Contribuţii Botanice, XLII, **2007**
Grădina Botanică "Alexandru Borza"
Cluj-Napoca

WATER QUALITY EVALUATION OF THE DRAINAGE BASIN OF THE ARIEŞ RIVER, USING EPILITHIC DIATOMS AS BIOINDICATORS

***Laura MOMEU*[1], *Leontin Ştefan PÉTERFI*[2]**
[1] Universitatea "Babeş-Bolyai", Facultatea de Biologie şi Geologie, Catedra de Taxonomie şi Ecologie, str. Clinicilor, nr. 5-7, **RO-400006 Cluj-Napoca**
[2] Universitatea "Babeş-Bolyai", Facultatea de Biologie şi Geologie, Catedra de Taxonomie şi Ecologie, str. Republicii, nr. 42, **RO-400015 Cluj-Napoca**
e-mail: lmomeu@yahoo.com

Abstract: Water quality evaluation of the drainage basin of the Arieş river, using epilithic diatoms as bioindicators. The present paper exhibits the results concerning the evaluation of water quality of the Arieş river and six of its tributaries, based on the Diatom Biological Index (DBI), Saprobity Index (SI) and Specific Diversity Index (H). The diatom samples were collected in October 2006 in 8 sampling site on the Arieş River and 6 on the tributaries. The computed indices suggest evident changes in all sampling sites except the spring area of the main river, where the present findings indicated excellent water quality (DBI) or very clean/class I quality (SI). The middle course of Arieş and some of its tributaries are strongly affected by the acidic mine waters. The diatom communities are disorganized in the Arieş river at Brăzeşti, downhill the mining area of Abrud – Roşia Montană – Roşia Poieni – Baia de Arieş. No diatoms could be detected in the Abrud and Valea Şesii rivulets. On the lower course of the main river, the water was altered, first of all, as concerning its saprobity, being of III class quality, heavily polluted (SI) or according to DBI being of acceptable towards mediocre.

Keywords: Water quality, epilithic diatoms, Diatom Biological Index, Saprobity Index, Species Diversity Index.

Introduction

The present tendencies in the evaluation, use and conservation of aquatic resources, according to the foresight of the Frame Directive 60/2000 of the European Union stipulates especially the use of biological components of the rivers for the evaluation of water quality and river management plans.

The use of biotic indicators in the estimation of water quality is motivated by the fact that they can supply valuable data concerning its evolution in space and time, while the physical or chemical analyses provide punctual and momentary view on the quality of water and are more expensive. It has been demonstrated that the structure of plant and animal communities of the lotic or lentic environment exhibits more accurately the healthiness of the continental water basins.

The diatoms form the main group of primary producers in running waters, especially in their upper and middle courses, being used more and more frequently in bio-monitoring processes of lotic ecosystems. The main features which make many of them valuable bio-indicators are:

- their high ecological diversity, the diatoms occurring in almost all natural water types, being the major algal group in most of the aquatic bodies;
- their short life cycles, with rapid multiplication;
- quick answer to short term changes of water, but integrates in the same time equally well the long term modifications for various impact types;
- have various survival forms (resting spores, cysts, zygotes etc.);

- exhibit different spreading possibilities, by means of water movements, wind, animals, humans etc.

The present paper exhibits some of the findings of the investigations carried out in the frame of the CNCSIS research project no. 1329, aiming to work out an integrated water quality monitoring system, based on biological indices and to emphasize the anthropical pressure upon the biocoenoses of the Arieş river catchment basin. This paper is focused on the pathway how the epilithic diatom communities of the Arieş river and six of its main tributaries (Fig. 1) exhibits the anthropical impact of the area by changing water quality. Data concerning the species composition of the diatom communities, correlated with some physical and chemical parameters of the water had already been published [6]. Some data concerning the changes occurring in the diatom community structure of the Arieş river due to pollution stress were published based on the truncated curve model [7].

Material and Methods

The epilithic algal samples from the Arieş river and its tributaries were collected in October 2006, in 14 different sampling sites, 8 distributed on the Arieş River, 6 on its tributaries (Fig. 1). In the same time, there were also measured some of the physical and chemical parameters of the water: pH, conductivity, salinity, dissolved oxygen and temperature (Table 1, 2). The sampling was carried out by scraping the surface of rocks and stones in order to remove the algal periphyton. The material collected was preserved in the field with 4% formalin and subsequently mounted in colophony according the standard treatments and cleaning methods. The diatom slides were examined under a Nikon Eclipse E 400 light microscope with 100X oil immersion lens, the taxa being identified according to the usual key books. There have been identified a total of 125 taxa.

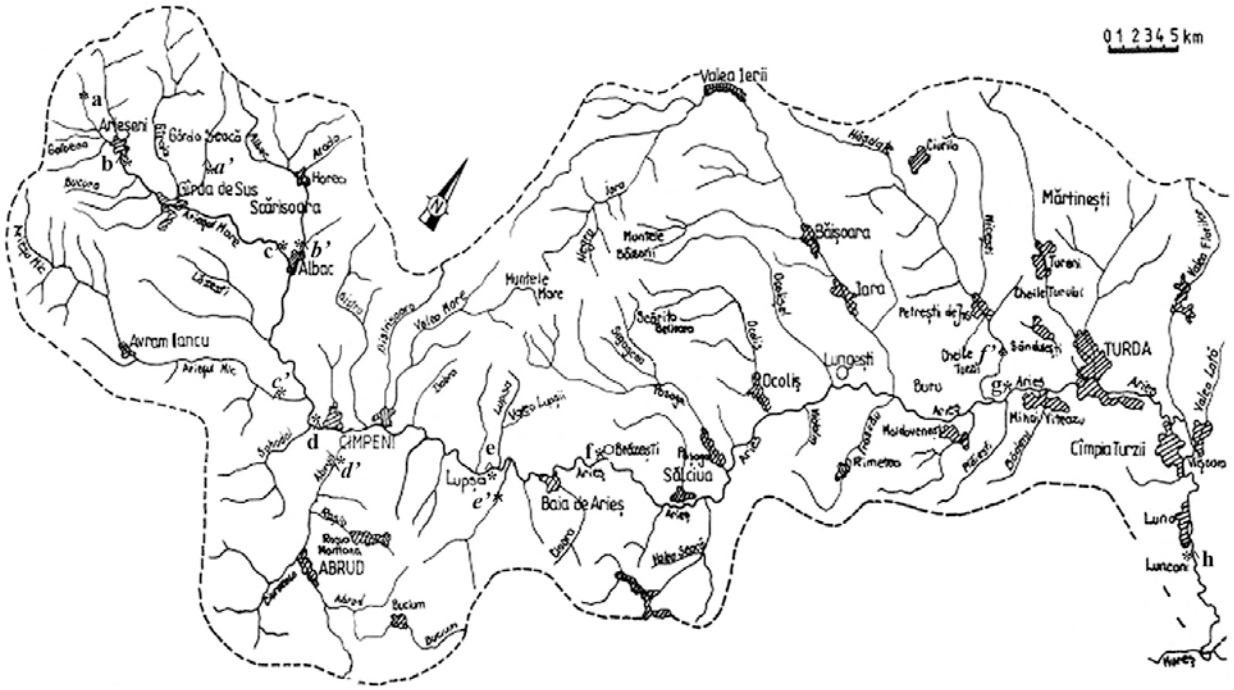

Fig. 1: The location of the 14 sampling site in the Arieş river catchment area (8 sites situated on the main river course: a- spring area of the Arieş river; b- Arieşeni; c- Uphill Albac; d- Uphill Câmpeni; e- Valea Lupşii village; f- Brăzăşti; g- Uphill Turda; h- Luncani; and 6 sites located on the main tributaries: *a'*- Gârda Seacă; *b'*- Albac rivulet; *c'*- Arieşul Mic; *d'*- Abrud rivulet; *e'*- Valea Şesii rivulet; *f'*- Hăşdate rivulet)

The diatom biological index (DBI) and the saprobity index (IS) were calculated based on the relative abundance and frequency of diatom species, after counting at least 400 individuals in

each slide. The steps required for the calculation of DBI were those recommended by Prygiel and Coste [10] (see also Voicinco and Momeu [15]).

The saprobity level of the water – or the index of saprobity (IS) was calculated based on Zelinka and Marvan [17].

There were also calculated for each sampling site, based on Shannon-Wiener, the species diversity (H) and equitability (E).

Table 1: The physical and chemical parameters of the water in the sampling sites located on the Arieş river

Sampling sites	Physical and chemical parameters					
	pH	Conductivity $\mu S.cm^{-1}$	Salinity $mg.l^{-1}$	Oxygen O_2 $mg.l^{-1}$	Oxygen O_2 %	Temperature ^0C
Spring of the Arieş river, uphill Arieşeni	5.92	960	502	8.33	79.2	13
Arieşeni	7.25	781	436	8.84	81.3	12.5
Uphill Albac	8.59	693	384	7.86	74.4	12.9
Uphill Câmpeni	6.25	798	443	7.41	72.7	14.3
Valea Lupşii village	8.54	1050	637	9.07	90.6	15.3
Băzeşti, downhill Baia de Arieş	6.92	1436	731	8.86	87.5	18.4
Uphill Turda town	8.45	1234	664	10.72	109.4	16.2
Luncani	7.59	966	516	8.13	81.1	15.2

Table 2: Physical and chemical parameters of the water in the sampling sites located on the main tributaries of the Arieş river

Sampling sites	Physical and chemical parameters					
	pH	Conductivity $\mu S.cm^{-1}$	Salinity $mg.l^{-1}$	Oxygen O_2 $mg.l^{-1}$	Oxygen O_2 %	Temperature ^0C
Upper course of the Arieş river						
Gârda Seacă	8.71	637	339	8.3	77.7	12.3
Albac rivulet	7.77	278	147	8.13	77.6	13.3
Arieşul Mic rivulet	8.1	452	230	8.23	80.9	14.3
Middle course of the Arieş river						
Abrud rivulet	4.71	1590	836	8.68	84.6	14.2
Şesii rivulet	4.36	4020	2270	8.5	88.3	16.6
Lower course of the Arieş river						
Hăşdate rivulet	8.45	783	412	8.65	86.2	15.1

Results and Discussions

To explain properly the present findings concerning the diatom communities, one has to detect the main pollution sources acting in the Arieş river catchment area.

First of all there should be mentioned some of the physico-geographical features that might potentially generate factors of natural risk: chalky relief, heavy collapses, fall of stones and formation of debris layers [2, 8], erosion of river banks, ground sliding that shuts off communication lines, causes forest destructions and floods [3, 12]. Beside these factors more dangerous are those which cause the deterioration of water quality in the Arieş basin, namely human activities. The oldest and most aggressive one is mining, the area being rich in auriferous and other non-ferrous metal deposits [9]. Even in the case of diminishing or ceasing of such activities after 1990, the existence of waste dumps, decantation ponds and the draining wastewaters of the deserted mines are important sources of heavy metal pollution in the Arieş river and its tributaries. The acidic mine-waters affect and modify the physico-chemical parameters of the water as shown by the measurement carried out in the sampling sites of the

Arieş and its tributaries (Tables 1, 2). Most evident are the low pH values (4.71; 4.37) of the Abrud and Şesii rivulets draining the mine-waters and decantation ponds and waste dumps located in the Roşia Montana area – Roşia Poieni – Abrud, as well as from the Arieş river at Brăzeşti, downhill Baia de Arieş (pH = 6.92). Similarly, there were measured in these sampling sites high and very high values for conductivity and salinity (Table 1).

Other anthropical impact form on the upper and middle course of the Arieş is the tourism connected with the chalky phenomena (Gheţarul de la Scărişoara, Gheţarul de la Vârtop [Ice Caves], or other interesting landscape elements (Detunata Goală, Detunata Flocoasă – basalt columns; Dealul cu Melci – Hill with Snails; Poiana cu Narcise de la Negrileasa – Narcissus Glade, Cheile Turzii – Turda Gorge etc.). In spite of the fact that these had been declared natural reserves [13], the tourism constitute for them a permanent source of pollution due to the wastes (paper and plastic wrappings, domestic wastes and fireplace remnants) left by the visitors. Due to the same reason a major cultural pollution source is the ski track at Arieşeni, located just at the spring area of the Arieş river. The grazing in this area, sometimes heavy one, like in the same area of Arieşeni springs, as well as intensive forest clearings after 1990 equally affects the river basin. There are large sawdust deposits on the bank of the Arieş river and of its tributaries and in the area of former reciprocating saws and wood processing factories at Gârda and Câmpeni. Another consequence of heavy forest clearing is the occurrence of ground sliding and spring high tides in the drainage basin of the Arieş river. One of the effects of sawdust accumulation on the river banks or in their littoral zone is the decrease of pH of the water. Such situation could be detected in the Arieş river, uphill Câmpeni opposite the wood processing factory, where the pH is only 6.25; comparatively with the 8.59 pH value measured in the sampling site located uphill Albac.

It should also be mentioned in addition the pollution caused by the household wastes deposited on the river bank in front of the localities Baia de Arieş, Turda and Câmpia Turzii and by the lack of an organized rural sanitary engineering. Therefore, the household wastes are deposited on the river banks or are thrown off straight into the river. In this way the household wastes affects not only the quality of water, but spoil the aesthetics of landscape, paper and plastic wrappings, used clothes and other remnants hang, up to 2-2.5 m high, on the branches of riverside trees and bushes of the riparian zone. The soil surface of the bank is covered by thousand of remnants of all sizes and colors.

A major source of pollution is the presence of ballast pits along the whole Arieş (upper, middle and lower courses) which dramatically alter the river bed.

On the lower course of the river the household and agricultural pollutants are supplemented by industrial ones, others than those connected with mining, especially downhill Turda and Câmpia Turzii.

Based on the color plates exhibiting the most important diatoms associated with the five water quality classes, presented by the methodological guide of Prygiel and Coste [10], in the Arieş river and its tributaries the following taxa indicating excellent and good water quality could be detected: *Diatoma hiemalis, D. mesodon, D. vulgare, Meridion circulare, Eunotia exigua, Fragilaria arcus, F. capucina var. vaucheriae, Frustulia vulgaris, Cymbella minuta, C. sinuata, Nitzschia dissipata, Navicula radiosa, Gomphonema acuminatum, G. olivaceum* and *Cymatopleura elliptica. Others, like Navicula capitatoradiata, N. viridula, Cocconeis pediculus, Gomphonema parvulum, Rhoicosphaenia abbreviata* indicate acceptable water quality. Waters of poor or mediocre quality are recognized by the presence of *Cyclotella meneghiniana, Navicula pupula, N. mutica, Hantzschia amphioxys* and *Nitzschia palea*. Diatoms occurring in inferior quality waters are *Navicula arvensis, N. cuspidate, N. veneta, N. frustulum* and *M. umbonata*.

The diatom biological index (DBI) values (Figs. 2, 3) could not be computed in two of the investigated tributaries, namely Valea Abrudului (Abrud Valley) and Valea Şesii (Şesii

Valley) or in the main Arieş river course, downhill Brăzeşti and Baia de Arieş, due to the total lack of diatoms in the tributaries or due to the low diatom number (6) in the main river course caused by heavy mine water pollution.

In the case of the Arieş river the values of DBI suggest excellent water quality only in the spring area of its upper course (Fig. 2). Nevertheless, it should be mentioned that in this case the dominant species – *Tabellaria flocculosa* (51%) and *Eunotia exigua*, *E. tenella* and *E. veneris* are characteristic for oligotrophic, oligo-mesotrophic or typical transitory peat bogs and not for running waters. These diatoms originate in the boggy area of the spring of the Arieş river.

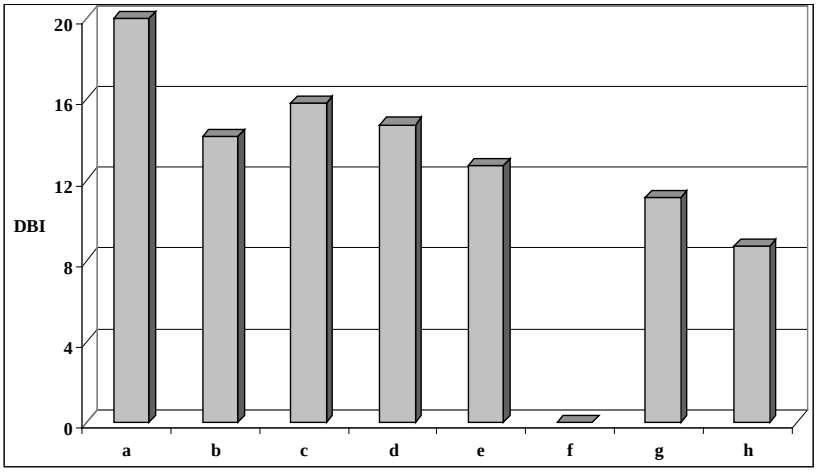

Fig. 2: Diatom biological index values (DBI) in different sampling sites of the Arieş river (sampling sites: a- Spring area of the Arieş river; b- Arieşeni; c- Uphill Albac; d- Uphill Câmpeni; e- Valea Lupşii village; f- Brăzăşti - not calculated; g- Uphill Turda; h- Luncani)

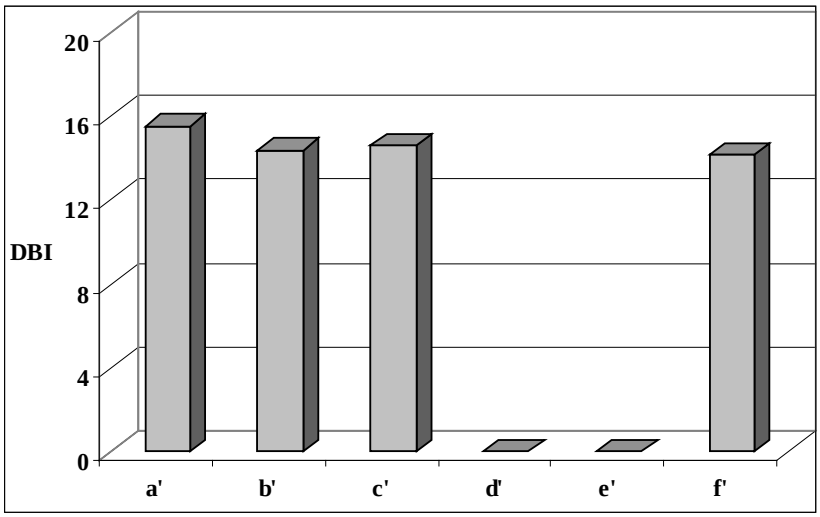

Fig. 3: Diatom biological index (DBI) values calculated for the main tributaries (sampling sites: a'- Gârda Seacă; b'- Albac rivulet; c'- Arieşul Mic; d'- Abrud rivulet; e'- Valea Şesii rivulet; f'- Hăşdate rivulet)

The presence of anthropical influences in the spring area and along the whole river course (tourism, grazing, wood clearing, and household waste) modifies the water quality of the river. That is why in the sampling site located at Arieşeni (about 9-10 km downhill the first sampling site), as well as on the upper course of the river (uphill Albac, uphill Câmpeni), the DBI values

indicate waters of good quality (Fig. 2). The same situation could be observed on the middle course of the Arieş river (at the sampling site located opposite Valea Lupşii village), but the computed DBI value (12.737) is closer to the values of acceptable water class, being affected by the mine waters of the Valea Abrudului rivulet (25 km from the mouth of the Abrudului rivulet, just before the inflow of the Şesii Valley rivulet). On the lower course of the Arieş river, at the sampling site located uphill Turda, DBI indicate acceptable, but at Luncani, before the Arieş joins the Mureş River, mediocre water quality (Fig. 2). In this area the river water quality is influenced in addition by the presence of the large waste deposits located on the river bank (Turda, Câmpia Turzii), agricultural and industrial pollution. The water of both tributaries, the Arieşul Mic, upper course and Hăşdate rivulet, lower course, according to the DBI values (Fig. 3) is of good quality.

The saprobity index values (Figs. 4, 5), correlated with the water quality classes (Table 3), indicate similar quality conditions with the DBI values. The only river sector of the Arieş with very good water quality (Class I), clean, oligosaprobic is the spring zone (Fig. 4). In the other sampling sites situated on the upper and middle course of the Arieş river, as well as on the Hăşdate and Arieşul Mic rivulets, according to the saprobity indices computed, the organic pollution of the water ranges between reduced and moderate, oligo-β-mesosaprobic, waters quality class I-II, and β-mesosaprobic, or moderate to heavy pollution, quality classes II-III and III, β-mesosaprobic to β-α-mesosaprobic waters. On the lower course at Luncani (Fig. 4), the value of saprobity index was 2.62, meaning heavily polluted water – α-mesosaprobic zone, water quality class III.

Table 3: Saprobity Index correlated with the properties of water, quality class and level of saprobity

Value of SI	Quality class	Water properties	Level of saprobity
SI ≤ 0.5	I	Very clean waters	xenosaprobic
0.5 < SI < 1.3	I	Clean waters	oligosaprobic
1.4<SI<1.7	I-II	Slightly polluted, low pollution	oligo- β mesosaprobic
1.8<SI<2.1	II	Moderately polluted	β - mesosaprobic
2.2<SI<2.5	II-III	Moderately to strongly polluted	β – α mesosaprobic
2.6<SI<3.0	III	Heavily polluted	α mesosaprobic
3.1<SI<3.4	III-IV	Heavily to very heavily polluted	α polysaprobic
SI > 3.5	IV	Very heavily polluted	polisaprobic

There have been identified indicator diatom species of different saprobity zones. For example, from the group of xeno-oligosaprobic diatoms should be mentioned *Meridion circulare, Tabellaria flocculosa, Cymbella helvetica, Gomphonema gracile, Diatoma mesodon, D. hiemalis, Eunotia* species etc. To the category of oligo-β-mesosaprobic or β-mesosaprobic diatoms belong *Achnanthes biasoletiana, Cymatopleura elliptica, Diatoma vulgaris, Fragilaria arcus, Frustulia vulgaris, Gomphonema angustatum, Navicula cryptotenella, N. radiosa* etc. Diatoms indicating critical saprobity level, β-α-mesosaprobic, α-mesosaprobic or α-polysaprobic zones, are *Anomoeoneis sphaerophora, Cymbella silesiaca, Fragilaria capucina var. vaucheriae, Navicula cincta, N. veneta, Nitzschia amphibia, N. hungarica, Surirella angusta, S. minuta* and others.

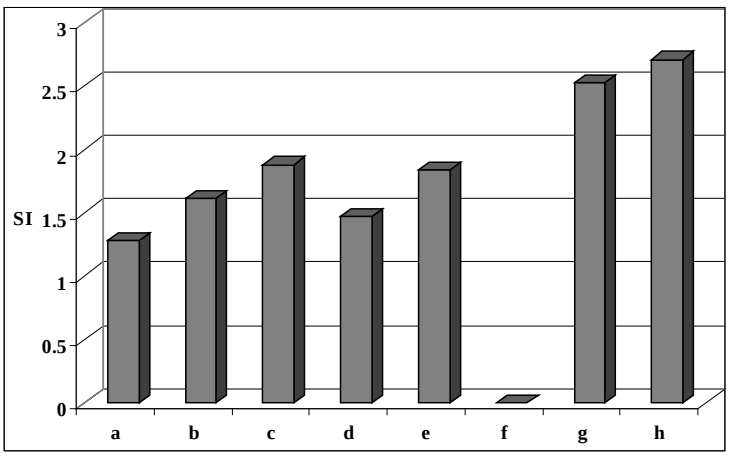

Fig. 4: Changes of the saprobity index (SI) values on the Arieş river (sampling sites: a- Spring area of the Arieş river; b- Arieşeni; c- Uphill Albac; d- Uphill Câmpeni; e- Valea Lupşii Valley; f- Brăzăşti - not calculated; g- Uphill Turda; h- Luncani)

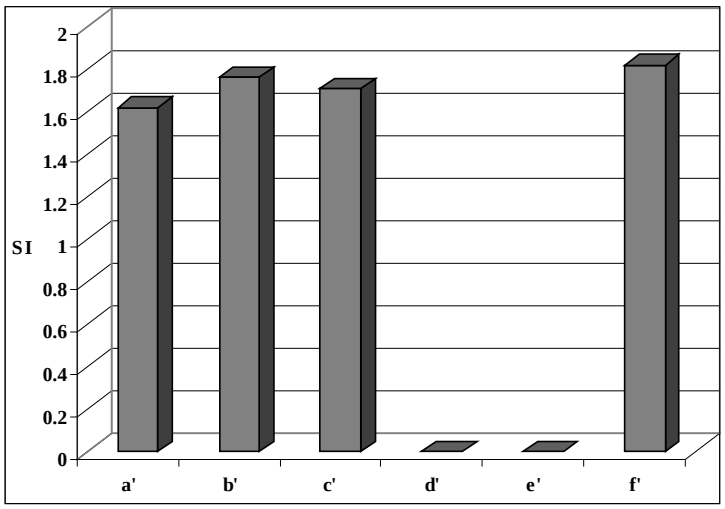

Fig. 5: Saprobity index (SI) values of the tributaries (sampling sites: a'- Gârda Seacă; b'- Albac rivulet; c'- Arieşul Mic; d'- Abrud rivulet - no diatoms found; e'- Valea Şesii rivulet - no diatoms found; f'- Hăşdate rivulet)

The present findings attest once more the validity of both biotic indices employed in the present investigations (DBI, SI) for the evaluation of running water quality. These data agree with previous ones published for the Arieş river [15] and other Transylvanian [1, 4, and 16] and European rivers [5, 10, 11, and 14].

The species diversity and equitability values suggest different affecting degrees of algal communities inhabiting the Arieş river and its tributaries, the decreasing tendency of values in the heavily polluted zones due to human impact to the total lack of algae in Valea Abrudului and Valea Şesii rivulets draining the mine waters. The highest values were calculated for the Arieş river, upriver Câmpeni, sampling site with 55 species. On the tributaries, in sampling site located on the Arieşul Mic (Fig. 7) the values of diversity and equitability were the highest. The lowest values were calculated for the Arieş river, downriver the mining area Baia de Arieş, at Brăzeşti (Fig. 6) inhabited by 6 species, as well as on one of the tributaries – Hăşdate before its mouth (Fig. 7).

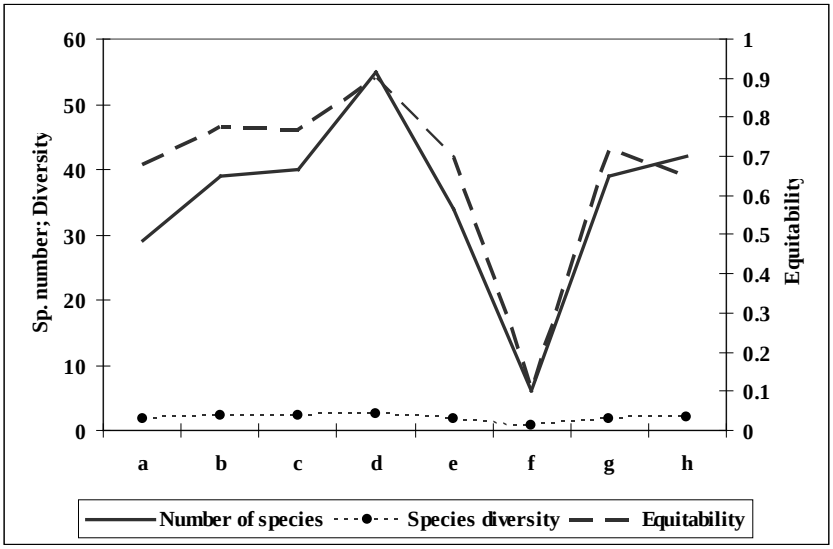

Fig. 6: Variations in species number, diversity and equitability on the Arieş river (sampling sites: a- Spring area of the Arieş, b- Arieşeni, c- Uphill Albac, d- Uphill Câmpeni, e- Valea Lupşii village, f- Brăzăşti, g- Uphill Turda, h- Luncani)

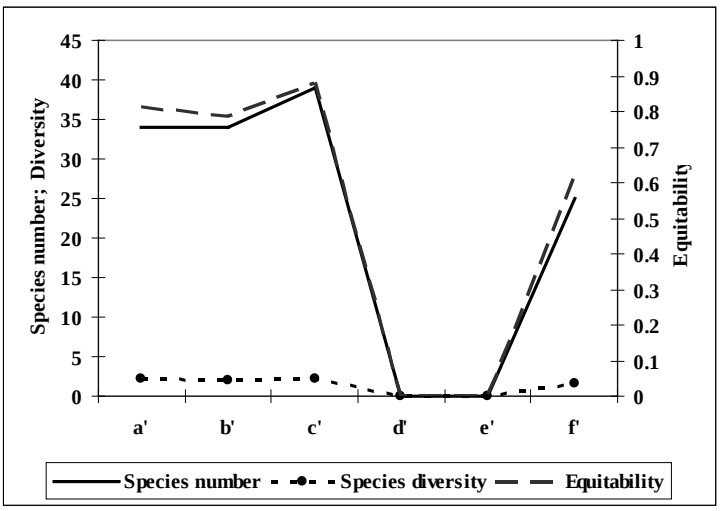

Fig. 7: Species number, diversity and equitability of the tributaries (sampling sites: a'- Gârda Seacă, b'- Albac rivulet, c'- Arieşul Mic, d'- Abrud rivulet, e'- Valea Şesii rivulet, f'- Hăşdate rivulet)

Conclusions

- The DBI and SI values suggest the water pollution of the Arieş river from its upper course toward its junction with the Mureş River, as well as of some of its tributaries, mainly due to the various forms of human impact.
- The diversity and equitability indices changed according to the affecting degree of algal communities due to the same motives.
- The changes in the quality of water are determined first of all by anthropical factors, wood clearing, tourism, grazing, industrial and agricultural pollution, household wastes, gravel pits etc. and in lesser extent by natural environment causes.
- The DBI and SI findings agree and are sustained by the physico-chemical parameters measured in the field.

REFERENCES

1. Battes, K.P., Momeu, L., Tudorancea, C., 2004, Estimarea calităţii apei râului Someşul Cald pe baza comunităţilor de diatomee bentonice, *Stud. şi comunic. – Şt. Nat., Muz. Brukenthal*, **29**: 47-53.
2. Bleahu, M., Bodea, S., 1981, *Munţii Bihor – Vlădeasa*, Ed. Sport –Turism, Bucureşti.
3. Diaconu, C., 1971, *Râurile României. Monografie hidrologică*, Serviciul de studii documentare şi publicaţii tehnice ale Institutului de Meteorologie şi Hidrologie, Bucureşti.
4. Florean, M., Péterfi, L.Ş., Momeu, L., 2006, Benthic diatom communities of the „Someşul Rece" river (Transylvania, Romania), *Contrib. Bot., Cluj-Napoca*, **XLI,** (2): 93-100.
5. Goma, J., Ortiz, R., Cambra, J., Ector, L., 2004, *Water quality evaluation in Catalonian Mediterranean rivers using epilithic diatoms as bioindicators*, Vie Milieu, **54**, (2-3): 81-90.
6. Momeu, L., Battes K.W., Pricope, F., Avram, A., Battes, K.P., Cimpean, M., Ureche, D., Stoica, I., 2007, Preliminary data on algal, macroinvertebrate and fish communities from the Aries catchment area, Transylvania, Romania, *Studia Universitatis Babeş – Bolyai, Biologia*, **LII**, (1): 25-36.
7. Péterfi, L.St, Momeu, L., 1985, Structura comunitatilor de diatomee din Arieş sub influenta stresului de poluare, *Trav. Station Stejarul, Limnol*., (1) **10**: 263-267.
8. Pop, G.P., 2000, *Carpaţii şi Subcarpaţii României*, Ed. Presa Univ. Clujeană, Cluj-Napoca.
9. Popa, A., 2000, *Mineritul aurifer din Munţii Apuseni*, Ed. Infomin Deva.
10. Prygiel, J., Coste, M., 2000, *Guide Méthodologique pour la mise en oeuvre de l`Indice Biologique Diatomées*, Ed. Cemagref, Bordeaux.
11. Rollin, C., Boisson, J., Grange, D., Fournier, A., 2002, *Inpacts of highway on the physico-chemical and biological quality of suburban streams*, Bull. des Labor. des Points et Chaussées, **236**: 73-83.
12. Ujvári, I., 1972, *Geografia apelor României*, Ed. Ştiinţifică, Bucureşti.
13. Toniuc, N., Oltean, M., Romanca, G., Zamfir, M., 1992, List of protected areas in Romania, *Ocrot. Nat. Med. înconj*., **36**, (1): 23-33.
14. Tudesque, L., Ector, L., 2002, *Inventaires des diatomées benthique des riviéres de Quadeloupe (campagne 2000-2001)*. Rapport final, Centre de Recherche Public-Gabriel Lippmann, Cellule de Recherche en Environnment et Biotechnologies – CREBS, Luxemburg.
15. Voicinco, N., Momeu, L., 2006, Water quality evaluation in Transylvanian rivers based on the diatom biologica index (DBI*), Stud. Cerc., Biol., Bacău*, **10**: 73-76.
16. Voicinco, N., Péterfi, L. Ş., Momeu, L., 2004, Preliminary studies on the benthic diatom communities from the Someşu Mare river, section Beclean (Transylvania, Romania), *Contrib. Bot., Cluj-Napoca*, 127-134.
17. Zelinka, M., Marvan, P., 1961, Zur Präzisierung der biologischen Klassifikation der Erinheit fliessender Gäwässer, *Archiv Hydrobiol*., **57**: 389-407.

EVALUAREA CALITĂŢII APEI DIN BAZINUL DE DRENAJ AL RÂULUI ARIEŞ FOLOSIND DIATOMEELE EPILITICE CA BIOINDICATORI

(Rezumat)

Lucrarea prezintă rezultatele evaluării calităţii apei din râul Arieş şi şase dintre principalii săi afluenţi pe baza indicelui biologic de diatomee (IBD) şi a indicelui de saprobitate (IS). Calcularea acestor indici, ca şi a indicelui de diversitate şi echitabilităţii s-a făcut pe baza prelucrării unor probe (8 din râul propriu-zis şi 6 din afluenţi) prelevate în luna octombrie 2006. Indicii calculaţi sugerează modificare calităţii apei încă de pe cursul superior ; singura staţiune unde s-a înregistrat apă de calitate excelentă (cf. IBD) sau ape foarte curate – clasa I de calitate (cf. IS) este cel din zona de izvor. Pe cursul mijlociu apa din Arieş precum şi unii afluenţi este puternic afectată de apele acide de mină, astfel că algele dispar cu totul în pâraiele Abrud şi Valea Şesii sau comunităţile sunt dezorganizate, ca de ex. în Arieş la Brăzeşti, în aval de zona de minieră Abrud – Roşia Montană – Roşia Poieni – Baia de Arieş. Pe cursul inferior s-a observat în primul rând degradarea apei sub aspectul încărcăturilor organice, încadrându-se în clasa III de calitate (IS), cu poluare puternică, respectiv în categoria apelor acceptabile spre mediocre pe baza IBD.

Received: 8.10.2007; Accepted: 19.12.2007