

REPRODUCTIVE BIOLOGY OF *CARASSIUS GIBELIO* (BLOCH 1782) FEMALES IN THE WATER RESERVOIRS OF THE NISTRU RIVER BASIN

FULGA Nina, BULAT Dumitru

Abstract. The comparative characteristic of reproductive biology of *Carassius gibelio* females in water bodies of the Dniester basin is given. It was established that higher indexes of growth rate, relative gonad weight and oocyte dimension in the phase of complete vitellogenesis contribute to the increasing of reproduction rate of *Carassius gibelio* population in lower sector of the Dniester. The biological analysis of sexually mature individuals from the lower Dniester and Cuchurgan water cooler basin has revealed the distinctions in mean values of linearly-weight indicators, which are defined by the ecological conditions of existence of *Carassius gibelio* from different populations. The physiological condition of sexually mature females during prespawning and spawning periods is most satisfactory at individuals from the river. Higher indicators of growth rate and relative gonad weight contribute also to higher rate of reproduction in the population of *Carassius gibelio* in the lower sector of the Dniester River.

Keywords: oocyte, reproductive system, vitellogenesis, reproductive biology, relative gonad weigh.

Rezumat. Biologia reproductivă a femelelor de *Carassius gibelio* (BLOCH 1782) în lacurile de acumulare ale bazinului râului Nistru. Este dată caracterizarea comparată a biologiei reproductivă a femelelor de *Carassius gibelio* în bazinele acvatice ale bazinului râului Nistru. S-a stabilit că indicii mai înalți ai ratei creșterii, ai greutateii relative a gonadelor și ai dimensiunilor oocitelor în faza vitelogenezei complete contribuie la creșterea ratei de reproducere a populației de *Carassius gibelio* în sectorul inferior al Nistrului. În urma analizei biologice a indivizilor sexual maturi din Nistrul inferior și lacul refrigerent Cuciurgan s-au stabilit diferențe în valorile medii ale indicatorilor lineari de greutate, condiționate/influențate de condițiile ecologice de trai ale peștilor din diferite populații. Starea fiziologică a femelelor sexual mature înaintea depunerii icrelor și pe parcursul perioadei de depunere a icrelor este mai satisfăcătoare la indivizii din râu. Indicatorii mai mari ai ratei creșterii și greutateii relative a gonadelor, de asemenea, contribuie la creșterea ratei productivității în populațiile de *Carassius gibelio* în sectorul inferior al Nistrului.

Cuvinte cheie: oocite, sistem reproductiv, vitelogeneză, biologie reproductivă, greutatea relativă a gonadelor.

INTRODUCTION

During the existence of Cuchurgan water cooler basin considerable changes of its thermal regime have been noted. In the beginning of operation of the Moldova hydro-electric power station, further MHEPS, (1964-1966) the reservoir thermal changes was insignificant, but in process of escalating of electric power station capacities (1967-1970), the mid-annual water temperature in the cooler basin already exceeded the natural one by 3.7°C. At achievement by the station of the designed capacity (1981-1985) the water temperature has exceeded the natural one by 6.1°C in the lower course and by 4.0°C in the middle sectors of water cooler basin (GORBATENKY et al., 1988).

As a result of MHEPS capacities decreasing the temperature regime of the basin over the last 10 years almost did not differ from the natural one. However, the disturbance of the hydrological regime of the reservoir has led to the abundant growing of macrophytes and to the secondary organic pollution by products of their decomposition (ZUBKOV et al., 2008).

In the period of weak influence of MHEPS exhaust water and in the conditions of increased thermal changes of the cooler basin, the research carried out by the scientists of the Institute of Zoology of ASM revealed changes in the rate of increase and also in the development of reproductive system and reaction of the sexual cells of *Carassius gibelio* females, to the temperature factor of the cooler basin (VLADIMIROV et al., 1973; KARLOV et al., 1988; STATOVA, 1973, 1985; STATOVA et al., 1988).

The barrage of Dnestrovsk Hydroelectric Power Station in 1981 has blocked the Dniester river in the lower part of the upper river course and cut it off from its middle course, that radically changed the dynamics of the annual drain, the course of natural waters, the physical and chemical regimes of the river (RUSEV, 2004; SHEVTSOV, 2004; ZUBKOV et al., 2004). The maximum expense of water is observed in March at the temperatures, which are not corresponding to conditions of fish reproduction; during the spawning period, the volume of water drastically decreases and suffers considerable fluctuations.

The purpose of the present work is to reveal the changes in the reproductive biology of *Carassius gibelio* induced by the modifications of the temperature regime in Cuchurgan water cooler basin and in the lower course of the Dniester for the last 10 and 20 years accordingly.

MATERIAL AND METHODS

The study material was represented by sexually mature females of *Carassius gibelio* collected between 2007-2009 in Cuchurgan water cooler basin and in the lower Dniester in prespawning and at the beginning of spawning periods, a total of 24 and 18 individuals accordingly. The materials collected and investigated in the previous years are

also involved in the comparative analysis (VLADIMIROV et al., 1973; KARLOV et al., 1988; STATOVA, 1973, 1985; STATOVA et al., 1988).

Samples of sexual cells were fixed in Bouin liquid and filled in paraffin-wax with further histological processing by the standard technique. All the studied females are subjected to the general biological analysis with calculation of gonad-somatic index (GSI), fatness coefficient after Clark (FC). The stages of gonad maturity were determined according to the recommendation of SAKUN, BUTSKAIA, and development degree of oocytes – after classification of KAZANSKII, with additions proposed by MAKEEVA, EMELJANOVA (1989) for carp. Cuts of gonads were coloured after Mallory method (ROSKIN, LIVENSON, 1957). Diameter of oocytes was determined using the ocular-micrometer. All data were processed statistically (LAKIN, 1980). Microphotos were made by the microscope with videocamera «Lomo, Mikmed-2», using increasing ocular 10x; objective 15x.

RESULTS AND DISCUSSIONS

Carassius gibelio is one of species from fish communities that showed high plasticity and adaptive possibility to the modified conditions in the water reservoirs of the Dniester basin. The change of speed of linearly-weight growth in sexually mature females in modern conditions of the Cuchurgan water basin can serve as proof (Figs. 1, 2).

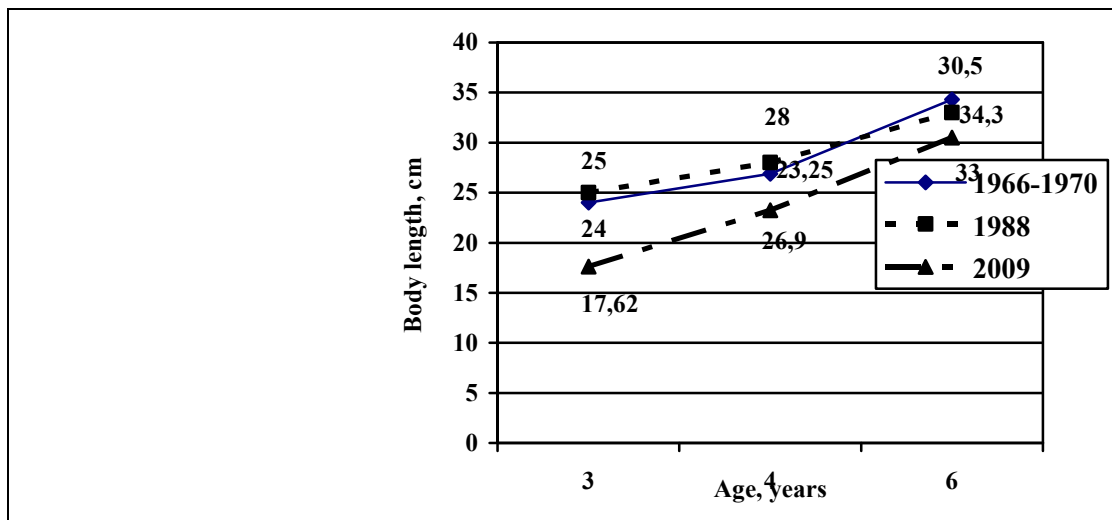


Figure 1. Dynamics of linear growth mean values of *Carassius gibelio* sexually mature females in the last 40 years.
 Figura 1. Dinamica valorilor medii ale creşterii liniare la femelele adulte de *Carassius gibelio* în ultimii 40 de ani.

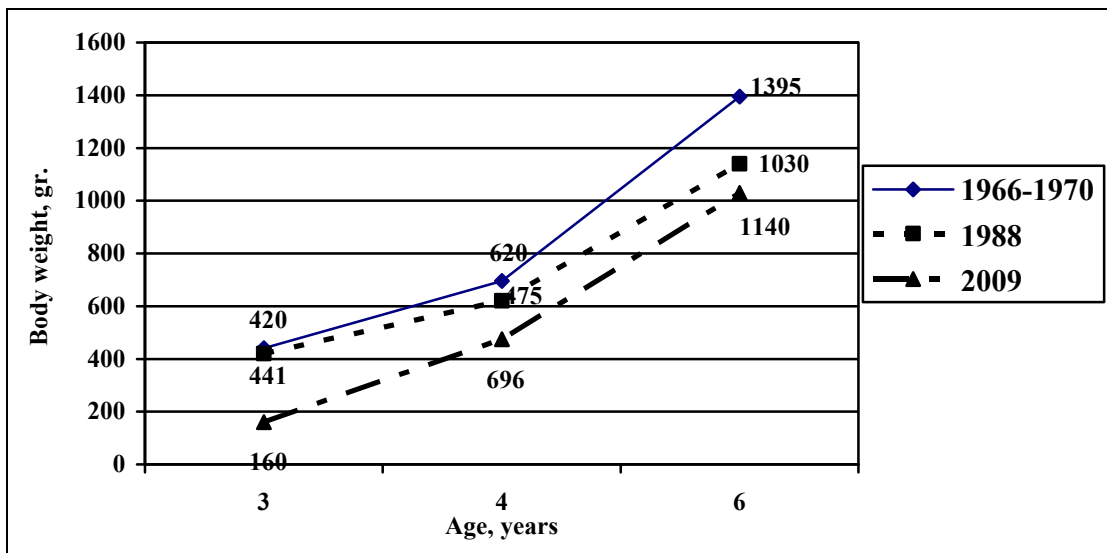


Figure 2. Dynamics of weight growth mean values of *Carassius gibelio* sexually mature females in the last 40 years.
 Figura 2. Dinamica valorilor medii ale creşterii greutateii la femelele adulte de *Carassius gibelio* în ultimii 40 de ani.

As it can be seen from the table, a decrease in the rate of growth and body weight of individuals from all specified age groups for last 40 years of existence of the water cooler basin is registered.

According to our research, the sexual maturation of females in Cuchurgan water cooler basin comes in three and, more rarely, in two year. Hence, the females become sexually mature at the smaller sizes, than it has been noted for the first years of the water cooler basin functioning (VLADIMIROV et al., 1973) and during the period when there was a growth of thermal influence of Cuchurgan hydro-electric power station upon the temperature regime of the water basin (KARLOV, 1988).

According to the growth rate *Carassius gibelio* is a medium growing fish, but depending on its inhabiting conditions, the difference in its growth rate can vary. For example, the females of the same age in the lower Dniester reach considerably bigger sizes than it is observed in the conditions of Cuchurgan water cooler basin (Table 1).

Table 1. Biological characteristics of *Carassius gibelio* females from different populations.
Tabel 1. Caracteristicile biologice ale femelelor de *Carassius gibelio* din diverse populații.

Age, years	Body length, cm	Body weight, g	Gonad weight, g	FC (after Clark)
Lower Dniester 2007-2009				
2	18.05±0.25	180.0±10.2	25.5±2.26	2.15±0.24
3	19.7±0.16	245.7±15.09	39.1±1.47	1.76±0.12
4	24.5±0.64	540.6±39.82	96.25±4.90	2.54±0.59
Cichurgan water reservoir 2007-2009				
3	17.62±0.35	160.0±8.65	16.37±1.50	2.47±0.12
4	23.25±0.43	475.0±25.0	67.0±5.20	2.89±0.10
6	30.5±0.48	1030.0±32.70	205.0±24.30	2.69±0.08

According to the table data, in the females from the Lower Dniester considerable fluctuations of fatness coefficient are registered, whereas at individuals from the water cooler basin this indicator is more stable. The minimum value of fatness in the females from the Dniester is, obviously, connected with their higher reproductive capacity. In females from both reservoirs the dependence of oocyte sizes that finished the vitellogenesis (phase E) on the age of individuals and on their body weight is accurately remarked (Table 2).

Table 2. Reproductive capacity of *Carassius gibelio* females in various aquatic basins.
Tabel 2. Capacitatea reproductivă a femelelor de *Carassius gibelio* în diverse bazine acvatice.

Age, years	The Lower Dniester			Cuchurgan water cooler basin		
	Body weight, g	GSI	Oocyte dimension in phase "E", μm 1 st gen.	Body weight, g	GSI	Oocyte dimension in phase "E", μm 1 st gen.
2	180.0±10.2	19.9±2.45	895.0±6.53	-	-	-
3	245.7±15.09	22.3±1.36	930.0±5.04	169.0±8.65	12.2±1.94	891.0±6.80
4	540.6±39.82	28.1±0.80	942.0±4.47	475.0±25.0	18.3±2.10	906.4±4.33
6	-	-	-	1030.0±32.70	26.7±4.71	961.6±6.43

Reduction of the thermal regime in Cuchurgan water cooler basin as a result of capacity reduction of the Moldova hydro-electric power station caused the shift of fish spawning for later terms. At present, the females begin spawning 15-25 days later (at the end of April – beginning of May) in comparison with 1980-1985 (middle of April) when the water temperature in the basin exceeded the natural one by 4-6.0°C (CARLOV et al., 1988; STATOVA, 1985).

The last years of research (2007-2009) have shown that in the Lower Dniester, due to the increased temperatures during autumn and winter, the warm water has caused the displacement of fish first spawning for earlier terms. The first spawning in *Carassius gibelio* is registered at present in the beginning of the third decade of April (Fig. 3), and in the first decade of May the female gonads were on the IV₂ maturity stage. In the previous year studies the beginning of fish spawning occurred later – at the end of April – beginning of May (STATOVA, 1985) and in the first decade of May (FULGA, 1994).

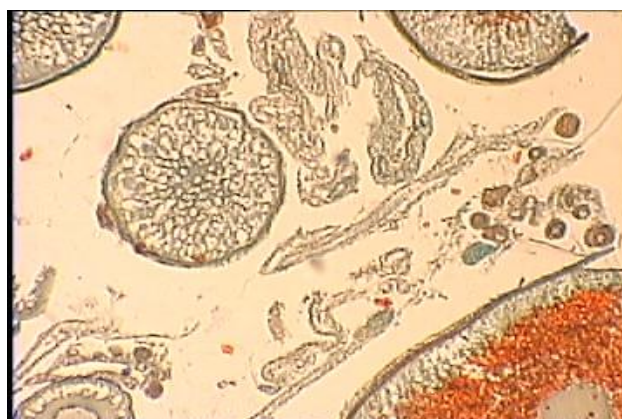


Figure 3. Oocytes of *Carassius gibelio* after the first spawning in lower Nistru.
Figura 3. Oocite de *Carassius gibelio* după prima depunere de icre în Nistrul inferior.

At the beginning of spawning the proportion of the first portion of spawn in *Carassius gibelio* from different populations fluctuates in various limits. In the lower Dniester, it constitutes 47-72%, in Cuchurgan water cooler basin – 34-68% from the quantity of protoplasmatic growth oocytes.

The variability of the spawn content in the first portion defines the gonad weight and the value of gonadosomatic index (GSI) in females before the beginning of the reproduction, of which lower values are recorded in the fish from Cuchurgan water cooler basin (Table 2)

As an indicator of the unfavourable ecological conditions of the water cooler basin for the reproduction of *Carassius gibelio* female, we mention the destructive changes in oocytes, which have finished the accumulation of trophic substances. In some individuals, the total resorption of the first generation oocytes is recorded, and younger cells are subjected to the degenerative changes, which are expressed in vacuolisation and nucleus deformation, in destruction of cortical vacuoles, the content of which gets a foamy structure and the oocyte membrane is swelling (Fig. 4). Such females do not participate in spawning, which negatively affects the population reproduction as a whole.

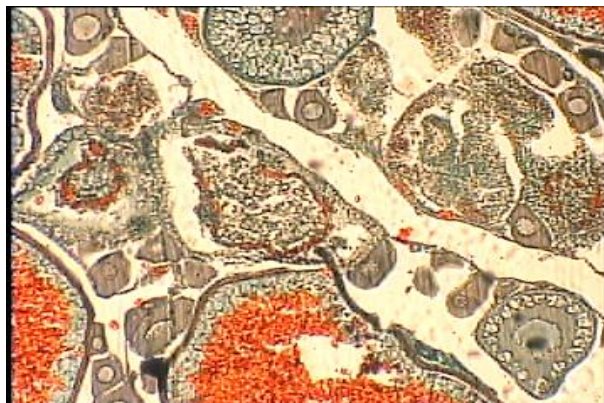


Figure 4. Total resorption of first generation oocytes in female from Cuchurgan water cooler basin.
 Figura 4. Rezorbția totală a primei generații de oocite la femelele din lacul refrigerent Cuciurgan.

In some investigated females from the lower Dniester considerable asynchrony in transition of oocytes of finished vitellogenesis phase in maturation period is revealed. In this connection, the quantity of empty follicles in oocytes is insignificant and there are a lot of residual yolk oocytes, which testifies about the egg spawning in small portions. Furthermore, in the middle of May, females on IV₂ maturity stage with total oocyte resorption on all the phases of the trophoplasmatic period growth were registered, which also has been noted in earlier works (FULGA et al., 1994).

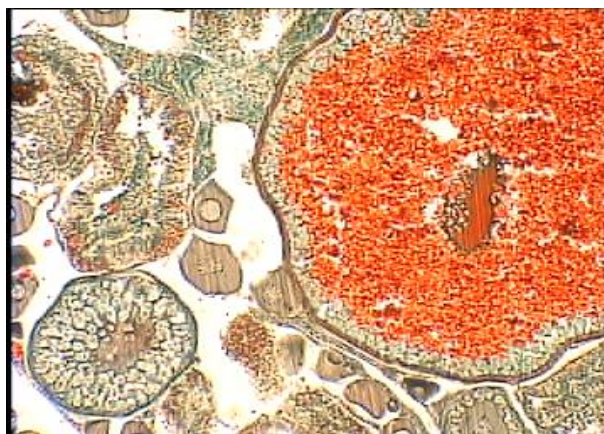


Figure 5. Resorption of oocytes from the first generation in slow growing form of *Carassius gibelio* females in Cichurgan water cooler basin.
 Figura 5. Rezorbția primei generații de oocite la forma cu creștere lentă la femelele de *Carassius gibelio* în lacul refrigerent Ciciurgan.

The studies of ichthyologic material of the last two years have revealed the presence in the water cooler basin of a slow growing form of *Carassius gibelio* with low growth rate. In the caught three-year-old sexually mature individuals, there were recorded body length and weight (15.32±0.24 cm and 96.67±3.27g accordingly), and in some females, it was observed the resorption of the first generation oocytes, which have finished the accumulation of yolk granules, thus indicating improper conditions for their transitions in the maturing phase (Fig. 5).

According to SHATUNOVSKY (2007) under unfavourable ecological conditions in the reservoir, the occurrence of dwarfish forms in population contributes to the stability of fish reproduction.

CONCLUSIONS

1. In the new conditions of inhabiting and reproduction of *Carassius gibelio*, there occurred a change in oocyte vitellogenesis that led to the shift of the beginning of fish spawning season. At the females from Cuchurgan water reservoir, the increase in duration of the process of intensive vitellogenesis led to later spawning, while at the individuals from the lower Dniester, because of the reduction of vitellogenesis period, we noticed an earlier spawning.

2. The increased intensity of vitellogenesis in fish oocytes from the lower Dniester provides higher values of gonad weight, GSI and oocyte size in the phase of finished vitellogenesis (E), and consequently higher reproductive capacity of the females.

3. The biological distinctions in mean values of linearly-weight indicators, which are defined by the ecological conditions of the existence of *Carassius gibelio* from different populations.

4. The physiological condition of sexually mature females during prespawning and spawning periods is most satisfactory at individuals from the river. Higher indicators of growth rate and relative gonad weight contribute also to higher rate of reproduction in the population of *Carassius gibelio* in lower sector of the Dniester river.

ACKNOWLEDGEMENTS

We are grateful to Laurentia Ungureanu, PhD. of biology, principal scientific researcher of the Laboratory of Hydrobiology and Toxicology of the Institute of Zoology, ASM for the assistance in micro-preparation preparing.

REFERENCES

- CARLOV V. I. & CREPIS B. I. 1988. *Perestroika ihtiofauni, raspredelenie i structura populatii promislovo-tenih vidov ryb*. Bioproductionie resursi v vodoiome-ohladiatele TAS. Iz-vo „Știința”: 165-180 [Russian].
- FULGA N. I., BODAREU N. N., MARIT A. S., USATHI M. A. *Morfo-funcțională haracteristica gonad u necotarih samoc promislivih vidob rib Dnestra*. Izv. ANM. Ser. Biol. i him. Nauk.: 36-40. [Russian].
- GORBATENKY G. G. & BIZGU S. E. 1988. *Haracteristica osnovnyh abioticeschih factorov ecosistemi vodohranilisha – ohladitelea Moldavskoi GRAS*. Bioproductionie protesi v vodohranilishah-ohladiateliah TAS. Chishinev “Știința”: 3-5. [Russian].
- LAKIN G. F. 1980. *Biometria*. Moskva. „Vishaia shcola”: 291 [Russian].
- MAKEEVA A. P., EMELIANOVA N. G. 1989. *Periodizatsia oogeneza u carpovih rib*. Voprosy Ihtiologii. **29**(6): 931-934 [Russian].
- ROSKIN G. I. & LIVENSON L. B. 1957. *Microscopiceskaia tehnika*. M. “Covetskaia nauka”: 487. [Russian].
- RUSEV I. T., RUSEVA T. D., TERNOV P. A. TERNOVA I. V. 2004. *Vnedrenie ekologicheskikh pravil exploatatsii Dnestrovskogo gidrouzla – vajneishii instrument ustoiichivogo funkcionirovania ecosistemy delity Dnestra*. Mejdunarodnaia Conferentsia „Integririvanoe upravlenie prirodnimi resursami transgranichnogo baseina Dnestra”: 266-271. [Russian].
- SACUN O. F. & BUTSKAIA N. F. 1963. *Opredelenie stadii zrelosti i izuchenie polovyh tsiclov u ryb*. M. „Nauka”: 17. [Russian].
- SHATUNOVSKII M. I., RUBAN G. I., AKIMOVA N. V. 2007. *O populiationih i ontogeneticheskikh mehanizmah reguliatii vosproizvodstva rib*. Uspehi sovremenoi biologii. **127**(1): 87-96. [Russian].
- SHEVTSOV L., GULEIKOVA A., MANTUROVA O., TIBULISKII A. 2004. *Gidrologiceskaia haracteristika transgranichnih ucastcov nijnego Dnestra*. Mejd. Conf. “Integririvanoe upravlenie prirodnimi resursami transgranichnogo baseina Dnestra: 380-383 [Russian].
- STATOVA M. P. 1973. *Polovoie sozrevanie, razmnojenie i plodovitosti rib s portionim*. Cuchurganskii liman-ohladiiteli MGRAS. Iz-vo „Știința”: 153-158. [Russian].
- STATOVA M. P. 1985. *Sravnitelnyie ekologo-fziologicheskije issledovania necotoryh carpovyh ryb vodoemov Moldavii*. Osobennosti reproductivnyh tsiclov u ryb v vodoemah raznyh shirot. Izd-vo „Nauka”: 99-111. [Russian].
- STATOVA M. P., CORNEEVA M. G., FULGA H. I. 1988. *Osobennosti funkcionirovania reproductivnoi sistemi leshcha, serebrennogo carasia i tolstolobika v period godichnogo tsicla*. Bioproductionnyie protsessi v vodohranilishchah-ohladiateliah TAS. Chishinev “Știința”: 187-201. [Russian].
- VLADIMIROV M. Z. & NABREJNII A. I. 1973. *Razmerno-vozzrastnoi sostav, pitanie, temp rosta i upitannosti ryb*. Cuchurganskii liman-ohladiiteli MGRAS. Iz-vo „Știința”: 125-148 [Russian].
- ZUBKOVA E. I., SHLENK D., ZUBKOVA N. N. 2004. *Sovremenoe sostoianie cacestvo vodi rechi Dnestr*. Mejd. Conf. “Integririvanoe upravlenie prirodnimi resursami transgranichnogo baseina Dnestra: 266-271. [Russian].

ZUBKOVA E. I., SHLENK D., ZUBKOVA N. N., BILETCHII L. I., SAPOJNIKOVA E., CREPIS O. I., CEBANU A. S. 2008. *Soderjanie metalov v ribe iz Dubosarskogo i Cuchurgansckogo vodohranilish*. Izv. ANM. Ser. Nauki o jizni. 1: 115-121. [Russian].

Fulga Nina,

Institute of Zoology of ASM, office 423,
Str. Academiei 1, Chisinau, MD-2028, Republic of Moldova
E-mail: fulganina@yahoo.com

Bulat Dumitru,

Institute of Zoology of ASM, office 423,
Str. Academiei 1, Chisinau, MD-2028, Republic of Moldova
E-mail: bulatdm@yahoo.com

Received: April, 25, 2010
Accepted: July 19, 2010