Turk J Zool
25 (2001) 163-168

On the Age, Growth and Reproduction of the Barbel, *Barbus plebejus escherichi* (Steindachner, 1897) in the Oltu Stream of Çoruh River (Artvin-Turkey)

Ayhan YILDIRIM
Department of Fisheries, Hamza Polat Vocational School, Atatürk University, İspir, Erzurum - TURKEY
Orhan ERDOĞAN
Department of Fisheries, Faculty of Agriculture, Atatürk University, Erzurum - TURKEY
Mustafa TÜRKMEN
Faculty of Fisheries, Mustafa Kemal University, İskenderun, Hatay - TURKEY

Received: 19.06.1998

Abstract: In this study, the age, growth and reproduction properties of 627 barbels, *Barbus plebejus escherichi* (Steindachner, 1897), from Oltu Stream in the Çoruh River Basin were investigated during a period from August 1994 to July 1996. The age of this species ranged between age groups 1 and 10, the second age group being dominant. Individuals were composed of 64.59% males and 35.41% females. von Bertalanffy growth parameters and length-weight relationships were $L_t=29.35x(1-e^{-0.139(t+1.640)})$, $W_t=281.11x(1-e^{-0.139(t+1.640)})^{2.843}$, $W=0.0189.FL^{2.843}$ (r=0.96) in males and $L_t=32.77x(1-e^{-0.116(t+1.891)})$, $W_t=392.10x(1-e^{-0.116(t+1.891)})^{2.911}$, $W=0.0152.FL^{2.911}$ (r=0.97) in females. Condition coefficients of males and females were calculated to be 1.221 and 1.220 respectively. Sexual maturity was 11.45-13.75 cm fork length (2-3 years old) in males and 13.65-15.95 cm (3-4 years old) in females. Fecundity was calculated to be 1256 (3^{rd} age group)-8445 (7^{th} age group) eggs/female. The spawning period was between May and July when the water temperature was between 14 and 19ºC in both years.

Key Words: Age, Growth, Reproduction, Barbel, *Barbus plebejus escherichi*.

Çoruh Nehri Oltu Çayı'nda (Artvin-Türkiye) Yaşayan Bıyıklı Balık, *Barbus plebejus escherichi* (Steindachner, 1897)'nın Yaş, Büyüme ve Üreme Özelliklerinin İncelenmesi

Özet: Bu çalışmada, Ağustos-1994 ile Temmuz-1996 tarihleri arasında Çoruh nehri Oltu Çayı'ndan yakalanan 627 adet, *Barbus plebejus escherichi* (Steindachner, 1897)'nin yaş, büyüme ve üreme özellikleri incelenmiştir. Yaş dağılımı 1-10 arasında dağılım göstermiş olup, 2 yaş dominant olduğu belirlenmiştir. Bireylerin %64.59'unu erkekler, %35.41'ini dişiler oluşturmuştur. von Bertalanffy büyüme parametreleri ile boy-ağırlık ilişkileri erkek ve dişilerde sırasıyla; $L_t=29.35x(1-e^{-0.139(t+1.640)})$, $W_t=281.11x(1-e^{-0.139(t+1.640)})^{2.843}$, $W=0.0189.FL^{2.843}$ (r=0.96) ve $L_t=32.77x(1-e^{-0.116(t+1.891)})$, $W_t=392.10x(1-e^{-0.116(t+1.891)})^{2.911}$, $W=0.0152.FL^{2.911}$ (r=0.97) olduğu tespit edilmiştir. Kondisyon faktörü erkeklerde 1.221, dişilerde ise 1.220 olduğu belirlenmiştir. Cinsi olgunluk boyu erkeklerde 11.45-13.75 cm FL (2-3 yaş), dişilerde 13.65-15.95 cm FL (3-4 yaş) olarak belirlenmiştir. Fekondite 1256 (3. yaş)-8445 (7. yaş) adet/birey arasında değişmiştir. Üreme; her iki yılda da su sıcaklığının 14-19ºC olduğu mayıs-temmuz aylarında olduğu belirlenmiştir.

Anahtar Sözcükler: yaş, büyüme, üreme, bıyıklı balık, *Barbus plebejus escherichi*

Introduction

The *Barbus plebejus escherichi* is a subspecies of the genus Barbus of Cyprinidae and widely is distributed in the basin of Black Sea, Marmara Sea and Aegean Sea (1-18). There is little information about taxonomic and systematic characteristics of *Barbus plebejus escherichi* living in the Çoruh Basin (1, 4, 10). This study is the first on the age, growth and reproductive characteristics of this subspecies Oltu stream of Çoruh Basin.

Study Area, Materials and Methods

This study was carried out at Oltu Stream, one of the most important branches of the Çoruh Basin in eastern Turkey (41º 41' 49' ' E- 40o 46' 51' ' N). During this study, air and water temperatures varied from +9 to +28ºC and from +6 to +26ºC respectively. The source of the river is in the East Anatolia Region of Turkey (Figure 1). Specimens were captured monthly by means of cast nets with 12-12 mm mesh sizes between August 1994 and July 1996. The captured fish were frozen immediately and transported to the laboratory where, once thawed, their size (FL, ±1 mm), weight and gonad weight (W ±1 g) were determined. Sexes were determined by examination of the gonad tissue either by eye for bigger fish or with the aid of a microscope for smaller fish. Age was determined from microscope examination of scales. Mean length at age data were used to estimate the growth parameters of the von Bertalanffy growth equation $L_t = L_\infty(1-e^{-K(t+to)})$ in length and $W_t = W_\infty(1-e^{-K(t+to)})^b$ in weight. The length-weight relationship was estimated as $W=a.FL^b$. The condition coefficient was calculated for both sexes using the formula $K=(W/FL^3)$ x100 (19,20).

The age of sexual maturity and the spawning period were estimated from the gonad development (GSI) and monthly variations of the samples. Gonads were removed and weighed to the nearest 0.1 g and the ovaries were preserved in 7% formaldehyde solution. Gonadosomatic index (GSI) was calculated from the equation GSI=(Wg /Wt)x100. Fecundity was estimated by the gravimetric method (22). The relationships between fecundity and fork length, total weight, gonad weight and age were calculated from the equations $F= aFL^b$, $F= aW^b$, $F= aGW^b$ and $F= at^b$ respectively (23). All calculations were made using Statistica 5.0 for Windows 95.

Results

Sex Ratio and Age Composition

The sex ratio and age composition of specimens are given in Table 1. Most fish were 2 years old. The oldest males and females were 8 and 10 years old respectively. Although older fish may exist in the river, probably they were not caught because of mesh sizes and natural obstacles. Samples were composed of 64.59% males and 35.41% females.

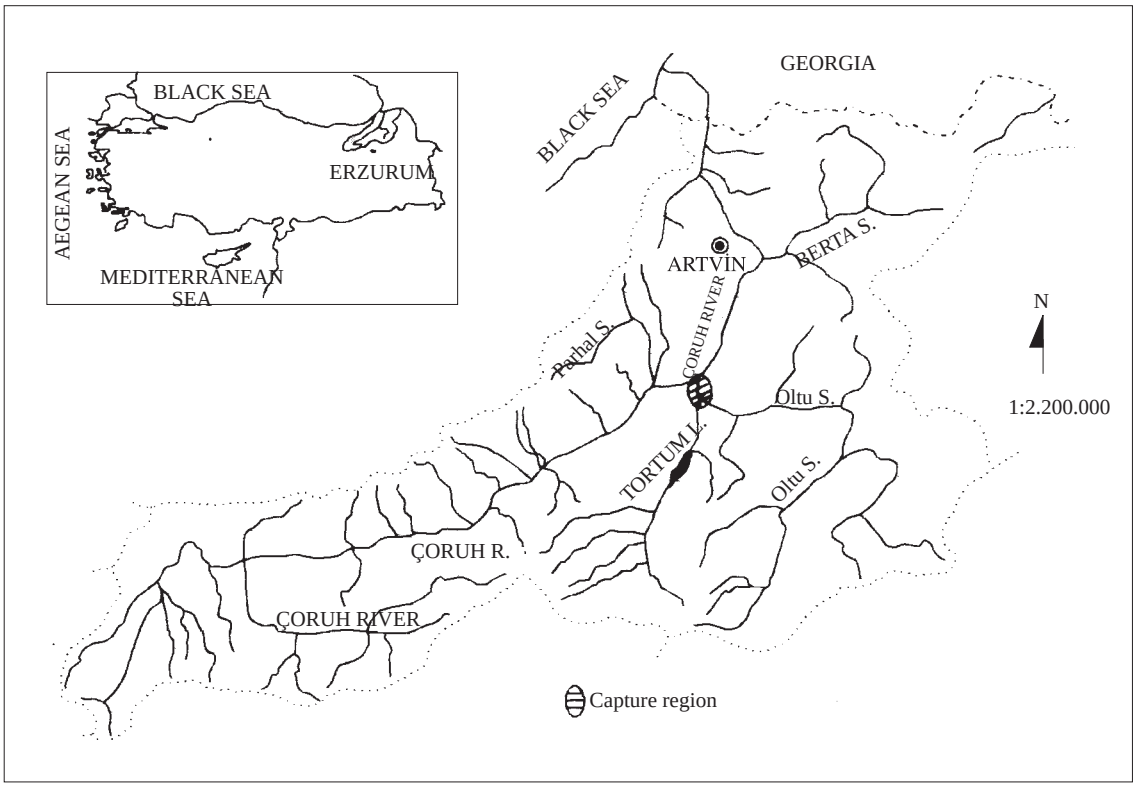

Figure 1. The sampling area.

Table 1. Sex Ratio And Age Composition of *Barbus plebejus escherichi* (N: The Number of Samples).

Age Groups	All Sample		Male		Female		
	N	N%	N	N%	N	N%	p=0.05
1	61	9.73	42	6.70	19	3.03	P<0.05
2	189	30.14	119	18.98	70	11.16	P<0.05
3	136	21.69	105	16.75	31	4.94	P<0.05
4	96	15.31	73	11.64	23	3.67	P<0.05
5	73	11.64	47	7.50	26	4.15	P<0.05
6	32	5.10	8	1.28	24	3.83	P<0.05
7	25	3.99	8	1.28	17	2.71	P<0.05
8	10	1.59	3	0.48	7	1.12	P<0.05
9	3	0.48	-	-	3	0.48	-
10	2	0.32	-	-	2	0.32	-
Total	627	100.00	405	64.59	222	35.41	P<0.05

Growth

The mean fork length and mean total weight at different ages of females and males of *Barbus plebejus escherichi* are given in Table 2. Age-length relationships (von Bertalanffy growth equations) calculated using mean fork lengths were $L_t=29.35\ (1-e^{-0.139(t+1.640)})$ and $W_t=281.11\ (1-e^{-0.139(t+1.640)})^{2.843}$ in males and $L_t=32.77\ (1-e^{-0.116(t+1.891)})$ $Wt=392.10(1-e^{-0.116(t+1.891)})^{2.911}$ in females.

Length-Weight Relationship

Length-weight relationships for males and females were found to be $W=0.0189.FL^{2.843}$ (r=0.96) and $W=0.0152.FL^{2.911}$ (r=0.97) respectively.

Condition Coefficient

Mean condition coefficients for males and females were 1.221 and 1.220 respectively (Table 3). Monthly variation of condition coefficient were plotted in Figure 2.

Age and Length at First Spawning

Males matured at between 11.45 and 13.76 cm (2-3 years old) and females between 13.65 and 15.95 cm FL (3-4 years old). In addition, the maturity to age of specimens was determined and the results were summarized as follows: males were 24.6% in the first age group, 67.8% in the second, 98.7% in the third and 100% in the fourth and above; mature females were 35.6% in the third age group, 72.1% in the fourth, 92.5% in the fifth, 100% in the sixth and above.

Table 2. The mean fork length ($\bar{FL}$) and mean total weight of different age groups of *Barbus plebejus escherichi* (N: The number of samples).

Age	Male (Total N: 405)			Female (Total N: 222)		
	N	$\bar{FL}$ (cm)	$\bar{W}$ (g)	N	$\bar{FL}$ (cm)	$\bar{W}$ (g)
1	42	9.00±0.16	9.84±0.47	19	9.01±0.27	9.85±0.63
2	119	11.45±0.14	19.44±0.89	70	11.39±0.11	18.49±0.55
3	105	13.76±0.12	32.25±0.94	31	13.65±0.19	30.78±1.34
4	73	15.96±0.12	51.19±1.26	23	15.95±0.27	46.05±2.52
5	47	17.72±0.19	65.92±2.14	26	18.01±0.25	76.01±3.29
6	8	19.15±0.59	90.12±8.29	24	19.36±0.213	92.15±3.39
7	8	20.35±0.53	97.12±8.64	17	20.73±0.20	107.00±4.32
8	3	21.50±0.56	107.50±18.55	7	21.45±0.62	127.49±7.98
9	-	-	-	3	22.67±1.45	160.08±26.38
10	-	-	-	2	24.50±2.00	195.00±55.00

Table 3. Condition Coefficients in Different Age Groups of *Barbus plebejus escherichi* Samples ($\bar{K}$: Condition Coefficients).

Age	Male	Female	p=0.05
1	1.299±0.031	1.339±0.046	p>0.05
2	1.190±0.014	1.235±0.018	p>0.05
3	1.218±0.016	1.195±0.029	p>0.05
4	1.253±0.021	1.208±0.022	p>0.05
5	1.219±0.017	1.127±0.029	p>0.05
6	1.269±0.053	1.159±0.042	p>0.05
7	1.122±0.052	1.197±0.035	p>0.05
8	1.068±0.130	1.300±0.059	p>0.05
9	--	1.352±0.036	p>0.05
10	--	1.369±0.054	p>0.05
Mean	1.221±0.008	1.220±0.012	p>0.05

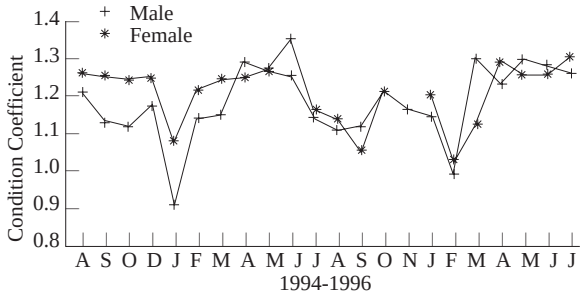

Figure 2. Seasonal variations in the condition coefficient for males and females of *Barbus plebejus escherichi*.

Gonad Development and Spawning Period

Monthly variations of gonad development studied using gonadosomatic index (GSI) values of specimens are presented in Figure 3. Spawning occurred between May and July when water temperatures were between 14 and 19ºC in both years of study.

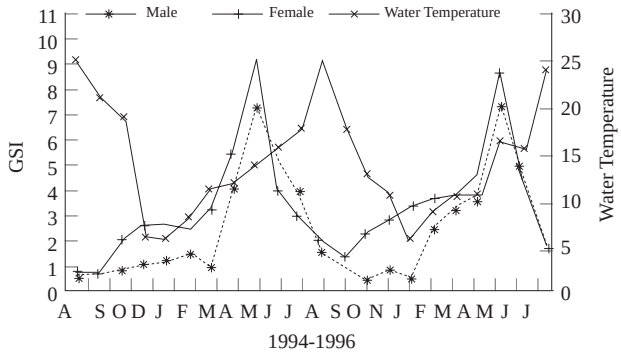

Figure 3. Monthly variations in GSI of *Barbus plebejus escherichi* and water temperature.

Fecundity

Fecundity was estimated in 45 females captured just prior to spawning (Table 4). Fecundity increased when the fish length, weight, gonad weight and age increased. In addition, the relationships between fecundity (F) and length (FL), weight (W), ovary weight (W_o) age (t) were calculated to be $F= 0.9697FL^{2.844}$ ($r=0.72$, $p<0.05$), $F= 173.26W^{0.723}$ ($r=0.64$, $p<0.05$), $F= 686.81W_o^{1.210}$ ($r=0.75$, $p<0.05$) and $F=1523.27t^{0.615}$ ($r=0.56$, $p<0.05$) respectively.

Table 4. Fecundity, Fork Length and Weight in Different Age Groups of *Barbus plebejus escherichi* Samples.

Age Groups	N	(cm)	(g)	Fecundity
3	6	13.56±0.67	33.57±5.22	1256±204.14
4	10	19.63±0.43	93.62±8.06	4513±536.32
5	19	20.38±0.42	111.24±8.12	5265±531.22
6	8	20.75±0.35	109.13±7.45	5231±1066.37
7	1	22.5	152.80	8445
8	1	23.5	173.60	8250
Mean	45	19.48±0.43	98.91±5.96	4694±385.21

Discussion

In the early life stage (until the 5th age group), the rate of males was higher than that of females, but in the later stages the rate of females was higher than that of males. Several authors have reported similar patterns (16, 24-28) for their barbus populations.

The growth in length and weight of males and females were similar (Table 2). These results were similar to those reported by Baysal and Kutrup (14), but different from those reported by Ekmekçi (9), Solak (10), Kutrup and Baysal (15), and Karataş (16). Nikolsky (29) and Wootton (32) reported that variations in fish growth in terms of length and weight can be explained as an adaptive response to different experimental conditions such as temperature, organic matter, quality of food, and the water system in which the fish live (lake or river). However, there are different genetic structures between species.

The L_∞ value of females was higher than that of males. The reason for this is that females grow faster than males, and longer (33).

The length-weight relationships males (b=2.843) and females (2.911) of *Barbus plebejus escherichi*, estimated in Oltu Stream, show that growth is isometric. The values found in this study were close to those found by Baysal and Kutrup (14), and Bircan and Ergül (18), but different from those found by Kutrup and Baysal (15), and Daoulos and Economides (26). These variations in the exponents could also be attributed to different stages in otogenetic development, as well as in age, maturity, sex, season and fish feeding. Geological location and associlated environmental conditions such as seasonality (date, time of capture), stomach fullness, disease and parasite loads (34), can also affect the value of b.

The condition coefficient changed according to month and age group (Table 3, Figure 2), increasing as age increased. In general, seasonal conditions showed a similar pattern in both sexes. In the years of this study, it was maximum in May-June, being higher in the feeding months and just prior to spawning. These results were similar to those found by Ekmekçi (9), Karataş (16), and Bircan and Ergül (18). Variations in condition coefficient may be explained by differences in environmental conditions such as seasonality, quality of food and the water system in which the fish live (lake or river) and between species (30).

Ages at first spawning were 2-3 in males and 3-4 in females, and this situation was similar to that reported by Şen (6), Ekmekçi (9), Ünlü and Balcı (12), Ölmez (13), Karataş (16), and Bircan and Ergül (17). The first spawning age in fish is affected by species, size of fish and environmental factors such as temperature, quality of food and feeding. During this study the water temperature ranged from +6ºC (December, January) to +26ºC (August). It has been observed that cool waters produce later maturing individuals of a species than warm waters (31, 35).

Spawning in both years of the study occurred from May to July (Figure 3). This pattern is similar to that reported by Şen (6), Akyurt (32), Ekmekçi (9), Karataş (16) and Bircan and Ergül (17), but Ünlü and Balcı (12) and Ölmez (13) reported that spawning occurred between April and May. The spawning periods of fish vary in respect of their species and the ecological characteristics of the water system in which they live. These characteristics of fish are determined by ecological factors such as temperature and quality of food (29). Although in the first year the water temperature was lower than in the second year, reproduction took place during the same period. The reproduction temperature for this species is 14ºC and above.

Fecundity varied from a mean of 1256 eggs per female (3^{rd} age group) to a mean of 8445 eggs per female (7^{th} age group) and was generally higher than that reported by Ünlü and Balcı (12) and Karataş (16), but was lower than that reported by Ekmekçi (9). It is well known that fecundity is affected by the age, size, species, feeding of fish, season and environmental conditions. Additionally, it differs between populations of some species and does not remain constant from year to year. Fecundity increased when the fish length, weight and age increased, and longer and older fish showed a higher fecundity. These patterns were similar to those found Ünlü and Balcı (12), Ekmekçi (9), Karataş (16) and Bircan and Ergül (17). A major feature of fecundity is its increase (with certain limits) during the growth of fish. The correlation of fecundity with weight in most fish was higher than that with length, which was in turn higher than that with age (30).

References

1. Slastenenko, E., 1955-56, Karadeniz Havzası Balıkları (Çev. Hanifi ALTAN). Et Ve Balık Kurumu Müdürlüğü Yayını, İstanbul, S 711.
2. Geldiay, R. & Balık, S., 1973, Nif Çayı Ve Kollarında Yaşayan Tatlı Su Balık Populasyonları Üzerinde Taksonomik Ve Ekolojik Araştırmalar. TÜBİTAK, IV. Bilim Kongresi 5-8 Kasım 1973, Ankara.
3. Balık, S., 1975, Batı Anadolu Tatlı Su Balıklarının Taksonomik Durumu ve Bu Formların Bölgedeki Coğrafik Dağılımı. TÜBİTAK V. Bilim Kongresi, 29 Eylül-3 Ekim 1975, İzmir. S.299-313.
4. Kuru, M., 1975, Dicle-Fırat, Kura-Aras, Van Gölü ve Karadeniz Havzası Tatlı Sularında Yaşayan Balıkların (Pisces) Zoocografik Yönden İncelenmesi. Atatürk Üni. Fen Fak. (Doçentlik Tezi) Erzurum.
5. Erk'akan, F., 1983, Sakarya Havzası Balıklarının Sistematiği Ve Biyo-Ekolojisi Üzerine Araştırmalar. Doğa Tr. Vet. ve Hay. Derg., 7, 141-154.
6. Şen, D., 1985, Kalecik-Karakoçan Sulama Göletinin Balık Faunasının İncelenmesi. Fırat Uni. Fen Bilim. Ens. Doktor Tezi, Elazığ.

7. Erk'akan, F. & Akgül, M., 1986, Kızılırmak Havzası Ekonomik Balık Stoklarının Incelenmesi. Doğa Tr. Vet. ve Hay. Derg., 3, 239-250.
8. Geldiay, R. & Balık, S, 1988, Türkiye Tatlı Su Balıkları.Ege Üni. Ders Kitapları serisi No: 97, İzmir.
9. Ekmekçi, F.G., 1989, Sarıyar Baraj Gölünde (ANKARA) Yaşayan Yaşayan *Barbus plebejus escherichi* (Steindachner, 1876)'nin Bazı Büyüme ve Üreme Özellikleri. Hacettepe Fen ve Mühendislik Bilimleri Derg., 11, 145-167.
10. Solak, K., 1989, Çoruh Havzasının Bazı Derelerinde Yaşayan *Barbus plebejus escherichi* Steindachner, 1876'nin (Cyprinidae, Pisces) Yaş-Boy ve Yaş Ağırlık İlişkileri. Doğa TU Zooloji Derg., 13, 1: 34-38.
11. Özdemir, N., 1991, Çıldır Gölünün Balık Türleri Üzerinde Bir Araştırma. İstanbul Üni. Su Ürünleri Fak. Derg., 1,2; 71-84.
12. Ünlü, E. & Balcı, K., 1991, Savur Çayında Yaşayan Bazı Cyprinidae (Pisces) Türlerinin Eşeysel Olgunluk Yaşı, Yumurtlama Dönemi ve Yumurta Verimi Üzerine Bir Araştırma. Ege Üni. Su Ürünleri Yüksekokulu. Eğitiminin 10. Yılında Su Ürünleri Sempozyumu. 12-14 Kasım 1991. İzmir. 347-357.
13. Ölmez, M., 1992, Yukarı Sakarya Havzası Sakaryabaşı Bölgesi Balıklarının Populasyon Dinamiği Üzerinde Bir Araştırma. Doktora Tezi. Ankara Üni. Fen Bilimleri Enstitüsü, Ankara.
14. Baysal, A. & Kutrup, B., 1994, Şana Deresinde (Trabzon) Yaşayan *Barbus plebejus* (Bon.1832)'un Bazı Büyüme Parametrelerinin Saptanması. C.Ü. Fen-Edebiyat Fak. Fen Bilimleri Derg. 47; 17-26.
15. Kutrup, B. & Baysal, A. 1994, Kara Derede (Trabzon) Yaşayan *Barbus plebejus escherichi* (Steindachner, 1897)'Un Bazı Büyüme Özelliklerinin Incelenmesi C.Ü. Fen-Edebiyat Fak. Fen Bilimleri Derg. 47; 17-26.
16. Karataş, M., 1995, Almus Baraj Gölünde *Yaşayan Leuciscus* cephalus, *Barbus plebejus*'un Üreme Özellikleri lle Et Verimlerinin Araştırılması. Atatürk Üni. Fen Bilimleri Enstitüsü Zootekni Anabilim Dalı (Doktora Tezi) Erzurum.
17. Bircan, R. & Ergün, S., 1997, Bafra-Altınkaya Baraj Gölü'ndeki Bıyıklı Balığın (*Barbus plebejus escherichi*, Steindachner, 1897) Üreme Biyolojisi. Akdeniz Balıkçılık Kongresi, 9-11 Nisan 1997, İzmir.
18. Bircan, R. & Ergün, S., 1997, Bafra-Altınkaya Baraj Gölü'ndeki Bıyıklı Balığın (*Barbus plebejus escherichi*, Steindachner, 1897) Bazı Biyolojik Özelliklerinin İncelenmesi. Doğa Tr. Vet. ve Hay. Derg. (Baskıda).
19. Lagler, F. K., Bardach, J.E., & Miller, R.R., 1962, Ichthyology, The study of Fishes, John Wiley and Sons Inc. New York, London, 545 p.
20. Ricker, W.E. 1975. Computation and Interpretation of Biological Statistics of Fish Populations. Bull. Fish. Res. Bd. Can. 191:1-382.
21. Busacker, P.G., Adelman, I.R., And Goolish, E.M., 1990, Growth, Methods of Fish Biology. Edt. Schreck C.B. And Moyle P.B. American Fisheries Society. Bethonda, Maryland, USA, P. 363-382.
22. Crim, L.W. And Glebe, B.D., 1990, Reproduction. Methods of Fish Biology. Edt. Schreck C.B. And Moyle P.B. American Fisheries Society. Bethonda, Maryland, USA. P.529-547.
23. Düzgüneş, O., Kesici, T., Kavuncu, O. & Gürbüz, F., 1983, İstatistik Metotları, Ankara Üni. Ziraat Fak. Yayınları No. 861, Ankara, 218 S.
24. Lobon-Cervia, J. & Fernandez-Delgado, C.,1984, On The Biology Of The Barbel (*Barbus barbus bocagei*) In The Jarama River. Folia Zoologica, 33 (4): 371-384.
25. Herrera, M., J.A., Hernando, C., Fernandez-Delgade And M., Bellido, 1988, Age, Growth and Reproduction of The Barbel, *Barbus sclarteri* (Günther, 1868), In A First Order Stream In Southern Spain. J. of Fish Biology, 33:371-381.
26. Daoulos, C. & Economides, P., 1989, Age, Growth and Feeding of *Barbus albenicus* Steindachner In The Kremaste Reservior, Greece. Arch. Hydrobiol., 114, 591-601.
27. Herrera, M. & Fernandez-Delgado, 1992, The Life History Patterns of *Barbus bocagei sclateri* (Günther, 1868) In A Tributary Stream of The Guadalquivir River Basin, Southern Spain. Ecology of Freshwater Fish, 1, 42-51.
28. Krupka, I.,1985, On The Age And Growth of Barbel (*Barbus barbus* L. 1758) In The Vlara River. Prace Laboratoria Rybarstva A Hydrologie. 5, 199-215.
29. Nikolsky, G.W., 1963, The Ecology of Fishes. Academic Press London And New York, P. 352.
30. Nikolsky, G.W., 1969, Theory of Fish Population Dynamics. Printed In Great Britain By T. And A. Constable Ltd., Edinburgh. P. 321.
31. Blaxter, J. H. S. 1969. Development: Eggs and larvae. Fish physiology (Edt. W.S. Hoar and D.J. Randal). Reproduction growth, bioluminescence, pigments and poisons: Academic Press, New York and London, 3, 180-184.
32. Wootton, R.S., 1992, Fish Ecology. Printed in Great Britain by Thomson Litho Ltd. Scotland. p. 203.
33. Weatherly, A. H., Growth and Ecology of Fish Populations: Academic Press., 293 pp., London, 1972.
34. Bagenal, T.B., Tesch, F.W., 1978. Age and growth. In: T.B. Bagenal (Editor), Methods for Assessment of Fish Population in Fresh Waters. IBP Handbook, Vol.3, Blackwell Scientific, London, pp. 101-136.
35. Ross, S.W., 1988. Age, growth, and mortality of Atlantic croaker in North Carolina, with comments on Board Can., 191: 203-233.