefficient of *A. microlepis*.

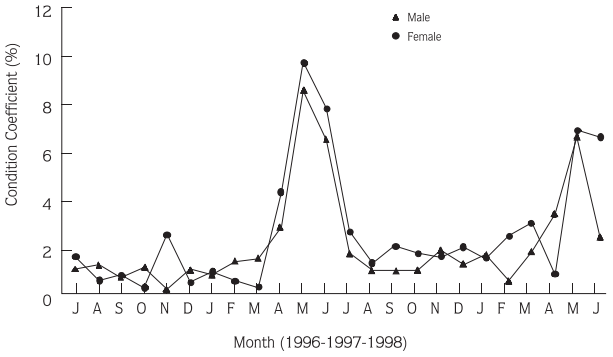

Figure 6. Monthly variations of GSI in *A. microlepis*.

study, the cycle of GSI was approximately similar to that in the first year (Figure 6).

Fecundity

Fecundity was estimated in 57 females captured just prior to spawning. Female *A. microlepis* maturing at age 2 produced a mean of 2830 eggs per female. At age 7, this rose to a mean of 9705 eggs per female. Fecundity was correlated with fish length, weight, age and ovary weight, and fecundity and egg size increased with the fish length, weight, ovary weight and age. The relationships between fecundity (F) and fish length (L), fish weight (W), ovary weight (W_0), fish age (t) were calculated as $F=11.261L^{2.246}$ (r=0.751), $F=317.263W^{0.715}$ (r=0.782), $F=2994.813W_0^{0.597}$ (r=0.736) and $F=1049.812t^{1.363}$ (r=0.645) respectively. The best correlation with fecundity was found to be the weight of fish. Egg sizes in females captured in the spawning period varied from 0.70 to 1.65 mm, and increased with fish length, weight and age.

Discussion

In this study, the age of specimens ranged between 1 and 7 years. Because of the large mesh size (12-22 mm), fish less than 1 year old were not represented. Although the oldest male and female were 6 and 7 years old respectively, older fish may exist in the river, but were probably not captured because of the mesh sizes and natural obstacles. The sex ratio of captured specimens was 1.06/1.0 (M/F), not significantly different from 1:1. It is well known that the sex ratio in the majority of species is close to one (6). In the early life stages, the rate of males was higher than that of females, but older females were more numerous than males. Similar patterns were also reported by many researchers (7-10).

The differences at ages 3 and 4 were statistically significant but they are small differences; the differences at age 6 is less convincing because of the small sample (N=7) of males. Variations in fish growth in length and weight can be explained as an adaptive response to different environmental conditions (11).

The condition coefficient increased with age. Ekmekçi (8), Altındağ (12) and Türkmen, et al. (13) reported similar patterns. Seasonal condition generally showed a similar pattern in both sexes and it was generally higher in the feeding and spawning months, but it was lower in other months. Variations in condition coefficients may be explained by differences in environmental conditions and between species (14).

The values of "b" in the length-weight relationship of males (3.032) and females (3.098) were very close to each other. Türkmen and Akyurt (10) and Vitali and Braghieri (15) reported similar patterns. Values of "b"

are often 3.0 and generally between 2.5 and 4.0. The values of "b" in fish differ according to the species, sex, age, sexual maturity of fish, season and fish feeding (3).

First spawning age for both sexes was 2 years old. Spawning in both years of the study occurred between May and July. The spawning characteristics of fishes vary with respect to their species and the ecological characteristic of the water system in which they live. These characteristics of fishes are determined by environmental factors (16).

Fecundity varied from a mean of 2830 eggs per female (2 years old) to a mean of 9705 eggs per female (7 years old), and it correlated significantly with fish length, weight, age and gonad weight. Fecundity increased when the fish length, weight, gonad weight and age increased, and larger and older fish showed a higher fecundity. It was reported that fecundity increased when fish length, weight, age and gonad weight increased (17). A major feature of fecundity is its increase (with certain limits) during the growth of fish. A large fish lays more eggs than a small one, and the correlation of fecundity with weight in most fish is higher than that with length, which in turn is higher than that with age (14). The egg sizes in captured females just prior to the spawning period varied from 0.70 to 1.65 mm. Many researchers reported that egg size increased with fish length, weight and age (13,18-20).

Based on these results and evaluations, in order to maintain the population in equilibrium, it is of great importance to give each fish the chance of reproduction at least once in its lifetime, and therefore, the minimum fishing size should be 15.7 cm for fork length. Prohibition of fishing is recommended during the spawning season which extends between April and August. The water temperature should also be taken into consideration

Acknowledgments

The authors wish to thank Prof. Dr. İhsan AKYURT for his technical assistance during our study.

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