Bulgarian Journal of Agricultural Science, 14 (No 2) 2008, 214-220
National Centre for Agrarian Sciences

AGE AND GROWTH OF THE CHUB, *LEUCISCUS CEPHALUS* L. FROM THE MARITZA RIVER (SOUTH BULGARIA)

E. STEFANOVA[1], E. UZUNOVA[1], T. HUBENOVA[2], P. VASILEVA[2], D. TERZIYSKI[2] and I. ILIEV[2]
[1]*University of Sofia, Faculty of Biology, Department of General and Applied Hydrobiology, BG - 1164, Sofia, Bulgaria*
[2]*Institute of Fisheries and Aquaculture, BG-4003 Plovdiv, Bulgaria*

Abstract

STEFANOVA, E., E. UZUNOVA, T. HUBENOVA, P. VASILEVA, D. TERZIYSKI and I. ILIEV, 2008. Age and growth of the chub, *Leuciscus cephalus* L. from the Maritza River (South Bulgaria). *Bulg. J. Agric. Sci.*, 14: 214-220

Age-size structure and growth parameters of chub, *Leuciscus cephalus* were studied to obtain information on population status of this species from the middle section of the Matritza River. A total of 161 specimens were collected by electrofishing during the period between March to June 2007. Age groups 1+ to 4+ were observed in the chub population. The age group 2+ was most abundant (57.5%) followed by the fish from age group 1+ (27.5 %). In the investigated population dominated fish with size between 121 to 150 mm. The calculated weight-length relationship for chub could be explained by the follow equation: $W=0.0148.L^{3.0595}$ ($r^2 = 0.994$; n=161). The length growth curve was calculated according to the von Bertalanffy equation: $L_t = 488[1\text{-}e^{-0.152(t-0.05)}]$. The average condition factor for females and male fish was 2.52 and 2.01 respectively:

Key words: *Leuciscus cephalus*, Maritza River, length and weight relationships, growth, age and size composition, von Bertalanffy's parameters, condition factor

Introduction

The chub, *Leuciscus cephalus* (L.1758), belonging to the family *Cyprinidae*, is widely distributed in Europe and Asia. One of the possible reasons for that is the high environmental tolerance of the chub (Arlinghaus and Wolter, 2003). This species have economical importance in the middle parts of the Bulgarian rivers where usually dominate in respect of biomass (Dikov et al., 1994; Raikova-Petrova, 2004).

Growth parameters and live history traits of the chub significantly vary between populations from different regions. Because of that many studies have been carried out on age and growth peculiarities of the chub stocks (Lelek, 1959; Pecl and Tandon, 1978; Hanel, 1982; Dikov and Zivkov, 1985; Dikov, 1988; Jocev and Dikov, 1991; Hamwi et al., 2005; Kalkan et al., 2005; Vlach et al., 2005). In particular interest is the status of fish populations from areas with serious ecological problems. The Maritza is with a length of 480 km, the longest river that runs solely in the interior of the Balkans. It has its origin in the Rila Mountains in Western Bulgaria flowing southeast between the Balkan and Rhodopa mountains to Edirne, Turkey. In

the middle part of the river there are numerous ecological problems caused by agricultural and industrial pollutions and inert material extraction. The most frequently observed results from the negative anthropogenic impact were habitat degradation and biodiversity loses. Another important factor are over fishing and poaching.

Our study is focused on the age - size distribution, linear and weight growth of not studied population of the *L. cephalus* inhabiting the Maritza River (South Bulgaria).

Materials and Methods

161 fish were collected in period between March 2007 and June 2007 using the method of electrofishing (SAMUS 757). The study area was a part of the middle stream of the Maritza River and covered section 5 km in length located between the Stara Reka River and the Salzliiska River.

In Table 1 was shown observed physical and chemical parameters in the investigated area. The water temperature increased from 11 to 22°C during the period.

Table 1

Hydro chemical and physical parameters of the Maritza River in the sampling area

Parameter	Unity	Mean
Nitrogen (ammonia)	$mg.l^{-1}$	0.19
pH		8.016
BOD_5	$mg.l^{-1}$	2.032
Nitrate nitrogen	$mg.l^{-1}$	1.09
Nitrite nitrogen	$mg.l^{-1}$	0.031
Dissolved oxygen	$mg.l^{-1}$	8.275
Total phosphorus	$mg.l^{-1}$	0.13

The captured fish were measured (standard, SL and total length, TL), weighted (total, Wt and gutted weight, Wg). About 15 scales per fish were collected under the dorsal fin. The gonads were removed and measured to accuracy 0.1 g (Ws).

Fish age determination and measurement of scale radius were performed on the oral part of the scales using microfilm reader with magnification 17.5X.

The length growth was estimated by back calculation. The obtained data were used for the theoretical representation of length growth, described by the von Bertalanffy growth equation:

$L_t=Linf\ [1-e^{-k(t-t0)}]$, where: Lt(cm) is a standard length at the age t, Linf (cm) is the asymptotic body length, t is the age of fish and t_0 is the hypothetical time at which the fish reaches zero length. Omega parameter ($\omega_L=L_{inf}.k$ Galucci & Quinn, 1979) and index of Ww linear growth $\varphi'=\log_{10}.k+2\log_{10}.L_{inf}$ Munro, Ff Pauly,1983) was calculated.

The weight growth was estimated according to the equation:

$W=aSL^b$, where W is a total individual weight at time of capture [g], ***a*** and ***b*** are parameters of W-SL relation.

The linear and weight growth and increment per year were calculated:

$t=L_{(t+1)}-L_t$; $t=W_n-W_{(n-1)}$.

The condition coefficient according to Fulton's equation was calculated as follows:

$k=(Wt/SL^b).100$, where *b* is the exponent from length-weight relationship.

Results and Discussion

Age and size composition

Four age groups were presented in the chub population from the middle section (Figure 1). The age group 2+ was most abundant (57.5%) followed by the fish from age group 1+ (27.5%). The age group 4+ was presented with only 0.65%. In the investigated population dominated fish with size between 121 to 150 mm (Figure 2). The most variable in respect of size were fish from 1+ and 2+ age groups (Table 2). It's observed significant overlap in size between fish from different age groups. $t=L_{t+1}-L_t$; $t=L_{t+1}-L_t$.

In respect of biomass dominated age group 2+ (54%) followed by age group 3+ (25%).

The data presented in Table 3 suggest significant differences among the populations in relation to the maximum age and length of the chub. In comparison

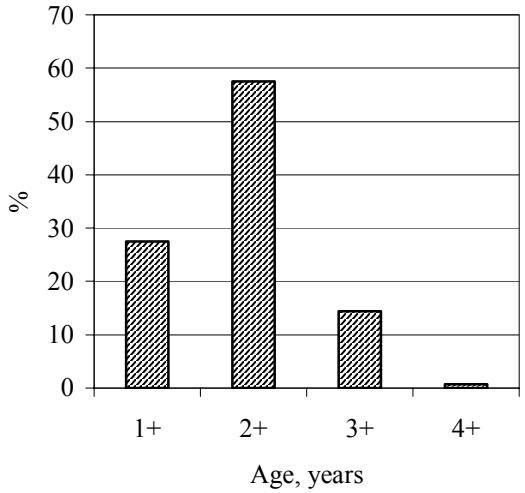

Fig. 1. Age distribution of chub (*Leuciscus cephalus* L.) samples from the middle stream of the Maritza River

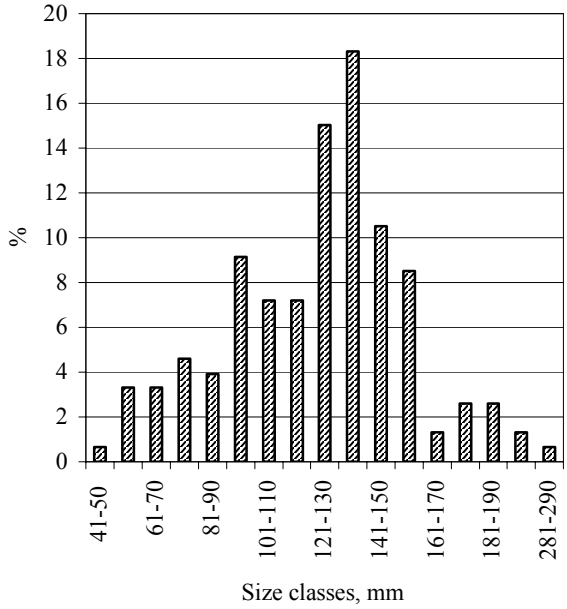

Fig. 2. Size distribution of chub (*Leuciscus cephalus* L.) samples from the middle stream of the Maritza River

with the other Bulgarian water bodies population from the Maritza River reached significantly higher weight and length at age 4+ (Table 3).

It was observed significant disproportion between the number of females and males fish. Among 161 specimens of chub, which were collected during the period between March to June, females predominated (92%). This disproportions probably related to the uneven distribution of females in the river's bed during their pre- and reproductive period.

Length growth

Length growth was back calculated on the basis of relationship between scale radius and standard length at the time of catch:

$SL=2.473+0.242.R$ ($r^2=0.919$, n=161)

The growth rate for diferent generations was similar (Figure 3).

The highest increase in length growth was calculated for age groups 1+ and 2+. The growth decreased with the subsequent ages (Figure 4).

Von Betallanffy's growth equation had the form: $L_t = 48.8[1-e^{-0.152(t-0.05)}]$

ω_L parameter and growth index φ' were 7.4 and 3.1 respectively.

Weight growth and length - weight relationships

Figure 5 shows the dependence between standard body length and weight for the chub population from the Maritza River (middle section).

Growth rates, determined on the basis of back-calculations, are shown on Figure 6. No significant differences were observed between different generations. Mean weight increment per year was increased subsequently. Mean annual weight increment was increased with ages and significantly higher for female individuals (Figure 7). The condition factor was calculated as 2.52 for females and 2.01 for males.

Nowadays, *Leuciscus cephalus* is one of the most common and abundant fish species in the middle part of the Maritza River. Our investigation found out that the chub population was presented with only four age groups. Most probably, the observed short lifespan is due to intensive fishing in the region. The preferred targets are 3+ and above year old fish, because their size. Therefore, the chub from the Maritza River no real chance to reach maximum reported years and sizes for this species in Bulgarian waters (Zhivkov, 1974; Zhivkov et al., 2003; Hamwi et al., 2005). The observed lifespan of *L.cephalus* in Maritza River agreed with maximum reported age for the species

Table 2

Age and size structure of chub (*Leuciscus cephalus* L.) from the middle stream of Maritza River

Size class (L, mm)	Numerical individuals of chub in the different age groups					
	1+	2+	3+	4+	n	%
41-50	1				1	0.65
51-60	5				5	3.3
61-70	5				5	3.3
71-80	4	3			7	4.6
81-90		6			6	3.9
91-100	1	13			14	9.15
101-110	3	8			11	7.2
111-120	5	6			11	7.2
121-130	8	15			23	15.03
131-140	7	13	8		28	18.3
141-150	2	9	5		16	10.5
151-160	1	8	4		13	8.5
161-170		2			2	1.3
171-180		2	2		4	2.6
181-190		3	1		4	2.6
221-230			2		2	1.3
281-290				1	1	0.65
Σn	42	88	22	1	153	
%	27.5	57.5	14.4	0.65		100%

Table 3

Maximum age and size of chub (*Leuciscus cephalus* L.) from different Bulgarian water bodies

Water body	Age	Length (L, mm)	Weight (W, g)
Batak Dam (Zivkov , 1974)	11+	411	1250
Veleka River (Zivkov et al., 2003)	5+	390	800
Iskar River (Hamwi et al., 2005)	7+	388	1150
Maritza River (our data)	4+	283	368
Vit River (Dikov et al., 1994)	6	204	153
Struma River (Dikov et al., 1994)	7	243	232
Mesta River (Dikov et al., 1994)	5	214	167
Djerman River (Dikov and Zivkov, 1985)	4	200	135
Palakaria River (Dikov et al., 1994)	6	186	114
Fakiiska River (Dikov et al., 1994)	4	180	111
Sredetzka River (Dikov et al., 1994)	3	162	77
Arda River (Dikov et al., 1994)	4	159	64

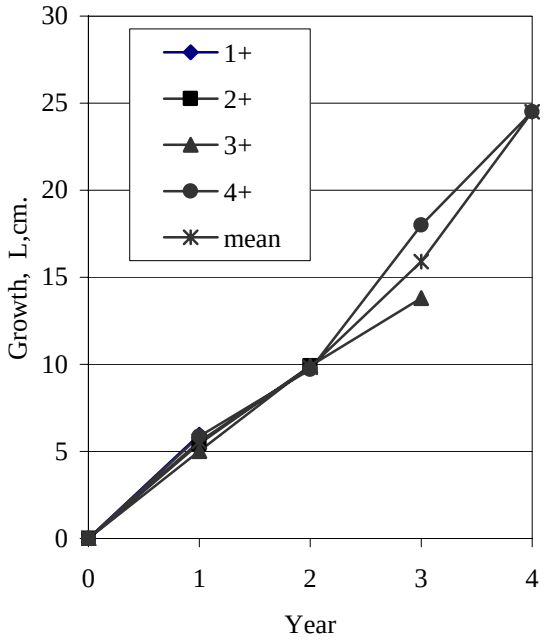

Fig. 3. Age-length relationships of the *L. cephalus* generations in the middle part of the Maritza River

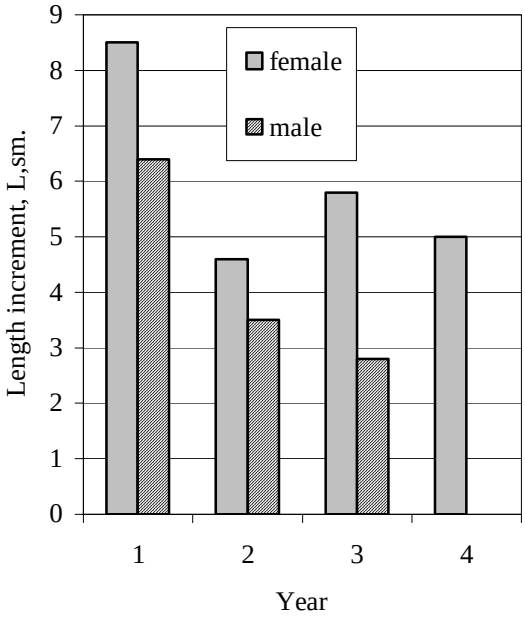

Fig. 4. Mean length increment of male and female chubs in the middle part of the Maritza River

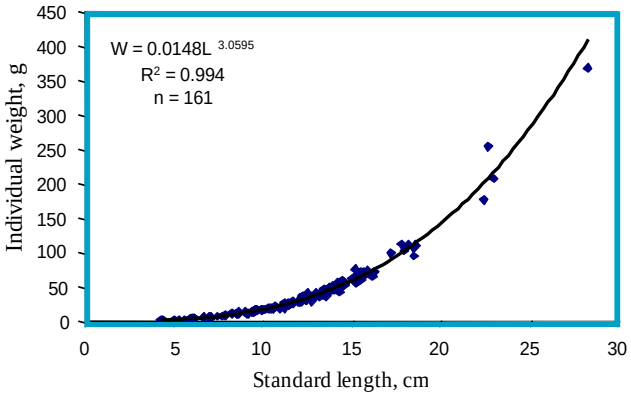

Fig. 5. Relationship between standard length and weight of chub (*Leuciscus cephalus* L.) samples from the middle stream of the Maritza River

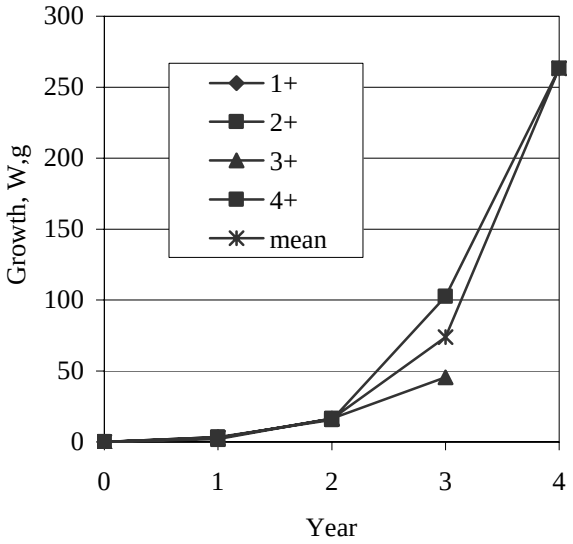

Fig. 6. Age-weight relationships of the *Leuciscus cephalus* generations in the middle part of the Maritza River

from the Dzherman, Fakiijska and Arda River (Zhivkov, 1985; Dikov et al., 1994).

In the investigated population dominated fish with low length (120 - 150 mm). For other chub populations was reported to dominate higher size groups (Hamwi et al., 2005). In general, growth parameters of the chub population in the middle stream of the Maritza River agreed with those reported from other studies of this species and indicate a good growing performance. Value of the asymptotic length (L_τ) was

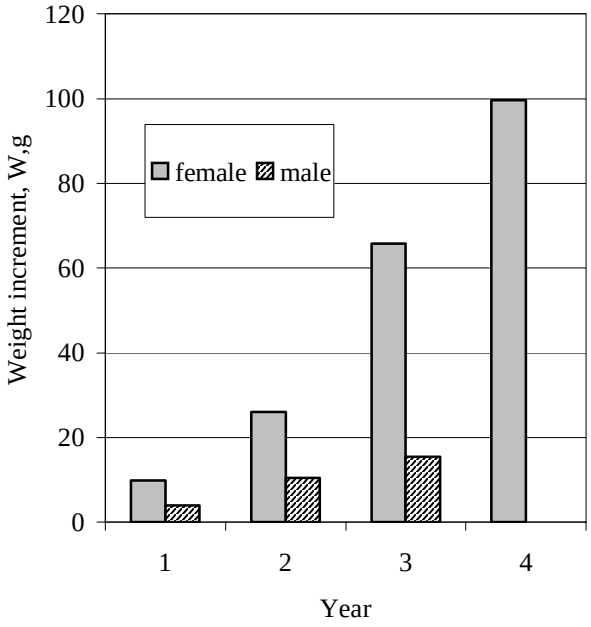

Fig. 7. Mean weight increment of the *Leuciscus cephalus* generations in the middle stream of the Maritza River

relatively high in comparison with other populations (Vlach et al., 2005). Standard length (SL) obtained from back calculation were greater for females than that for males. The same results were recorded for population in Karakaya dam lake (Kalkan et al., 2005). It's observed that in the end of their first year, mean standard body length for chub in the Maritza River is the lowest in comparison with other investigated populations (Penczak et al., 1985; Unver, 1998; Turkmen et al., 1999; Hamwi et al., 2005; Vlach et al., 2005). The slow growth rate of the first age group, probably due to an insufficient supply of plankton, which are feeding base for chub in this period. The linear growth rate in next years was similar to those reported in literature (Kalkan et al., 2005).

Weights of the *L.cephalus* in the middle part of the Maritza River were significantly lower than those from other water bodies. At age 1 the chub from this region reached only 2.9 g. Other studies recorded much higher values (Penczak et al., 1985; Hamwi et al., 2005; Kalkan et al., 2005).

One of the most useful tools for assessment of fish condition is relationship between length and weight. Estimated condition indexes for male and female chub for Maritza River are close to those presented in the literature for other chub populations (Hamwi et al., 2005). Differences in the mean values between the reported data could be the result of different year seasons at capture and biological status of fish respectively.

Some factors such genetic isolation and specific environmental conditions (e.g. temperature, eutrophication levels, food supply and diseases) are responsible for intraspecific differences in growth parameters.

Conclusions

The low number of age groups and domination of relatively small size classes in chub population from the middle part of the Maritza River is related to over fishing in this river sector. Good growing performance of chub indicates to a stable food base and favourable environmental conditions in the region.

References

Àrlinghaus, R. and C. Wolter, 2003. Amplitude of ecological potential: chub *Leuciscus cephalus* (L.) spawning in an artificial lowland canal. (Short Communication) *J. Appl. Ichthyol.*, **19:** 52-54.

Bertalanffy, L., 1938. A quantitative theory of organic growth. (Inquiries on growth laws. I I). *Human Biol.*, **10**(2): 182-213.

Dikov, C., 1988. Age composition and speed of growth of the chub (*Leuciscus cephalus* L.) in the Vit River. *Hydrobiology*, **32:** 50-57.

Dikov, C. and M. Zhivkov, 1985. Age, linearity and weight growth of the chub (*Leuciscus cephalus* L.) in the Dzerman River. *Hydrobiology*, **(24):** 13-22.

Dikov, Ts., J. Jankov and S. Jocev, 1994. Fish stocks in rivers of Bulgaria. *Pol. Arch. Hydrobiol.*, **41**(3): 377-391.

Gallucci, V. F. and T. J. Quinn, 1979. Reparameterizing, fitting and testing a simple growth model. *Transactions of the American Fisheries Society*, **108:** 14-25.

Hamwi, N. I., G. N. Raikova-Petrova and I. K. Petrov, 2005. Age and Size Composition of Chub (*Leuciscus cephalus*

L.) in the Middle Stream of the Iskar River, Bulgaria. *Acta Zool. Bulg.*, **57**(3): 363-370.

Hanel, L., 1982. Note on the length growth of chub (*Leuciscus cephalus*, Pisces, Cyprinidae) in the reservoir Klí èava and the river Berounka. *Vest. ès. Spoleè. zool.*, **46**: 241-256.

Jocev, S. and C. Dikov, 1991. Age, linearity and weight growth of the chub (*Leuciscus cephalus* L.) in the river Palakarija, a tributary of the river Iskar. *Hydrobiology*, **36**: 68-75.

Kalkan, E., M. Yilmaz, A. and U. Erdemli, 2005. Some Biological Properties of the *Leuciscus cephalus* (L.,1758) Population Living in Karakaya Dam Lake in Malatya (Turkey). *Turk. J. Vet. Anim. Sci.*, **29**: 49-58.

Lelek, A., 1959. Poznamky o stari a pomneru pohlavi u jelce tlouste, *Leuciscus cephalus* (L.) v rece Rokythe. *Zool. listy*, **8**: pp. 1 (Cz).

Munro, J. L. and D. Pauly, 1983. A simple method for comparing the growth of fishes and invertebrates. *Fishbyte*, **1**(1): 5-6.

Pecl, K. and K. Tandon, 1978. The abundance, growth and production of the Chub population in the Klicava reservoir during the years 1967-1975. *Vest. Cesk. Spol. Zool. Svaz.*, **17**: 52-59.

Penczak, T., J. Jankov, Ts. Dikov and M. Zalewski, 1985. Fish production in the Mesta Rive, Rila mountain, Samokov, Bulgaria.

Raikova-Petrova, G., N. Hamwi and I. Petrov, 2004. Changes in the ichthyofauna of the middle stream of Iskar river (Bulgaria). *Forest Science*, **3:** 87-92.

Turkmen, M., H.. Haliloglu, O. Erdogan and A. Yildirim, 1999. The growth and reproduction characteristics of chub *Leuciscus cephalus orientalis* (Nordmann,1840) living in the river Aras. *Tr. J. of Zoology*, **23:** 355-364.

Unver, B., 1998. An investigation on the reproduction properties of chub (*Leuciscus cephalus* L., 1758) in lake Todutge (Zara/Sivas). *Tr. J. of Zoology*, **22:** 141-147.

Vlach, P., J. Dusek, M. Š vátora and P. Moravec, 2005. Growth analysis of chub, *Leuciscus cephalus*(L.), and dace, *Leuciscus leuciscus* (L.), in the Upor stream using growth data of recapitured marked fish. *Czech J. Anim. Sci.*, **50**(7): 329-339.

Zhivkov, M., 1974. Dynamics of the numerical strength of fish populations in the Batak Dam. I. Age structure and increase in the population of chub (*Leuciscus cephalus L.)*. *Bulletin of Zool. Inst.*, **40:** 203-216. (Bg).

Zhivkov, M., 1985. Regularity of changes of fish populations structure. *National Conference of Biology,* Sofia. pp. 83-87 (Bg).

Zhivkov, M., T. Dikov and T. Trichkova, 2003. Age, growth and mortality of dominant fish species in the River Veleka, Bulgaria. *Acta Universitattis Carolinae, Environmentalica*, **17:** 49-57.

Received February, 20, 2008; accepted for printing March, 15, 2008.