

## **BIOLOGICAL DIVERSITY AND ECOLOGICAL EVALUATION OF THE FRESH WATER ECOSYSTEMS FROM THE ARDA RIVER**

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**Abstract.** The purpose of the carried on analysis has been to investigate the biological variety of the freshwater ecosystems of the Arda river and to make an ecological evaluation of their condition. The analyses have been made in the region after the reservoir 'Ivaylovgrad' during 2002 year. For an ecological evaluation of the situation of the freshwater ecosystems analysed, principal biotic indices have been fixed. The analysis of the dominant structure of the found taxons has been presented to the level of the component societies. These researches would allow to make a characterisation of the situation and a prognostication of the changes in the studied freshwater biocenoses under the influence of the anthropogeneous effects; to present recommendations for preservation of the genetic fund in them; to plan possibilities for preservation of the natural water resources in connection with the total decreasing of the water resources in Bulgaria and the possibility to use them for drinking water in the nearest future; to plan possibilities to prevent any transborder pollution and the consequences related to it (Agreement between the Republic of Bulgaria and the Republic of Greece for collaboration at using the river waters that flow through the territories of the two countries, etc.).

**Keywords:** biodiversity, biomonitoring, Arda river.

### **AIMS AND BACKGROUND**

The Arda river is related to the Aegean water collecting region. The valley of the river from the sources to the State border is indicated as a region with middle and high degree of importance in respect of the date about the species richness, the endemic and rare taxons<sup>1</sup>.

Macroinvertebrates, freshwater fishes and their helminthes are between the most frequently used bioindicating organisms to evaluate the situation of the freshwater systems<sup>2</sup>.

This research would allow to make a characterisation of the situation and a prognostication of the changes in the studied freshwater biocenoses under the influence of the anthropogeneous effects; to present recommendations for preservation of the genetic fund in them; to plan possibilities for preservation of the

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natural water resources in connection with the total decreasing of the water resources in Bulgaria and the possibility to use them for drinking water in the nearest future; to plan possibilities to prevent any transborder pollution and the consequences related to it, etc.<sup>3</sup>

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## EXPERIMENTAL

The analyses were made in the region after the reservoir 'Ivaylovgrad' (region of village Huhla) during 2002 year. The criteria of Rosenberg et al., Marcogliese, etc.<sup>2,4</sup> was applied. For an ecological evaluation of the situation of the analysed freshwater ecosystems, principal biotic indices were fixed: P% (frequency of distribution), MA (average density), HB (index of Brillouin, diversity), H' (index of Shannon, diversity), E (index of Pielou, evenness) etc. (according to Refs 5-8). The analysis of the dominant structure of the found taxons was presented to the level of the component societies<sup>8</sup>.

## RESULTS AND DISCUSSION

*General characterisation of the studied biotopes.* Studies have been performed of freshwater ecosystems from the Arda river in the vicinity of the village of Huhla, marked as biotope Huhla (Fig. 1). Biotope Huhla includes a section of the Arda river, starting after the reservoir 'Ivaylovgrad'. It begins with shallow, fast running water and continues with deep pools and slow running water. The bed is entirely gritty and clayey.



Fig. 1. The district of study

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The water<sup>f</sup> of the river in this biotope is being distinguished with acidity 7.0 pH units, measured at temperature 23°C.

The riverside vegetation is situated high above the river bed. The riverside is absorbed in greenery, represented mainly by *Quercus frainetto* Tenore, *Q. coccifera* L., *Q. cerris* L., *Q. pubescens* Willd., *Q. thracica* Stef. and Ned., *Q. polycarpa* Schur., *Acer tataricum* L., *A. campestre* L., *Ulmus minor* Mill., *Carpinus betulus* L., *C. orientalis* Miller, *Fraxinus ornus* L., etc.

*Biological diversity and ecological estimation of the macroinvertebrate fauna from the study of freshwater ecosystems of the Arda river.* In biotope Huhla during the period of the study are registered generally 21 taxons of bioindicators macroinvertebrate organisms and the general number of the specimens – 126 (Table 1).

With highest numbers are distinguished the representatives of *Nematoda* sp. (25 specimens), *Eylais meridionalis* (18 specimens), *Hydropsyche* sp. (15 specimens) and *Tabanus* sp. (12 specimens) (Table 1).

The determined indices of diversity  $H'$  and  $HB$  ( $H' = 2.61$  and  $HB=2.36$ , respectively) and of evenness  $E$  ( $E = 0.86$ ) testify to originally high diversity of species in the biotope Huhla (Table 1).

The saprobial degree of the studied biotopes of the Arda river is determined with the using of saprobial valences and indicating weight, as well as the number of each one of the concrete found bioindicating taxons<sup>7</sup>. The saprobial valences of one taxon in the performed study is higher for  $\alpha$ -saprobity (*Simulium* sp. (larvae)).

19 taxons are distinguished with higher saprobial valences for  $\beta$ -mesosaprobity. 3 taxons of those found at this stage are distinguished with equal saprobial valences for  $\alpha$ -saprobity and  $\beta$ -mesosaprobity. These are: *Hyphydrus* sp., *Ephemerella* sp. (larvae) and *Stenophylax* sp. (larvae). Two of the taxons (*Asellus aquaticus* and *Tipula* sp. (larvae)) have proved highest saprobial valences for  $\alpha$ -mesosaprobity, and one taxon – for  $p$ -saprobity (*Limnodrilus hoffmeisteri*) (Table 1).

The values of the saprobial degrees determine, according to the present study, the biotope Huhla as  $\beta$ -mesosaprobity. The diversity of species of the determined taxons justifies that biotope Huhla can be determined with biotical index 4,5 (Ref. 9).

The values of the determined index of evenness ( $E$ ) confirm in a mathematically authentic way the established degrees of  $\beta$ -mesosaprobity in the studied biotopes ( $E>0.6$  –  $\beta$ -mesosaprobial zone, according to the criteria of Pielou<sup>10</sup>).

The authenticity of the obtained results is also confirmed by  $t$ -criterion ( $t=1.01$ ;  $v=25$ ;  $q>0.3$ ), guarantying in more than 90% of the cases, that the obtained results are not accidental.

**Table 1.** Biodiversity of the bioindicating macroinvertebrates fauna from Arda river

Biodiversity	Huhla (number/m <sup>3</sup> )
	Oligochaeta
<i>Stylaria lacustris</i> (L.)	7
<i>Limnodrilus hoffmeisteri</i> Cl a p.	2
	Nematoda
<i>Nematoda</i> g. sp.	25
	Gastropoda
<i>Radix peregra</i> D r a p.	2
	Crustacea
<i>Asellus aquaticus</i> (L.)	2
	Hydracarina
<i>Eylais meridionalis</i> (L.)	18
	Insecta
<i>Dytiscus</i> sp. (larvae) (Coleoptera)	4
<i>Hyphydrus</i> sp. (Coleoptera)	1
<i>Ephemerella</i> sp. (larvae) (Ephemeroptera)	3
<i>Baetis vernus</i> C u r t. (Ephemeroptera)	5
<i>Leptophlebia</i> sp. (Ephemeroptera)	5
<i>Aechna</i> sp. (larvae) (Odonata)	5
<i>Notonecta</i> sp. (Heteroptera)	1
<i>Stenophylax</i> sp. (larvae) (Trichoptera)	2
<i>Hydropsyche</i> sp. (larvae) (Trichoptera)	15
<i>Tabanus</i> sp. (larvae) (Diptera)	12
<i>Culex</i> sp. (larvae) (Diptera)	3
<i>Simulium</i> sp. (larvae) (Diptera)	1
<i>Tipula</i> sp. (larvae) (Diptera)	2
<i>Cryptochironomus</i> sp. (larvae) (Diptera)	2
<i>Chaoborus flavicans</i> M e i g e n (larvae) (Diptera)	9
Common number of bioindicating species	21
Common number of bioindicating specimens	126
H' (index of Shannon, diversity)	2.61
HB (index of Brillouin, diversity)	2.36
E (index of Pielou, evenness)	0.86

*Biological diversity and ecological estimation of the helminth communities in Leuciscus cephalus* (L., 1758) from the studied freshwater ecosystems. The studies of the biological diversity of the ichthiofauna of the Arda river (after the reservoir 'Ivaylovgrad') have not been performed<sup>1</sup>. There are also no data about studies of the helminthic fauna of some of its representatives.

15 species of fishes on the territory of Bulgaria and their helminthic complexes are determined as bioindicators<sup>11</sup>. One of the bioindicating species of fish is *L. cephalus*. The chub is a predatory fish<sup>12</sup>. These are the basic reasons that

determine them as a targets for studying of their helminthic complexes and for ecological estimation of the studied biotope of the Arda river.

As a result of the performed for the first time in Bulgaria helminthic study of 33 specimens of *Leuciscus cephalus* of the Arda river, an invasion has been found with 8 species of helminthes: *Ichthyocotylurus pileatus* (metacercaria), *Clinostomum complanatum* (metacercaria), *Caryophyllaeides fennica*, *Caryophyllaeus brachycollis*, *Bothriocephalus achielognatii*, *Ligula intestinalis* (plerocercoid), *Acanthocephalus anguillae*, *Rhabdocona denudata* (Table 2).

With the greatest mean abundance (MA) is distinguished *I. pileatus* (MA = 7.00), followed by those of *C. brachycollis* (MA=5.00) and *R. denudata* (MA = 2.90) (Table 2).

The dominant structure of the found helminthic communities has been determined. According to the criteria of Bush et al.<sup>8</sup>, the basic species of helminthes is *R. denudata* (P%=51.52); the component species of helminths is *C. brachycollis* (P%=15.15). All the present species of helminths, according to the performed study, are accidental (Table 2, Fig. 2).

**Table 2.** Biodiversity and basic ecological indices of *L. cephalus* (L., 1758) from Arda river

Species of helminths	Huhla	
	<i>L. cephalus</i> (N=33)	
	n/p	P%/MA
Trematoda		
<i>Ichthyocotylurus pileatus</i> (metacercaria) (R u d., 1802)	3/21	9.09/7.00
<i>Clinostomum complanatum</i> (metacercaria) (R u d., 1819)	2/5	6.06/2.50
Cestoda		
<i>Caryophyllaeides fennica</i> (S c h n e i d e r, 1902)	2/3	6.06/1.5
<i>Caryophyllaeus brachycollis</i> J a n i s z e w s k a, 1951	5/25	15.15/5.00
<i>Bothriocephalus achielognatii</i> J a m a g u t i, 1934	1/1	3.03/1.00
<i>Ligula intestinalis</i> (L., 1758) (plerocercoid)	1/2	3.03/2.00
Acanthocephalla		
<i>Acanthocephalus anguillae</i> (M ü l l e r, 1780)	2/5	6.06/2.50
Nematoda		
<i>Rhabdocona denudata</i> (D u j a r d i n, 1845)	17/49	51.52/2.90
Common number of species	8	
Common numbers of specimens	111	
H' (index of Shannon, diversity)	1.50	
HB (index of Brillouin, diversity)	1.40	
E (index of Pielou, evenness)	0.723	

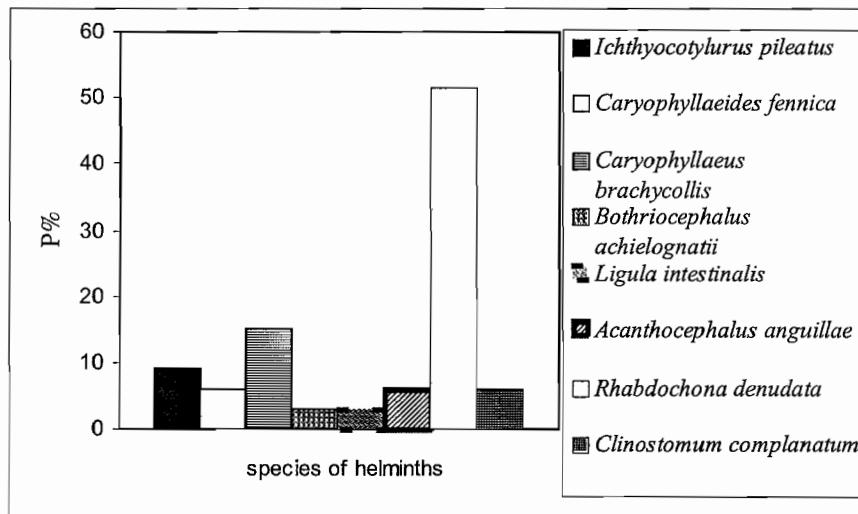


Fig. 2. Frequency of distribution (P%) of determined in *L. cephalus* species of helminths from the Arda river

For the biotope Huhla higher values are found for  $H'$  ( $H' = 1.50$ ), HB (HB = 1.40) and E ( $E = 0.723$ ) and the results are in close connection with the dominant structure of the found communities of helminthes. These biotic indices are concerning the fully counted collections and it is sensitive to data with low frequency<sup>10</sup>.

In the biotope Huhla are represented species of helminthes, which are developing with the presence of intermediate hosts cyclops and representatives of *Hydropsyche*, *Heptagenia*, *Ephemerella*, *Oligohaeta*, *Gastropoda* and *Crustacea* (*Asellus aquaticus*)<sup>13</sup>.

The obtained results for the helminthic complexes of *L. cephalus* correspond and are in a close connection and dependence of the biology and ecology of the concrete species of helminthes and the place of the intermediate hosts as bioindicators for the status of the studied natural hydroecosystems.

## CONCLUSIONS

For the first time in Bulgaria systematical ecological monitoring researches have been performed on the freshwater ecosystems of the Arda river (biotope Huhla, after the reservoir 'Ivaylovgrad'). Basic abiotic indices of the water environment have been determined. Researches have been performed of the bioindicating macroinvertebrate fauna, the ichtiofauna and the helminthic complexes of the chub (*L. cephalus*). Totally 21 taxons bioindicating macroinvertebrate fauna and 8 species of endohelminthes, have been found. The obtained results and the

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performed mathematical processing determine, according to the present study, the biotope Huhla as  $\beta$ -mesosaprobial and indicate the favourable development of the studied ecosystems of the Arda river.

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