

# THE MARAMUREȘ MOUNTAINS NATURE PARK (ROMANIA). STONEFLY (INSECTA: PLECOPTERA) COMMUNITIES DIVERSITY ANALYSIS

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This study presents the description of the structure and diversity analysis of Plecoptera larvae communities of the Vișeu River basin. The paper is based on quantitative benthic macroinvertebrates and stoneflies qualitative samples, collected in 2007 (June-September), in 24 sampling stations. In the studied area 21 stonefly species belonging to nine genera and six families were identified, representing 17.95 % of the Romanian Plecoptera fauna. The stonefly larvae communities present the highest diversity on the Ruscova River, on the lower Vaser River and on the upper course of the Vișeu River (Vișeuț Stream). In these lotic sectors the aquatic habitats are characteristic for the Carpathian rivers, in good state, close to the natural one and the anthropogenic impact in this area is insignificant. These areas should be managed for the aquatic biodiversity conservation. The stonefly presents the lowest species diversity (one species) in the Țâșla Stream, two km upstream the confluence with Bălăsâna (T1) – sector degraded due to the pollution resulted from the local mining exploitations and in the Vișeu River 50 m upstream the Moisei locality (V5), one km downstream Vișeu de Jos (V6) – sectors degraded by the impact generated by the riverine localities Borșa, Vișeu de Sus, Vișeu de Jos and the riverbed exploitation. In these sectors ecological restoration measurements should be implemented for the lotic habitats.

*Key words:* Romanian Carpathians, Maramureș Mountains, Vișeu River basin, Țâșla River, Vaser River, Ruscova River, Plecoptera larvae communities.

## INTRODUCTION

This study presents the description of the structure and diversity analysis of Plecoptera larvae communities of the Vișeu River basin. The information resulted from this study will be useful for the Maramureș Mountains Nature Park management plan attainment.

The Vișeu River is a second order tributary of the Danube localized in the north part of the Romanian territory. The majority of the Vișeu River basin was included in the Maramureș Mountains Nature Park.

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

Actual hydrobiological research concerning the benthic macroinvertebrates in this area are few, in this respect we have to mention the study concerning the benthic macroinvertebrates and fish along the Vișeu River, realised by Staicu *et al.* (1998), the ecological assessment study of the Vișeu River basin based on macroinvertebrate communities structure (Curtean-Bănăduc, 2008), the study concerning the Maramureș Nature Park mayfly communities (Curtean-Bănăduc, 2009) and the study regarding a proposal for an integrated monitoring system for the Maramureș Nature Park which contains also data regarding benthic macroinvertebrates (Bănăduc & Curtean-Bănăduc, 2010).

Until present, coenological studies regarding the stonefly larvae of the Vișeu River basin were not made.

#### MATERIAL AND METHODS

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

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, overexploitation of the river bed mineral resource and exploitation of riverine lands, in order to highlight the Plecoptera species diversity, and also the variation of the community structure.

In each station 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 analyzed. The benthic macroinvertebrates quantitative samples were carried out with an 887 cm<sup>2</sup> surface Surber Sampler, with a 250 μ mesh net. The sampled biological material was fixed in 4% formaldehyde solution at which NaHCO<sub>3</sub> was added.

The sampled biological material was identified based on Aubert (1959) and Găldean (2002), and included 3760 Plecoptera larvae in life cycle periods which allowed their identification to the species level. 31.5 % of the quantitatively sampled individuals were in life cycle periods which did not allow their identification to the species level.

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

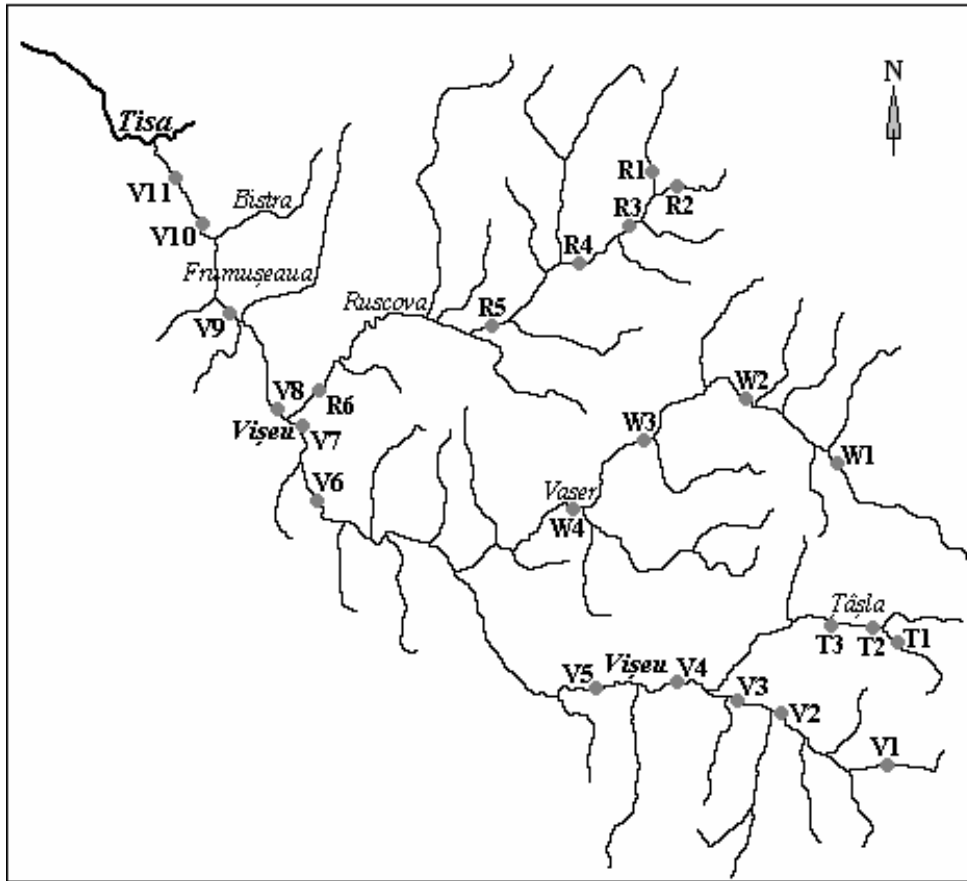


Fig. 1. The Vişeu River basin sampling stations (V1-V11, T1-T3, W1-W4, R1-R6) layout.

## RESULTS AND DISCUSSION

21 stonefly species were found, belonging to nine genera and six families. The identified stonefly species list of the Maramureş Mountains Nature Park, with the specific sampling sites (V1-V11, T1-T3, W1-W4, R1-R6 – sampling stations):

### Family Taeniopterygidae

*Brachyptera risi* (Morton, 1896) – V7

*Brachyptera seticornis* (Klapálek, 1902) – V7

### Family Leuctridae

*Leuctra nigra* (Olivier, 1811) – V1

*Leuctra fusca* (Linnaeus, 1758) – V2, V8, V11, R5

*Leuctra hippopus* Kempny, 1899 – R2, R3, R4, R5

*Leuctra rosinae* Kempny, 1900 – V1

*Leuctra inermis* Kempny, 1899 – V2, V3, V4, V8, V9, V10, V11, W3, W4, R6

**Family Nemouridae**

*Amphinemura sulcicollis* (Stephens, 1836) – V10

*Nemoura cinerea* (Retzius, 1783) – V4

*Protonemura praecox* (Morton, 1894) – V1, V3, V9, V10, V11, T2, T3, W1, W2, W3, W4, R2, R3, R4, R5, R6

*Protonemura intricata* (Ris, 1902) – V1, V2, V3, T1, T2, R1, R6

*Protonemura aestiva* Kis, 1965 – V2

*Protonemura montana* Kimmins, 1941 – Bălăsâna Stream (only in qualitative samples)

**Family Perlidae**

*Perla marginata* (Panzer, 1799) – V9, W3, W4, R1, R2, R3, R4, R5, R6

*Perla burmeisteriana* Claassen, 1936 – W4, R2, R3

*Perla pallida* Guerin, 1838 – R6

**Family Perlodidae**

*Perlodes microcephala* (Pictet, 1833) – V1, V2, V3, V4, V11, W4, R5, R6

*Perlodes intricata* (Pictet, 1841) – V5, V6, V8, T2, T3, R6

*Isoperla grammatica* (Poda, 1761) – T2, T3, W1, W2

*Isoperla rivulorum* (Pictet, 1841) – R1, R2

**Family Chloroperlidae**

*Chloroperla tripunctata* (Scopoli, 1763) – V2

In the studied area, the stoneflies have the highest species diversity (7 species) in the Ruscova River, 50 m upstream the confluence with the Vișeu River (R6) (Table 1).

The stonefly presents the lowest species diversity (one species) in the Țâșla Stream, 2 km upstream the confluence with Bălăsâna (T1) – sector degraded due to the pollution coming from the local mining exploitations and in the Vișeu River, 50 m upstream the Moisei locality (V5), 1 km downstream Vișeu de Jos (V6) – sectors degraded by the impact generated by the riverine localities Borșa, Vișeu de Sus, Vișeu de Jos (Table 1).

The stonefly species with the widest distribution in the Vișeu River basin are *Protonemura praecox* (present in 16 of the 24 studied lotic sectors) and *Leuctra inermis* (present in 10 of the 24 studied lotic sectors). The species with the most restricted distributions are *Brachyptera risi*, *Brachyptera seticornis*, *Leuctra nigra*, *Leuctra rosinae*, *Amphinemura sulcicollis*, *Nemoura cinerea*, *Protonemura aestiva*, *Perla pallida* and *Chloroperla tripunctata*, sampled only in one of the 24 studied lotic sectors.

The numerical weight of the stonefly larvae in the benthic macroinvertebrate communities vary, in the reference area, between 50.0% in the Vaser River at Comănu (W1) and 1.11 % in Vișeu River one km downstream Vișeu de Jos locality (V6) (Table 1).

The stonefly larvae communities with the highest heterogeneity (according to the Simpson Index) are present on the Vişeu River – upper course (Vişeuţ Stream – V2), on the Ruscova River 50 m upstream the confluence with Vişeu River (R6) and on the lower Vaser River at the confluence with Novicior Brook (W4) (Table 1).

Table 1

The structure of the stonefly 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 – Plecoptera numerical weight in the benthic macroinvertebrate community structure; Ds – Plecoptera average density; A% – relative abundance of each species; qs – taxa present only in qualitative samples)

Sampling station	P (%)	Ds (number of individuals/m <sup>2</sup> )	Inverted Simpson index (1-I)	The specific structure of the Ephemeroptera larvae community	A (%)
V1	12.58	36.76	0.759	<i>Leuctra nigra</i> <i>Leuctra rosinae</i> <i>Protonemura praecox</i> <i>Protonemura intricata</i> <i>Perlodes microcephala</i>	14.3 10.7 17.9 42.9 14.3
V2	10.20	28.18	0.848	<i>Leuctra fusca</i> <i>Leuctra inermis</i> <i>Protonemura intricata</i> <i>Protonemura aestiva</i> <i>Perlodes microcephala</i> <i>Chloroperla tripunctata</i>	16.7 25.0 33.3 8.3 8.3 8.33
V3	6.0	16.91	0.762	<i>Leuctra inermis</i> <i>Protonemura intricata</i> <i>Perlodes microcephala</i>	13.3 26.7 40.0
V4	1.41	11.27	0.670	<i>Leuctra inermis</i> <i>Nemoura cinerea</i> <i>Perlodes microcephala</i>	28.57 50.0 21.43
V5		qs	–	<i>Perlodes intricata</i>	100
V6	1.11	5.64	0	<i>Perlodes intricata</i>	100
V7	1.38	16.91	0.429	<i>Brachyptera risi</i> <i>Brachyptera seticornis</i>	25.0 75.0
V8	8.50	73.28	0.709	<i>Leuctra fusca</i> <i>Leuctra inermis</i> <i>Perlodes intricata</i>	27.27 27.27 45.45
V9	10.0	28.18	0.722	<i>Leuctra inermis</i> <i>Protonemura praecox</i> <i>Perla marginata</i>	50.0 25.0 25.0
V10	4.0	5.64	0.600	<i>Leuctra inermis</i> <i>Amphinemura sulcicollis</i> <i>Protonemura praecox</i>	16.67 66.67 16.67

Table 1  
(continued)

Sampling station	P (%)	Ds (number of individuals/m <sup>2</sup> )	Inverted Simpson index (1-I)	The specific structure of the Ephemeroptera larvae community	A (%)
V11	5.61	33.82	0.762	<i>Leuctra fusca</i> <i>Leuctra inermis</i> <i>Protonemura praecox</i> <i>Perlodes microcephala</i>	20.0 13.33 40.0 26.67
T1		qs	–	<i>Protonemura intricata</i>	100
T2	2.78	5.67	0.718	<i>Protonemura praecox</i> <i>Protonemura intricata</i> <i>Perlodes intricata</i> <i>Isoperla grammatica</i>	46.15 30.77 15.38 7.69
T3	10.34	16.91	0.655	<i>Protonemura praecox</i> <i>Perlodes intricata</i> <i>Isoperla grammatica</i>	54.55 27.27 18.18
W1	50.0	45.10	0.527	<i>Protonemura praecox</i> <i>Isoperla grammatica</i>	57.14 42.86
W2	32.14	50.73	0.495	<i>Protonemura praecox</i> <i>Isoperla grammatica</i>	64.29 35.71
W3	20.0	62.01	0.689	<i>Leuctra inermis</i> <i>Protonemura praecox</i> <i>Perla marginata</i>	40.0 35.0 25.0
W4	15.79	67.64	0.824	<i>Leuctra inermis</i> <i>Protonemura praecox</i> <i>Perla marginata</i> <i>Perla burmeisteriana</i> <i>Perlodes microcephala</i>	14.29 1.26 23.81 19.05 14.29
R1	13.33	11.27	0.567	<i>Protonemura intricata</i> <i>Perla marginata</i> <i>Isoperla rivulorum</i>	62.5 12.5 25.0
R2	15.03	163.47	0.722	<i>Leuctra hippopus</i> <i>Protonemura praecox</i> <i>Perla marginata</i> <i>Perla burmeisteriana</i> <i>Isoperla rivulorum</i>	12.5 37.5 21.88 18.75 9.38
R3	8.39	67.64	0.735	<i>Leuctra hippopus</i> <i>Protonemura praecox</i> <i>Perla marginata</i> <i>Perla burmeisteriana</i>	19.23 23.08 42.31 15.38
R4	2.38	22.55	0.667	<i>Leuctra hippopus</i> <i>Protonemura praecox</i> <i>Perla marginata</i>	23.81 28.57 47.62

Table 1  
(continued)

Sampling station	P (%)	Ds (number of individuals/m <sup>2</sup> )	Inverted Simpson index (1-I)	The specific structure of the Ephemeroptera larvae community	A (%)
R5	25.81	180.38	0.752	<i>Leuctra fusca</i>	4.76
				<i>Leuctra hippopus</i>	33.33
				<i>Protonemura praecox</i>	33.33
				<i>Perla marginata</i>	23.81
				<i>Perlodes microcephala</i>	4.76
R6	6.25	62.00	0.831	<i>Leuctra inermis</i>	18.42
				<i>Protonemura praecox</i>	10.53
				<i>Protonemura intricata</i>	18.42
				<i>Perla marginata</i>	28.95
				<i>Perla pallida</i>	15.79
				<i>Perlodes microcephala</i>	5.26
				<i>Perlodes intricata</i>	2.63

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

I. communities where the species *Perla marginata* and *Protonemura praecox* are numerically codominant, which were found in R2, R3, R4 and R5 sampling stations;

II. communities where the species *Perla marginata* and *Leuctra inermis* are numerically codominant, which were found in W3 and W4 sampling stations;

III. communities where the species *Protonemura praecox* is numerically dominant, which was found in W1, W2, T2, T3 and V11 sampling stations;

IV. communities where the species *Perlodes intricata* is numerically dominant, which was found in V5, V6 and V8 sampling stations;

V. communities built up by *Leuctra inermis* and *Protonemura praecox*, which were found in V9 and V10 sampling stations;

VI. community built up by *Brachyptera seticornis* and *Brachyptera risi*, which were found in V7 sampling station;

VII. community where the species *Nemoura cinerea* is numerically dominant, which was found in V4 sampling station;

VIII. communities where the species *Protonemura intricata* is numerically dominant, which were found in R1, T1, V1, V2 and V3 sampling stations;

IX. community where the species *Perla marginata*, *Leuctra inermis*, *Protonemura intricata* and *Perla pallida* appear with relative abundances over 15%, which were found in R6 sampling station.

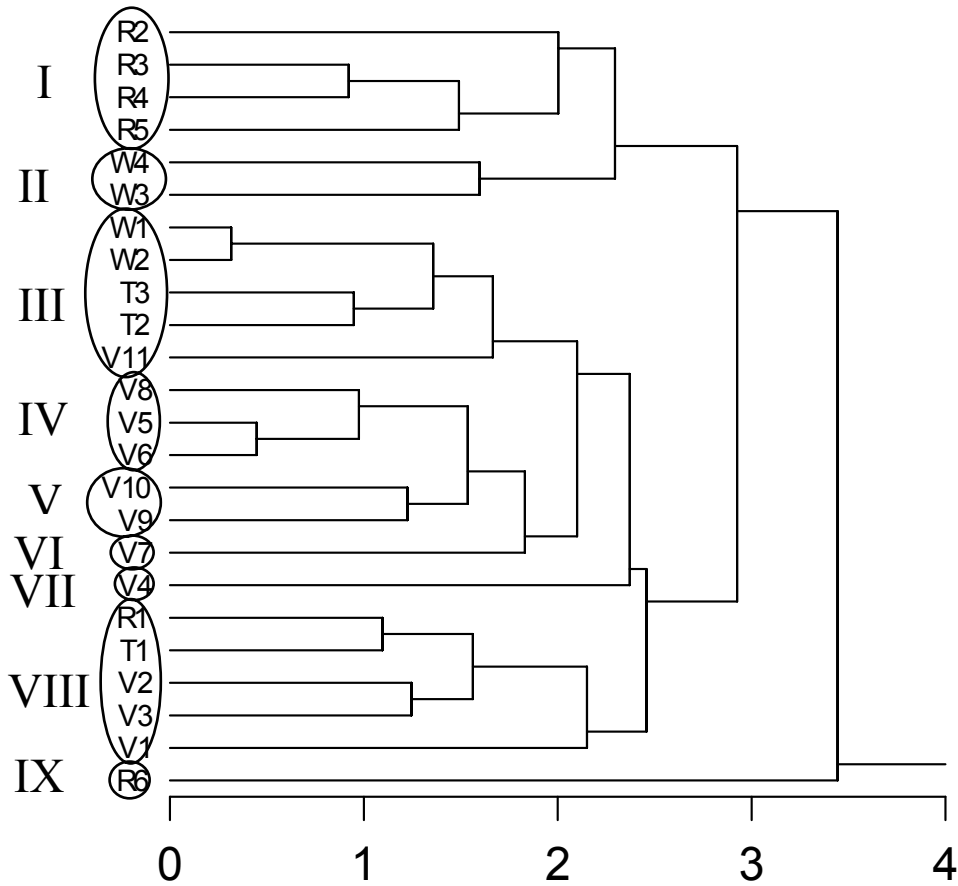


Fig. 2. Cluster analysis based on the stonefly species relative abundance (A%), of the 24 analysed lotic sectors (euclidean distances, V1 – V11, T1 – T3, W1 – W4, R1 – R6 – sampling stations).

### CONCLUSIONS

The Plecoptera fauna of the Vișeu River basin presents a relatively high species diversity. In the studied area 21 stonefly species belonging to nine genera and six families were identified, representing 17.95 % of the Romanian Plecoptera fauna.

The stonefly larvae communities present the highest diversity on the Ruscova River, on the lower Vaser River (W4) and on the upper course of the Vișeu River (Vișeuț Stream – V1, V2). In these lotic sectors the aquatic habitats are characteristic for the Carpathian rivers, in good ecological state, close to the natural

one and the anthropogenic impact in this area is insignificant. These areas should be managed for the aquatic biodiversity conservation.

The stonefly communities structure and low diversity reveal the fact that the Țâșla Stream two km upstream the confluence with Bălăsâna (T1), the Vișeu River between Moisei locality and the confluence with Ruscova River (V5, V6, V7) and the upper course of Vaser River (W1, W2) are affected by human activities: mining exploitations (Țâșla Stream), waste waters pollution and the lotic substratum exploitation (Vișeu River), forest exploitation (Vaser River upper course). In these sectors ecological rehabilitation measurements are needed for the lotic habitats.

*Acknowledgements.* This 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 the members of the Administration of the Maramureş Mountains Nature Park for their continuous and generous support in the field.

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Received June 16, 2010