

Riparian vegetation along streams in the Tatra Mts, Slovakia

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Abstract. 103 relevés of riparian vegetation have been submitted to cluster analyses, five vegetation types were distinguished: *Petasites hybridus*, *Rubus idaeus* - *Urtica dioica*, *Senecio nemorensis*, *Luzula sylvatica*-*Dicranum scoparium*, *Ligusticum mutellina*. Every vegetation type is characterized from ecological and floristical viewpoints. Physico-chemical characteristics (Conductivity, pH, dissolved oxygen, redox potential, chemical oxygen demand, calcium carbonate, nitrates, ammonia and chlorides) were plotted as ordination axes (CCA) and some geographical characteristics (bedrock, orientation, chalet presence) were plotted as supplementary environmental variables. Natural or anthropogenic disturbance events result in extra input of nutrients. Some species correlate with environmental variables, e. g. with altitude correlate *Anthoxanthum alpinum*, *Solidago *minuta*, with NO_3^- *Chamaerion angustifolium* and *Petasites hybridus*, with NH_3 *Urtica dioica*.

Key words: riparian vegetation, cluster analysis, water quality, Tatra Mts

Introduction

For riparian vegetation is characteristic high ecological or species diversity. This is a migration corridor for animals and plants (Timoney *et al.* 1997). Riparian wetland is the major transition zone between aquatic and terrestrial ecosystems and has an important role in water purification (Wang and Wang 2010). Nevertheless, the retention of nitrogen pollution by riparian wetland soil occurs mainly in the top 0-10 cm layer (Zhao 2009).

The study area represents around 90000 hectares and covers parts of two major catchments: Baltic sea and Black sea. The glacial history of the region has resulted in a complex pattern of glacial relief types like glaciated knobs, morainic basins and others. On November 19, 2004, the Northern downslope wind (locally named Bora) felled 12,000 ha of forest; about 2.3 million m^3 of wood in the Tatra Mts. Consequently, a large wildfire hit the windfall area at July 31, 2005, and 250 ha was completely burnt. Forest stand disintegration or deforestation may disturb hydrology and ecology.

Riparian vegetation in the Tatra Mts grows in a variety of geomorphic settings ranging from talus cones in Podtatranská kotlina basin to morainic basins in the alpine region. Elimination of riparian vegetation occurs either where high ground-water use lowers the water table below the rooting depth of riparian species or where base flow is completely diverted, or both (Webb and Leak 2006).

The land use or the chemistry of the waters of riparian vegetation was the matter of interest of more researchers. Chemical oxygen demand (COD) gives information on organic contamination - disintegration of animal or plant bodies, leakage of manures.

The term "salinity" refers to the amount of dissolved salts that are present in water. Sodium and chloride are the predominant ions, and the concentrations of magnesium, calcium, and sulfate ions are also substantial. The measure of dissolved ions in the water is conductivity.

Value of redox potential gives informations on oxidative or reducing conditions in the waters. Positive value suggests an oxidative situation in the waters and negative value reducing status. In natural waters oxidative situations are connected with dissolved oxygen, this is the most important dissolved gas and is precondition for life in waters. In running waters predominates oxygen of atmospheric origin and is indicator of water purity.

Ammonium cations may be indicator of faecal contamination or may come from geological background. In combination with increased COD (Chemical oxygen demand), show contamination by animal waste material.

The important nitrates source is decomposition of organic substances in soils, significant nitrates source is atmospheric deposition also. Increasing downstream nitrates concentration suggests organic substances input. In mountain conditions, chlorides concentration in running waters depends exclusively in atmospheric precipitation, the source is marine aerosols containing sodium chloride.

Hardness in water is defined as concentration of bivalent cations, these cations include Ca^{2+} and Mg^{2+} . The hardness is often indicated by German degrees (*Deutsche Härte*, °dH or dH), where one degree German is defined as 10 milligrams of calcium oxide per litre of water. This is equivalent to 17.848 milligrams of calcium carbonate per litre of water, or 17.848 ppm.

Total Dissolved Solids (TDS) is a measure of the combined content of all inorganic and organic substances contained in a liquid, in molecular, ionized or micro-granular (colloidal sol) suspended form. Primary sources for TDS are agricultural and residential runoff. The most common chemical

constituents are calcium, phosphates, nitrates, sodium, potassium and chlorides. When submerged, these plants are highly flexible and, therefore, adapt themselves to the flow, they react in a wavy motion to the flow.

White and Greer (2005) investigated the effects of watershed urbanization on streamflow characteristics and the riparian vegetation of Los Penaskuitos Creek in Southern California. In 1966 – 2000 urban land uses increased from 9% to 37% of the watershed, over the same time period median and minimum daily discharges increased significantly (White and Greer 2005). For differentiation in the ecosystems, probably the most significant influence is the transport of sediments with nutrients (Barendregt 2003).

Małek and Krakowian (2009) analysed waters in the catchments of two streams (Zimnik and Czyrna) in the Beskid Śląski. The data set consists of nutrients contents and physicochemical characteristics. Schneider *et al.* (2000) studied indication of trophic status using submerged macrophyte vegetation.

Wang (2010) found that submerged vegetation combined with flow intensity influences the NH_4^+ -N release. When the water flow is relatively small, the submerged vegetation is quite capable of inhibiting sediment suspension and reducing NH_4 -N release, but when flow reaches a certain value, the presence of aquatic plants exacerbates sediment suspension and promotes NH_4^+ -N release.

Wondzell *et al.* (2007) developed models to evaluate the effects of natural disturbances and land-use practices on aquatic and riparian habitats, consisting of discrete states defined by channel morphology and riparian vegetation.

Material and Methods

Data set

All the 103 relevés were taken following standard procedures of the Zürich-Montpellier School (Braun-Blanquet 1964; Westhoff and Van Den Maarel 1978), using the modified 9-degree Braun-Blanquet's sampling scale (Barkman *et al.* 1964) transformed into the ordinal scale of Van den Maarel (1979) and stored in the TURBOVEG data-base (Hennekens and Schaminée 2001). Shrub- and herb-layer records for any one taxon were merged, the data were exported into JUICE 7.0 software for analysis (Tichý and Holt 2006). Nomenclature of the taxa follows the Checklist by Marhold & Hindák (1998).

Data analysis

CANOCO 4.5 for Windows package (Ter Braak and Šmilauer 2002) was used for all statistical analysis. Since the length of the longest gradient in the log report was > 5 , we used the unimodal methods - CCA (Ter Braak and Šmilauer 2002). The statistical significance of the explanatory (environmental) variables in canonical methods were determined by Monte Carlo permutation tests. Explanatory variables were tested separately (partial tests). For ordination analysis we used ordinal species data without transformation. Numerical classification of the 103 relevés was performed using the statistical

tool for plant ecology MULVA-5 (Wildi and Orłóci 1996). For ecological interpretation of the ordination axes, bedrock, orientation and chalet presence was plotted onto CCA ordination diagram as supplementary environmental variables.

Chemistry

The following parameters were measured by portable devices at sampling sites: Conductivity and salinity using device YSI EC300, pH level using device YSI pH100. Determination of dissolved oxygen is based on fluorescence detection using device YSI DO200. Determination of chlorides, ammonia and nitrates is based on colorimetry using direct-reading photometer YSI 9500, redox potential (ORP) by device YSI ORP 15. Volumetric methods have been used for determination following features-manganometry for chemical oxygen demand (COD) determination and chelatometry for CaCO_3 determination.

Results and discussion

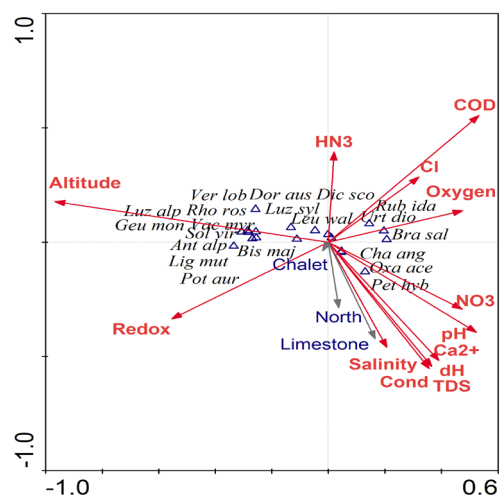


Fig. 1. Canonical correspondence analysis (CCA), triplot, ordination diagram of selected species and environmental variables. Species list: Urt dio – *Urtica dioica*, Rub ida – *Rubus idaeus*, Cha ang – *Chamaerion angustifolium*, Lig mut – *Ligusticum mutellina*, Ver lob – *Veratrum *lobelianum*, Luz alp – *Luzula alpino-pilosa*, Geu mon – *Oreogonum montanum*, Sol vir – *Solidago *alpestris*, Pot aur – *Potentilla aurea*, Bis maj – *Bistorta major*, Rho ros – *Rhodiola rosea*, Ant alp – *Anthoxanthum alpinum*, Dor aus – *Doronicum austriacum*, Luz syl – *Luzula sylvatica*, Leu wal – *Leucanthemum waldsteinii*, Vac myr – *Vaccinium myrtillus*, Oxa ace – *Oxalis acetosella*, Pet hyb – *Petasites hybridus*, Bra sal – *Brachythecium salebrosum*, Dic sco – *Dicranum scoparium*.

The first axis explains 18.3 % of species-environment relation (Eigenvalue 0.642), this axis negatively correlate with altitude ($r = -0.9206$), in a lesser extent the first axis is positively correlated with COD ($r = 0.5059$). The second axis explains 12.2% of species-environment relation (Eigenvalue 0.429), no significant correlations have been found with this axis, only in a lesser extent the second axis is positively correlated with COD ($r = 0.4781$).

Species correlated with altitude are *Potentilla aurea*, *Veratrum * lobelianum*, *Ligusticum mutellina*, *Anthoxanthum alpinum*, *Solidago * minuta*, *Rhodiola rosea*, *Doronicum austriacum*, *Vaccinium myrtillus*. With NO_3 , conductivity and pH shifted to neutral zone correlate *Chamaerion angustifolium* and *Petasites hybridus*. Species correlated with NH_3 , COD, dissolved oxygen and Cl are *Urtica dioica*, *Rubus idaeus*, *Brachytheceium salebrosum*.

As for environment variables, positively are highly correlated salinity - conductivity ($r = 0.942$), salinity - TDS ($r = 0.938$), salinity - Ca^{2+} ($r = 0.839$), positively are also correlated Ca^{2+} - TDS ($r = 0.918$), Ca^{2+} - conductivity ($r = 0.904$), Ca^{2+} - pH ($r = 0.830$), conductivity - pH ($r = 0.716$). The correlations between Ca^{2+} and conductivity or conductivity and pH level are easy to explain. The more calcium cations the higher conductivity and the more basic reaction. Chlorides and nitrates have a partly common origin. In mountain conditions, chlorides concentration in running waters depends exclusively in atmospheric precipitation, the source are marine aerosols containing sodium chloride. Significant nitrates source is atmospheric deposition as well. Another nitrates source is decomposition of organic substances in soils. Probably this is why the correlation is insignificant ($r = 0.567$). Negative correlation between dissolved oxygen and oxydo-reduction potential ($r = -0.644$) is unexpected and difficult to explain. The value of redox potential gives information on oxidative or reducing conditions in the waters. Positive value suggests an oxidative situation in the waters and negative value reducing status. In natural waters oxidative situations are connected with dissolved oxygen.

Some physico-chemical characteristics are highly significant: Altitude $p = 0.002$; COD $p = 0.002$; pH $p = 0.002$; Ca^{2+} $p = 0.002$; dH $p = 0.004$; Conductivity $p = 0.002$; TDS $p = 0.006$; Redox potential $p = 0.002$; NO_3^- $p = 0.016$; Cl $p = 0.052$; Oxygen $p = 0.006$; Salinity $p = 0.022$; NH_3 $p = 0.104$.

Corbacho *et al.* (2003) found that nearly 50% of the natural Mediterranean riparian vegetation of the study area has been highly modified or has disappeared, in most cases replaced by non-natural formations.

Wondzell *et al.* (2007) found that Euro-American settlement dramatically changed riparian vegetation and channel conditions, which resulted in substantial declines in habitat quality. Impacts of land use and management may strongly influence fire properties and regimes in riparian areas (Dwire and Kauffman 2003).

Huang *et al.* (2011) searched for mean removal per flood pulse throughout the US Midwest for some nutrients. Mean removal per flood pulse for nitrate-nitrite were 1.81 g-N.m⁻² per pulse.

Limit value of COD is 3 mg.l⁻¹. In the Tatra Mts, this value was overstepped in sites with human activities.

The ammonium limit concentration in running waters is 0.5 mg NH₄⁺ 1000 ml⁻¹. This concentration has never been exceeded in streams, usually vary between 0 – 0.2 mg NH₄⁺, only exceptionally 0.35 mg, Velická dolina, 1825 m a.s.l. Because of low value of COD on the site (0.61 mg.l⁻¹), contamination by animal waste material is excluded. The only explanation is local faecal contamination.

Riparian vegetation

The following vegetation types correlating with altitude were created as a result of cluster analysis (Table 1):

- A. Vegetation type *Petasites hybridus*
- B. Vegetation type *Rubus idaeus-Urtica dioica*
- C. Vegetation type *Senecio nemorensis*
- D. Vegetation type *Luzula sylvatica-Dicranum scoparium*
- E. Vegetation type *Ligusticum mutellina*

Vegetation type	A	B	C	D	E
No. of relevés	21	22	13	25	22
Differential species					
<i>Petasites hybridus</i>	70.7 ¹⁰⁰	--- ³²	--- ³¹	--- ⁴	---
<i>Urtica dioica</i>	19.7 ⁴⁸	52.2 ⁷⁷	--- ²³	---	---
<i>Rubus idaeus</i>	--- ³⁸	53.5 ⁹¹	--- ²³	--- ²⁸	--- ¹⁴
<i>Chamaerion angustifolium</i>	--- ²⁴	51.5 ⁶⁸	--- ¹⁵	--- ⁴	--- ⁹
<i>Brachytheceium salebrosum</i> (E0)	11.5 ²⁹	27.0 ⁴¹	--- ¹⁵	--- ⁸	--- ⁵
<i>Senecio nemorensis</i> agg.	--- ³³	--- ⁴¹	25.7 ⁶⁹	4.3 ⁴⁸	--- ²⁷
<i>Oxalis acetosella</i>	6.7 ³⁸	--- ¹⁸	--- ³¹	43.1 ⁷²	---
<i>Luzula sylvatica</i>	--- ¹⁹	--- ⁵	--- ⁸	66.4 ⁷⁶	---
<i>Dicranum scoparium</i>	--- ¹⁰	--- ⁵	---	60.8 ⁶⁰	--- ⁵
<i>Doronicum austriacum</i>	--- ¹⁰	--- ¹⁸	--- ⁸	31.6 ⁵²	13.5 ³⁶
<i>Leucanthemum rotundifolium</i>	9.4 ³³	--- ⁵	--- ²³	35.5 ⁶⁶	--- ⁹
<i>Vaccinium myrtillus</i>	--- ⁵	--- ⁹	--- ¹⁵	45.1 ⁶⁸	14.8 ⁴¹
<i>Ligusticum mutellina</i>	---	---	--- ⁸	--- ¹⁶	87.2 ¹⁰⁰
<i>Veratrum * lobelianum</i>	---	--- ⁵	--- ²³	--- ²⁰	63.8 ⁸²
<i>Luzula alpinopilosa</i>	---	---	--- ¹⁵	---	78.8 ⁸²
<i>Oreogeuum montanum</i>	---	---	---	---	76.4 ⁶⁴

continued...

<i>Solidago *minuta</i>	---	---	--- ⁸	--- ⁸	54.6 ⁵⁰
<i>Potentilla aurea</i>	---	---	---	--- ⁴	66.6 ⁵⁵
<i>Polygonum bistorta</i>	--- ¹⁰	---	--- ¹⁵	---	49.1 ⁵⁰
<i>Rhodiola rosea</i>	---	---	---	---	70.0 ⁵⁵
Other species					
<i>Chaerophyllum hirsutum</i>	19.3 ⁸¹	--- ⁵⁹	7.2 ⁶⁹	22.4 ⁸⁴	--- ¹⁸
<i>Deschampsia cespitosa</i>	--- ³⁸	--- ²⁷	5.2 ⁵⁴	7.3 ⁵⁶	19.5 ⁶⁸
<i>Alchemilla vulgaris</i>	3.3 ⁴⁸	--- ¹⁴	--- ³¹	3.7 ⁴⁸	37.7 ⁸²
<i>Calamagrostis villosa</i>	--- ²⁴	--- ⁴¹	--- ³⁸	20.7 ⁶⁴	6.6 ⁵⁰
<i>Viola biflora</i>	--- ²⁹	---	--- ²³	31.6 ⁶⁴	21.6 ⁵⁵
<i>Stellaria nemorum</i>	12.2 ⁴⁸	5.2 ⁴¹	10.6 ⁴⁶	--- ³⁶	--- ⁹
<i>Aconitum firmum</i>	--- ¹⁰	--- ¹⁴	--- ³¹	24.6 ⁵⁶	23.0 ⁵⁵
<i>Myosotis scorpioides</i> agg.	--- ²⁴	3.3 ³²	--- ²³	25.5 ⁵²	--- ¹⁴
<i>Caltha *laeta</i>	--- ⁵	--- ⁵	9.3 ³⁸	24.1 ⁵²	21.9 ⁵⁰
<i>Picea abies</i>	16.7 ⁴³	--- ¹⁴	--- ²³	35.8 ⁶⁰	---
<i>Homogyne alpina</i>	--- ⁵	--- ⁵	--- ⁸	31.6 ⁵²	34.6 ⁵⁵
<i>Geranium sylvaticum</i>	--- ¹⁴	--- ¹⁸	--- ²³	9.5 ³²	9.3 ³²
<i>Senecio subalpinus</i>	--- ¹⁰	--- ⁵	--- ¹⁵	20.2 ⁴⁰	26.7 ⁴⁵
<i>Avenella flexuosa</i>	---	---	--- ²³	20.8 ⁴⁰	32.7 ⁵⁰
<i>Rumex alpestris</i>	--- ¹⁹	--- ⁹	9.0 ³¹	--- ¹⁶	21.0 ⁴¹
<i>Athyrium filix-femina</i>	--- ¹⁴	1.4 ²³	11.2 ³¹	22.4 ⁴⁰	---
<i>Aegopodium podagraria</i>	20.4 ³⁸	23.8 ⁴¹	--- ¹⁵	--- ⁸	--- ⁵
<i>Luzula luzuloides</i>	3.6 ²⁴	13.5 ³²	2.7 ²³	--- ¹²	--- ¹⁴
<i>Sorbus aucuparia</i>	--- ¹⁰	--- ¹⁸	4.0 ²³	30.2 ⁴⁴	--- ⁵
<i>Salix silesiaca</i>	--- ¹⁴	17.3 ³²	--- ⁸	2.1 ²⁰	--- ¹⁸
<i>Taraxacum officinalis</i> agg.	6.4 ²⁴	--- ⁹	--- ⁸	--- ⁸	34.1 ⁴⁵
<i>Geum rivale</i>	16.9 ³³	--- ¹⁸	4.1 ²³	--- ²⁰	--- ⁵
<i>Arabis alpina</i>	7.6 ²⁴	---	--- ¹⁵	13.0 ²⁸	6.2 ²³
<i>Fragaria vesca</i>	15.7 ³³	8.2 ²⁷	22.1 ³⁸	--- ⁴	---
<i>Soldanella carpatica</i>	--- ⁵	---	--- ⁸	38.6 ⁴⁴	9.4 ²³
<i>Petasites albus</i>	--- ⁵	--- ¹⁴	--- ¹⁵	33.5 ⁴⁰	--- ⁵
<i>Calamagrostis arundinacea</i>	2.3 ¹⁹	19.2 ³²	7.6 ²³	--- ⁸	--- ⁵
<i>Ranunculus aconitifolius</i>	--- ¹⁴	--- ⁵	---	14.4 ²⁴	19.1 ²⁷
<i>Hypericum maculatum</i>	--- ⁵	--- ¹⁴	10.9 ²³	--- ¹²	10.4 ²³
<i>Galium schultesii</i>	6.2 ¹⁹	11.5 ²³	1.1 ¹⁵	1.9 ¹⁶	---
<i>Valeriana sambucifolia</i>	12.3 ²⁴	10.8 ²³	--- ¹⁵	--- ⁴	--- ⁹
<i>Chrysosplenium alternifolium</i>	6.5 ¹⁹	--- ¹⁴	12.2 ²³	--- ¹²	--- ⁵
<i>Dryopteris dilatata</i>	---	--- ⁵	14.0 ²³	38.7 ⁴⁰	---
<i>Primula elatior</i>	16.1 ²⁴	---	3.6 ¹⁵	--- ¹²	1.0 ¹⁴
<i>Angelica sylvestris</i>	15.9 ²⁴	7.6 ¹⁸	3.4 ¹⁵	--- ⁸	---
<i>Angelica archangelica</i>	---	1.2 ¹⁴	3.8 ¹⁵	--- ⁸	21.5 ²⁷
<i>Milium effusum</i>	2.4 ¹⁴	8.2 ¹⁸	15.6 ²³	--- ⁸	---
<i>Lamium maculatum</i>	17.3 ²⁴	15.7 ²³	4.6 ¹⁵	---	---
<i>Dactylis glomerata</i>	37.9 ³³	13.0 ¹⁸	---	---	---
<i>Athyrium distentifolium</i>	---	---	---	3.9 ¹²	45.1 ³⁶
<i>Ranunculus repens</i>	1.3 ¹⁰	24.6 ²³	--- ⁸	--- ⁴	---
<i>Moneses uniflora</i>	--- ⁵	---	--- ⁸	36.5 ²⁸	---
<i>Ranunculus lanuginosus</i>	45.8 ³³	---	--- ⁸	---	---
<i>Adenostyles alliariae</i>	---	---	--- ⁸	--- ⁴	36.3 ²⁷
<i>Poa nemoralis</i>	--- ⁵	42.6 ²⁷	---	---	---

continued ...

<i>Gymnocarpium dryopteris</i>	---	5.1 ⁹	2.3 ⁸	19.1 ¹⁶	---
<i>Gentiana punctata</i>	---	---	---	---	55.8 ⁴¹
Bryophytes					
<i>Brachythecium rivulare</i>	15.5 ³⁸	---	---	---	8.3 ³²
<i>Rhizomnium magnifolium</i>	---	---	---	20.4 ²⁸	26.0 ³²
<i>Plagiomnium undulatum</i>	32.7 ³⁸	---	11.6 ²³	---	---
<i>Cirriphyllum piliferum</i>	26.3 ²⁴	---	---	12.5 ¹⁶	---
<i>Rhizomnium punctatum</i>	9.6 ¹⁹	---	---	29.1 ³²	---
<i>Bryum schleicheri</i>	---	---	---	27.7 ²⁸	4.5 ¹⁴
<i>Pleurozium schreberi</i>	---	---	13.6 ¹⁵	22.2 ²⁰	---
<i>Polytrichum formosum</i>	---	---	2.4 ⁸	27.4 ²⁰	---
<i>Polytrichastrum alpinum</i>	---	---	2.5 ⁸	27.6 ²⁰	---

Table 1. Shortened synoptic table of riparian vegetation with percentage frequency and modified fidelity index (ϕ – Φ – coefficient). The taxa are sorted according to their fidelity (ϕ coefficient x 100, upper index). A - vegetation type *Petasites hybridus*, B - vegetation type *Rubus idaeus-Urtica dioica*, C - vegetation type *Senecio nemorensis*, D - vegetation type *Luzula sylvatica-Dicranum scoparium*, E - vegetation type *Ligusticum mutellina*. The species occurring in only one column were excluded from the table, as well as the species of $\Phi < 0.20$.

A. Vegetation type *Petasites hybridus* (Table 2)

Nitrophilous broad-leaved tall herb communities dominated by *Petasites hybridus* and *Chaerophyllum hirsutum*, occurring at riparian habitats along streams, most often in habitats influenced by man or by cattle. In the Tatra Mts., the community occurs in the altitude 639 – 1252 m a.s.l. Similar community described Jarolímek and Kliment (2004) in the Nízke Tatry Mts (community *Petasites hybridus* within the class *Mulgedio-Aconitetea*) occurring also in the surrounding of abandoned shepherd's shanties. The vegetation type prefers SSE facing, mild inclined slopes, approximately 10°.

High °dH value (3.98) indicates high concentration of bivalent cations which correlates with basic pH (7.81). Decomposition of organic substances in soils is indicated by high concentration of nitrates (1.52 mg.l⁻¹) and by high value of COD (1.29 mg.l⁻¹). Agricultural and residential runoff is indicated by high TDS value (0.08g.l⁻¹). The high measure of dissolved ions in the water induces relatively high conductivity (80.72 µS.cm⁻²/25 °C).

Relevé localities:

- Suchá dolina, riparian vegetation, 995 m a.s.l., cover total 80%, E1 80%, E0 40%, relevé area 4.50 m², July 21, 2010, longitude 193625.00, latitude 491246.00, aspect 225°, slope 65°, leg. Ciriaková.
- Bielovodská dolina, riparian vegetation, 1208 m a.s.l., cover total 70%, E2 15%, E1 65%, E0 5%, relevé area 4.50 m², June 27, 2010, longitude 200637.00, latitude 491208.00, aspect 45°, slope 5°, leg. Ciriaková.
- Dolina Bielej vody kežmarskej, riparian vegetation, 1010 m a.s.l., cover total 100%, E2 20%, E1 100%, E0 1%, relevé area 3.00 m², August 24, 2010, longitude 201650.00, latitude 491141.00, aspect 135°, slope 15°, leg. Šoltés.
- Suchá dolina, riparian vegetation, 863 m a.s.l., cover total 70%, E1 55%, E0 60%, relevé area 4.00 m², July 21, 2010, longitude 193630.00, latitude 491253.00, aspect 180°, slope 7°, leg. Ciriaková.
- Kóprová dolina, riparian vegetation, 984 m a.s.l., cover total 95%, E1 65%, E0 60%, relevé area 4.00 m², September 21, 2010, longitude 195526.00, latitude 490911.00, aspect 270°, slope 10°, leg. Ciriaková, Šoltés.

6. Bobrovecká dolina, riparian vegetation, 882 m a.s.l., cover total 75%, E3 30%, E1 60%, E0 20%, relevé area 4.00 m², September 14, 2010, longitude 194518.00, latitude 491646.00, aspect 45°, slope 3°, leg. Ciriaková.

7. Bystrá dolina, riparian vegetation, 862 m a.s.l., cover total 75%, E3 30%, E1 60%, E0 20%, relevé area 3.00 m², August 11, 2010, longitude 195137.00, latitude 490715.00, aspect 180°, slope 45°, leg. Ciriaková.

8. Jalovská dolina, riparian vegetation, 862 m a.s.l., cover total 100%, E1 100%, E0 1%, relevé area 4.00 m², July 23, 2010, longitude 193851.00, latitude 490951.00, aspect 90°, slope 20°, leg. Ciriaková.

9. Liptovské Matiašovce, riparian vegetation, 643 m a.s.l., cover total 100%, E1 100%, E0 3%, relevé area 3.00 m², July 21, 2010, longitude 193301.00, latitude 490933.00, aspect 225°, slope 5°, leg. Ciriaková.

10. Bielovodská dolina, riparian vegetation, 1007 m a.s.l., cover total 80%, E3 35%, E1 75%, E0 3%, relevé area 4.50 m², June 27, 2010, longitude 200604.00, latitude 491435.00, aspect 90°, slope 5°, leg. Ciriaková.

11. Štôla, riparian vegetation, 816 m a.s.l., cover total 90%, E2 5%, E1 90%, E0 50%, relevé area 4.00 m², October 14, 2010, longitude 200833.00, latitude 490501.00, aspect 90°, slope 5°, leg. Ciriaková, Šoltés, Cachovanová.

12. Ždiar-Biela, riparian vegetation, 832 m a.s.l., cover total 90%, E1 80%, E0 50%, relevé area 4.50 m², October 21, 2010, longitude 201732.00, latitude 491558.00, aspect 90°, slope 25°, leg. Ciriaková, Šoltés, Cachovanová.

13. Tat. Javorina-Javorinka, riparian vegetation, 951 m a.s.l., cover total 80%, E1 80%, E0 40%, relevé area 4.50 m², October 21, 2010, longitude 200901.00, latitude 491612.00, aspect 45°, slope 15°, leg. Ciriaková, Šoltés, Cachovanová.

14. Vážec, riparian vegetation, 783 m a.s.l., cover total 100%, E1 100%, E0 40%, relevé area 4.00 m², October 14, 2010, longitude 195819.00, latitude 490328.00, aspect 225°, slope 3°, leg. Ciriaková, Šoltés, Cachovanová.

15. Látaná dolina, riparian vegetation, 1075 m a.s.l., cover total 80%, E2 5%, E1 75%, E0 25%, relevé area 4.00 m², September 15, 2010, longitude 194254.00, latitude 491434.00, aspect 270°, slope 10°, leg. Ciriaková.

16. Zverovka, riparian vegetation, 1024 m a.s.l., cover total 100%, E1 100%, E0 5%, relevé area 4.00 m², September 15, 2010, longitude 194228.00, latitude 491444.00, aspect 45°, slope 4°, leg. Ciriaková.

17. Beliansky potok, riparian vegetation, 1295 m a.s.l., cover total 100%, E1 100%, relevé area 3.00 m², July 14, 2010, longitude 195854.00, latitude 490829.00, aspect 270°, slope 15°, leg. Ciriaková.

18. Bobrovecká dolina, riparian vegetation, 1178 m a.s.l., cover total 100%, E1 100%, E0 15%, relevé area 4.00 m², September 14, 2010, longitude 194605.00, latitude 491446.00, aspect 360°, slope 2°, leg. Ciriaková.

19. Tristárska dolina, riparian vegetation, 993 m a.s.l., cover total 100%, E2 1%, E1 100%, relevé area 4.00 m², August 5, 2010, longitude 201329.00, latitude 491602.00, aspect 180°, slope 3°, leg. Ciriaková.

20. Bobrovecká dolina, riparian vegetation, 845 m a.s.l., cover total 85%, E1 85%, E0 1%, relevé area 4.00 m², September 14, 2010, longitude 194424.00, latitude 491715.00, aspect 315°, slope 5°, leg. Ciriaková.

21. Tichá dolina, riparian vegetation, 1252 m a.s.l., cover total 100%, E2 15%, E1 100%, E0 1%, relevé area 4.00 m², September 21, 2010, longitude 195733.00, latitude 491320.00, aspect 45°, slope 6°, leg. Ciriaková, Šoltés.

Relevé No	1234567891111111122	012345678901
Differential species:		
<i>Petasites hybridus</i>	533343354433443554554	
Other species:		
<i>Chaerophyllum hirsutum</i>	1.+r+++.r422332232.3	
<i>Stellaria nemorum</i>	2.....+1...12r2+21	
<i>Alchemilla vulgaris</i>	.1+.r.....+++.r+2.+	
<i>Urtica dioica</i>	..1...+.2.+1+r.2.+.	
<i>Picea abies</i>	.22rr2r.....r.2.....	
<i>Oxalis acetosella</i>	2.++.2.+...+...2.+...	
<i>Deschampsia cespitosa</i>	.2..2+...+...+...+...+	
<i>Rubus idaeus</i>	+.r...+r.r2...r2...2	
<i>Aegopodium podagraria</i>	...+...r..+2+...+...	
<i>Ranunculus lanuginosus</i>	2...+.1...r.+...1+...	
<i>Leucanthemum rotundifolium</i>	..11.+...+...1r+.	
<i>Senecio nemorensis agg.</i>	+.r...+1.2...+.r...	
<i>Fragaria vesca</i>	..r+++..1...+.....	
<i>Dactylis glomerata</i>	...+...1+1...1++	
<i>Geum rivale</i>	...r...12.2...+2	
<i>Viola biflora</i>	.1...+...+...+11...	
<i>Primula elatior</i>	r..r.r.....+...+...	
<i>Cardaminopsis arenosa</i>	+.r.+...r.....+.	
<i>Luzula luzuloides</i>	+.r...+...r.....+.	
<i>Arabis alpina</i>	+.r.....r.....12r.	
<i>Myosotis scorpioides agg.</i>	+.r.....+...+...+	
<i>Taraxacum officinalis agg.</i>	r..r.r.....+...+...	
<i>Chamaerion angustifolium</i>	...+...1++...+...+.	
<i>Calamagrostis villosa</i>	...12.+..22.....	
<i>Pulmonaria obscura</i>	...1.1.....2...+..+	
<i>Angelica sylvestris</i>	...r+.r.....r.....+	
<i>Valeriana sambucifolia</i>	...+...+1...r.....2..	
<i>Lamium maculatum</i>	...+...+...2.1.212	
<i>Mycelis muralis</i>	+...11+...+...+...	
<i>Geranium robertianum</i>	+...+...+...+...+...	
<i>Digitalis grandiflora</i>	r.....r.....r.....+	
<i>Epilobium montanum</i>	+.r...+r.....+...+	
<i>Luzula sylvatica</i>	r.....+...+...+...+	
<i>Chrysosplenium alternifolium</i>	r.....+...+1.....	
<i>Galium schultesii</i>	..3r+1.....	
<i>Calamagrostis arundinacea</i>	..2.+...+...+...+	
<i>Agropyron caninum</i>	..2.+...+...+...+	
<i>Rumex alpestris</i>	...+...+...+...+...	
<i>Carduus personata</i>	...+...+...+...+...2	
<i>Galeobdolon luteum</i>	2...+...+...1.....	
<i>Crepis paludosa</i>	+..2.....r.....	
<i>Silene dioica</i>	r.....+...+...+...	
<i>Salix silesiaca</i>	.2..+...+...+...2	
<i>Athyrium filix-femina</i>	+.r...+...+...+...	
<i>Equisetum arvense</i>	...r...+...+...+...	
<i>Anthriscus sylvestris</i>	...1.....+...+...3.	
<i>Epilobium collinum</i>	...+...+...r.....+	

<i>Rumex obtusifolius</i>	.....r.....r.....
<i>Ranunculus aconitifolius</i>	.....+.r.r.....
<i>Milium effusum</i>	.....+...+...2....
<i>Geranium sylvaticum</i>	.....r.....+..+
<i>Valeriana tripteris</i>	..+..+.....
<i>Ranunculus species</i>	..+.....+.....
<i>Aconitum firmum</i>	..+.....1.....
<i>Doronicum austriacum</i>	..+.....r.....
<i>Thalictrum aquilegifolium</i>	..r.....r.....
<i>Dryopteris carthusiana</i>	..r.....+.....
<i>Heracleum sphondylium</i>	..r.....r.....
<i>Schistidium agassizii</i>	..r.....+...+
<i>Polygonum bistorta</i>	..r.....r.....
<i>Abies alba</i>	..2..1.....
<i>Veronica officinalis</i>	..1.r.....
<i>Poa species</i>	...+...+.....
<i>Sorbus aucuparia</i>	...r.....r.....
<i>Ranunculus repens</i>+...+.....
<i>Filipendula ulmaria</i>	.....r.....r.....
<i>Impatiens noli-tangere</i>	.....r.....r.....
<i>Galium aparine</i>	.....2...+.....
<i>Alnus incana</i>	.....32.....
<i>Stachys sylvatica</i>+..+.....
<i>Cirsium oleraceum</i>	.....+...r.....
<i>Cardamine opicii</i>+...+...
<i>Senecio subalpinus</i>+...+
Bryophytes	
<i>Plagiomnium undulatum</i>	...21...22r.2+...r.
<i>Brachythecium rivulare</i>	.....r..233..r.21r.
<i>Brachythecium salebrosum</i>	..+..225.1.....2.....
<i>Cirriophyllum piliferum</i>	2..2+r...+.....
<i>Rhizomnium punctatum</i>	.....+...r..2.r.....
<i>Conocephalum conicum</i>	.....12r...2...
<i>Ctenidium molluscum</i>	3..3.....
<i>Dicranum scoparium</i>	..1+.....
<i>Plagiomnium affine</i>	..+.....r.....
<i>Atrichum undulatum</i>	...1r.....
<i>Drepanocladus uncinatus</i>	.....2.r.....
<i>Rhizomnium magnifolium</i>	.....+...r.

Species in only one relevé:

Herb layer:

Dentaria glandulosa 1: +; *Galium species* 2: +; *Petasites albus* 2: +; *Hypericum maculatum* 2: +; *Plagioghecium denticulatum* 2: r; *Abies alba* 3: 2; *Vaccinium myrtillus* 3: +; *Valeriana simplicifolia* 3: +; *Astrantia major* 4: 1; *Hieracium murorum* 4: +; *Prenanthes purpurea* 4: +; *Soldanella carpatica* 4: +; *Daphne mezereum* 4: +; *Cortusa matthioli* 4: +; *Euphorbia amygdaloides* 4: +; *Salvia glutinosa* 4: +; *Pleurospermum austriacum* 4: r; *Dactylo-rhiza fuchsii* 4: r; *Solidago virgaurea* 5: +; *Agrostis capillaris* 5: +; *Trifolium pratense* 5: +; *Hieracium species* 5: r; *Thymus species* 5: r; *Acer pseudoplatanus* 6: 1; *Prunella vulgaris* 6: +; *Moneses uniflora* 6: +; *Artemisia vulgaris* 7: +; *Daucus carota* 7: r; *Aruncus dioicus* 8: r; *Mentha longifolia* 9: 2; *Vicia cracca* 9: 2; *Festuca gigantea* 9: +; *Pimpinella major* 9: +; *Rubus caesius* 9: +; *Epilobium parviflorum* 9: +; *Maianthemum bifolium* 10: r; *Eurhynchium crassinervium* 10: r; *Agrostis canina* 11: +; *Caltha *laeta* 11: r; *Stellaria longifolia* 11: r; *Silene vulgaris* 12: r; *Trifolium repens* 13: +; *Gnaphalium sylvaticum* 13: r; *Lolium perenne* 14: 2; *Lathyrus palustris* 14: +; *Asarum europaeum* 14: r; *Rumex acetosa* 14: r; *Homogyne alpina* 16: +; *Carex sylvatica* 18: +; *Salix caprea* 19: r; *Poa nemoralis* 21: +.

Moss layer:

Racomitrium microcarpon 2: r; *Rhytidiadelphus triquetrus* 4: 2; *Plagiogchila asplenioides* 4: 2; *Dicranum fuscescens* 4: 2; *Mnium marginatum* 4: r; *Fissidens adianthoides* 4: r; *Hypnum cupressiforme* 5: 3; *Homalothecium lutescens* 5: 2; *Polytrichum formosum* 5: +;

continued...

Marchantia polymorpha 6: 1; *Racomitrium canescens* 7: +; *Bryum schleicheri* 8: r; *Rhytidiadelphus subpinnatus* 10: r; *Plagiomnium rostratum* 10: r; *Chiloscyphus polyanthos* 12: 2; *Bryum pseudotriquetrum* 13: r; *Pohlia nutans* 13: r; *Brachythecium nutabulum* 14: 3; *Plagiomnium medium* 14: 2; *Plagiochila porelloides* 15: r; *Lophocolea heterophylla* 15: r; *Rhytidiadelphus squarrosus* 16: +; *Pellia neesiana* 16: r; *Chiloscyphus pallescens* 16: r.

Table 2. Vegetation type *Petasites hybridus*

B. Vegetation type Rubus idaeus-Urtica dioica
(Table 3)

The community is widespread in the altitude 679 – 1252 m a.s.l., usually along felled areas, only exceptionally occurs in higher altitudes, always in man influenced habitats, e. g. vertical exception is the site near Chata pri Zelenom plese (1529 m asl). The sites are dominated by nitrophilous felled area species – *Chamaerion angustifolium*, *Urtica dioica*, *Rubus idaeus*. The group of differential species is finished by bryophyte *Brachythecium salebrosum*. The community occupies mainly rather steep slopes (19° in average) facing SE.

Similar secondary community in the Tatra Mts described Šmarda *et al.* (1963) in Tomanova dolina Valley. Forest floor species, felled area species and nitrophilous species are occurring in the relevés.

Organic contamination brought about high COD value (1.78 mg.l⁻¹ in average), which correlates with higher NO₃⁻ concentration (1.29 mg.l⁻¹ in average).

Relevé localities:

1. Mengusovská dolina, riparian vegetation, 1195 m a.s.l., cover total 100%, E2 15%, E1 100%, E0 1%, relevé area 3.00 m², August 13, 2010, longitude 200457.00, latitude 490659.00, aspect 90°, slope 25°, leg. Šoltés.
2. Skalnatá dolina, riparian vegetation, 928 m a.s.l., cover total 100%, E2 5%, E1 100%, E0 1%, relevé area 3.00 m², August 16, 2010, longitude 201718.00, latitude 491045.00, aspect 90°, slope 10°, leg. Šoltés.
3. Veľký Šum, riparian vegetation, 1106 m a.s.l., cover total 100%, E2 5%, E1 100%, E0 2%, relevé area 4.50 m², August 3, 2010, longitude 200650.00, latitude 490712.00, aspect 90°, slope 10°, leg. leg. Šoltés.
4. Batizovská dolina, riparian vegetation, 1130 m a.s.l., cover total 100%, E2 2%, E1 100%, E0 2%, relevé area 4.50 m², July 8, 2010, longitude 200824.00, latitude 490726.00, aspect 180°, slope 10°, leg. Šoltés.
5. Kamenistá dolina, riparian vegetation, 910 m a.s.l., cover total 80%, E1 80%, E0 1%, relevé area 4.00 m², August 3, 2010, longitude 195347.00, latitude 490810.00, aspect 180°, slope 5°, leg. Ciriaková.
6. Važecká dolina, riparian vegetation, 1223 m a.s.l., cover total 100%, E2 60%, E1 80%, E0 1%, relevé area 3.00 m², July 13, 2010, longitude 200054.00, latitude 490716.00, aspect 225°, slope 15°, leg. Ciriaková, Šoltés.
7. Slavkovský potok, riparian vegetation, 973 m a.s.l., cover total 100%, E1 100%, E0 1%, relevé area 3.00 m², July 14, 2010, longitude 201208.00, latitude 490745.00, aspect 90°, slope 45°, leg. Šoltés.
8. Stará Lesná, riparian vegetation, 719 m a.s.l., cover total 100%, E1 100%, E0 35%, relevé area 4.00 m², October 13, 2010, longitude 201825.00, latitude 490803.00, aspect 135°, slope 40°, leg. Ciriaková, Šoltés, Cachovanová.
9. Mlynčeky, riparian vegetation, 679 m a.s.l., cover total 90%, E2 5%, E1 50%, E0 50%, relevé area 6.00 m², October 13, 2010, longitude 202258.00, latitude 490959.00, aspect 135°, slope 20°, leg. leg. Ciriaková, Šoltés, Cachovanová.

10. Poprad-letisko, riparian vegetation, 689 m a.s.l., cover total 80%, E2 5%, E1 80%, E0 1%, relevé area 4.00 m², October 13, 2010, longitude 201554.00, latitude 490400.00, aspect 135°, slope 10°, leg. Ciriaková, Šoltés, Cachovanová.
11. Tatranská Lomnica-Eurocamp, riparian vegetation, 736 m a.s.l., cover total 100%, E2 5%, E1 100%, E0 1%, relevé area 4.00 m², October 13, 2010, longitude 201926.00, latitude 490842.00, aspect 180°, slope 10°, leg. Ciriaková, Šoltés, Cachovanová.
12. Batizovce, riparian vegetation, 749 m a.s.l., cover total 100%, E1 100%, E0 1%, relevé area 6.00 m², October 13, 2010, longitude 201115.00, latitude 490425.00, aspect 135°, slope 2°, leg. Ciriaková, Šoltés, Cachovanová.
13. Račková dolina, riparian vegetation, 791 m a.s.l., cover total 70%, E1 70%, E0 2%, relevé area 4.50 m², October 13, 2010, longitude 194829.00, latitude 490618.00, aspect 135°, slope 15°, leg. Ciriaková, Cachovanová.
14. Veľická dolina, riparian vegetation, 990 m a.s.l., cover total 95%, E2 2%, E1 95%, E0 2%, relevé area 4.00 m², October 14, 2010, longitude 201028.00, latitude 490716.00, aspect 135°, slope 5°, leg. Ciriaková, Šoltés, Cachovanová.
15. Tatranská Štrba, riparian vegetation, 859 m a.s.l., cover total 90%, E1 85%, E0 25%, relevé area 4.00 m², October 14, 2010, longitude 200436.00, latitude 490422.00, aspect 180°, slope 10°, leg. Ciriaková, Šoltés, Cachovanová.
16. Dolina Zeleného potoka, riparian vegetation, 1534 m a.s.l., cover total 90%, E2 3%, E1 90%, E0 1%, relevé area 3.00 m², June 28, 2010, longitude 201326.00, latitude 491239.00, aspect 135°, slope 5°, leg. Ciriaková.
17. Veľký Šum, riparian vegetation, 1191 m a.s.l., cover total 80%, E1 80%, E0 2%, relevé area 3.00 m², July 9, 2010, longitude 200627.00, latitude 490732.00, aspect 90°, slope 3°, leg. Ciriaková.
18. Belanský potok, riparian vegetation, 1092 m a.s.l., cover total 85%, E3 20%, E2 20%, E1 65%, E0 2%, relevé area 2.00 m², July 14, 2010, longitude 195755.00, latitude 490821.00, aspect 225°, slope 65°, leg. Ciriaková.
19. Studená dolina, riparian vegetation, 928 m a.s.l., cover total 70%, E2 25%, E1 70%, E0 5%, relevé area 6.00 m², October 14, 2010, longitude 201540.00, latitude 490906.00, aspect 135°, slope 20°, leg. Ciriaková, Šoltés, Cachovanová.
20. Bielovodská dolina, riparian vegetation, 953 m a.s.l., cover total 80%, E1 80%, E0 5%, relevé area 4.50 m², October 21, 2010, longitude 200703.00, latitude 491455.00, aspect 45°, slope 30°, leg. Ciriaková, Šoltés, Cachovanová.
21. Kôprová dolina, riparian vegetation, 1495 m a.s.l., cover total 90%, E1 80%, E0 15%, relevé area 3.00 m², September 21, 2010, longitude 200000.00, latitude 491138.00, aspect 135°, slope 2°, leg. leg. Ciriaková, Šoltés.
22. Slavkovská dolina, riparian vegetation, 1252 m a.s.l., cover total 75%, E1 75%, E0 2%, relevé area 3.00 m², July 2, 2010, longitude 201103.00, latitude 490831.00, aspect 135°, slope 60°, leg. Ciriaková.

Relevé No	123456789111111111222 0123456789012
Differential species:	
<i>Rubus idaeus</i>	244122.3+23.12+1r22212
<i>Urtica dioica</i>	121.+223113+112223...
<i>Chamaerion angustifolium</i>	42223312...+1.r.211+
<i>Brachythecium salebrosum</i> (E0)	.r.r.r.r.22...+...+....
Other species:	
<i>Chaerophyllum hirsutum</i>	+2..222....214+2..243
<i>Senecio nemorensis</i> agg.	222+1...+.....r+r...
<i>Calamagrostis villosa</i>	22.3....+...3..3.111.
<i>Stellaria nemorum</i>	...+....+...1r3++..+2
<i>Aegopodium podagraria</i>	.....+1432.+2..+r...
<i>Luzula luzuloides</i>	+..+1.....+...11+
<i>Calamagrostis arundinacea</i>	..+23.....+1..3.3
<i>Salix silesiaca</i>	..+...r.....+...r3+r...
<i>Myosotis scorpioides</i> agg.	...++1.....+...1...r1
<i>Petasites hybridus</i>	...2.22+...22.....2..
<i>Fragaria vesca</i>	+...+.....+...+...+...
<i>Deschampsia cespitosa</i>	...11+...+.....2...1..

continued...

<i>Poa nemoralis</i>	...+...+...21...+2...
<i>Valeriana sambucifolia</i>	+1...+...r+...
<i>Athyrium filix-femina</i>	+...2...1...r...1
<i>Sambucus racemosa</i>	...++...44...2...
<i>Galium schultesii</i>	...2...2...2...12...
<i>Lamium maculatum</i>	...2r4...+...2...
<i>Ranunculus repens</i>	...+...+1...1...+
<i>Salix caprea</i>	2...+...r...r...r
<i>Dactylis glomerata</i>	+...+...+...+...
<i>Oxalis acetosella</i>	+...2...+...+...
<i>Sorbus aucuparia</i>	...22...+...r...
<i>Doronicum austriacum</i>	...1...r...1...3...
<i>Heracleum sphondylium</i>	...+...2...r+...
<i>Epilobium montanum</i>	...+...r...r...r...
<i>Dryopteris filix-mas</i>	...r+...r...1...
<i>Angelica sylvestris</i>	...+...+...+1...
<i>Miliium effusum</i>	...+...+...+1...
<i>Geranium sylvaticum</i>	...+...+...+r+...
<i>Geum rivale</i>	...+...+...+11...
<i>Picea abies</i>	2...1...r...
<i>Petasites albus</i>	12...2...
<i>Angelica archangelica</i>	+...2...r...
<i>Lonicera nigra</i>	...r1...2...r...
<i>Silene vulgaris</i>	...2+...r...
<i>Rumex obtusifolius</i>	...1...+...+...
<i>Tussilago farfara</i>	...+...+...+...
<i>Cirsium oleraceum</i>	...+...r...r...
<i>Mycelis muralis</i>	...+...+...1+...
<i>Alchemilla vulgaris</i>	...+...+...2...1...
<i>Galium aparine</i>	...r...22...
<i>Anthriscus sylvestris</i>	...221...
<i>Chrysosplenium alternifolium</i>	...+...r...r+...
<i>Arctium species</i>	...r...r...r...
<i>Agrostis stolonifera</i>	...11...+...
<i>Glechoma hederacea</i>	...+...+...+...
<i>Cirsium arvense</i>	...1+...r...
<i>Hypericum maculatum</i>	...+...r...+...
<i>Aconitum firmum</i>	...2+...1...
<i>Silene dioica</i>	+...r...r...
<i>Betula pubescens ssp. carpatica</i>	+...r...
<i>Campanula trachelium</i>	...+...2...
<i>Arrhenatherum elatius</i>	...+...+...
<i>Veronica chamaedrys</i>	...+...2...
<i>Gymnocarpium dryopteris</i>	...+...r...r...
<i>Vaccinium myrtillus</i>	...1...+...
<i>Agropyron caninum</i>	...2...+...
<i>Rumex alpestris</i>	...+...r...
<i>Achillea millefolium</i>	...+...+...
<i>Acer pseudoplatanus</i>	...+...2...
<i>Salix pentandra</i>	...2...2...
<i>Galium mollugo</i>	...+...1...
<i>Festuca rubra</i>	...+...2...
<i>Festuca pratensis agg.</i>	...+...+...
<i>Taraxacum officinalis agg.</i>	...+...r...
<i>Larix decidua</i>	...r...2...
<i>Hieracium murorum</i>	...r...+...
<i>Thalictrum aquilegifolium</i>	...r...1...
<i>Solidago virgaurea</i>	...+...2+...
<i>Gentiana asclepiadea</i>	...+...+...
Bryophytes:	
<i>Brachythecium rutabulum</i>	...+...1...r...2...
<i>Brachythecium rivulare</i>	...2...r...+...r
<i>Plagiochila asplenioides</i>	...+...r...r...
<i>Drepanocladus uncinatus</i>	...+...r...2...
<i>Rhytidiadelphus triquetrus</i>	...r...r...
<i>Hylocomium splendens</i>	...r...r...
<i>Plagiomnium undulatum</i>	...22...
<i>Fissidens taxifolius</i>	...2+...
<i>Brachythecium reflexum</i>	...r...r...
<i>Brachythecium velutinum</i>	...2...r...

Species in only one relevé:

Herb layer: *Carduus personata* 16: 1; *Ranunculus aconitifolius* 16: +; *Veronica officinalis* 16: +; *Cicerbita alpina* 16: +; *Veratrum album ssp. lobelianum* 16: +; *Alnus*

incana 4: 2; *Scrophularia nodosa* 4: 1; *Galeopsis speciosa* 4: +; *Dryopteris dilatata* 12: 1; *Poa trivialis* 20: 2; *Hylolephium maximum* 20: +; *Cirsium rivulare* 18: +; *Ranunculus acris* 18: r; *Viola tricolor* 18: r; *Rosa pendulina* 9: 2; *Ribes petraeum* 9: 1; *Epilobium hirsutum* 7: +; *Poa species* 7: +; *Melampyrum sylvaticum* 7: r; *Melica uniflora* 3: +; *Sambucus nigra* 3: r; *Salix fragilis* 11: 2; *Rubus caesius* 11: +; *Impatiens parviflora* 11: +; *Euonymus europaeus* 11: r; *Sonchus oleraceus* 11: r; *Filipendula ulmaria* 5: r; *Phragmites australis* 13: 5; *Scirpus sylvaticus* 13: 2; *Equisetum arvense* 13: +; *Carex hirta* 13: +; *Tanacetum vulgare* 21: +; *Sanguisorba minor* 21: +; *Vicia cracca* 21: +; *Moehringia trinervia* 21: +; *Epilobium collinum* 21: +; *Trifolium repens* 21: r; *Cardaminopsis arenosa* 21: r; *Galeopsis tetrahit* 21: r; *Centaurea species* 21: r; *Artemisia vulgaris* 10: 1; *Linaria vulgaris* 10: +; *Salix purpurea* 10: r; *Astragalus glycyphyllos* 10: r; *Galeobdolon luteum* 17: +; *Caltha *lata* 17: +; *Stachys sylvatica* 17: +; *Fraxinus excelsior* 17: r; *Epilobium alpestre* 2: 2; *Homogyne alpina* 2: 1; *Pinus mugo* 2: 1; *Rumex acetosa* 2: r; *Festuca versicolor* 2: r; *Cirsium heterophyllum* 14: 2; *Digitalis grandiflora* 19: 2; *Listera ovata* 19: r; *Hypericum perforatum* 6: 1; *Thesium pyrenaicum* 6: +; *Viburnum opulus* 6: +; *Lotus corniculatus* 6: +; *Cerastium arvense* 6: +; *Pinus sylvestris* 6: +; *Anthyllis vulneraria* 6: +; *Encalypta streptocarpa* 6: r; *Leontodon species* 6: r; *Senecio subalpinus* 1: r; *Prenanthes purpurea* 1: r; *Leucanthemum rotundifolium* 22: 2; *Rumex alpinus* 22: 1; *Festuca carpatica* 22: 1; *Luzula sylvatica* 22: +; *Festuca species* 8: 1;

Moss layer: *Plagiothecium curvifolium* 4: +; *Dicranum scoparium* 12: r; *Plagiothecium platyphyllum* 7: r; *Amblystegium juratzkanum* 7: r; *Plagiomnium ellipticum* 3: 2; *Hygrohypnum luridum* 3: +; *Plagiomnium cuspidatum* 3: +; *Pohlia nutans* 13: r; *Drepanocladus exannulatus* 2: r; *Ditrichum flexicaule* 6: r; *Bryum caespiticium* 6: r; *Tortella tortuosa* 6: r; *Rhytidiadelphus subpinnatus* 1: 2; *Lophocolea bidentata* 1: r; *Rhytidiadelphus squarrosus* 22: +;

Table 3. Vegetation type *Rubus idaeus-Urtica dioica***C. Vegetation type *Senecio nemorensis*** (Table 4)

This vegetation type occurs in the vertical span 676 – 1497 m a.s.l., stands are without distinct differential species, relatively higher constancy shows *Senecio nemorensis*. Vegetation type prefers mild inclined (12° in average), SSW facing slopes. Decomposition of organic substances in soils is indicated by rather high NO₃⁻ concentration (1.25 mg.l⁻¹ in average).

Relevé localities:

1. Kóprová dolina, riparian vegetation, 1194 m a.s.l., cover total 100%, E1 100%, E0 2%, relevé area 4.00 m², September 21, 2010, longitude 195758.00, latitude 490926.00, aspect 270°, slope 7°, leg. Ciriaková, Šoltés.
2. Žiarska dolina, riparian vegetation, 1165 m a.s.l., cover total 45%, E1 45%, E0 1%, relevé area 4.00 m², July 22, 2010, longitude 194250.00, latitude 491023.00, aspect 135°, slope 5°, leg. Ciriaková, Šoltés.
3. Bobrovecká dolina, riparian vegetation, 1010 m a.s.l., cover total 90%, E3 10%, E2 7%, E1 80%, E0 10%, relevé area 3.00 m², September 14, 2010, longitude 194526.00, latitude 491533.00, aspect 135°, slope 5°, leg. Ciriaková.
4. Tichá dolina, riparian vegetation, 986 m a.s.l., cover total 100, E1 100%, E0 1%, relevé area 4.00 m², September 21, 2010, longitude 195525.00, latitude 490921.00, aspect 180°, slope 5°, leg. Ciriaková, Šoltés.
5. Kamenistá dolina, riparian vegetation, 1497 m a.s.l., cover total 80, E1 80%, E0 20%, relevé area 4.00 m², August 3, 2010, longitude 195139.00, latitude 491103.00, aspect 135°, slope 5°, leg. Ciriaková.

6. Račková dolina, riparian vegetation, 1398 m a.s.l., cover total 100, E1 100%, relevé area 2.50 m², August 17, 2010, longitude 194854.00, latitude 491102.00, aspect 225°, slope 3°, leg. Ciriaková.
7. Mengusovská dolina, riparian vegetation, 1464 m a.s.l., cover total 100, E1 100%, relevé area 3.00 m², July 10, 2010, longitude 200443.00, latitude 490857.00, aspect 135°, slope 3°, leg. Ciriaková.
8. Tristarská dolina, riparian vegetation, 1120 m a.s.l., cover total 50, E1 50%, E0 2%, relevé area 3.00 m², July 10, 2010, longitude 201246.00, latitude 491532.00, aspect 360°, slope 20°, leg. Ciriaková.
9. Látná dolina, riparian vegetation, 1076 m a.s.l., cover total 75, E3 40%, E1 50%, E0 35%, relevé area 4.50 m², September 15, 2010, longitude 194256.00, latitude 491433.00, aspect 225°, slope 10°, leg. Ciriaková.
10. Podbanské, riparian vegetation, 914 m a.s.l., cover total 80, E1 30%, E0 80%, relevé area 4.00 m², September 21, 2010, longitude 195413.00, latitude 490830.00, aspect 180°, slope 25°, leg. Ciriaková, Šoltés.
11. Suchá dolina, riparian vegetation, 735 m a.s.l., cover total 60, E3 15%, E1 50%, E0 40%, relevé area 3.00 m², July 21, 2010, longitude 193444.00, latitude 491020.00, aspect 180°, slope 15°, leg. Ciriaková.
12. Veľký Slavkov, riparian vegetation, 676 m a.s.l., cover total 100, E1 100%, relevé area 4.00 m², October 13, 2010, longitude 201658.00, latitude 490532.00, aspect 225°, slope 3°, leg. Ciriaková, Šoltés, Cachovanová.
13. Vavrišovo, riparian vegetation, 697 m a.s.l., cover total 50, E2 40%, E115%, E0 1%, relevé area 6.00 m², October 14, 2010, longitude 194612.00, latitude 490352.00, aspect 270°, slope 1°, leg. Ciriaková, Šoltés, Cachovanová.

	1234567891111
Relevé No	0123
Differential species:	
<i>Senecio nemorensis</i> agg.	1+2.2+r+++.+
Other species:	
<i>Chaerophyllum hirsutum</i>	.+322332+.2..
<i>Deschampsia cespitosa</i>	2+.+231..+..
<i>Stellaria nemorum</i>	.11+211.....
<i>Calamagrostis villosa</i>	51....+.2+...
<i>Fragaria vesca</i>	+.....+++r
<i>Caltha *laeta</i>	..r.+1.2..+..
<i>Oxalis acetosella</i>	+ .1.....2.2..
<i>Athyrium filix-femina</i>	.22.....r1....
<i>Rumex alpestris</i>	+.+.11.....+
<i>Petasites hybridus</i>	..+1.....+2..
<i>Aconitum firmum</i>	....2r2....r..
<i>Alchemilla vulgaris</i>	....+221.....
<i>Calamagrostis arundinacea</i>	1.1.....1....
<i>Urtica dioica</i>	r1.2.....
<i>Hypericum maculatum</i>	r.....+.....
<i>Geum rivale</i>	.2.....22.....
<i>Chrysosplenium alternifolium</i>	+++.....
<i>Dryopteris dilatata</i>	+++r.....
<i>Veratrum *lobelianum</i>	+.+.+.1.....
<i>Myosotis scorpioides</i> agg.	+.+.+.r.....
<i>Luzula luzuloides</i>	.r.....+.....
<i>Sorbus aucuparia</i>	..2.....1r....
<i>Rubus idaeus</i>	..1...21.....
<i>Milium effusum</i>	..+.r.....+...
<i>Geranium sylvaticum</i>	..+...r2.....
<i>Viola biflora</i>	....2.+1.....
<i>Avenella flexuosa</i>	....1...2+...
<i>Leucanthemum rotundifolium</i>	....r...r+...
<i>Picea abies</i>	.....3r..2
<i>Galium schultesii</i>	1+.....
<i>Senecio subalpinus</i>	1.....r.....
<i>Galeobdolon luteum</i>	.2.....2..
<i>Filipendula ulmaria</i>	..+.....2.....
<i>Agrostis stolonifera</i>	..+.....+.....

<i>Lamium maculatum</i>	..22.....
<i>Petasites albus</i>	..+...2.....
<i>Valeriana sambucifolia</i>	..+...1.....
<i>Asarum europaeum</i>	..+.....+..
<i>Geranium robertianum</i>	..+.....+..
<i>Chamaerion angustifolium</i>	...r3.....
<i>Luzula alpinopilosa</i>	....2.1.....
<i>Arabis alpina</i>+...+.....
<i>Campanula scheuchzeri</i>	....r...+...
<i>Polygonum bistorta</i>	....2+.....
<i>Angelica archangelica</i>	....1+.....
<i>Primula elatior</i>	....+...r..
<i>Hieracium murorum</i>	....21....
<i>Vaccinium myrtillus</i>	....r+...
<i>Angelica sylvestris</i>+..
<i>Alnus incana</i>	....2.3
<i>Aegopodium podagraria</i>	....r.+
Bryophytes:	
<i>Pleurozium schreberi</i>	r.....2...
<i>Plagiomnium undulatum</i>	r..r.....2..
<i>Brachythecium salebrosum</i>	..r.....r
<i>Brachythecium rivulare</i>	..r.2.....
<i>Plagiochila porelloides</i>	..r.....2...
<i>Chiloscyphus polyanthos</i>	....r...r....
<i>Hypnum cupressiforme</i>	....22...
<i>Mnium marginatum</i>	....11...

Species in only one relevé:**Herb layer:**

Luzula sylvatica 1: +; *Taraxacum officinalis* agg. 1: +; *Festuca sp.* 1: +; *Achillea millefolium* 1: +; *Ranunculus acris* 1: +; *Silene vulgaris* 1: +; *Galeopsis speciosa* 2: 1; *Cardaminopsis arenosa* 2: +; *Agrostis canina* 2: +; *Poa pratensis* 2: +; *Gymnocarpium dryopteris* 2: r; *Epilobium parviflorum* 2: r; *Acer pseudoplatanus* 3: 2; *Pulmonaria obscura* 3: 2; *Digitalis grandiflora* 3: +; *Epilobium collinum* 3: +; *Myosotis sylvatica* 3: +; *Cardamine trifolia* 3: +; *Rumex alpinus* 4: 5; *Salix silesiaca* 4: r; *Cirsium palustre* 4: r; *Scirpus sylvaticus* 4: r; *Adenostyles alliariae* 5: 2; *Solidago * minuta* 5: +; *Cardamine opicifolia* 5: +; *Ligusticum mutellina* 5: +; *Homogyne alpina* 5: +; *Heracleum sphondylium* 6: 1; *Carduus personata* 6: 1; *Doronicum austriacum* 6: +; *Phyteuma spicatum* 6: r; *Cicuta virosa* 7: r; *Anthriscus sylvestris* 8: +; *Cortusa matthioli* 8: +; *Cirsium erisithales* 8: +; *Calamagrostis varia* 8: +; *Poa species* 8: r; *Moneses uniflora* 9: +; *Soldanella carpatica* 10: +; *Lonicera nigra* 10: +; *Nardus stricta* 10: +; *Melampyrum sylvaticum* 10: r; *Crepis paludosa* 11: 1; *Astrantia major* 11: 1; *Stachys sylvatica* 11: +; *Ranunculus lanuginosus* 11: +; *Daphne mezereum* 11: r; *Fraxinus excelsior* 11: r; *Dentaria glandulosa* 11: r; *Veronica beccabunga* 12: 5; *Ranunculus repens* 12: +; *Glyceria nemoralis* 12: +; *Salix eleagnos* 13: 2; *Pinus sylvestris* 13: 2; *Hieracium species* 13: +; *Sanguisorba minor* 13: +; *Carex species* 13: +; *Medicago lupulina* 13: +; *Anthyllis vulneraria* 13: +; *Glechoma hederacea* 13: +; *Festuca pratensis* agg. 13: r; *Leucanthemum vulgare* 13: r; *Tanacetum vulgare* 13: r.

Moss layer:

Atrichum undulatum 1: +; *Conocephalum conicum* 3: 2; *Cirriphyllum cirrosum* 3: r; *Cephalozia lunulifolia* 3: r; *Encalypta rhaptocarpa* 3: r; *Bryum schleicheri* 5: +; *Brachythecium glaciale* 5: +; *Cratoneuron commutatum* 8: +; *Plagiomnium affine* 9: 2; *Rhizomnium punctatum* 9: 2; *Polytrichastrum alpinum* 9: +; *Plagiothecium laetum* 9: r; *Orthodicranum montanum* 9: r; *Hylacomium splendens* 10: 3; *Drepanocladus uncinatus* 10: 1; *Polytrichum formosum* 10: +; *Peltigera apthosa* 10: +; *Climacium dendroides* 10: +; *Eurhynchium striatum* 11: 2; *Plagiochila asplenioides* 11: 2; *Aneura pinguis* 11: 1; *Lophocolea bidentata* 11: +; *Jungermannia obovata* 11: +; *Pohlia nutans* 13: r; *Schistidium apocarpum* 13: r; *Desmatodon latifolius* 13: r; *Rhytidiadelphus squarrosus* 13: r.

Table 4. Vegetation type *Senecio nemorensis*

D. Vegetation type Luzula sylvatica-Dicranum scoparium (Table 5)

This vegetation type is widespread in the altitude 901–1664 m a.s.l., usually occupies SSE facing and mild inclined slopes (9.8° in average).

Large group of differential species is created by *Oxalis acetosella*, *Luzula sylvatica*, *Doronicum austriacum*, *Leucanthemum rotundifolium*, *Vaccinium myrtillus* and moss *Dicranum scoparium*. Unusual large participation constitute bryophytes in the floristic composition (32%).

Low value of TDS (0.02 g.l⁻¹) indicates lack of agricultural and residential runoff, which answers low nitrate concentration (1.06 mg.l⁻¹ in average) and low value of COD (1.20 mg.l⁻¹ in average).

Relevé localities:

1. Kamenistá dolina, riparian vegetation, 1273 m a.s.l., cover total 75%, E3 30%, E2 5%, E1 60%, E0 30%, relevé area 4.00 m², August 3, 2010, longitude 195235.00, latitude 491009.00, aspect 135°, slope 15°, leg. Ciriaková.
2. Mlynická dolina, riparian vegetation, 1338 m a.s.l., cover total 70%, E1 35%, E0 60%, relevé area 2.00 m², July 12, 2010, longitude 200402.00, latitude 490706.00, aspect 180°, slope 5°, leg. Ciriaková, Šoltés.
3. Žiarska dolina, riparian vegetation, 1269 m a.s.l., cover total 95%, E1 80%, E0 40%, relevé area 3.00 m², July 22, 2010, longitude 194311.00, latitude 491050.00, aspect 180°, slope 7°, leg. Ciriaková, Šoltés.
4. Mengusovská dolina, riparian vegetation, 1264 m a.s.l., cover total 98%, E1 93%, E0 5%, relevé area 3.00 m², July 10, 2010, longitude 200427.00, latitude 490752.00, aspect 135°, slope 6°, leg. Ciriaková.
5. Kóprová dolina, riparian vegetation, 1333 m a.s.l., cover total 90%, E2 3%, E1 70%, E0 70%, relevé area 4.00 m², September 21, 2010, longitude 195927.00, latitude 491113.00, aspect 180°, slope 5°, leg. Ciriaková, Šoltés.
6. Roháčska dolina, riparian vegetation, 1204 m a.s.l., cover total 95%, E3 10%, E2 2%, E1 95%, E0 5%, relevé area 4.50 m², September 15, 2010, longitude 194339.00, latitude 491318.00, aspect 360°, slope 2°, leg. Ciriaková.
7. Tichá dolina, riparian vegetation, 1532 m a.s.l., cover total 80%, E2 25%, E1 70%, E0 10%, relevé area 4.00 m², September 21, 2010, longitude 195911.00, latitude 491243.00, aspect 360°, slope 10°, leg. Ciriaková, Šoltés.
8. Malá Studená dolina, riparian vegetation, 1311 m a.s.l., cover total 95%, E1 80%, E0 60%, relevé area 6.00 m², October 13, 2010, longitude 201304.00, latitude 491010.00, aspect 180°, slope 40°, leg. Ciriaková, Šoltés, Cachovanová.
9. Roháčska dolina, riparian vegetation, 1066 m a.s.l., cover total 85%, E2 20%, E1 55%, E0 45%, relevé area 3.00 m², September 15, 2010, longitude 194258.00, latitude 491419.00, aspect 90°, slope 2°, leg. Ciriaková.
10. Jalovská dolina, riparian vegetation, 1048 m a.s.l., cover total 60%, E3 5%, E2 2%, E1 55%, E0 45%, relevé area 3.00 m², July 23, 2010, longitude 193944.00, latitude 491118.00, aspect 135°, slope 15°, leg. Ciriaková.
11. Žiarska dolina, riparian vegetation, 901 m a.s.l., cover total 75%, E2 5%, E1 70%, E0 20%, relevé area 4.00 m², July 22, 2010, longitude 194200.00, latitude 490842.00, aspect 135°, slope 7°, leg. Ciriaková, Šoltés.
12. Tristarská dolina, riparian vegetation, 981 m a.s.l., cover total 98%, E1 95%, E0 35%, relevé area 3.00 m², August 5, 2010, longitude 201314.00, latitude 491604.00, aspect 180°, slope 3°, leg. Ciriaková.
13. Tichá dolina, riparian vegetation, 1385 m a.s.l., cover total 70%, E2 5%, E1 50%, E0 35%, relevé area 4.00 m², September 21, 2010, longitude 195840.00, latitude 491303.00, aspect 45°, slope 30°, leg. Ciriaková, Šoltés.
14. Roháčska dolina, riparian vegetation, 1080 m a.s.l., cover total 80%, E3 40%, E1 50%, E0 40%, relevé area 3.00 m², September 15, 2010, longitude 194256.00, latitude

- 491411.00, aspect 45°, slope 3°, leg. Ciriaková.
15. Jamnická dolina, riparian vegetation, 1168 m a.s.l., cover total 80%, E3 15%, E1 60%, E0 45%, relevé area 3.00 m², August 17, 2010, longitude 194626.00, latitude 491035.00, aspect 135°, slope 3°, leg. Ciriaková.
16. Račkova dolina, riparian vegetation, 1142 m a.s.l., cover total 70%, E3 30%, E1 60%, E0 40%, relevé area 4.00 m², August 17, 2010, longitude 194828.00, latitude 490944.00, aspect 90°, slope 8°, leg. Ciriaková.
17. Jamnická dolina, riparian vegetation, 1376 m a.s.l., cover total 75%, E3 30%, E1 60%, E0 40%, relevé area 4.50 m², August 17, 2010, longitude 194634.00, latitude 491130.00, aspect 180°, slope 3°, leg. Ciriaková.
18. Skalnatá dolina, riparian vegetation, 1331 m a.s.l., cover total 60%, E2 3%, E1 45%, E0 35%, relevé area 4.50 m², June 29, 2010, longitude 201454.00, latitude 491103.00, aspect 90°, slope 5°, leg. Ciriaková.
19. Bystrá dolina, riparian vegetation, 1264 m a.s.l., cover total 70%, E1 30%, E0 65%, relevé area 4.50 m², August 11, 2010, longitude 195108.00, latitude 490913.00, aspect 135°, slope 2°, leg. Ciriaková.
20. Veľký Šum, riparian vegetation, 1481 m a.s.l., cover total 65%, E1 65%, E0 2%, relevé area 3.00 m², July 9, 2010, longitude 200554.00, latitude 490810.00, aspect 135°, slope 3°, leg. Ciriaková.
21. Roháčska dolina, riparian vegetation, 1382 m a.s.l., cover total 100%, E1 100%, E0 5%, relevé area 4.00 m², September 15, 2010, longitude 194451.00, latitude 491246.00, aspect 45°, slope 3°, leg. Ciriaková.
22. Jalovská dolina, riparian vegetation, 1142 m a.s.l., cover total 100%, E2 2%, E1 100%, E0 2%, relevé area 3.00 m², July 23, 2010, longitude 194020.00, latitude 491123.00, aspect 270°, slope 15°, leg. Ciriaková.
23. Vážecká dolina, riparian vegetation, 1549 m a.s.l., cover total 80%, E2 5%, E1 80%, E0 50%, relevé area 2.00 m², July 13, 2010, longitude 200035.00, latitude 490813.00, aspect 90°, slope 20°, leg. Ciriaková, Šoltés.
24. Račkova dolina, riparian vegetation, 949 m a.s.l., cover total 85%, E3 50%, E1 70%, E0 35%, relevé area 4.00 m², August 17, 2010, longitude 194740.00, latitude 490850.00, aspect 270°, slope 10°, leg. Ciriaková.
25. Látaná dolina, riparian vegetation, 1336 m a.s.l., cover total 80%, E3 15%, E1 60%, E0 45%, relevé area 4.50 m², September 15, 2010, longitude 194524.00, latitude 491347.00, aspect 360°, slope 5°, leg. Ciriaková.

Relevé No	123456789111111111222222 0123456789012345
Differential species:	
<i>Luzula sylvatica</i>	+21+1322+.r.22+2+.22+.+
<i>Dicranum scoparium</i> (E0)	21....22.21.2222223..122
<i>Doronicum austriacum</i>	...r.r.r+.+.+.1+.2+.r..2.+
<i>Oxalis acetosella</i>	2+.+.+.2+++233.222.+121
<i>Leucanthemum rotundifolium</i>	...2.2+.2+2211...2.+21
<i>Vaccinium myrtillus</i>	4...2212.+.+1+122+.+.2+2+
Other species:	
<i>Chaerophyllum hirsutum</i>	..25421.++22.+1221++2+122
<i>Calamagrostis villosa</i>	+23+1322+.+.+.+.2331.
<i>Viola biflora</i>	..21+1...+.+++..+121++21.
<i>Picea abies</i>	3...+.2..rr232331.r...32
<i>Deschampsia cespitosa</i>	.1.+.++++.2.+.+.4+2..
<i>Aconitum firmum</i>	..++++r+....+.r2+r+r+
<i>Homogyne alpina</i>	1...2++2.+.+.+.2+++.1.3
<i>Caltha *laeta</i>	.2r2.1...++++.+.+.+.1.
<i>Myosotis scorpioides</i> agg.	..r...+r...r+r+r+.2+1...
<i>Senecio nemorensis</i> agg.	.r+....+.+.+.r++2.++
<i>Alchemilla vulgaris</i>	..++++.+.+.1...+.2.+.+
<i>Soldanella carpatica</i>	+.+.+.+.+.++++.....+
<i>Sorbus aucuparia</i>	+....2.++2.r++r..r...+
<i>Dryopteris dilatata</i>	+...1+.1...2...+.2.+.1.2
<i>Athyrium filix-femina</i>	+...1+...+1.1+.....++
<i>Avenella flexuosa</i>	+...+.1...+.+.+.+.+.+

continued...

<i>Senecio subalpinus</i>	..1...+2+r...+r...+1...
<i>Petasites albus</i>	.....r32333.1.....+2r
<i>Stellaria nemorum</i>	..+...r...+...+...221...++
<i>Geranium sylvaticum</i>	..+...r...+...r...+...
<i>Moneses uniflora</i>	1+r.....22+...+.....
<i>Arabis alpina</i>	r.....+...+...+...2+...+
<i>Rubus idaeus</i>	..r...+...r...+...2...
<i>Ranunculus aconitifolius</i>	..2...+...+...+...r.....
<i>Veratrum *lobelianum</i>	..2.....1.....r...r.....
<i>Geum rivale</i>	...+...1.....2.....+...+...
<i>Salix silesiaca</i>	...12...r...r...r...r...
<i>Galeobdolon luteum</i>	+.....+.....+.....+.....
<i>Hieracium murorum</i>	r.....+...+...+.....
<i>Gymnocarpium dryopteris</i>	r.....1...+...+.....
<i>Gentiana asclepiadea</i>	.....1...+...r...r.....
<i>Ligusticum mutellina</i>	.....+.....1...+...+
<i>Galium schultesii</i>	.....+.....+...2...r...
<i>Rumex alpestris</i>	.....+.....r...+r.....
<i>Chrysosplenium alternifolium</i>	..+.....+.....+.....1...
<i>Athyrium distentifolium</i>	..+...+.....1.....
<i>Luzula luzuloides</i>	.....+1.....+.....
<i>Primula elatior</i>	.....r...r...r.....
<i>Hypericum maculatum</i>	.....+.....+.....+1...
<i>Heracleum sphondylium</i>	.....+.....r...r...r.....
<i>Cardamine opicii</i>	.....+.....+1.....
<i>Taraxacum officinalis agg.</i>	..r...r.....
<i>Aegopodium podagraria</i>	..r.....+.....
<i>Solidago virgaurea</i>	.....+...r.....
<i>Pinus mugo</i>	.....2.....2...
<i>Milium effusum</i>+.....+.....
<i>Prenanthes purpurea</i>	.....+...r.....
<i>Calamagrostis arundinacea</i>+.....+.....
<i>Angelica archangelica</i>	.....r...+.....
<i>Agropyron caninum</i>+.....
<i>Crepis paludosa</i>	.....+.....1.....
<i>Solidago * minuta</i>+.....+.....
<i>Veronica officinalis</i>+.....+.....
<i>Dryopteris filix-mas</i>	.....+.....+.....1...
<i>Campanula scheuchzeri</i>	.....r...r.....
<i>Phyteuma spicatum</i>	.....+.....r.....
<i>Carduus personata</i>	.....r...+.....
<i>Angelica sylvestris</i>	.....r...+.....
Bryophytes:	
<i>Rhizomnium punctatum</i>	..2.....r...+...2...+2...11
<i>Bryum schleicheri</i>	++2.....r.....r...+...r...
<i>Rhizomnium magnifolium</i>	..113...2...1.2.....1
<i>Pleurozium schreberi</i>	..+...+...r.....1.....+.....
<i>Polytrichum alpinum</i>	.....+1...+...r.....r.....
<i>Polytrichum formosum</i>	.....+...r...+1.....2
<i>Brachythecium rivulare</i>	.....2+...1...+r.....
<i>Rhytidiadelphus triquetrus</i>	22.....2...1.....
<i>Orthodicranum montanum</i>	++.....r.....r.....r.....
<i>Drepanocladus exannulatus</i>	..2...+...r...r.....
<i>Cirriphyllum piliferum</i>	.....+r.....r...r.....
<i>Rhytidiadelphus subpinnatus</i>	.....+.....1r...+.....
<i>Sphagnum girgensohnii</i>	.....r...1...2...3...
<i>Plagiochila porelloides</i>	.....r.....r...1.....r
<i>Drepanocladus uncinatus</i>	.....2.2.....1...2...
<i>Polytrichum commune</i>	.....2...22...2...
<i>Hylocomium splendens</i>	..2...+3.....
<i>Plagiomnium affine</i>	..+...1...2.....
<i>Plagiochila asplenioides</i>	..r.....2.....r.....r.....
<i>Racomitrium heterostichum</i>	.....r...r...2.....
<i>Rhytidiadelphus squarrosus</i>	.....r...3...2.....
<i>Plagiothecium laetum</i>	1.....r.....
<i>Brachythecium salebrosum</i>	..+.....r.....
<i>Pellia neesiana</i>	..+...+.....
<i>Marchantia polymorpha</i>	.....3...+.....
<i>Plagiomnium medium</i>	.....1.....2...
<i>Rhytidiadelphus loreus</i>	.....1...1.....
<i>Bryum pseudotriquetrum</i>	.....r.....r.....

Species in only one relevé:

Herb layer: *Lonicera nigra* 1: 1; *Cicerbita alpina* 1: +; *Tussilago farfara* 2: +; *Poa trivialis* 2: +; *Poa pratensis* 2:

+; *Glechoma hederacea* 2: +; *Leucanthemum vulgare* 2: r; *Valeriana sambucifolia* 4: r; *Ranunculus repens* 4: r; *Delphinium oxysepalum* 5: +; *Rumex alpinus* 5: +; *Vaccinium vitis-idaea* 6: 2; *Gentiana punctata* 7: +; *Cerastium holosteoides* 8: +; *Poa species* 8: +; *Myurella julacea* 8: r; *Sambucus nigra* [5] 11: 2; *Fragaria vesca* 12: 2; *Prunella vulgaris* 12: 1; *Carex sylvatica* 12: +; *Pleurospermum austriacum* 12: +; *Agrostis canina* 12: +; *Carex digitata* 12: +; *Ajuga reptans* 12: +; *Lamium species* 12: +; *Leontodon species* 12: r; *Petasites hybridus* 13: 2; *Potentilla aurea* 13: 1; *Chamaerion angustifolium* 13: +; *Anthriscus sylvestris* 13: +; *Dryopteris carthusiana* 14: +; *Adenostyles alliariae* 18: 2; *Phegopteris connectilis* 18: +; *Polygonatum verticillatum* 18: r; *Valeriana tripteris* 18: r; *Silene dioica* 19: r; *Ranunculus species* 20: r; *Rumex obtusifolius* 24: r;

Moss layer: *Eurhynchium angustirete* 2: +; *Brachythecium species* 3: 2; *Lophocolea bidentata* 5: 2; *Harpanthus flotovianus* 5: +; *Plagiothecium undulatum* 10: 2; *Hypnum cupressiforme* 11: 1; *Pogonatum urnigerum* 13: 2; *Barbilophozia hatcheri* 13: 1; *Calypogeia azurea* 13: +; *Nardia scalaris* 13: +; *Blepharostoma trichophyllum* 14: r; *Bazzania tricrenata* 16: 2; *Mnium spinosum* 16: +; *Scapania undulata* 18: 2; *Tetraphis pellucida* 18: r; *Plagiomnium undulatum* 21: +; *Dicranella palustris* 22: r; *Barbilophozia lycopodioides* 25: r; *Brachythecium reflexum* 25: r.

Table 5. Vegetation type *Luzula sylvatica*-*Dicranum scoparium*

E. Vegetation type Ligusticum mutellina (Table 6)

This vegetation type occupies headwater sites in the altitude 1344 – 1947 m a.s.l, predominantly mild inclined (8° in average), SSE facing slopes. From phytocoenological viewpoint, these sites are evaluated within the class *Mulgedio*-*Aconitetea*, mainly within the alliance *Trisetion fusci*. Group of differential species is large, consists of *Ligusticum mutellina*, *Veratrum *lobelianum*, *Luzula alpinopilosa*, *Oreogalum montanum*, *Solidago * minuta*, *Potentilla aurea*, *Polygonum bistorta*, *Rhodiola rosea*.

The low TDS (0.01 g.l⁻¹ in average), low COD (0.92 mg.l⁻¹ in average) and low nitrate concentration (0.85 mg.l⁻¹ in average) suggest that the water is similar to rain water in chemistry.

Relevé localities:

1. Tristárska dolina, riparian vegetation, 1346 m a.s.l., cover total 60%, E2 5%, E1 60%, E0 5%, relevé area 4.50 m², June 24, 2010, longitude 201236.00, latitude 491517.00, aspect 90°, slope 5°, leg. Ciriaková.
2. Važecká dolina, riparian vegetation, 1836 m a.s.l., cover total 90%, E1 90%, E0 1%, relevé area 3.00 m², July 13, 2010, longitude 200014.00, latitude 490906.00, aspect 180°, slope 8°, leg. Ciriaková.
3. Batizovská dolina, riparian vegetation, 1893 m a.s.l., cover total 45%, E1 45%, E0 2%, relevé area 3.00 m², July 8, 2010, longitude 200756.00, latitude 490906.00, aspect 225°, slope 15°, leg. Ciriaková.
4. Mlynická dolina, riparian vegetation, 1892 m a.s.l., cover total 65%, E1 65%, E0 2%, relevé area 3.00 m², July 12, 2010, longitude 200231.00, latitude 490936.00, aspect 235°, slope 5°, leg. Ciriaková, Šoltés.
5. Mlynická dolina, riparian vegetation, 1488 m a.s.l., cover total 70%, E1 60%, E0 60%, relevé area 3.00 m², July 12, 2010, longitude 200310.00, latitude 490820.00, aspect 180°, slope 5°, leg. Ciriaková, Šoltés.
6. Veľká Studená dolina, riparian vegetation, 1746 m a.s.l., cover total 60%, E1 60%, E0 1%, relevé area 3.00 m², July 1, 2010, longitude 201041.00, latitude 491038.00,

- aspect 180°, slope 5°, leg. Ciriaková.
7. Jamnická dolina, riparian vegetation, 1654 m a.s.l., cover total 80%, E1 80%, E0 1%, relevé area 4.50 m², August 17, 2010, longitude 194631.00, latitude 491156.00, aspect 180°, slope 20°, leg. Ciriaková.
8. Kamenistá dolina, riparian vegetation, 1633 m a.s.l., cover total 100%, E1 100%, E0 2%, relevé area 4.00 m², August 3, 2010, longitude 195136.00, latitude 491125.00, aspect 135°, slope 5°, leg. Ciriaková.
9. Račková dolina, riparian vegetation, 1630 m a.s.l., cover total 90%, E1 90%, E0 5%, relevé area 4.00 m², August 17, 2010, longitude 194847.00, latitude 491132.00, aspect 135°, slope 15°, leg. Ciriaková.
10. Bystrá dolina, riparian vegetation, 1547 m a.s.l., cover total 95%, E1 95%, E0 1%, relevé area 4.00 m², August 11, 2010, longitude 195058.00, latitude 491001.00, aspect 90°, slope 15°, leg. Ciriaková.
11. Bystrá dolina, riparian vegetation, 1774 m a.s.l., cover total 80%, E1 80%, E0 7%, relevé area 4.00 m², August 11, 2010, longitude 195047.00, latitude 491030.00, aspect 180°, slope 5°, leg. Ciriaková.
12. Žiarska dolina, riparian vegetation, 1631 m a.s.l., cover total 70%, E1 70%, E0 25%, relevé area 4.00 m², July 22, 2010, longitude 194430.00, latitude 491121.00, aspect 180°, slope 10°, leg. Ciriaková, Šoltés.
13. Mlynická dolina, riparian vegetation, 1685 m a.s.l., cover total 70%, E1 70%, E0 25%, relevé area 4.00 m², July 22, 2010, longitude 200250.00, latitude 490905.00, aspect 90°, slope 3°, leg. Ciriaková, Šoltés.
14. Velická dolina, riparian vegetation, 1824 m a.s.l., cover total 80%, E1 80%, relevé area 4.50 m², July 6, 2010, longitude 200910.00, latitude 490946.00, aspect 90°, slope 3°, leg. Ciriaková.
15. Javorová dolina, riparian vegetation, 1526 m a.s.l., cover total 60%, E3 10%, E1 55%, E0 5%, relevé area 3.00 m², July 15, 2010, longitude 200927.00, latitude 491218.00, aspect 45°, slope 10°, leg. Ciriaková.
16. Javorová dolina, riparian vegetation, 1601 m a.s.l., cover total 73%, E1 70%, E0 5%, relevé area 3.00 m², July 15, 2010, longitude 200923.00, latitude 491144.00, aspect 360°, slope 10°, leg. Ciriaková.
17. Velická dolina, riparian vegetation, 1650 m a.s.l., cover total 75%, E1 70%, E0 20%, relevé area 4.50 m², July 6, 2010, longitude 200927.00, latitude 490918.00, aspect 135°, slope 5°, leg. Ciriaková.
18. Malá Studená dolina, riparian vegetation, 1639 m a.s.l., cover total 80%, E1 80%, relevé area 3.50 m², June 30, 2010, longitude 201222.00, latitude 491107.00, aspect 225°, slope 5°, leg. Ciriaková.
19. Dolina Zeleného plesa, riparian vegetation, 1560 m a.s.l., cover total 70%, E1 70%, E0 3%, relevé area 3.00 m², June 28, 2010, longitude 201302.00, latitude 491235.00, aspect 135°, slope 3°, leg. Ciriaková.
20. Jalovská dolina, riparian vegetation, 1460 m a.s.l., cover total 90%, E2 2%, E1 90%, E0 1%, relevé area 3.00 m², July 23, 2010, longitude 194143.00, latitude 491136.00, aspect 180°, slope 15°, leg. Ciriaková.
21. Veľká Studená dolina, riparian vegetation, 1603 m a.s.l., cover total 90%, E1 85%, E0 5%, relevé area 3.00 m², July 1, 2010, longitude 201108.00, latitude 491036.00, aspect 135°, slope 5°, leg. Ciriaková.
22. Skalnatá dolina, riparian vegetation, 1745 m a.s.l., cover total 70%, E2 8%, E1 70%, relevé area 3.00 m², June 29, 2010, longitude 201401.00, latitude 491117.00, aspect 180°, slope 5°, leg. Ciriaková.

123456789111111111222
0123456789012

Relevé No**Differential species:**

<i>Ligusticum mutellina</i>	+1221112+221+11r12221+
<i>Veratrum *lobelianum</i>	r222+..r1..222+122221
<i>Luzula alpinopilosa</i>	..12++..32122212221+22
<i>Orogeum montanum</i>	.1r2..2+2121..2+r1...r

<i>Solidago *minuta</i>	.rr+.+.r.r.+r....+++..
<i>Potentilla aurea</i>	.r.r+.+.+2r....12+++
<i>Polygonum bistorta</i>	r....+.+.+.+.3+2.r222
<i>Rhodiola rosea</i>	+22.....2.2+.2+.21.2
Other species:	
<i>Alchemilla vulgaris</i>	21..+.222++..2212+22+2+
<i>Deschampsia cespitosa</i>	.12...22.22223..2++223
<i>Viola biflora</i>	r22..+.....+1+++...+12
<i>Homogyne alpina</i>	.21+2+.r1+++...+1...
<i>Aconitum firmum</i>	..r...221+..r121+..r...
<i>Calamagrostis villosa</i>	.31.1321322...2...2..
<i>Caltha *laeta</i>	...+.2.212+.2223...2
<i>Avenella flexuosa</i>	...+.222422...+..2+2
<i>Senecio subalpinus</i>	r1.....+...r...+1r11.
<i>Taraxacum officinalis agg.</i>	rr+.....r++..r+.r+
<i>Anthoxanthum alpinum</i>	.1+2...+.+11...12...
<i>Gentiana punctata</i>	.2+2...+rr+...1...r.
<i>Vaccinium myrtillus</i>	.2r.32+.2...2...1...1.
<i>Rumex alpestris</i>	...+.1+...22+...+1
<i>Doronicum austriacum</i>	..r.r....+.+.r.2...+
<i>Athyrium distentifolium</i>	.....312+.2...+r.1..
<i>Geranium sylvaticum</i>	21.....1.2112.
<i>Ranunculus aconitifolius</i>	2.....r.1r.r.+
<i>Adenostyles alliariae</i>	.122.....22.1..
<i>Ranunculus pseudomontanus</i>	r+r.....+...+.
<i>Angelica archangelica</i>	...+.2...2.2+2+....
<i>Senecio nemorensis agg.</i>	.....r.r....+.1++
<i>Arabis alpina</i>	+.....1.....r+...+
<i>Soldanella carpatica</i>	..r.r.+...r.r.+...+
<i>Hypericum maculatum</i>	.....2.+...2+...r.
<i>Thalictrum aquilegifolium</i>	2.....22.2.
<i>Salix silesiaca</i>	2.....rr....+
<i>Carex atrata</i>	.1+.+.+.+.r....
<i>Cardamine opiciei</i>	.....22.+...+....
<i>Chaerophyllum hirsutum</i>	.....2++.....3..
<i>Epilobium alsinifolium</i>	.....+2...+r.....
<i>Silene dioica</i>	.....r.r.+r....
<i>Primula elatior</i>	2.....r....
<i>Polygonum viviparum</i>	.r2+.....r....
<i>Pulsatilla alpina</i>	..+.1.....r
<i>Carex sempervirens</i>	..+.+.+.+.+.r....
<i>Doronicum chusii</i>	..r....r....+
<i>Festuca picturata</i>	...+.2...+....
<i>Luzula luzuloides</i>	.....r....+2
<i>Myosotis scorpioides agg.</i>	.....r....+
<i>Phleum alpinum agg.</i>+.+.+.+.+
<i>Campanula scheuchzeri</i>	.....r+r.....
<i>Rubus idaeus</i>	.....r.r.+
<i>Valeriana sambucifolia</i>	r.....1.
<i>Stellaria nemorum</i>	.....11.....
<i>Chamaerion angustifolium</i>	.....1.....r.
<i>Leucanthemum rotundifolium</i>	.....r.....+
<i>Silene pusilla</i>	.....+2.....
<i>Cerastium species</i>	.....r....r....
<i>Anthriscus sylvestris</i>	.....2.2.....
<i>Ranunculus species</i>	.....+.+.r
<i>Thymus alpestris</i>	.....12.....
<i>Anemone narcissiflora</i>	.....r.r....
<i>Heracleum sphondylium</i>	.....r.r....
Bryophytes:	
<i>Brachythecium rivulare</i>	.....r1..r...+2.1r..
<i>Rhizomnium magnifolium</i>	.....rrr.2..+r2.....
<i>Philonotis seriata</i>	.....r.r.r.r....1.....
<i>Racomitrium sudeticum</i>	.r.r.r.r....2.....
<i>Bryum schleicheri</i>	.....r....r.r....
<i>Rhytidiadelphus subpinnatus</i>	r...3.....
<i>Grimmia incurva</i>	.r.r.r....r....
<i>Scapania undulata</i>	.....r....r....
<i>Plagiochila porelloides</i>	.....r....r....

Species in only one relevé:

Herb layer: *Calamagrostis varia* 1: 3; *Salix kitaibeliana* 1: 2; *Geum rivale* 1: +; *Sesleria tatrae* 1: +; *Aegopodium podagraria* 1: r; *Hypericum species* 1: r; *Filipendula vulgaris* 1: r; *Aster bellidiastrum* 1: r; *Myurella julacea* 2: r;

continued...

Cochlearia tatrae 3: +; *Campanula alpina* 3: +; *Bartsia alpina* 3: +; *Oreochloa disticha* 3: +; *Pedicularis oederi* 3: r; *Hieracium* sp. 5: +; *Phyteuma spicatum* 5: r; *Vaccinium vitis-idaea* 5: r; *Leontodon hispidus* 7: r; *Juncus trifidus* 9: 2; *Hieracium murorum* 10: +; *Nardus stricta* 11: +; *Hieracium alpinum* 11: +; *Avenula versicolor* 11: +; *Sempervivum montanum* 12: +; *Trollius europaeus* 14: 2; *Achillea species* 14: +; *Chrysosplenium alternifolium* 14: +; *Sorbus aucuparia* 15: 2; *Calamagrostis arundinacea* 15: 2; *Petasites albus* 16: 2; *Valeriana tripteris* 18: +; *Galium species* 18: +; *Gnaphalium norvegicum* 18: r; *Oxyria digyna* 19: 2; *Poa alpina* 19: +; *Pedicularis hacquetii* 21: 1; *Gentiana asclepiadea* 21: +; *Pinus mugo* 22: 2; *Poa species* 22: +; *Hypochaeris uniflora* 22: r.

Moss layer: *Ptychodium plicatum* 1: 1; *Leskea polycarpa* 1: r; *Cirriphyllum piliferum* 4: r; *Pohlia drummondii* 4: r; *Rhizomnium punctatum* 5: 2; *Pleurozium schreberi* 5: 2; *Lophocolea bidentata* 5: 2; *Plagiomnium affine* 5: 1; *Plagiothecium laetum* 5: 1; *Dicranum scoparium* 5: 1; *Polytrichum commune* 5: 1; *Sphagnum girgensohnii* 6: r; *Racomitrium aciculare* 7: r; *Brachythecium salebrosum* 7: r; *Paraleucobryum enerve* 9: r; *Schistidium alpicola* 9: r; *Pellia neesiana* 10: r; *Pohlia ludwigii* 10: r; *Dicranum fuscescens* 11: +; *Polytrichum strictum* 11: +; *Drepanocladus uncinatus* 11: r; *Polytrichastrum alpinum* 12: r; *Jungermannia leiantha* 12: r; *Plagiomnium rostratum* 13: r; *Bryum pallescens* 13: *Hygrohypnum luridum* 15: +; r; *Cratoneuron commutatum* 16: +; *Pohlia wahlenbergii* 16: r; *Pohlia obtusifolia* 17: r; *Drepanocladus exannulatus* 20: r; *Sphagnum russowii* 21: 2.

Table 6. Vegetation type *Ligusticum mutellina*

Summary

103 relevés have been taken in periodically flooded riparian zones, along streams of the Tatra Mts in the altitude 639 – 1947 m a.s.l. The relevés were stored in the database system TURBOVEG, exported into JUICE 7.0 for cluster analysis. The following vegetation types were distinguished: *Petasites hybridus*, *Rubus idaeus* – *Urtica dioica*, *Senecio nemorensis*, *Luzula sylvatica*-*Dicranum scoparium*, *Ligusticum mutellina*. The vegetation types *Petasites hybridus*, *Rubus idaeus*-*Urtica dioica* are nitrophilous, occurring most often in habitats in lower parts of the territory influenced by man or by cattle. Vegetation type in the vertical span 676-1497 m a.s.l., is without distinct differential species, relatively higher constancy shows *Senecio nemorensis*. Decomposition of organic substances in soils is indicated by rather high NO₃⁻ concentration. Vegetation type *Luzula sylvatica*-*Dicranum scoparium* is widespread in the altitude 901-1664 m a.s.l., large group of differential species is created by forest floor species, large proportion in the floristic composition show bryophytes. Vegetation type *Ligusticum mutellina* occupies headwater sites.

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