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The human impact on benthic community structure and dynamics of different ecosystems from Lunca Mureșului Nature Park (West of Romania)

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Abstract. The anthropic impact, which takes various forms, changes the water quality parameters and disturb the living environment of benthic macroinvertebrates. The present study aims to track the way pollution sources influence the macrozoobenthic community. Collecting quantitative samples, at different seasons, from Mureș River and Cărămidăriei Lake, within the area of Lunca Mureșului Nature Park before and after each major pollution source, shows the way pollution affects, both qualitatively and quantitatively, the community of benthic invertebrates. 9 groups of benthic invertebrates were identified, their density, abundance and frequency undergoing changes from one station to another and from one season to another. When the river flows through the park, the benthic community reflects strong water quality degradation of Mureș River. The river, naturally flowing on a long distance allows, through the self-purification process, an improvement in water quality emphasized by the occurrence of some sensitive groups to pollution which disappear completely once the tributary stream Mureșelul and other non-purified waters from the town of Pecica flow into the river. The seasonal dynamics of dominant groups (Oligochaeta, Diptera-Chironomidae) suggests a similarity, recording high values within the autumn-winter time interval.
Key Words: benthonic macroinvertebrates, water quality, diversity.

Rezumat. Impactul antropic sub diferite forme modifică parametrii calitativi ai apei și contribuie la perturbarea mediului de viață al macronevertebratelor bentonice. Studiul de față urmărește modul în care sursele de poluare influențează comunitatea macrozoobentonică. Colectarea de probe cantitative, sezonier, din râul Mureș și lacul Cărămidărie, pe teritoriul Parcului Natural Lunca Mureșului, înainte și după fiecare sursă majoră de poluare, arată modul în care acestea afectează calitativ și cantitativ, comunitatea de nevertebrate bentonice. Au fost identificate 9 grupe de macronevertebrate bentonice, densitatea, abundenta și frecvența acestora modificându-se de la o stație la alta și în funcție de anotimp. La intrarea râului in parc, comunitatea bentonică reflectă o puternică degradare a calității apei Mureșului. Cursul râului lăsat in regim natural pe o distanță mare permite, prin fenomenul de autoepurare, o îmbunătățire a calității apei evidențiată prin apariția unor grupe sensibile la poluare, dar care dispar complet, odată cu intrarea unui tributar (Mureșelul), și a primirii unor ape neepurate din orașul Pecica. Dinamica sezonieră a grupelor dominante (Oligochaeta, Diptera-Chironomidae) sugerează o similaritate, înregistrând valori crescute în intervalul toamnă-iarnă.
Cuvinte cheie: macronevertebrate bentonice, calitatea apei, diversitate.

Kivonat. A vízminőséget befolyásoló különböző emberi behatások egyúttal a makroszkopikus vízi gerinctelen életközösségek élőhelyét is degradálja. Jelen kutatás a szennyezőforrások makrozoobentoszra gyakorolt hatását vizsgálja. A szezonális, kvantitatív mintavételek a Maros folyónak a Maros-ártér Natúrpark (Parcul Natural Lunca Mureșului) határain belül húzódó szakaszát, valamint a szintén védett területen lévő Téglavető-tavat (lacul Cărămidărie) fedték le. A szennyezések előtti és utáni mintavételekből adódó különbségek arra mutatnak rá, miképpen hatnak ezek a szennyezések, úgy a kvalitatív, mint a kvantitatív változások tükrében, a vízi gerinctelen életközösségekre. Mindösszesen 9 makroszkopikus gerinctelen állatcsoportot azonosítottunk, melyek denzitása illetve előfordulási gyakorisága a mintavételi helyek illetve évszakok függvényében változott. A natúrparkba belépő Maros vízminősége kifejezetten rossz ezen a szakaszon, mint az a bentosz viszonylagos faj- és egyedszegénységéből is kitűnik. Az ezt követő hosszú, természetes folyószakasz az öntisztítási

folyamatokon keresztül elősegíti a Maros vízminőségének javulását, ami többek között egyes, a szennyezésekre egyébként érzékeny vízi gerinctelenek megjelenésében mutatkozik meg. Ezen fajok azonban ismételten eltűnnek, amint egy, Pécska város (Pecica) kezeletlen szennyvizét elvezető mellékfolyócska (Mureșelul) beömlik a Marosba. Az egyes domináns fajcsoportok (a kevéssörtéjű illetve árvaszúnyog fauna - Oligochaeta, Diptera-Chironomidae) szezonális dinamikája összhangban van egymással, a magas értékek az őszi-téli periódusra datálódnak.
Kulcsszavak: bentonikus makroszkopikus gerinctelenek, vízminőség, diverzitás.

Introduction. Benthic macroinvertebrates are considered to be one of the most important biological parameters for the quality of surface waters and have the following characteristics: they live in constant contact with the sediments where pollutants are accumulated, have a fairly long-lasting lifecycle, are present in all types of aquatic ecosystems, are easily collected and quite easy to identify (Ogbeibu & Oribhabor 2002; Braukmann & Biss 2004; Badea et al 2010; Kubosova et al 2010).

The anthropic impact taking different forms can have a direct influence on the macrozoobentos invertebrates, taking into account both diversity and density or abundance (Azrina et al 2006; Korte et al 2010).

The present paper aims to use these parameters in order to analyze the quality of Mureș River within the area of Lunca Mureșului Nature Park, taking into account the main polluting factors (Arad, Pecica and a few villages along the river). Several studies were carried out along the whole river valley focusing on the effects caused by anthropic pressure and emphasized the impact of these effects upon water quality (Hamar & Sárkány-Kiss 1995; Sárkány-Kiss et al 1997; Sandu et al 2008; Sandu & Bloesch 2008; Triebskorn et al 2008); yet, no study made reference to the river sector flowing through Lunca Mureșului Nature Park. The present paper attempts to bring new contributions with regard to the influence of polluting factors upon the benthic macroinvertebrates inhabiting the river course through the park.

Material and Method. Throughout the period 2009-2010, 3 quantitative benthic samples were collected, at different seasons, from Mureș River and Cărămidăriei Lake. The samples were collected with Ekman-sampler with a surface of 225 cm^2 and were subsequently washed with benthic nets (meshes of 250 μm) and stored in 8% formaldehyde.

Laboratory works were conducted to carry identifications to order level, except for Oligochaeta (subclass level). A number of 11.207 individuals were processed.

The sample collecting stations were located upstream and downstream of the main sources of pollution (Purification Station of Arad, Mureșel flowing into Mureș River – Mureșel, tributary stream with polluted water from north Mureș, Purification Station of Pecica).

The sample collecting stations were located as follows: S1 - Alfa district of Arad, upstream of the canal bringing water from the purification station of Arad city, upstream of the area Muresul flows through Lunca Mureșului Nature Park; S2 - upstream of the area Mureșelul flows into Mureș; Mureșelul is a tributary stream bringing polluted water from the towns and villages situated in the north of Mureș River; S3 – upstream of Pecica town; S4 – downstream of Pecica town; S5 - Cărămidăriei Lake (see Figure 1).

The river bank within this lower sector is covered by clusters of *Salix* sp. and *Amorpha fruticosa.* The coverage degree of the river bed with riparian vegetation was: 20% (S1), 25% (S4 and S5) 30% (S2,) 35% (S3). The sub-layer varied from gravel (S1), sand (S3, S4) and ooze consolidated with fine detritus (S2, S5).

The density ($Di = ni\ Sp^{-1}$), the abundance ($A = (ni\ N^{-1}) * 100$) and the frequency ($F = Ni * 100\ Np^{-1}$) were further calculated, where ni represents the total number of individuals for the i series, Sp the total researched area, N the total number of individuals belonging to all species (from the sample or the studied samples), Ni the number of stations within which been identified the subjected species, Np the total number of stations (Stan 1995). Confidence intervals of average values were calculated to $p = 0.05$.

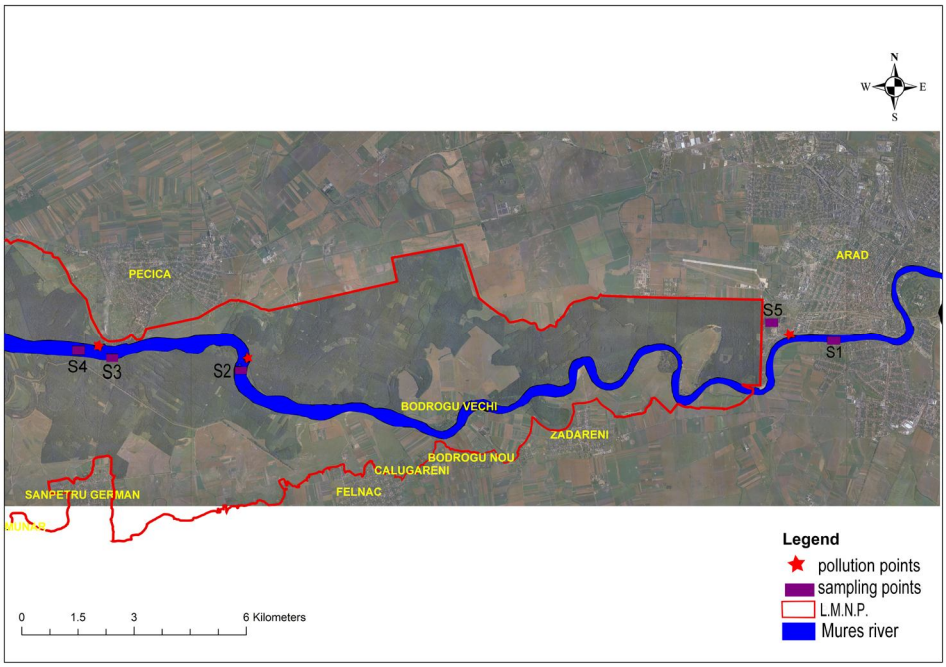


Figure 1. The location of the sample collecting stations on the Mureș River in Lunca Mureșului Nature Park.

Results and Discussion. Once the benthos samples were processed, 9 groups of benthic macroinvertebrates were identified: Nematoda, Oligochaeta, Diptera, Gastropoda, Bivalvia, Trichoptera, Ephemeroptera, Odonata and Heteroptera whose average density throughout the whole period of study is presented in Figure 2. Due to the fact that high Oligochaeta and Diptera values hide the values of the other groups, the diagram from Figure 3 shows the density of benthic invertebrates without the two aforementioned groups.

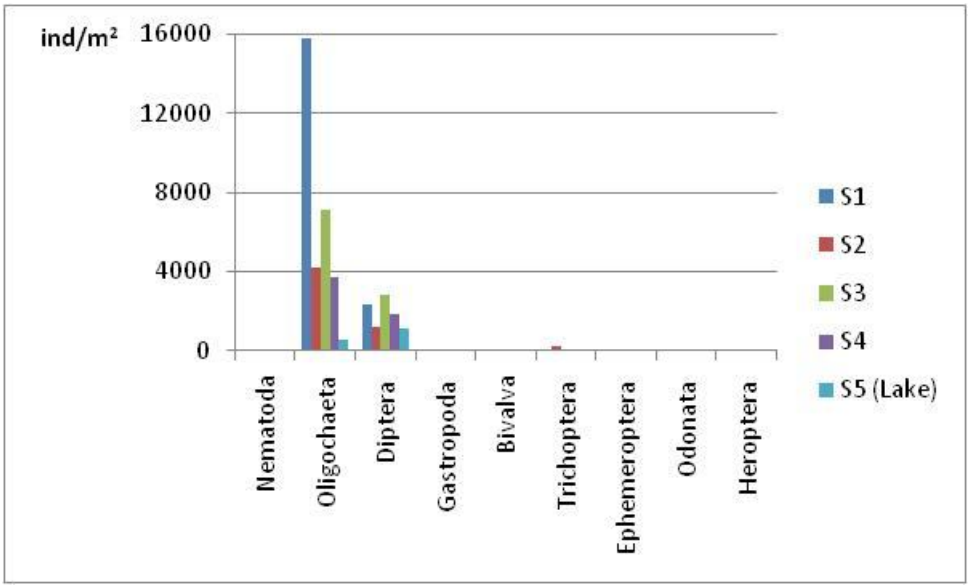
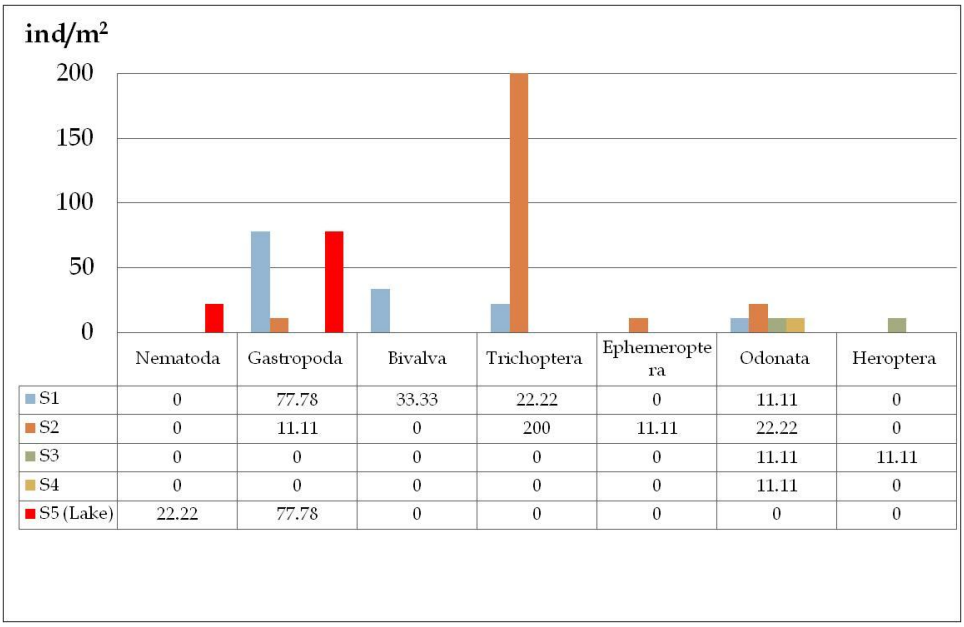


Figure 2. Macroinvertebrates density (individuals m^{-2}) from Mureș River and Cărămidăriei Lake, 2009-2010.



	Nematoda	Gastropoda	Bivalva	Trichoptera	Ephemeroptera	Odonata	Heroptera
S1	0	77.78	33.33	22.22	0	11.11	0
S2	0	11.11	0	200	11.11	22.22	0
S3	0	0	0	0	0	11.11	11.11
S4	0	0	0	0	0	11.11	0
S5 (Lake)	22.22	77.78	0	0	0	0	0

Figure 3. Macroinvertebrates density (individuals m^{-2}) from Mureș River and Cărămidăriei Lake (without Diptera & Oligochaeta), 2009-2010.

For both Oligochaeta and Diptera we notice high density values (15777.78±248.1 individuals m^{-2} and respectively, 2333.33±71.29 individuals m^{-2}) at the sample collecting station outside Arad city (S1), which confirms a massive load of the sub-layer with polluting organic substances coming from the urban and industrial city of Arad. At this sample station, Larvae from Chironomidae Family were included in the Diptera category. The high tolerance of Oligochaeta and Chironomidae has been demonstrated in numerous studies (Marchese et al 2008; Benbow 2009; Courtney & Merritt 2009; Collier et al 2010). These two groups of invertebrates show significantly larger tolerance limits, adapting to various environmental conditions (Lucan-Bouché et al 1999; Verdonschet 1999).

After this station (S1), the natural meander-like course without major pollution sources provides the conditions called for an improvement in water quality through natural purification, which leads to a decrease in the density of these two groups at station S2 (4166.67±77.6 individuals m^{-2} at Oligochaeta and 1177.78±36.9 individuals m^{-2} at Diptera) and the occurrence of others (Gastropoda, Trichoptera, Ephemeroptera, Odonata), indicators of better water quality (Lorenz 2003). The Ephemeroptera detected in station S2, with a density of 11.11±0.49 individuals m^{-2}, belongs to Caenidae Family (Small Squaregilled Mayflies) and Baëtidae Family. These families are listed by Hilsenhoff (1988) and Bode et al (2002) as having a tolerance value for organic population of 6 (Caenidae) and 5 (Baëtidae), measured on a scale ranging from 0-intolerant to 10-tolerant.

The overflow process of non-purified tributary stream Muresel has a significant impact upon the density in these 2 groups (Oligochaeta and Diptera) at station S3, station that records increased values as compared to the previous station (see Figure 2).

The influence of a totally inoperative purification station (of Pecica town), which brings other pollutants beside the load of organic matter, leads to a density decrease even in these two groups that were regarded as tolerant to pollution (Chironomidae and Oligochaeta) at S4. Likewise, at this station the other benthic groups, more sensitive, disappear (Trichoptera and Ephemeroptera).

Cărămidăriei Lake has an extremely low diversity of benthic groups due to the high eutrophication degree as this lake is situated near a human settlement without purification stations and with domestic animals that use water from the lake for bathing and drinking. The oozy layer loaded with organic substances favors the development of

nematodes, this station (S5) being the only one where these invertebrates were detected (see Figure 3).

As far as the seasonal variation of the density in the two dominant groups, Oligochaeta (see Figure 4) and Diptera (see Figure 5) is concerned, a similar dynamics, with higher density values, is noticed in all stations during winter and autumn seasons.

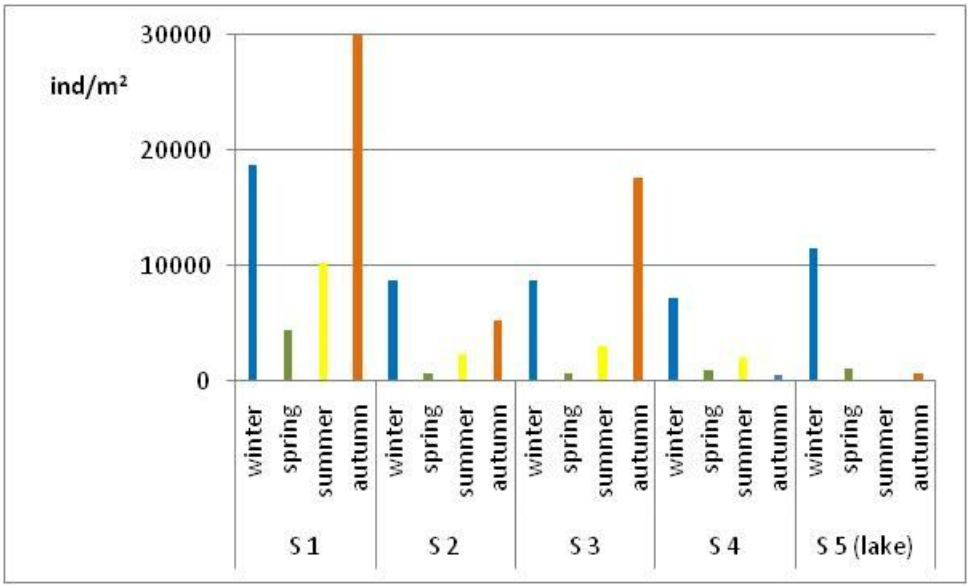


Figure 4. Seasonal density dynamics (individuals m^{-2}) for Oligochaeta.

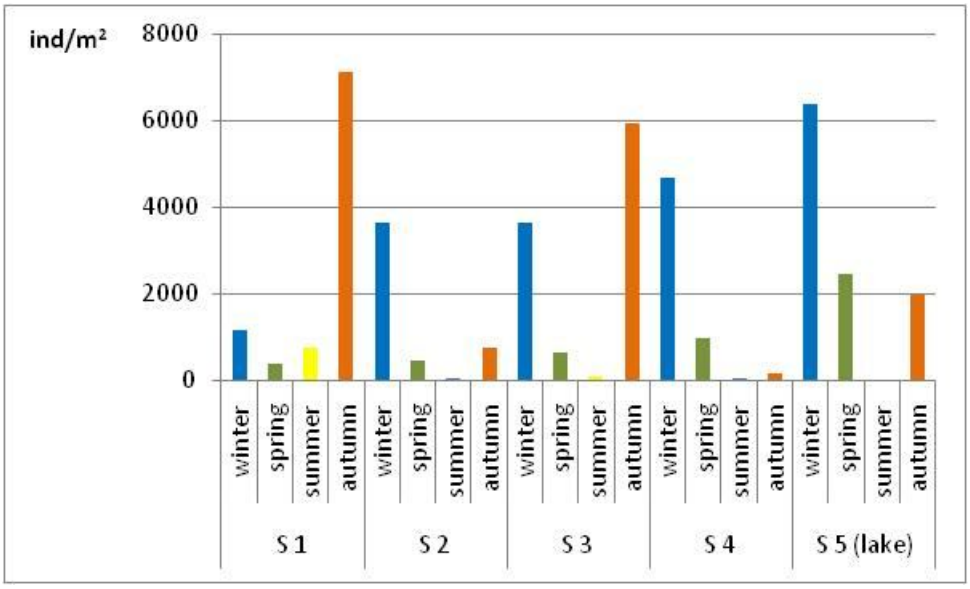


Figure 5. Seasonal density dynamics (individuals m^{-2}) for Diptera Family larvae.

Conclusions. The analysis of benthic communities from Mureș River before the river flows through Lunca Mureșului Nature Park and Cărămidăriei Lake shows the occurrence of 9 groups of invertebrates, among which Oligochaeta and Diptera (preponderantly represented by Chironomidae Family) held a 100% frequency. The other groups occurred in the benthos depending on the pollution degree of water and sub-layer at different station submitted to analysis.

When the river flows through the park, the benthic community reflects a strong water quality degradation of Mureș River. The river, naturally flowing on a long distance allows, through the self-purification process, an improvement in water quality emphasized by the occurrence of some sensitive groups to pollution which disappear completely once Mureșelul stream and non-purified waters from the town of Pecica flow into the river.

The seasonal dynamics of dominant groups (Oligochaeta, Diptera-Chironomidae Family) suggests a similarity in the autumn-winter time interval.

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