THE MARAMUREŞ MOUNTAINS NATURE PARK (ROMANIA) MAYFLY (INSECTA, EPHEMEROPTERA) COMMUNITIES DIVERSITY ANALYSE

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KEYWORDS: Romanian Carpathians, Maramureş Mountains, Vişeu River basin, Ţâşla River, Vaser River, Ruscova River, Ephemeroptera larvae communities.

ABSTRACT

This study presents the description of the structure and diversity analyse of Ephemeroptera larvae communities of the Vişeu River basin. The paper is based on quantitative benthic macroinvertebrates and mayflies qualitative samples, sampled in 2007 (June-September), in 24 sampling stations.

In the reference zone 24 mayfly species were identified, belonging to 12 genera and six families, representing 33.33% of the Romanian Ephemeroptera fauna.

The mayfly larvae communities present the highest diversity on the Ruscova River, on the lower Vaser River and on the Vişeu River - upper cours (Vişeuţ Stream), downstream the confluence with Ruscova River and in the Vişeu Gorge. In these lotic sectors the aquatic habitats are in good state, close to the natural one and the anthropogenic impact in this area is not significant. These areas should to be managed for the aquatic biodiversity conservation.

The mayflay communities present the lowest diversity in the Ţâşla Stream two km upstream the confluence with Bălăsâna and in the Vişeu River 50 m upstream the Moisei locality and one km downstream Vişeu de Jos locality. In these sectors ecological restoration measurements should be implemented for the lotic habitats, these being degraded due to the pollution, respectively due to the substratum exploitation.

ZUSAMMENFASSUNG: Diversitätsanalyse der Eintagsfliegen-Gemeinschaften (Insecta, Ephemeroptera) des Naturparks Munţii Maramureşului/Maramuresch - Gebirge (Rumänien).

Die Arbeit umfasst eine Beschreibung der Struktur der Larvengemeinschaften von Eintagsfliegenarten aus dem Einzugsgebiet des Vişeu-Flusses und die Analyse der Diversität dieser Gemeinschaften. Die in der Arbeit vorgestellten Ergebnisse beruhen auf der Auswertung von quantitativen Zoobenthos- und qualitativen Ephemeropterenproben, die 2007 (Juni-September) an 24 Probestellen entnommen wurden.

Im Referenzgebiet wurden 24 Ephemeropterenarten festgestellt, die zu zwölf Gattungen und sex Familien gehören und 33,33% der in Rumänien bekannten Ephemeropterenarten ausmachen.

Die Gemeinschaften der Ephemeropterenlarven haben eine hohe Diversität im Ruscova-Fluss, im Unterlauf des Vaser-Flusses sowie im Oberlauf des Vişeu (Vişeuţ-Bach), unterhalb der Einmündung des Ruscova-Flusses und in der Vişeu-Klamm. In diesen Abschnitten sind die Gewässerhabitate in einem guten, naturnahen Zustand, wobei der menschliche Einfluss sehr gering ist. Daher muss hier das Management im Sinne der Erhaltung der aquatischen Biodiversität durchgeführt werden.

Die geringste Biodiversität an Ephemeropteren wurde im Ţâşla-Fluss zwei km oberhalb des Zusammenflusses mit dem Bălăsâna-Bach und im Vişeu 50 m oberhalb von Moisei und ein km unterstrom der Ortschaft Vişeu de Jos/Unterwischau festgestellt. In diesen Abschnitten sind Maßnahmen zur Wiederherstellung der lotischen Habitate erforderlich, da sie sich durch die Verschmutzung, bzw. durch Substratabbau in einem schlechten Zustand befinden.

REZUMAT: Analiza diversităţii comunităţilor de efemeroptere (Insecta, Ephemeroptera) din Parcul Natural Munţii Maramureşului (România).

Lucrarea prezintă descrierea structurii comunităţilor larvelor de efemeroptere din bazinul hidrografic Vişeu şi analiza diversităţii acestor comunităţi. Datele prezentate în lucrare se bazează pe probe cantitative de bentos şi calitative de efemeroptere, colectate în anul 2007 (iunie - septembrie) din 24 staţii de prelevare.

În zona de referinţă, au fost identificate 24 specii de efemeroptere, din 12 genuri şi şase familii, acestea reprezintă 33,33% dintre speciile de efemeroptere semnalate în România.

Comunităţile larvelor de efemeroptere prezintă o diversitate mare în râul Ruscova, în cursul inferior al Vaserului şi în Vişeu - cursul superior (pârâul Vişeuţ), aval de confluenţa cu Ruscova şi în Cheile Vişeului. În aceste sectoare de râu, habitatele acvatice prezintă o stare bună, apropiată de cea naturală, iar impactul antropic este nesemnificativ. Aceste zone trebuie gestionate în sensul conservării biodiversităţii acvatice.

Cea mai mică diversitate a efemeropterelor se înregistrează în Ţâşla, la doi km amonte de confluenţa cu Bălăsâna şi în Vişeu la 50 m amonte de localitatea Moisei şi la un km aval de localitatea Vişeu de Jos. În aceste sectoare, se impun măsuri de redresare a habitatelor lotice, acestea fiind degradate datorită poluării, respectiv exploatării substratului.

INTRODUCTION

This study presents the description of the structure and diversity analyse of Ephemeroptera larvae communities of the Vişeu River basin.

The information resulted from this study will be useful for the Maramureş Mountains Nature Park management plan attainment.

Vişeu River is a second order tributary of Danube localized in the north of Romania. The most part of the Vişeu River basin was included in the Maramureş Mountains Nature Park.

Vişeu River has its sources in the Rodna Mountains, 80 km river length, 1,606 km^2 basin surface and a multiannual average flow at the confluence with Tisa River of 30.7 m^3/s. Some of the most important tributaries of Vişeu River are (from upstream to downstream): Ţâşla River (20 km length, 106 km² drain surface), Vaser River (42 km length, 422 km^2 drain surface, 9 m^3/s multiannual average flow at the confluence with Vişeu River) and Ruscova River (39 km length, 435 km^2 drain surface**,** 11 m^3/s multiannual average flow at the confluence with Vişeu River) (Roşu, 1980; Badea et al., 1983; Posea et al., 1982).

Actual hydrobiological research in this area are few, in this respect we have to mention the study concerning the benthic macroinvertebrates and fish along Vişeu River, realised by Staicu, Bănăduc and Găldean (1998). Until the present, coenological studies regarding the mayfly larvae of the Vişeu River basin were not made.

MATERIAL AND METHODS

This paper is based on quantitative benthic macroinvertebrates and mayflies qualitative samples, sampled in 2007 (June-September), at 24 sampling stations (Fig. 1).

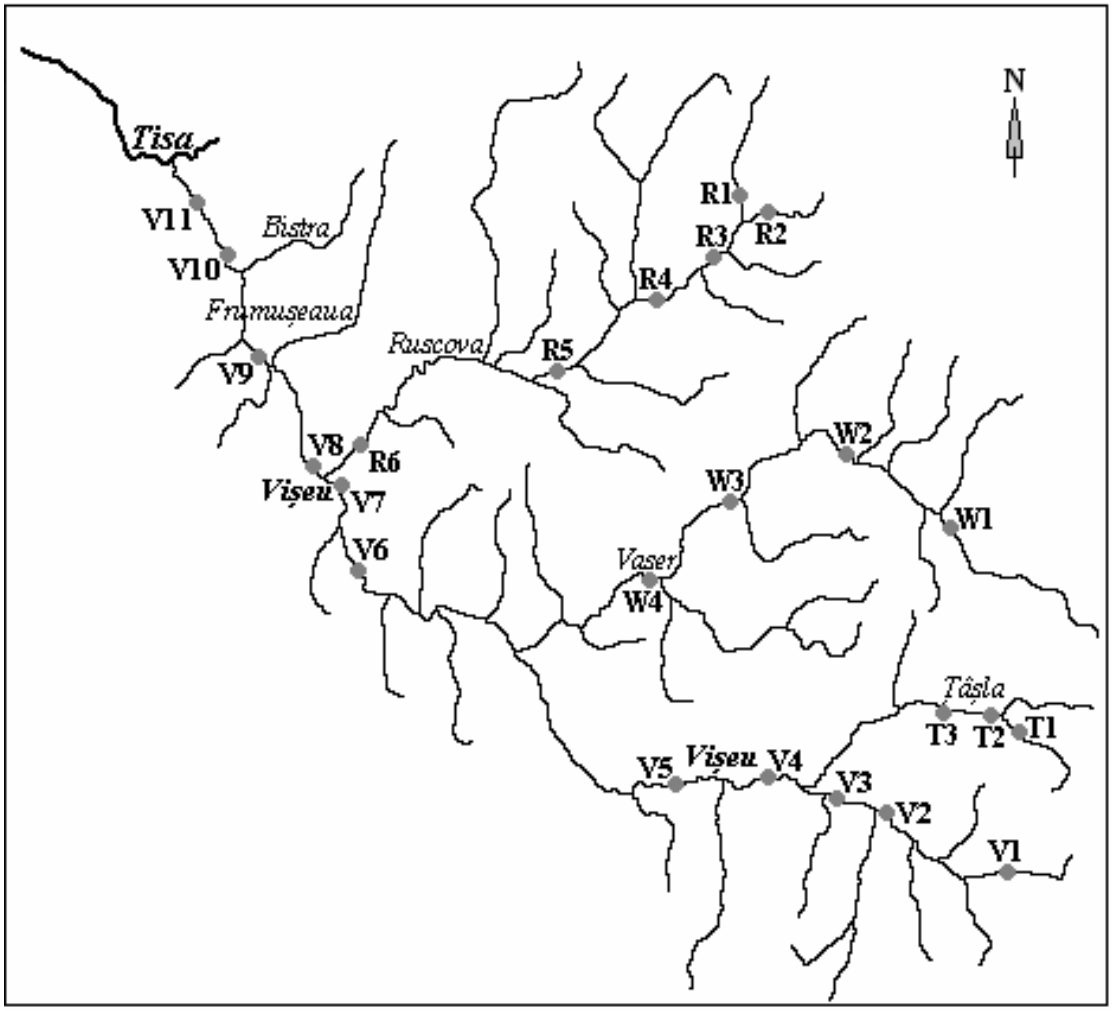

Figure 1: The Vişeu River basin sampling stations (V1 - V11, Vişeu Basin; T1 - T3, Ţâşla Basin; W1 - W4, Vaser Basin; R1 - R6, Ruscova Basin) layout.

The sampling stations were chosen according to the valley morphology, the confluence with the main tributaries and the human impact types and degrees on the river sectors - hydro-technical works, pollution sources, and over exploitation of the riverbed mineral resource and exploitation of riverine lands, in order to highlight the Ephemeroptera species diversity, and also the variation of the benthic macroinvertebrate communities structure. At each site were sampled quantitative samples from five points, in order to highlight the micro-habitats specific diversity. In the study period 260 quantitative benthic macroinvertebrates samples were sampled and analysed. The benthic macroinvertebrates quantitative samples were carried out with an 887 cm^2 surface Surber Sampler, with a 250 μm mesh net. The sampled biological material was fixed in 4% formaldehyde solution at which $NaHCO_3$ was added.

The analysed biological material included 4,160 Ephemeroptera larvae in life cycle periods which allowed their identification to the species level.

For the quantitative structure description of the mayfly communities we have used the relative abundance (A%) and the statistical density (Ds). For the mayfly communities' diversity quantifying, the heterogeneity index Simpson (Gomoiu and Skolka, 2001) were determined, based on the quantitative samples.

To analyse and quantify the association degree among species, the average square contingency coefficient (CCM) values and the Cole interspecific association coefficient were determined; to test which of the species are statistically significantly associated the χ^2 test was used for the probability level of 5% ($\chi^2 > 3.89$) (Krebs, 1989).

RESULTS AND DISCUSSION

24 mayfly species were found, belonging to 12 genera and six families.

The identified mayfly species list of the Maramureş Mountains Nature Park, with the specific sampling sites (V1 - V11, T1 - T3, W1 - W4, R1 - R6 - sampling stations):

Fam. Leptophlebiidae

Leptophlebia marginata (Linnaeus 1767) - W4, R6
Habrophlebia fusca (Curtis 1834) - R6
Habroleptoides modesta (Hagen 1864) - V3

Fam. Ephemerellidae

Serratella ignita (Poda 1761) - V3, V8, V9, V11, W4, R5, R6
Ephemerella notata (Eaton 1887) - R4, R6

Fam. Caenidae

Caenis robusta Eaton 1884 - V7
Caenis horaria (Linnaeus 1758) - R6
Caenis macrura Stephens 1835 - V8

Fam. Baëtidae

Baëtis rhodani (Pictet 1843) - V1, V2, V3, V4, V6, V7, V9, V10, T1, T2, T3 W3, W4, R1, R2, R3, R4, R5, R6
Baëtis vernus Curtis 1834 - V1, V2, V3, V4, V5, V11, T2, T3, W2, W3, R1, R2, R3, R4
Baëtis alpinus (Pictet 1843) - V2, W1, W2, R5
Baëtis lutheri Müller-Liebenau 1967 - W4, R6
Baëtis fuscatus (Linnaeus 1761) - V11

Fam. Siphlonuridae

Siphlonurus aestivalis Studemann, Tomka, Landolt 1992 - V7

Fam. Heptageniidae

Heptagenia flava Rostock 1878 - Frumuşeaua River (only in qualitative samples)
Ecdyonurus venosus (Fabricius 1775) - V1, V8, W4, R1, R5, R6
Ecdyonurus alpinus Hefti, Tomka and Zurwerra 1987 - V1
Ecdyonurus dispar (Curtis 1843) - V7, V8, R4, R6
Ecdyonurus picteti (Meyer-Dür 1864) - R1, R2
Ecdyonurus helveticus (Eaton 1877) - R4
Ecdyonurus torrentis (Kimmins 1942) - R6
Epeorus sylvicola (Pictet 1865) - R5
Rhithrogena semicolorata (Curtis 1834) - V2, V3, V4, V8, V10, V11, T2, W1, W2, W3, W4, R1, R2, R3, R4, R5, R6
Rhithrogena picteti Sowa 1971 - V1, V2, W1, R1, R2

In the reference zone, the mayflies had the highest species diversity (11 species) in the Ruscova River 50 m upstream the confluence with Vişeu River (R6) (Tab. 1).

The mayflay assemblage present the lowest species diversity (one species) in the Ţâşla Stream, two km upstream the confluence with Bălăsâna (T1) - sector degraded due to the pollution coming from the local mining exploitations and in the Vişeu River 50 m upstream the Moisei locality (V5) and one km downstream Vişeu de Jos (V6) - sectors degraded due to the impact generated by the riverine localities Borşa, Vişeul de Sus and Vişeul de Jos (Tab. 1).

The Ephemeroptera larvae communities with the highest heterogeneity (according to the Simpson Index) are present in the Ruscova River, in the lower Vaser River and in the Vişeu River - upper course (Vişeuţ Stream - V1, V2), downstream confluence with Ruscova River (V8) and in the Vişeu Gorge (V11).

The mayfly species with the widest distribution in the Vişeu River basin are *Baëtis rhodani* (present in 19 of the 24 studied lotic sectors) and *Rhithrogena semicolorata* (present in 17 of the 24 studied lotic sectors). The species with the most restricted distributions are *Habrophlebia fusca*, *Caenis horaria*, *Ecdyonurus torrentis*, *Ecdyonurus picteti*, *Ecdyonurus alpinus*, *Habroleptoides modesta*, *Caenis robusta*, *Siphlonurus aestivalis* and *Baëtis fuscatus* sampled only in the one of the 24 studied lotic sectors.

The numerical weight of the mayfly larvae in the benthic macroinvertebrate comunities vary, between the reference area with 93.24% in the Vişeu River 50 m upstream the Moisei locality (V5) and 7.14% in upper course of Vaser River (W2) (Tab. 1).

Table 1: The structure of mayfly communities present in the 24 lotic sectors analysed in the Maramureş Nature Park and the numerical weight of this systematic group in the benthic macroinvertebrate communities (P - Ephemeroptera numerical weight in the benthic macroinvertebrate communities structure, Ds - Ephemeroptera average density, A% - relative abundance of each species).

Sampling station	P (%)	Ds (number of individuals/m^2)	Inverted Simpson index (1-l)	The specific structure of the ephemeroptera larvae community	A (%)
V1	18.54	54.17	0.791	*Baëtis rhodani* *Baëtis vernus* *Ecdyonurus venosus* *Ecdyonurus alpinus* *Rhithrogena picteti*	22.22 16.67 38.89 11.11 11.11
V2	48.98	135.29	0.714	*Baëtis rhodani* *Baëtis vernus* *Baëtis alpinus* *Rhithrogena semicolorata* *Rhithrogena picteti*	40.63 34.38 12.5 9.37 3.12
V3	48.00	135.28	0.558	*Habroleptoides modesta* *Serratella ignita* *Baëtis rhodani* *Baëtis vernus* *Rhithrogena semicolorata*	3.17 1.59 57.14 3.18 34.92
V4	69.01	552.42	0.669	*Baëtis rhodani* *Baëtis vernus* *Rhithrogena semicolorata*	27.42 40.32 32.26

Table 1: continued.

Sampling station	P (%)	Ds (number of individuals/m^2)	Inverted Simpson index (1-l)	The specific structure of the ephemeroptera larvae community	A (%)
V5	93.24	129.65	0	*Baëtis vernus*	100
V6	25.55	129.65	0	*Baëtis rhodani*	100
V7	50.92	625.70	0.582	*Caenis robusta* *Baëtis rhodani* *Siphlonurus aestivalis* *Ecdyonurus dispar*	17.39 47.83 13.04 21.74
V8	18.95	163.47	0.784	*Serratella ignita* *Caenis macrura* *Ecdyonurus venosus* *Ecdyonurus dispar* *Rhitrogena semicolorata*	40 15 10 15 20
V9	24	67.64	0.441	*Serratella ignita* *Baëtis rhodani*	29.41 70.59
V10	40	56.37	0.467	*Baëtis rhodani* *Rhithrogena semicolorata*	70 30
V11	22.43	135.29	0.724	*Serratella ignita* *Baëtis vernus* *Baëtis fuscatus* *Rhithrogena semicolorata*	18.52 22.22 44.45 14.81
T1	12.56	5.67	0	*Baëtis rhodani*	100
T2	25.0	50.73	0.467	*Baëtis rhodani* *Baëtis vernus* *Rhithrogena semicolorata*	70.83 20.83 8.34
T3	13.79	22.55	0.429	*Baëtis rhodani* *Baëtis vernus*	75 25
W1	37.5	33.82	0.628	*Rhithrogena semicolorata* *Rhithrogena picteti* *Baëtis alpinus*	39.13 47.83 13.04
W2	7.14	11.27	0.668	*Baëtis vernus* *Baëtis alpinus* *Rhithrogena semicolorata*	46.16 26.92 26.92
W3	41.82	129.65	0.706	*Baëtis rhodani* *Baëtis vernus* *Ecdyonurus venosus* *Rhithrogena semicolorata*	33.33 36.67 3.33 26.67
W4	57.90	248.03	0.834	*Leptophlebia marginata* *Serratella ignita* *Baëtis rhodani* *Baëtis lutheri* *Ecdyonurus venosus* *Rhithrogena semicolorata*	16.67 9.52 21.43 14.29 26.19 11.9

Table 1: continued.

Sampling station	P (%)	Ds (number of individuals/m^2)	Inverted Simpson index (1-l)	The specific structure of the ephemeroptera larvae community	A (%)
R1	53.34	45.10	0.733	*Baëtis rhodani* *Baëtis vernus* *Ecdyonurus venosus* *Ecdyonurus picteti* *Rhithrogena semicolorata* *Rhithrogena picteti*	5.71 14.29 11.43 2.86 42.86 22.85
R2	39.37	428.4	0.757	*Baëtis rhodani* *Baëtis vernus* *Ecdyonurus picteti* *Rhithrogena semicolorata* *Rhithrogena picteti*	23.81 42.86 9.52 14.29 9.52
R3	60.14	484.78	0.532	*Baëtis rhodani* *Baëtis vernus* *Rhithrogena semicolorata*	65.38 19.24 15.38
R4	50.0	473.51	0.787	*Ephemerella notata* *Baëtis rhodani* *Baëtis vernus* *Ecdyonurus dispar* *Ecdyonurus helveticus* *Rhithrogena semicolorata*	8.33 36.11 13.89 11.11 5.56 25
R5	33.87	236.75	0.695	*Serratella ignita* *Baëtis rhodani* *Baëtis alpinus* *Ecdyonurus venosus* *Epeorus sylvicola* *Rhithrogena semicolorata*	9.09 27.27 9.09 2.27 4.55 47.73
R6	41.48	411.50	0.907	*Leptophlebia marginata* *Habrophlebia fusca* *Serratella ignita* *Ephemerella notata* *Caenis horaria* *Baëtis rhodani* *Baëtis lutheri* *Ecdyonurus dispar* *Ecdyonurus venosus* *Ecdyonurus torrentis* *Rhithrogena semicolorata*	8.33 5 11.67 6.67 5 18.33 6.67 13.33 10 5 10

Analysing the similarity of the mayfly larvae communities in the 24 sampled lotic sectors, on the basis of the species relative abundance (Tab. 1), allows these communities to be grouped in 11 classes (Fig. 2).

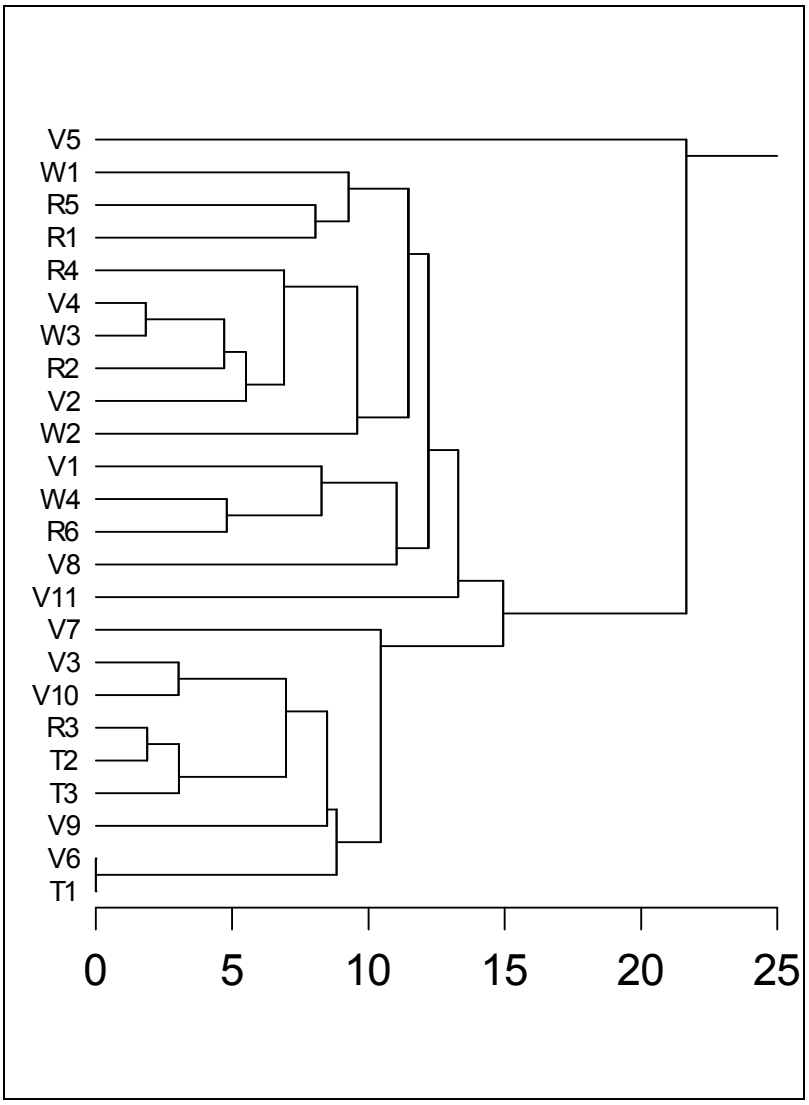

Figure 2: Tree diagram based of the mayfly species relative abundance (A%), of the 24 analysed lotic sectors (Euclidian distances, V1 - V11, T1 - T3, W1 - W4, R1 - R6; sampling stations).

The present analysis of the contingency tables in the cases of the total of 24 mayfly species identified in the Vişeu River basin, taken as pairs, based on the Cole interspecific association coefficient (C) and on the average square contingency coefficient (CCM), indicate significant positive associations, for a significance level of 5%, among the species: *Baëtis rhodani* and *Baëtis vernus* ($\chi^2 = 4.863$, CCM = 0.512, C = 0.890 ± 0.323), *Baëtis rhodani* and *Rhithrogena semicolorata* ($\chi^2 = 5.780$, CCM = 0.444, C = 0.538 ± 0.192), *Ecdyonurus venosus and Baëtis rhodani* ($\chi^2 = 3.956$, CCM = 0.372, C = 0.583 ± 0.267).

CONCLUSIONS

The studied Ephemeroptera group fauna of the Vişeu River basin presents a relative high species diversity. In the studied area a total of 24 mayfly species belonging to 12 genera and six families were identified, representing 33.33% of the Romanian Ephemeroptera fauna.

The mayfly larvae communities present the highest diversity in the Ruscova River, also in the lower Vaser River and in the Vişeu River - its upper course (Vişeuț Stream - V1, V2), downstream the confluence with Ruscova River (V8) and in the Vişeu Gorge (V11). In all these studied lotic sectors the aquatic habitats are considered as being in a good state, close to the natural one and the anthropogenic impact in this areas is not a significant one. These areas should be managed for the aquatic biodiversity conservation.

The mayfly assemblage present the lowest diversity in the Țâşla Stream two km upstream the confluence with Bălăsâna Stream (T1) and in the Vişeu River 50 m upstream the Moisei locality (V5) and one km downstream Vişeu de Jos locality (V6). In all these sectors ecological rehabilitation measurements are needed for the lotic habitats, these being degraded due to pollution, respectively due to the river courses substratum exploitation.

ACKNOWLEDGEMENTS

This specific study was funded by UNDP/GEF # 41462 Strengthening Romania's Protected Area System by Demonstrating Public-Private Partnership in Maramureş Mountains Nature Park project.

We thank to the Administration of the Maramureş Mountains Nature Park members for their continuous and generous support in the field.

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