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AQUATIC MICROFLORA OF THE JIU RIVER, IȘALNIȚA-ZĂVAL SECTOR

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ABSTRACT

This paper presents the ecological status of the designated water bodies on the Jiu River in the downstream sector of the Ișalnița reservoir - upstream of the Danube River confluence (Ișalnița-Zăval sector), taking into account the biological quality indicator for surface waters - phytoplankton, an essential component of the aquatic microflora of the Jiu River. The paper presents the characteristics of the river from a biological and physico-chemical point of view, respectively the water quality in three important sections of the Jiu-Danube Hydrographic Area: the first one marking the upper limit of the Lower Basin of the Jiu River (the Jiu to Podari section), the second one Jiu to Malu-Mare and the third one marking the closure of the Jiu River reception basin with the balance of chemical compound loads, upstream of the confluence with the Danube River (the Jiu to Zăval section). The paper also presents other aspects related to the anthropogenic impact on water bodies but also to the self-purification capacity of the Jiu River, a process generated by aquatic organisms in general and phytoplankton in particular.

INTRODUCTION

The Jiu River basin is located in the south-west of Romania between 43°45' - 45º30' north latitude and 22º34' – 24º10' east longitude.

The Jiu River basin (Fig.1) covers an area of 10,080 km^2, has an average width of 60 km in the upper part and 20 km in the lower part. The Jiu River is 339 km long [Jiu River Basin Management Plan, Report 2004, taken over in 2009]. The studied river sector (Jiu River, Ișalnița-Zăval) crosses the Oltenia plain after having crossed the mountainous region (Jiu Valley and Jiu Gorge) and the Getic Piedmont area (in Gorj County and in the north of Dolj County).

On the sector researched in the work, namely the Jiu River, Ișalnița-Zăval sector (Fig. 2) , the Jiu Water Basin Administration, through the Basin Management Plan structure, two important water bodies were designated: the water body RORW7-1_B121 (Jiu Accumulation Ișalnița-Bratovoiești) and the water body coded RORW7-1_B148 (Jiu Bratovoiești-Danube confluence) (***, 2003). Both are natural water bodies, and from an abiotic point of view, the water body RORW7-1_B121 falls into the type RO10* - watercourse sector located in the plain area, and RORW7-1_B148 corresponds to the abiotic type RO11* defined as a watercourse sector with wetlands located in the plain area. On this sector, 3 monitoring sites were established - the Jiu River at Podari, the Jiu River at Malu Mare and the Jiu River at Zăval (***, 2021).

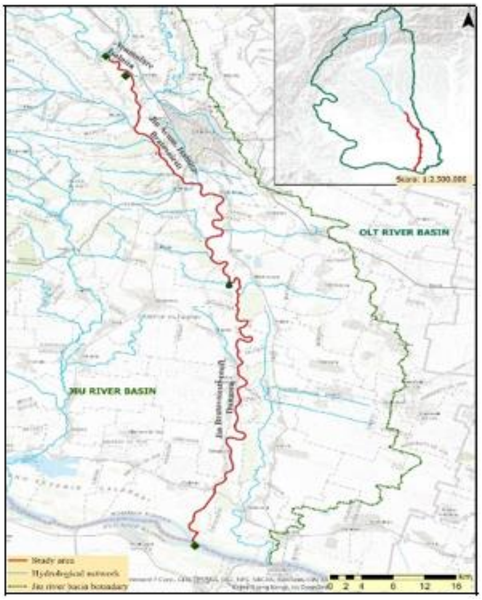

Figure 1. Jiu River Basin -within the Oltenia region (source: Jiu WBA, 2010)

Figure 2. Jiu Ișalnița-Craiova sector (source: Jiu WBA, 2024)

In order to characterize the ecological status of surface waters in any river basin, including the Jiu River Basin, the Water Framework Directive 2000/60/EC (***, 2000) requires the analysis of biological quality elements in order to assess the ecological status, as follows - for surface waters of rivers, the following are analyzed: the composition and abundance of aquatic flora; the composition and abundance of benthic invertebrate fauna; the composition, abundance and age structure of fish fauna. The paper is focused on the assessment of ecological status starting from the aquatic microflora in lowland rivers, respectively phytoplankton.

MATERIAL AND METHODS

The materials used in this research are samples collected for physico-chemical and biological determinations, respecting the sampling and analysis technique according to the regulations in force. The samplings were carried out in April 2024, during the period favorable for the development of aquatic microflora, respectively phytoplankton. For the aquatic microflora of the rivers in the plain area, the relevant biological indicator for assessing the ecological status of water bodies is phytoplankton (FPL), also evaluated in this work focused on research carried out on the Jiu River, Ișalnița -Zăval sector. The systematics of the microflora sampled from the Jiu River water was carried out in accordance with international taxonomic classifications (Germain 1981). Taxonomic determinations were made according to the determinants for the algae groups identified microscopically by specialists from water quality laboratories, specialists in determinations of the phytoplankton indicator and the calculations of trophic indices were carried out with the OMNIDIA program, used in all laboratories of the Romanian National Waters, in accordance with current international standards (***, 2008).

The method for defining the ecological status of the lower section of the Jiu River using biological quality elements is described in WFD 60/2000/EC. Here, the method for assessing the ecological status of rivers using biological quality elements for 5 ecological statuses of aquatic ecosystems (high, good, moderate, poor and bad ecological status) is presented. The method uses all biological water quality indicators, including aquatic microflora, in our case the phytoplankton indicator. The methodology was applied for 3 monitoring sites of the Jiu River on the Ișalnița-Zăval sector, namely for the sections: Jiu to Podari, Jiu to Malu-Mare, Jiu to Zăval, the entire sector having a length of 101.59 km, approximately 1/3 of the total length of the Jiu River. To assess the water quality, additional determinations were made for the physico-chemical indicators in the water samples taken from the listed above sites, according to the working procedures implemented by the Jiu River Basin Management Plan service, using data from the water quality laboratories within the Jiu Water Basin Administration (Jiu WBA). The laboratories developed test reports for the analyses performed on the water samples taken during periods relevant for algae development, and these analyses formed the basis for the assessment of the ecological status of the water bodies in the research carried out by the authors of this paper (Jiu, Ișalnița-Zăval sector).

RESULTS AND DISCUSSIONS

The aquatic microflora of the two water bodies corresponding to the lower basin of the Jiu River was assessed as being in good ecological status, by applying the methodology in all 3 sites, and by integrating the qualitative elements of the flowing waters (biological-phytoplankton and physico-chemical) and by applying the worst-case scenario principle ("one out-all out"), both water bodies were classified in the II quality class, respectively in the "good" ecological status, a status that must be achieved and maintained according to the Water Framework Directive 2000/60EC for all natural surface water bodies (Vannote et al. 1980).

The research carried out for the aquatic microflora of the Jiu River led to the following results: in the first section, Jiu at Podari (Fig. 3) of the 16 species determined, 6 belong to the green algae group, and 10 species to the diatom algae group. In this section, the *Monoraphidium arcuatum* species predominated in abundance with 1032 specimens/ml (table 1).

The Jiu at Malu Mare (Fig. 4) presents, in terms of microflora, 15 species of algae, 8 species of green algae and 7 species of diatom algae. The dominant species was *Monoraphidium contortum* with 885 specimens/ml (table 2).

For the Jiu section at Zaval, 17 species of algae were identified, 8 species of algae from the Bacillariophyta group and 9 species of algae from the Chlorophyta group, the dominant species, according to the Water Quality Laboratory (WQL) test reports, being represented by *Monoraphidium arcuatum* with 701 specimens/ml (table 3).

The conclusion of the research on the aquatic microflora on the Jiu River, Ișalnița-Zăval sector is that the ecological status of the two water bodies investigated is a good ecological status, according to WFD 60/2000/EC, taking into account only the aquatic microflora, respectively the phytoplankton indicator.

In order to characterize the abiotic environment supporting the development of aquatic organisms (lotic biocenosis), the analysis of physico-chemical indicators is very important (Șerban 2011). These elements support the biological elements, which are key of establishing the ecological status for surface water bodies according to WFD 60/2000/EC

Table 1

List of aquatic algae species - phytoplankton indicator - Jiu River at Podari

Secțiunea	Data prelevării			
Jiu la Podari	16.04.2024			
Denumirea științifică	**Autor**	**Încrengătura**	**Nr. ex./ml**	**Biovolum (mm3/l)**
Amphora ovalis	Kützing	BACILLARIOPHYTA	15	0.351
Scenedesmus quadricauda	(Turp.) Breb.	CHLOROPHYTA	170	0.322
Gomphonema olivaceum	(Hornemann) Brebisson	BACILLARIOPHYTA	310	0.140
Scenedesmus acuminatus	(Lagerh.) Chod.	CHLOROPHYTA	199	0.219
Encyonema ventricosum	(Agardh) Grunow	BACILLARIOPHYTA	258	0.054
Cocconeis placentula	Ehrenberg	BACILLARIOPHYTA	29	0.180
Ulnaria ulna	(Nitzsch) Compère	BACILLARIOPHYTA	52	0.244
Tetraedron minimum	(A.Braun) Hansg.	CHLOROPHYTA	627	0.219
Monoraphidium arcuatum	(Korsh.) Hindák	CHLOROPHYTA	1,032	0.035
Crucigenia tetrapedia	(Kirchn.) W.G.S. West	CHLOROPHYTA	295	0.120
Diatoma vulgaris	Bory	BACILLARIOPHYTA	81	0.292
Hippodonta capitata	(Ehr.) Lange-Bert. Metzeltin & Witkowski	BACILLARIOPHYTA	74	0.031
Monoraphidium contortum	(Thur.) Kom.-Legn.	CHLOROPHYTA	546	0.062
Nitzschia acicularis	(Kützing) W.M.Smith	BACILLARIOPHYTA	229	0.067
Navicula tripunctata	(O.F.M.) Bory	BACILLARIOPHYTA	44	0.057
Nitzschia sigmoidea	(Nitzsch.) W.M. Smith	BACILLARIOPHYTA	15	0.540
			3,975	2.934

Table 2

List of aquatic algae species - phytoplankton indicator - Jiu River at Malu-Mare

Secțiunea	Data prelevării			
Jiu la Malu Mare	16.04.2024			
Denumirea științifică	**Autor**	**Încrengătura**	**Nr. ex./ml**	**Biovolum (mm3/l)**
Monoraphidium contortum	(Thur.) Kom.-Legn.	CHLOROPHYTA	885	0.100
Scenedesmus quadricauda	(Turp.) Breb.	CHLOROPHYTA	236	0.448
Diatoma vulgaris	Bory	BACILLARIOPHYTA	111	0.398
Scenedesmus acuminatus	(Lagerh.) Chod.	CHLOROPHYTA	74	0.081
Tetraedron minimum	(A.Braun) Hansg.	CHLOROPHYTA	369	0.129
Gomphonema olivaceum	(Hornemann) Brebisson	BACILLARIOPHYTA	376	0.170
Scenedesmus ecornis	(Ehrenb.) Chodat	CHLOROPHYTA	81	0.089
Crucigeniella apiculata	(Lemm.) Kom.	CHLOROPHYTA	590	0.029
Rhoicosphenia abbreviata	(C.Agardh) Lange-Bertalot	BACILLARIOPHYTA	170	0.163
Cocconeis placentula	Ehrenberg	BACILLARIOPHYTA	7	0.045
Nitzschia dissipata	(Kützing) Grunow	BACILLARIOPHYTA	479	0.081
Navicula gregaria	Donkin	BACILLARIOPHYTA	59	0.068
Monoraphidium arcuatum	(Korsh.) Hindák	CHLOROPHYTA	811	0.028
Tetraedron trigonum	(Nägeli) Hansgirg	CHLOROPHYTA	332	0.112
Gyrosigma acuminatum	(Kützing) Rabenhorst	BACILLARIOPHYTA	7	0.649
			4,587	2.591

Table 3

List of aquatic algae species - phytoplankton indicator - Jiu River at Zaval

Secțiunea	Data prelevării			
Jiu la Zăval	16.04.2024			
Denumire științifică	**Autor**	**Încrengătura**	**Nr.ex./ml**	**Biovolum (mm3/l)**
Ulnaria ulna	(Nitzsch) Compère	BACILLARIOPHYTA	59	0.279
Scenedesmus quadricauda	(Turp.) Breb.	CHLOROPHYTA	155	0.294
Gomphonema olivaceum	(Hornemann) Brebisson	BACILLARIOPHYTA	184	0.083
Scenedesmus obtusus	Meyen	CHLOROPHYTA	258	0.194
Scenedesmus acuminatus	(Lagerh.) Chod.	CHLOROPHYTA	103	0.114
Monoraphidium arcuatum	(Korsh.) Hindák	CHLOROPHYTA	701	0.024
Nitzschia dissipata	(Kützing) Grunow	BACILLARIOPHYTA	398	0.068
Cyclotella meneghiniana	Kützing	BACILLARIOPHYTA	74	0.078
Tetraedron minimum	(A.Braun) Hansg.	CHLOROPHYTA	258	0.090
Navicula tripunctata	(O.F.M.) Bory	BACILLARIOPHYTA	81	0.105
Monoraphidium contortum	(Thur.) Kom.-Legn.	CHLOROPHYTA	265	0.030
Nitzschia acicularis	(Kützing) W.M.Smith	BACILLARIOPHYTA	406	0.118
Cocconeis placentula	Ehrenberg	BACILLARIOPHYTA	29	0.180
Scenedesmus ecornis	(Ehrenb.) Chodat	CHLOROPHYTA	162	0.178
Achnanthidium minutissimum	(Kütz.) Czarnecki	BACILLARIOPHYTA	265	0.014
Closterium gracile	De Brebisson	CHAROPHYTA	37	0.076
Tetraedron trigonum	(Nägeli) Hansgirg	CHLOROPHYTA	332	0.112
			3,768	2.036

As can be seen in Table 4, the ecological status of the two water bodies: Jiu River: Isalnița – Bratovoiești and Jiu River: Bratovoiești – Danube confluence is assessed as being in good chemical status.

Table 4

Monitoring results of physico-chemical indicators of water

Physico-chemical indicators and micropollutants	**Jiu at Podari**	**Jiu at Zaval**
Temperature (°C)	27,98	25,88
pH	8,02	8,16
Dissolved Oxygen (mg/l)	7,03	7,21
Ammonium nitrogen N-NH_4^+ (mg N/l)	0.49	0.06
Nitrites nitrogen N-NO_2^- (mg N/l)	0,04	0,02
Nitrates nitrogen N-NO_3^- (mg N/l)	1,28	1,80
Phosphates phosphorus P-PO_4^{3-} (mg P/l)	0,12	0,09
Total Phosphorus (mg P/l)	0,17	0,12
Copper (µg/l)	3,79	2,89
Zinc (µg/l)	15	23,19
Arsen (µg/l)	1,74	1,89
Crom (µg/l)	0,73	0,66
Chemical status	**Good**	**Good**

(Source WQL- Jiu WBA, 2024)

According to the results obtained, the chemical status of the designated water bodies in the lower sector of the Jiu is a good chemical status, the monitored physico-chemical indicators being within the limits corresponding to the II class of surface water quality.

It should be noted that the main point source of pollution for the water bodies corresponding to the lower sector of the Jiu River (Ișalnița-Zăval sector) is the city of Craiova through the wastewater emitted by it. The municipality of Craiova has a wastewater treatment plant that was put into operation in 2011 with a capacity of 385,000 equivalent inhabitants and a sewage system that currently serves 217,250 equivalent inhabitants with an average wastewater flow discharged in 2024 of 653.31 liters/second.

In terms of compliance with the requirements of Directive 91/271 EEC (***, 1991) on urban wastewater treatment, the Craiova agglomeration is non-compliant due to the degree of connection at the sewerage and treatment which is below 98%, respectively 84.5 %. In terms of the efficiency of the treatment plant, the compliance condition is met, as demonstrated by the main quality indicators monitored: BOD_5 (13.34 mg/l), N-$NH4^+$ (0.47 mg N/l), N_T (4.68 mg/l) and P_T (0.07 mg/l) (Ionuș 2014).

Figure 3. Jiu, Podari monitoring site

Figure 4. Jiu, Malu Mare monitoring site

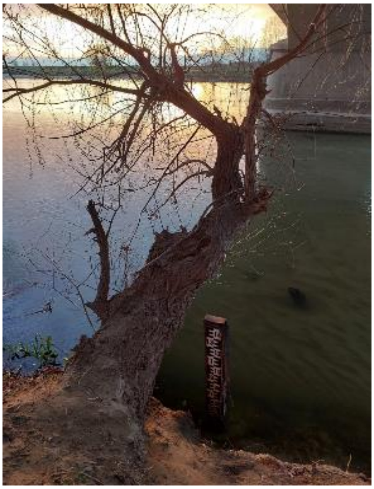

Figure 5. Jiu, Zaval monitoring site

Diffuse pollution of groundwater with substances from mineral or organic fertilizers used in agriculture represents another source of pollution in the studied river sector. The Jiu River meadow and terraces is a groundwater body (ROJI05) polluted with nitrates from agricultural sources. This aspect is monitored through the national network, also managed by Jiu WBA. The Jiu at Zaval monitoring site (Fig. 5) is relevant for assessing the ecological status of rivers in the Danube Hydrographic Area, because through the monitoring carried out here, the level of pollutants transferred by the Jiu River to the designated water body on the Danube River, namely PFII-Chiciu, can be assessed (Badea Dudău 2012).

CONCLUSIONS

Although the water bodies are in good ecological status, according to aquatic microflora, several measures need to be adopted to maintain the ecological health of the lower Jiu River, such as: biodiversity conservation, sustainable land use in agriculture, ecosystem restoration, pollution reduction and climate change mitigation.

Over time, the Jiu River has faced various pollution challenges, mainly due to urban development, industrial activities, chemicalization of agriculture and other anthropogenic activities. Pollutants such as: nutrients and organic compounds from agricultural sources, microbial contaminants from insufficiently treated urban wastewater, plastic waste and solid waste from improper disposal of household garbage are constantly monitored in order to maintain the water quality of the Jiu River and mitigate the effects of pressures on it.

Climate change also represents a significant threat to the ecosystems of the Jiu River. Altered precipitation patterns and rising temperatures may lead to changes in river flow regimes, affecting the timing of fish migration and habitat availability.

Climate change scenarios estimate a 20% probability of severe droughts in the next 10 years, especially in the southwest of the country (Jiu River Basin). This affects almost 50% of all agricultural land. The scenarios calculate that droughts, due to decreasing river flows, will become more frequent and severe (Jiu River Basin Management Plan).

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