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Contemporary Saprobiological Characteristics of Arda River in the Section of Future "Gorna Arda" Cascade Building

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Abstract: The Arda River and some of its tributaries' outfalls (the section of the "Gorna Arda" Cascade) are investigated during different seasons in the period of 1998-2000. The saprobiological state of all observed stations is in the range of β-mesosaprobe, excluding Davidkovska river outfall, which is oligosaprobic. The study results clearly demonstrate an improved saprobic condition of the section in comparison with 1964, 1981-1985 and 1987, when there was not established even a macrozoobenthic species because of the significant loading.

Key words: reservoir cascade, Arda River, macrozoobenthos, saprobity

Introduction

Current data on studies of Arda River basin, directed to the hydrofauna and the general ecological state are missing in the literature. The only available papers in this respect are those of Russev (1959, 1964), Russev and Janeva (1975) and Janeva (1973, 1989). The last two are referred to the Cherna River tributary.

Therefore the necessity of up-to-date study has a special meaning mainly by 2 reasons. Russev (1964) infers that Adra river is "dead" approximately 40 km below Rudozem and he has not established even a macrozoobenthic species. According to him the river section by this time is isosaprobic. The second reason is the forthcoming building of "Gorna Arda" Cascade, which will be situated namely on this part of the river and includes the "Madan" project (with Hydro-Power Plant (HPP) "Byal Izvor"), "Ardino" project (with HPP "Ardino") and "Sarnitsa" project (with HPP "Kitnitsa". Substantial changes will treat on the ecological state during the project realization. In general the lotic conditions in river sections will be relayed by lentic (in the reservoirs), which will cause change of the organism communities. This will have rather varied impact and will reflect on the individual characteristics of the river- hydrofaunistic composition, community structure, biological productivity and biological production, etc. (Weber, 1979; Jankovic, 1974; Rothschein, 1973; Russev, 1976, 1985, 1988). One of the important impact aspects is the reflection upon the reservoirs' saprobiological state as well as upon the river sections between them.

A necessary requirement for a good ecological state after the reservoirs building is not to be admitted a further charging of the river with by-products from the mine-redressing plants, heavy metals and detergents, or any living or industrial

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waste matter. The river sections between the reservoirs and the tributaries enriching them should not have a saprobity higher than -mesosaproby.

The aim of the present work is to make an assessment of up-to date Arda river saprobiological state. The results could be a basis of a program for long-term hydrobiological monitoring of the section during the building, as well as of the river sections between the reservoirs after putting the waterelectric power stations into operation.

Material and Methods

The investigations were carried out in July 1998, June, July 1999, and July, September and October 2000 on 4 points on Arda River, 3 points on Malka Arda River and one on Cherna, Davidkovska and Madanska rivers at their outfalls (Fig. 1).

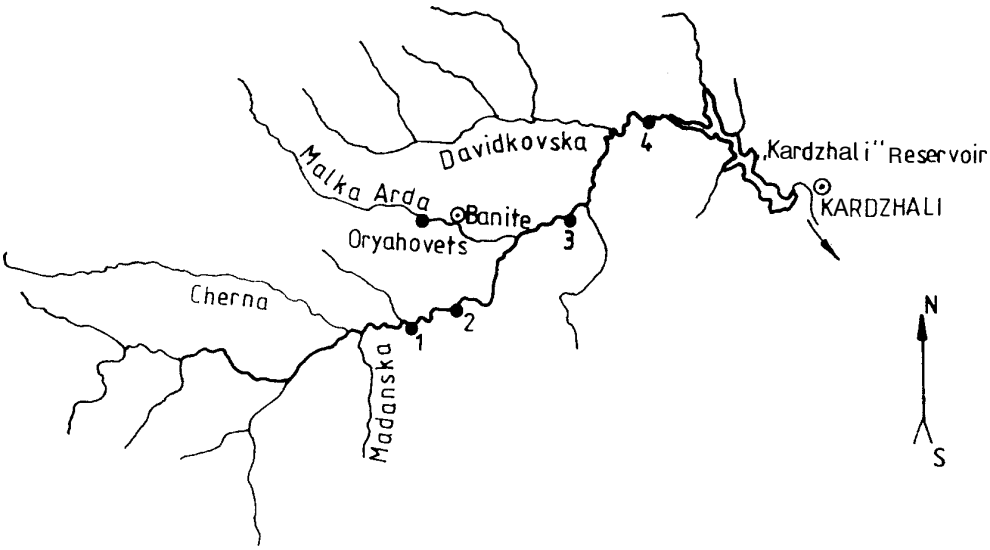

Fig.1. Scheme of the Arda River upper course
1 – Varbinski Bridge; 2 – "Madan" Dam; 3 – Dyavolski Bridge; 4 – above "Kardzhali" Reservoir

The samples were collected with a hydrobiological net from the gravel, slime and vegetable biotops and with a hydrobiological sieve for the sandy biotops.

The method of saprobic valences by Zelinka and Marvan (1961) for the saprobiological state estimation is applied. The saprobiological index is calculated by Rothschein (1962). The Irish Biotic index (IBI) (Clabby and Bowman, 1979), which is accepted by the Ministry of Environment and Waters in pursuit of hydrobiological monitoring, which is also used for a complex evaluation of the ecological state.

Results and Discusion

In different seasons of our studies all investigated stations on Arda River, evaluated by S_R, are in β-mesosaprobic state (Table 1.) The tributaries, outfall zones in the cascade section (Cherna, Madanska, Malka Arda and Davidkovska rivers) in the

Table 1. Saprobic indices (SR, IBI and BgBI) of Arda River and its tributaries during the period 1998-2000

River stations	Index	1998	1999		2000		
		07	06	07	07	09	10
Arda R.,	S_R	47.34β			44.34β	44.15β	57.58β
Varbina Bridge	IBI	3β-α			3β-α	3β-α	3-4β
Arda R.,	S_R	50.83β		47.73β	45.35β	44.95β	52.15β
Madan Dam	IBI	3β-α		4o-β	3β-α	3β-α	3β-α
Arda R.,	S_R		49.52β		46.24β	54.63β	50.57β
Dyavolski bridge	IBI		3-4β		3-4β	3-4β	3-4β
Arda R.,	S_R	48.84β	49.35β				
above Kardzhali Dam	IBI	3-4β	3-4β				
Cherna R.,	S_R	48.56β			46.60β	44.50β	50.95β
outflow	IBI	3β-α			3-4β	3-4β	3-4β
Madanska R.,	S_R						
outflow	IBI	2-3α					
Davidkovska R.,	S_R		67.05o				
outflow	IBI		4-5o				
Malka Arda R.,	S_R					58.55β	
above Oryahovets	IBI					3-4β	
Malka Arda R.,	S_R						51.03β
above Banite	IBI						3-4β
Malka Arda R.,	S_R					49.10β	50.70β
below Banite	IBI					3-4β	3-4β

most cases are in a steady β-mesosaprobic state, too. Only Davidkovska River is oligosaprobic. Because of the lack of enough bioindicators, the S_R for Madanska River below Madan was not evaluated.

The IBI values usually are in the ranges of 3-4. They characterize the state of cenoses, corresponding to β– or β–α-mesosaproby. These differences in the state assessment, made by both indices, are not essential.

Nearly 95 taxa from 19 benthic groups are found during the three-year period of our studies (Table 2.) Ephemeroptera order is the richest with taxa (24), followed by Oligochaeta class (20). All the rest groups are presented with less than 10 taxa. Poor species copmosition of some of the established groups, for instance Plecoptera and Trichoptera orders, as well as lack of established representatives from Hirudinea class (in the Arda River section) are observed. Fifty-nine taxa are established in Arda, while in the tributaries they are 72. Twenty-nine taxa of them are not found in the main river.

The abundance of the tributaries' outfalls (Table 3) is in the range of 331 (Madanska River) and 1358 specimens (October 2000, Cherna River). The higher abundance in Malka Arda below Banite, in comparison with the station above the village, is due to the bigger organic pollution, which is illustrated with the lower S_R values.

The total abundance of the established taxa at Arda River stations in different seasons is in the range of 157 (October, 2000, Madan Dam) and 1593 specimens (June, 1999, Dyavolski Bridge) (Table 4). The macrozoobenthic cenoses are less numerous in October at all stations. According to their total abundance, only three benthic groups dominate - Diptera order (3379 specimens, from which Chironomidae

Table 2. Species diversity of the bottom invertebrate communities (macrozoobenthos) in Arda River and its tributaries

Species	Arda River	tributaries
HYDROZOA		
Hydra sp.	+	
TURBELLARIA		
Dugesia gonocephala (Duges)		+
NEMATODA- Indet.	+	+
OLIGOCHAETA		
Chaetogaster diaphanus (Gruith.)		+
Eiseniella tetraedra Savigny	+	
Enchytraeidae,gen sp.	+	+
Limnodrilus sp.	+	+
Lumbricidae, gen.sp.		+
Lumbriculus variegatus Grube		+
Lumbriculidae, gen. sp.	+	
Nais communis Pig.	+	
N. sp.	+	+
Ophidonais serpentina (O.F.M.)		+
Oph. sp.		+
Peloscolex sp.	+	
Pristina amphibiotica Lastockin	+	
Pr. sp.	+	+
Psammoryctides sp.	+	+
Slavina appendiculata (d'Udekem)		+
Stylaria lacustris (Linn.)		+
Stylodrilus sp.	+	+
Tubifex tubifex (O.F.M.)	+	+
Tubificidae, gen. sp.	+	+
HIRUDINEA		
Dina lineata (O.F.M.)		+
Helobdella stagnalis (L.)		+
GASTROPODA		
Ancylus fluviatilis Muell.	+	+
Gyraulus albus Muell.		+
Radix peregra Muell.		+
Physa acuta Drap.	+	+
Ph. fontinalis L.		+
Planorbis planorbis (L.)		+
BIVALVIA		
Pisidium sp.		+
ISOPODA		
Asellus aquaticus L.	+	+
HYDRACARINA- Indet.	+	+
EPHEMEROPTERA		
Baetis alpinus (Pict.)		+
B. fuscatus L.	+	+
B. lutheri M.-L.	+	+
B. melanonyx (Pict.)		+
B. muticus (L.)	+	

Table 2. Continued

Species	Arda River	tributaries
B. rhodani (Pict.)	+	+
B. scambus Eaton	+	+
*B.*sp.		+
Caenis macrura Steph.	+	+
C. sp.	+	+
Ecdyonurus carpaticus vitoshensis Jacob&Braasch	+	
E. carpaticus Sowa	+	+
E. dispar (Curt.)	+	
E. insignis (Eaton)	+	
E. venosus (Fabr.)	+	+
E. sp.	+	+
Ephemera danica Muell.		+
E. sp.	+	
Ephemerella ignita (Poda)	+	+
Habroleptoides sp.	+	
Habrophlebia lauta Eaton	+	
Paraleptophlebia submarginata Steph.	+	+
Rhithrogena thracica Sowa, Soldan & Braasch		+
Pseudocentroptilum pennulatum (Eaton)		+
PLECOPTERA		
Leuctra sp.	+	+
Perla marginata (Panzer)	+	+
Perlodes intricata (Pict.)		+
ODONATA		
Gomphus sp.	+	+
Fam., gen. sp.	+	+
TRICHOPTERA		
Hydropsyche sp.	+	+
Rhyacophila sp.	+	+
Fam., gen. sp.	+	+
HETEROPTERA		
Nepa sp.		+
Fam,. gen. sp.	+	+
MEGALOPTERA		
Sialis lutaria L.	+	+
COLEOPTERA		
Elmidae, gen. sp.		+
Gyrinus sp.		+
Helodidae, gen. sp.		+
Ditiscidae, gen. sp.		+
Noterus sp.		+
Fam., gen. sp.	+	+
DIPTERA:SIMULIIDAE		
Eusimulium aureum (Fries)	+	+
Odagmia ornata (Mg.)	+	+
O. rheophila Knoz.	+	+
O. spinosa Doby & Debl.	+	+
O. variegata (Meigen)	+	+
Tetisimulium bezii (Corti)		+

Table 2. Continued

Species	Arda River	tributaries
Wilhelmia mediterranea (Puri)	+	+
Simuliidae, indet.		+
DIPTERA:CHIRONOMIDAE		
Ablabesmyia curticalcar Kieffer	+	+
Chironomus riparius Meigen	+	+
Crycotopus algarum Kieffer	+	
C. sylvestris (Fabr.)	+	+
Cryptochironomus defectus Kieffer	+	+
Dicrotendipes nervosus (Staeger)	+	
Eukiefferiella sp.	+	
Glyptotendipes gripekovensis Kieffer	+	+
Chironomidae, indet.	+	+
DIPTERA:VARIA		
Fam., gen. sp.	+	
ATHERICIDAE		
Atherix sp.	+	+
Fam., gen. sp.	+	+
BLEPHARICERIDAE		
Gen. sp.	+	
CERATOPOGONIDAE		
Bezzia sp.		+
DIXIDAE		
Dixa sp.	+	+
EMPIDIDAE		
Gen. sp.	+	+
LIMONIIDAE		
Dicranota sp.		+
Hexatoma sp.	+	
Antocha sp.	+	+
Gen. sp.	+	+
MUSCIDAE		
Limnophora sp.		+
PSYCHODIDAE		
Gen. sp.	+	
TABANIDAE		
Tabanus sp.	+	+
TIPULIDAE		
Tipula sp.		+
Fam., gen. sp.		+

Table 3. An abundance of the macrozoobenthic groups in Arda tributaries during the period 1998-2000

Taxa	1				2					3				4		total
	1998	2000			1998	1999	2000			1999	2000			1998	1999	
	07	07	09	10	07	07	07	09	10	06	07	09	10	07	06	
Hydrozoa			6					3								**9**
Nematoda			2	2		2		5								**11**
Oligochaeta	2	1	20	20	1	5	21	1	1	28	5	2	14	3		**124**
Gastropoda		2	3									6	14			**25**
Hydracarina	1	35	155	58	6	15	14	22	2		8	5	4	12		**337**
Ephemeroptera	576	157	20	3	298	279	56	126	12	654	188	41	72	316	311	**3109**
Odonata		9	25	11				9	9		2	9	3	2	1	**80**
Plecoptera	1	2	1			4		3			6	1		9	12	**39**
Heteroptera			5	3												**8**
Coleoptera			1			1				1						**3**
Megaloptera				1			1									**2**
Trichoptera	180	27	30	17	500	109	59	154	122	132	135	231	253	50	90	**2089**
Diptera	233	125	271	56	216	169	171	242	11	778	218	123	57	253	456	**3379**
Chironomidae	160	117	270	54	183	152	158	230	10	231	195	115	43	140	276	**2334**
Simuliidae	65				32	1	7	12		542	16	1	9	9	178	**872**
Total	**993**	**358**	**539**	**225**	**1021**	**584**	**322**	**565**	**157**	**1593**	**562**	**418**	**417**	**645**	**870**	

Notes: 1 – Varbinski Bridge; 2 – Madan Dam; 3 – Dyavolski Bridge; 4 – above Kardzhali Reservoir

Table 4. An abundance of the macrozoobenthic groups in Arda River during the period 1998-2000

Taxa	Cherna River outfall				Madanska River outfall	Davidkovska River outfall	Malka Arda River			
							above Oryachovets	above Banite	below Banite	
	1998		2000		1998	1999	2000			
	07	07	09	10	07	06	09	10	09	10
Turbellaria							3			
Nematoda				1		2			3	
Oligochaeta		80	8	150			1	93	5	144
Hirudinea	17	17	1	3						
Gastropoda	39	11	18	16			2	1	2	2
Bivalvia		5		3			3			
Isopoda		22	14	26						
Hydracarina			6	27			5	1	2	
Ephemeroptera	413	218	179	582		208	141	134	246	146
Odonata	1		9	2			34	3	52	3
Plecoptera						66	95	1	82	
Heteroptera									1	
Coleoptera						9	4	3	15	1
Megaloptera	1									
Trichoptera	202	137	137	410	103	15	77	81	220	62
Diptera	466	179	113	138	228	267	83	117	397	468
Chironomidae	158	138	101	100	120	250	49	104	380	127
Simuliidae	300	37		9	96	10	10	2	2	332
Total	**1139**	**669**	**485**	**1358**	**331**	**567**	**448**	**434**	**1025**	**826**

family - 2334 and Simuliidae family - 872), Ephemeroptera order (3109) and Trichoptera order (2089). The mass presence of Hydracarina (337 specimens) and Odonata (80 specimens) and at the same time - the less numerous Oligochaeta (124 specimens) make an impression. From all 15 cases, Ephemeroptera order dominates 7 times. In the rest of the cases Trichoptera order or Chironomidae family (4 times each of them) are usually most numerous.

An interesting regularity is observed in September and October 2000 at Varbinski Bridge. In both cases the aquatic ticks (Hydracarina) dominate, while the mayflies are presented with single specimen. According to the total abundance Chironomidae fam. and Trichoptera order are usually subdominants, but in some cases such are Simuliidae fam. (twice) or Odonata order (once).

These peculiarities can be logically explained with the fact that from the ecological point of view the river section is now in restoration after the long standing heavy loading. Such a conclusion can be made also on the basis of the study results on the species composition and the saprobiological assessment. Most probably the active restoration processes passed after 1987 since the results of the episodic investigations of Arda River below Srednogortsi during the period 1981-1985, according to the investigations of Yaneva, Russev (unpublished data), and Uzunov, Kovachev in 1985 and 1987 (Uzunov et al., 1992), show that the ecological situation reminds that in 1964. In 1992, "a permanent presence of bottom invertebrates, whose cenotic parameters characterize a satisfactory ecological state, comparable with the standards for second category by biotic criteria, including the species diversity" is established in this section (Uzunov et al., 1992).

For reaching the optimal ecological state, probably still many years will be needed, in case the poor river loading with living and industrial nature products continues. Our prognoses is that the reservoirs' building and keeping the present state both in river and its tributaries will have a positive effect over the restoration process. In this respect it is necessary to carry out a long standing monitoring of the river section during and after the cascade building. The results of the present study would be a good basis for comparison woth the river ecosystem changes.

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Съвременна сапробиологична характеристика на поречието на р. Арда в участъка на строителството на каскада "Горна Арда"

И. Янева, Я. Видинова, В. Тюфекчиева

(Резюме)

Река Арда и приустиевата зона на притоците в участъка на строителството на каскада "Горна Арда" са изследвани през различни сезони на периода 1998-2000 г. Всички изследвани пунктове са бета-мезосапробни, с изключение на устието на р. Давидковска, което е олигосапробно. Резултатите доказват значително подобрено сапробно състояние на участъка в сравнение с 1964, 1981-1985 и 1987 г., когато там не са констатирани никакви макрозообентосни организми поради значителното натоварване на реката.