SPRING VEGETATION IN THE GAUJA NATIONAL PARK

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For the first time in Latvia during the summers of 1999 and 2000, vegetation of springs and spring fens was investigated in the Gauja National Park. Most important study sites included Dāvida Springs, Vizuļu and Līču-Laņģu Cliffs, springs near Pērļupe River and in Kazu Ravine, Nurmiži Reserve and numerous smaller or larger spring areas located in the forest.
To describe spring and spring mire vegetation 210 relevés of 1 m² size were used. Study sites included 162 species of vascular plants and bryophytes. Vegetation was investigated using the Braun-Blanquet method.
Springs in the Gauja National Park cover small areas from the few quadrat meters around the spring, but can occupy larger areas where the springs border with the mire vegetation and water streams.
The studied plant communities in the spring areas are assigned to Montio-Cardaminetea, Phragmito-Magnocaricetea and Scheuchzerio-Caricetea fuscae classes. In spring areas Cratoneureto filicinae - Cardaminetum and *Palustriella commutata* community, as well as Cardamino-Chrysosplenietum alternifolii occur (Montio-Cardaminetea). In spring mires Caricetum paniculatae (Phragmito-Magnocaricetea) is distinguished and Caricetum rostratae (Scheuchzerio-Caricetea fuscae) occur.
The results reveal that spring areas have such communities which have an international value because in many West European countries these habitats have already become rare.

Keywords: spring vegetation, Montio-Cardaminetea, Cratoneurion commutati, Caricion remotae.

INTRODUCTION

In comparison with mire vegetation, spring vegetation has been much less studied in Europe. Investigations were carried out in Germany (Dierβen 1973), Denmark (Warnke 1980) and mostly in mountainous areas. There were investigations on lowland springs and spring mires, too, like in Poland (Wolejko et al 1994, 2000a).

The term "spring" in an ecological sense should be used for areas where the hydrostatic potential and movement of water usually exceed evapotranspiration, giving rise to the watercourse (Warnke 1980).

Based on the way the water discharges from the springs, Thienemann (1922) distinguished 3 types of springs: rheocrenes, limnocrenes and helocrenes. From rheocrenes (gushing springs) the water spurts out of the sloping strata and immediately races down into the valley. In limnocrenes (spring basins) the water wells up from below. In helocrenes (seepages or spring fens) the water seeps up through the ground**.** The margins may lead to mire vegetation.

Consequently, the term "fen" should be used only for waterlogged areas where the ground water does not give rise to the water-course. The above concept implies that all spring areas of a helocrene type are surrounded by fens. On the other hand, the occurrence of a fen does not imply the existence of a spring connected to the fen.

Springs in Latvia are less common than fens. Many different fen communities occur widely, wherever waterlogged conditions maintained and range in a size from extensive fen complexes to small sites of only a few square metres that can be associated with springs. Springs are characteristic for certain areas in Latvia and are especially present the Gauja National Park.

The aim of the paper is to characterise spring and spring fen vegetation in the Gauja National Park.

Nomenclature for vascular plants is after Gavrilova, Šulcs (1999), bryphytes after Āboliņa (2001).

STUDY AREA

The Gauja National Park is located in the Central, North-Vidzeme and Central-Latvia geobotanical districts (see page 6 – 2.).

The Baltic Sea influences the area, therefore climate involves maritime features: much precipitation and cyclone weather. Average year temperature is +5º C. Coldest months are January and February with average temperature – 6º C. Warmest is July with average temperature + 17º C. Medium duration of the vegetation period lasts 180 days. Annual sum of precipitation reaches 705 – 788 mm.

Deposits of the last Glacial period cover the whole area of the Gauja National Park except for steep slopes of riverbanks and valleys. Formation of the Gauja River and its tributaries started during the end of the Late Glacial period (Āboltiņš 1995). Erosion processes have caused the formation of valleys and ravines (Kuršs 1988). Seven terraces of the Gauja River represent it marking the old stream levels. Development of river valleys continued during the Holocene. By then the lower over-flooding terraces and flood plains have formed.

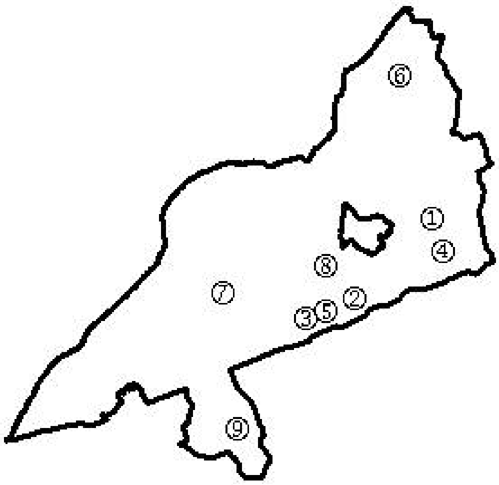
Due to the geological peculiarities, a number of river valleys with steep slopes and broad-leaved forests (Querco-Fagetea) occur in the Gauja National Park. In the ancient Gauja River valley old riverbeds, sandstone outcrops and slopes with springs, play an important role in ensuring the plant species diversity. Springs on the slopes of river ravines are characteristic elements of the hydrological net of the Gauja National Park. Waters from inside the Devonian sandstone and cracks in dolomites find their way out in the form of springs. Springs flowing close to dolomites are carbonic, but those coming out of sandstone are with iron.

There are also small spring – fed mires located in the Gauja River valley and its tributary valleys and the vegetation around these springs is that of mires with peculiar plant communities. Mires are located over the whole area. Still, the majority concentrate in the north-western part of the Gauja National Park. Fens have developed in the lower parts of the relief under the influence of a rather high level of groundwater.

MATERIAL AND METHODS

For the first time in Latvia, vegetation of springs and spring fens was investigated in the Gauja National Park during the summers of 1999 and 2000. Most important study sites are located in the area of Dāvida Springs, near Vizuļu and Līču-Laņģu Cliffs, Pērļupe River and in Kazu Ravine, Nurmiži Reserve. Numerous smaller and larger spring areas located in the forests (Fig. 1).

To describe spring and spring mire vegetation 210 relevés of 1 m² size were made. The study sites included 162 plant species. Vegetation was investigated using the Braun-Blanquet method (1964).



1. Kazu Ravine (Kazu grava),
2. Pērļupe River (Pērļupe),
3. Amata River near Vizuļu Cliff (Amata pie Vizuļu klintīm),
4. Dāvida springs near Vaive River (Dāvida avoti pie Vaives upes),
5. Kumada River near Ieriķi (Kumada pie Ieriķiem)
6. Līču – Laņģu Cliffs (Līču-Laņģu klintis),
7. Nurmiži Reserve (Nurmižu rezervāts)
8. Rakšupe River in Amata forestry (Rakšupe pie Amatas mežniecības)
9. Suda River (Sudas upe).

Fig.1. Studied sites in the Gauja National Park
1.att. Pētījumu vietas Gaujas Nacionālajā parkā

RESULTS AND DISCUSSION

The studied sites in the Gauja National Park include communities within three phytosociological classes:

- Spring-head vegetation, often dominated by bryophytes, the Montio-Cardaminetea
- Sedge-dominated flushes of the Phragmito-Magnocaricetea
- Rich fens with springs of the Scheuchzerio-Caricetea fuscae.

In the Gauja National Park Montio-Cardaminetea communities occur on the river ravine slopes, for example, near Pērļupe, Vaive and Amata Rivers. Most widespread communities are of the Class Montio-Cardaminetea that occur near springs, along flushes and rills (Zechmeister & Mucina 1994) from Cratoneurion commutati and Caricion remotae.

Characteristic features of spring areas are that chemical conditions and rate of discharge of water are relatively constant (Warnke 1980). Temperature of the water emerging at the surface through the cracks in minerogenous and organogenous deposits tends to be relatively constant and rather low. In springs oxygen saturation can be very high. This is one of the major ecological features of these ecosystems as compared to the still- or standing waters of similar semi-aquatic systems such as mires or fens. Bryophytes play an important role in spring communities. Only in strongly shaded sites, phanerogams may be more important in number and cover (Zechmeister & Mucina 1994). The leading life forms include bryophytic chamaephytes and helophytes (Hadač 1983).

Chemical features of water, speed of the stream and temperature are important for spring vegetation. Most often peat layer is thin in the studied spring areas, it is washed away by the stream. Springs that have developed at the foots of river ravines, like on the left bank of Amata or near Pērļupe River are richer in vascular plant species than the steep slopes with streams coming down.

Springs in the Gauja National Park occur on the river ravine slopes. When the slopes are steep the sites are characterised by the dominance of *Cratonoeron filicinum, Palustriella commutata, Plagiomnium ellipticum, Fissidens adianthoides, Bryum pseudotriquetrum, Pellia endivifolia* and *Conocephalum conicum.* At the foot of river ravines slopes and in forest springs *Cratonoeron filicinum, Palustriella commutata, Plagiomnium ellipticum* and other plants species, like *Cirsium oleraceum, Caltha palustris, Chrysosplenium alternifolium, Myosotis palustris, Galium palustre, Crepis paludosa, Cardamine amara, Veronica beccabunga, Myosoton aquaticum, Chrysosplenium alternifolium, Geum rivale, Crepis paludosa, Plagiomnium undulatum, P. elatum, Plagiochila asplenoides* occur. Some sites include also moss species *Trichocolea tomentella.*

Close to springs rare orchids, like *Malaxis monophyllos, Epipactis palustris* and *Dactylorhyza maculata* were observed.

The site near Dāvida springs on the bank of Vaive River differ from the sites near Amata and Pērļupe Rivers. This is a place where 34 springs run out from the Pļaviņu Formation deposits (Skrupšķele 1994). Small waterfalls are located on the steep slopes. From the spring water iron hydroxides are deposited. Typical communities from Cratoneurion commutati, like Cratoneureto filicinae-Cardaminetum and *Palustriella commutata* community occur there (Table 1, 2). It is a complex including Montio-Cardaminetea communities on the steep slopes, Phragmito-Magnocaricetea and fragments of Scheuchzerio-Caricetea fuscae mire vegetation. Springs, streams, tall-sedge communities near the flushes as well as small-sedge vegetation occur there.

Characteristic species are *Cirsium oleraceum, Deschampsia cespitosa, Veronica beccabunga, Myosoton aquaticum Equisetum palustre, Chrososplenium alternifolium, Caltha palustris, Cratonoeron filicinum, Conocephalum conicum, Plagiomnium ellipticum* and *Bryum pseudotriquetrum.*

Table 1

Floristic composition of Cratoneureto filicinae-Cardaminetum

Cratoneureto filicinae-Cardaminetum sabiedrību floristiskais sastāvs

No. Numurs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Constancy Konstantums
Locality* Apraksta vieta*	Dāv	Dāv	P	P	P	P	P	P	Kan	Kan	Kan	Kan	Kan	Kan	
Date (Day-Month) Datums (diena-mēnesis) Year: 2000	16-Jul	16-Jul	16-Au	16-Au	16-Au	16-Au	16-Au	16-Au	08-Se	8-Se	8-Se	8-Se	8-Se	8-Se	
Cover of schrub layer (%) Krūmu stāva segums (%)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	
Cover of herb layer (%) Lakstaugu stāva segums(%)	10	5	20	15	5	30	8	20	0	1	20	10	3	3	
Cover of moss layer (%) Sūnu stāva segums (%)	25	35	80	40	30	7	25	6	60	45	20	70	22	55	
Water (%) Ūdens straume (%)	30	20	0	0	1	0	20	0	0	0	0	0	0	0	
No. of vascular species Vaskulāro augu sugu skaits	3	4	6	4	1	4	2	4	0	6	4	10	9	9	
No. of bryophyte species Briofītu sugu skaits	5	3	4	5	6	5	5	2	8	8	5	2	6	5	
No. of species Kopējais sugu skaits	8	7	10	9	7	9	7	6	8	14	9	12	15	14	
Ch. Ass.															
Cratoneuron filicinum	7	30	75	35	15	3	10	5	40	10	20	70	20	50	**V**
Ch.Cl. Montio-Cardaminetea															
Conocephalum conicum	.	.	.	2	.	.	5	.	.	5	.	1	+	+	**III**
Pellia endivifolia	.	.	.	.	.	.	.	1	.	1	.	.	+	.	**II**

Table 1, continued

No. / Numurs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	**15**
Brachythecium rivulare	.	.	.	.	.	.	.	.	+	+	.	.	.	.	**I**
Rhizomnium punctatum	.	.	.	.	+	.	.	.	.	.	.	.	.	.	**I**
Other species															
Calliergonella cuspidata	10	.	1	.	10	+	7	.	+	.	+	.	1	2	**IV**
Poa palustris	1	+	+	2	+	5	.	.	.	+	+	+	.	.	**III**
Myosotis palustris	.	.	.	.	5	3	.	15	.	.	.	1	+	.	**III**
Cirsium oleraceum	.	.	.	.	.	20	.	.	.	.	15	1	.	+	**II**
Rhytidiadelphus subpinnatus	.	.	.	.	.	.	.	.	20	20	+	.	.	.	**II**
Plagiomnium undulatum	.	.	+	+	1	3	1	.	.	.	.	.	.	.	**II**
Bryum pseudotriquetrum	+	.	.	.	.	.	.	.	+	6	+	.	.	2	**II**
Plagiomnium ellipticum	2	2	.	1	3	+	.	.	+	.	+	.	.	.	**II**
Carex remota	.	.	10	.	.	.	.	5	.	1	.	.	.	.	**II**
Galium palustre	.	.	.	.	.	.	.	.	.	.	.	+	.	.	**I**
Veronica beccabunga	.	.	1	.	.	1	.	+	.	.	.	.	.	1	**II**
Fissidens adianthoides	.	.	.	+	.	.	1	.	+	+	.	.	.	.	**I**
Impatiens noli-tangere	3	4	.	.	.	.	.	.	.	.	.	.	.	.	**I**
Deschampsia caespitosa	.	+	.	.	.	.	.	.	.	.	1	+	+	.	**I**
Epilobium roseum	4	+	.	.	.	.	.	.	.	.	.	.	.	.	**I**
Palustriella commutata	5	.	.	.	.	.	.	.	.	.	.	.	.	.	**I**
Philonotis sp.	.	+	.	.	.	.	.	.	.	.	.	.	+	+	**I**
Carex sylvatica	.	.	5	.	.	.	3	+	.	.	.	.	.	.	**I**
Filipendula ulmaria	.	.	+	.	.	.	.	.	.	+	.	+	.	+	**I**
Myosoton aquaticum	.	.	1	1	.	.	5	.	.	.	.	.	.	.	**I**
Oxalis acetosella	.	.	+	.	.	.	.	.	.	+	.	.	.	.	**I**
Cladopodiella fluitans	.	.	1	.	.	+	.	.	.	.	.	.	.	.	**I**
Chaerophillum aromaticum	.	.	.	3	.	.	.	.	.	.	.	.	.	.	**I**
Lophocolea bidens	.	.	.	.	.	.	.	.	+	.	.	.	.	.	**I**
Picea abies	.	.	.	.	.	.	.	.	.	.	.	.	1	+	**I**
Paris quadrifolia	.	.	.	.	.	.	.	.	.	+	+	.	.	.	**I**
Molinia caerulea	.	.	.	.	.	.	.	.	.	.	2	.	.	.	**I**
Equisetum palustre	.	.	.	.	.	.	.	.	.	+	.	.	+	.	**I**
Aneura pinquis	.	.	.	.	.	.	.	.	.	+	.	.	.	.	**I**
Juncus articulatus	.	.	.	.	.	.	.	.	.	.	.	+	1	+	**I**
Geum rivale	.	.	.	.	.	.	.	.	.	.	.	2	.	.	**I**
Carex leporina	.	.	.	.	.	.	.	.	.	.	.	+	1	+	**I**
Carex panicea	.	.	.	.	.	.	.	.	.	.	.	+	.	.	**I**
Cirsium palustre	.	.	.	.	.	.	.	.	.	.	.	.	+	1	**I**
Carex rostrata	.	.	.	.	.	.	.	.	.	.	.	.	.	+	**I**
Potentilla erecta	.	.	.	.	.	.	.	.	.	.	.	.	.	+	**I**
Plagiomnium elatum	.	.	.	.	.	.	.	.	.	.	.	.	1	.	**I**
Lunaria rediviva	.	.	8	.	.	.	.	.	.	.	.	.	.	.	**I**

* Locality (Aprakstu vietas): Dāv- Dāvida springs (Dāvida avoti); P – Pērļupe River (Avoksnāji Pērļupes ielejā); Kan – Kazu Ravine, springs of western slope (Kazu grava, avoti rietumu nogāzē).

In the area of Dāvida springs, there are slopes with springs and streams, and locally spring fen vegetation has developed. The characteristic species in the fen vegetation is *Carex hostiana, C. panicea* and *Epipactis palustris.* In some localities in the fen springs reach the surface and have other species like, *Cirsium oleraceum* and *Cratonoeron filicinum.*

In Kazu Ravine spring fens, springs and streams coming down the steep slopes of the forest occur. Spring vegetation is a part of the mire that is characterised by Scheuchzerio-Caricetea fuscae vegetation (Caricetum rostratae). On the ravine slopes rheocrenes (gushing springs) occur where the water spurts out of a horizontal or download sloping strata and immediately races down into the valley. There are also limnocrenes (spring basins) where the water wells up from below. In the ravine itself helocrenes (seepages or spring fen) has developed where the water seeps up through the ground. The margins lead to mire vegetation.

On the forested slopes of Kazu Ravine typical spring vegetation of Caricion remotae occurs. Communities in such areas are assigned to Cardamineto-Chrysosplenietum alternifolii from Caricion remotae (Table 3)**.** In addition to the typical spring species, also other mosses, like *Thuidium philibertii*, *Rhytididelphus subpinnatus, Cirriphillum piliferum, Eurhynchium pulchellum* occur. There is also an ecotone zone that leads to the spring fen vegetation. This marginal zone between the spring vegetation and mire vegetation includes both typical spring species, like *Cirsium oleraceum,* and *Pellia endivifolia* and fen species, like *C. lepidocarpa, Cirsium palustre* and *Equisetum palustre.*

Rich fen vegetation is characterised by Caricetum rostratae including *Carex rostrata, C. panicea, Epipactis palustris, Dactylorhyza incarnata, Cirsium oleraceum, Galium palustre, Equisetum palustre, Primula farinosa* and mosses *Bryum pseudotriquetrum, Calliergonella cuspidata, Calliergon giganteum, Fissidens adianthoides, Campylium stellatum* and *Plagiomnium ellipticum.* Springs in Kazu Ravine are rich in calcium.

The sites near Suda River not far from Suda Mire differ from the all the above mentioned. It is a complex of springs that borders with mire vegetation. The spring area includes *Cirsium oleraceum, Poa palustris, Menyanthes trifoliata, Chrysosplenium alternifolium, Caltha palustris, Poa palustris, Crepis paludosa, Galium palustre, Menyanthes trifoliata, Cirsium palustre, Myosotis palustris* associated with *Calliergonella cuspidata* and *Bryum pseudotriquetrum.* It borders with vegetation that passes into transition mire vegetation characterised by *Betula humilis, B. pubescens, Salix rosmarinifolia* and *Frangula alnus* in the schrub layer, but *Eriophorum vaginatum, Comarum palustre, Equisetum palustre, Potentilla erecta* occur in the herb layer. *Sphagnum teres* and *S. squarrosum* grow in the moss layer and appear together with *Aulacomnium palustre* and *Calliergon stramineum.* In this case, mire vegetation development is clearly observed in the spring area and there are no sharp boundaries between springs and the mire vegetati

Table 2

Floristic composition of *Palustriella commutata* community
Palustriella commutata sabiedrības sugu sastāvs

No./ Numurs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	**Constancy Konstantums**
Locality Apraksta vieta	AmZ*	AmZ	AmZ	AmZ	AmZ	AmZ	P	Dāv	Dāv	Dāv	Dāv	Dāv	Ie	Ie	Ie	Ie	Ie	Ie	Amn	Amn	Amn	Amn	Amn	
Date (Day-Month) Datums (diena-mēnesis) Year: 2000 (relevé No.7 – 1999)	14-S	14-S	14-S	14-S	14-S	14-S	19-Au	16-Jul	16-Jul	16-Jul	16-Jul	16-Jul	19-Se	19-Se	19-Se	19-Se	19-Se	19-Se	15-Se	15-Se	15-Se	15-Se	15-Se	
Cover of schrub layer (%) Krūmu stāva segums (%)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	3	0	0	
Cover of herb layer (%) Lakstaugu stāva segums (%)	0	0	0	10	5	5	5	7	8	3	8	10	3	7	7	2	1	4	10	12	4	37	10	
Cover of moss layer (%) Sūnu stāva segums (%)	90	80	70	50	45	80	50	40	32	33	36	45	70	30	62	75	52	47	30	66	80	50	45	
Water (%) Ūdens straume (%)	10	20	10	40	50	15	20	50	30	20	15	5	0	0	0	0	0	0	0	5	0	0	10	
No. of vascular species Vaskulāro augu sugu skaits	0	0	0	1	1	3	2	5	4	4	5	4	3	3	4	3	1	2	9	4	3	5	4	
No. of bryophyte species Briofītu sugu skaits	1	3	3	1	3	2	4	3	3	4	3	3	1	4	3	3	3	3	7	2	2	1	5	
No. of species Kopējais sugu skaits	1	3	3	2	4	5	6	8	7	8	8	7	4	7	7	6	4	5	16	6	5	6	9	
Ch. Ass.																								
Palustriella commutata	90	80	70	50	35	80	50	30	30	25	30	30	70	25	60	70	50	35	25	65	80	50	40	**V**
Ch.Cl. Montio-Cardaminetea																								
Cratoneuron filicinum	.	.	.	.	.	.	.	5	1	5	3	.	.	5	2	.	.	10	+	.	.	.	2	**III**
Cardamine amara	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	**I**
Rhizomnium punctatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**I**
Brachythecium rivulare	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	**I**

Table 2, continued

No./ Numurs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	**24**
Fissidens adianthoides	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	**I**
Pellia endiviifolia	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	**I**
Philonotis sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	25	**I**
Other species								.																
Calliergonella cuspidata	.	.	.	.	.	.	.	.	1	.	.	10	.	+	.	.	1	2	1	1	.	.	3	**III**
Poa palustris	.	.	.	.	.	1	.	.	+	.	.	.	1	1	+	.	.	.	1	1	.	+	1	**III**
Myosoton aquaticum	.	.	.	10	5	.	.	.	.	.	.	.	1	3	.	.	.	.	.	.	.	.	.	**II**
Plagiochila asplenioides	.	1	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**I**
Rhytidiadelphus triquetrus	.	.	20	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**I**
Cirsium oleraceum	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	5	7	.	2	.	**I**
Veronica beccabunga	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	+	.	4	+	.	.	.	.	**I**
Bryum pseudotriquetrum	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	**I**
Geranium robertianum	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**I**
Impatiens noli-tangere	.	.	.	.	.	.	.	1	5	1	2	.	.	.	.	.	.	.	.	.	.	.	.	**I**
Deschampsia caespitosa	.	.	.	.	.	.	.	1	+	.	+	.	.	.	.	.	.	.	.	+	.	1	.	**I**
Epilobium roseum	.	.	.	.	.	.	.	3	.	1	3	.	.	.	.	.	.	.	.	.	.	.	.	**I**
Myosotis palustris	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	**I**
Plagiomnium ellipticum	.	.	.	.	.	.	.	2	.	+	3	5	.	.	.	.	.	.	2	.	.	.	.	**I**
Carex sylvatica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	**I**
Festuca gigantea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	**I**
Filipendula ulmaria	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	1	.	.	.	.	**I**
Eurhynchium hians	.	.	.	.	.	.	.	.	.	.	.	.	.	2	+	5	.	.	.	.	+	.	.	**I**
Alnus incana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	+	.	.	3	.	.	**I**
Mercurialis perennis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	3	1	35	3	**I**
Galium uliginosum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	**I**
Epilobium adenocaulon	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	**I**

Sporadic species: *Oxalis acetosella* + (12); *Equisetum palustre* 1 (13); *Galeobdolon luteum* 1 (15); *Epilobium sp*. + (12); *Picea abies* + (12); *Epilobium palustre* 1 (16); *Galium palustre* 1(16); *Plagiomnium undulatum* + (7); *Agrostis stolonifera* + (7); *Lunaria rediviva* +(9); *Ribes nigrum* 1 (10); *Urtica dioica* 1 (11); *Rumex acetosa* 1 (11).

*Locality (Aprakstu vieta): AmZ – Vizuļu Cliff on the left bank of the Amata River (Amatas kreisais krasts, avoksnāji pie Vizuļu ieža); P – Pērļupe River (Avoksnāji Pērļupes ielejā); Dāv – Dāvida Springs (Dāvida avoti); Ie – Kumada River near Ieriķi (Avoksnājs Ieriķos, Kumadas krasts); Amn – Slope of the Amata River left bank near Vizuļu Cliff (Amatas kreisā krasta nogāze pirms Vizuļu ieža).

Table 3

Floristic composition of the ass. Cardamineto-Chrysosplenietum alternifolii

Cardamineto-Chrysosplenietum alternifolii sabiedrību sugu sastāvs

No./ Numurs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Constancy Konstantums
Locality Apraksta vieta	Amm*	Amm	Amm	Amm	Amm	Amm	Amm	Amm	Amm	Am5	Su	Su	Su	Su	Su	Su	Su	Su	Su	Su	Su	Su	Su	
Date (Day-Month) Datums (diena-mēnesis) Year / gads: 2000	05-Jul	05-Jul	05-Jul	05-Jul	05-Jul	05-Jul	05-Jul	05-Jul	05-Jul	06-Jul	13-Se	13-Se	13-Se	13-Se	13-Se	13-Se	13-Se	13-Se	13-Se	13-Se	13-Se	13-Se	13-Se	
Cover of schrub layer (%) Krūmu stāva segums (%)	5	1	5	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Cover of herb layer (%) Lakstaugu stāva segums(%)	50	60	35	50	37	12	10	62	10	10	12	5	10	10	20	15	5	15	6	15	35	2	5	
Cover of moss layer (%) Sūnu stāva segums (%)	32	25	35	42	32	45	16	1	30	25	26	32	31	30	12	12	31	5	26	5	10	42	60	
Water (%) Ūdens straume (%)	0	0	0	0	0	0	20	10	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
No. of vascular species Vaskulāro augu sugu skaits	15	15	13	11	11	13	13	6	6	9	7	12	13	9	9	10	10	8	5	8	5	4	7	
No. of bryophyte species Briofītu sugu skaits	4	5	4	4	4	7	3	1	4	4	5	5	3	2	3	2	2	4	5	5	4	6	3	
No. of species Kopējais sugu skaits	19	20	17	15	15	20	16	7	10	13	12	17	16	11	12	12	12	12	10	13	9	10	10	
Ch. Ass.																								
Chrysosplenium alternifolium	+	+	+	2	1	1	+	.	.	2	.	.	2	1	3	2	2	+	.	3	+	+	1	**IV**
Cardamine amara	+	1	+	.	.	.	+	60	.	2	+	1	+	+	.	.	+	1	3	.	.	.	.	**III**
Urtica dioica	+	1	1	5	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	+	.	.	**II**
Phragmites australis	.	.	.	.	.	.	.	.	.	.	1	+	1	1	1	.	.	.	.	.	.	.	.	**II**

Table 3, continued

No./ Numurs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	**24**
Ch.Cl. *Montio-Cardaminetea*																								
Cratoneuron fillicinum	.	.	.	.	.	1	.	.	.	+	.	6	.	.	.	.	.	3	15	.	1	40	60	**III**
Pellia sp.	+	+	+	+	+	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	**III**
Rhizomnium punctatum	.	.	.	.	.	+	1	+	5	.	.	+	.	.	.	.	.	.	.	.	.	.	.	**II**
Brachythecium rivulare	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	**I**
Other species																								
Calliergonella cuspidata	.	3	3	20	10	10	5	.	+	20	1	1	1	10	1	.	1	1	+	5	3	.	.	**IV**
Cirsium oleraceum	40	50	30	30	20	5	1	.	2	.	10	1	+	+	.	.	.	.	.	.	5	.	.	**IV**
Plagiomnium ellipticum	.	.	.	.	.	.	.	.	.	+	20	25	30	20	10	10	30	.	1	+	+	+	+	**IV**
Filipendula ulmaria	5	1	5	+	.	+	+	.	+	.	1	+	.	+	.	.	.	.	.	.	.	.	.	**IV**
Poa palustris	1	1	.	1	.	+	+	+	.	3	.	.	.	.	1	.	1	+	.	+	2	1	1	**IV**
Plagiochila asplenioides	30	20	30	20	20	30	10	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**III**
Gallium palustre	+	+	.	+	.	+	.	+	+	+	.	+	+	.	.	.	+	.	.	.	.	.	1	**III**
Viola palustris	3	+	+	+	+	+	+	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	**III**
Myosotis palustris	+	+	1	.	+	.	.	.	.	+	.	.	1	.	.	.	.	.	.	+	.	+	1	**III**
Equisetum fluviatile	.	.	.	.	.	.	.	.	.	.	+	1	1	2	1	1	1	1	1	1	.	.	.	**III**
Crepis paludosa	+	1	1	+	+	+	+	+	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	**III**
Oxalis acetosella	+	+	+	+	+	1	2	+	1	.	.	+	.	.	.	.	.	.	.	.	.	.	.	**III**
Carex cespitosa	.	.	.	.	.	.	.	.	.	.	+	+	2	3	+	10	.	.	.	1	.	.	.	**II**
Myosoton aquaticum	.	.	.	.	.	.	.	.	.	.	+	1	2	1	10	.	.	+	+	5	+	.	.	**II**
Caltha palustris	.	.	.	.	1	.	.	.	.	1	.	.	+	.	.	.	+	.	1	1	.	+	.	**II**
Ranunculus repens	+	+	.	.	.	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**II**
Athyrium filix-femina	5	.	.	+	1	1	2	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**II**
Equisetum sylvatica	+	+	+	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**II**
Galeobdolon luteum	+	.	.	10	8	1	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	**II**
Climacium dendroides	+	+	.	.	.	.	.	.	.	.	5	.	+	.	.	.	.	.	.	.	.	.	+	**II**
Thelypteris palustris	+	+	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	**I**
Calliergon cordifolium	1	3	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**I**
Geum rivale	.	3	+	.	5	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**I**
Rubus idaeus	.	.	.	1	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**I**
Plagiomnium undulatum	.	.	.	.	.	.	.	.	20	.	.	.	.	.	.	.	.	+	.	.	.	.	.	**I**
Lysimachia vulgaris	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	**I**
Angelica sylvestris	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	2	.	.	+	.	.	.	.	**I**

Table 3, continued

No./ Numurs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	**24**
Gallium uliginosum	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	.	.	.	.	.	.	.	**I**
Deschampsia caespitosa	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	**I**
Molinia caerulea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	**I**
Epilobium palustre	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	**I**
Marschantia polymorpha	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	1	10	.	.	.	.	**I**
Bryum pseudotriquetrum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	**I**
Carex acuta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10	.	3	.	.	.	**I**

Sporadic species: *Padus avium* + (3); *Pleurozium schreberii* + (3); *Rhodobryum roseum* + (4); *Hylocomium splendens* + (6) ; *Scutellaria galericulata* + (16); *Maianthemum bifolium* + (22); *Chyloscyphus sp*. + (20); *Menyanthes trifoliata* 1 (23); *Veronica beccabunga* 30 (21); *Lychnis flos-cuculi* +; *Galium boreale* + (17, 18).

*Locality (Aprakstu vietas): Amm - Amata Forestry near Mežciemi house (Amatas mežniecība pie mājām "Mežciemi"); Am5 – Amata Forestry, 512. Kv. (Amatas mežniecības 512. kvartāls); Su – Springs near Suda River (Avoti pie Sudas upes).

Warnke (1980) stresses that there is a dynamic relationship and generally absence no absolute boundaries between spring area plant communities and the adjacent mire area. Vegetation in the combined spring fen areas often showed discontinua or sharp boundaries as well as gradually changing patterns or continua. Both kinds of distribution may occur mosaic-wise within the same locality. The study of Dāvida springs and springs in Kazu Ravine proves that here is a united complex of spring and spring mire vegetation.

The investigation of the springs reveals that some bryophyte species and genera are confined to spring habitats, like *Philonotis* and *Cratoneuron.* This is also mentioned by Zechmeister & Mucina (1994).

Spring communities on the sometimes very steep slopes of the forested river ravines belong to the alliance Caricion remotae**.** The investigated sites are predominantly located on the slopes and floors of small river ravines. These are springs of rheocrene and limnocrene type. Communities of the Caricion remotae are dominated by tall phanerogams and these spring sites are often shaded. Often such spring sites are shaded. Small-sized stands are often embedded in closed-canopy woodland (Maas 1959). These communities of Caricion remotae are often shaded and include *Coryllus avellana, Alnus incana* and *Padus avium*, but near Suda River *Picea abies*, *Pinus sylvestris, Betula pubescens* and *Sorbus aucuparia* appear.

It is shown by Wolejko et al. (1994) that spring mires are very complex and dynamic systems, and the vegetation is rich and well differentiated. In Poland Wolejko et al (1994) has distinguished two spring communities of Caricion remotae: Cardamino – Chrysosplenietum alternifolii. The Cardamino – Chrysosplenietum alternifolii occurs on the seepage cupolas and on firm sandy floors of the spring water courses. *Cardamine amara* plays an important role but a variant with *Palustriella commutata* frequently occurs in the strongly eroded depressions between seepage cupolas. These communities have species in common with those that occur in the Gauja National Park from Caricion remotae, like *Carex remota, Chrysosplenium alternifolium, Cirsium oleraceum, Deschampsia cespitosa, Veronica beccabunga, Myosoton aquaticum, Palustriella commutata, Pellia endivifolia, Conocephalum conicum* and *Plagiomnium ellipticum.*

The Cardamino – Chrysosplenietum alternifolii occurs also in Slovakia (Valachovič, Janovicova 1999). It is one of the most widespread spring communities in the low-altitude mountain areas of Slovakia. The dominating species are *Chrysosplenium alternifolium, Cardamine amara, Impatiens noli-tangere, Circea luteciana, Stellaria nemoreum. Carex remota* is present but not abundant. In the moss layer *Brachythecium rivulare, Plagiomnium undulatum, Conocephalum conicum, Eurhynchium hians* occur.

Communities of Cratoneurion commutati are less common in the Gauja National Park, mainly near Dāvida springs and near Vaive River. In Poland Wolejko (2000b) also distinguishes Cratoneureto filicinae – Cardaminetum and *Palustriella commutata* community that also occurs in the Gauja National Park.

Spring fens are very specific elements for the Kashubian Lakeland in Poland (Herbich 1992). They occur in various types of landscape and valleys. They can develop at small outflows as well as in big spring cirques, on bottoms of valleys and their slopes. Vegetation of spring fens includes tall sedge communities of the Magnocaricion (specific spring form mainly of Caricetum paniculatae). Also *Carex paniculata* is mentioned in a spring mire complex (Wolejko et al 1994). In Latvia Caricetum paniculatae was distinguished in Dāvida springs.

In Europe spring communities mostly are investigated in mountainous areas, although there are also studies in the lowland areas. Therefore, there are differences in the plant species composition of the communities.

In the Appennine peatlands species of Montio-Cardaminetea are mentioned, such as *Philonotis calcarea, Brachythecium rivulare, Palustriella commutata* and a subassociation of Eriophoretum latifolii with *Palustriella commutata* is distinguished (Gerdol & Tomaselli 1987).

Syntaxonomycal synopsis of spring and spring mire vegetation in the Gauja National Park

Class: Montio- Cardaminetea Br.–Bl.et R. Tx. ex Klika et Hadač 1944
Order: Montio-Cardaminetalia Pawlowski 1928
Alliance: Cratoneurion commutati Koch 1928
Ass. Cratoneureto filicinae - Cardaminetum Maas 1959
Comm. *Palustriella commutata*
Alliance: Caricion remotae Kästner 1941
Ass. Cardamino-Chrysosplenietum alternifolii Maas 1959

Class: Phragmito-Magnocaricetea Klika in Klika &Novak 1941
Order: Phragmitetalia Koch 1926
Alliance: Magnocaricion elatae Koch 1926
Ass. Caricetum paniculatae Wangerin ex von Rochow 1951

Class: Scheuchzerio-Caricetea fuscae (Nordhagen 1936) Tüxen 1937
Order: Scheuchzerietalia palustris Nordhagen 1936
Alliance: Caricion lasiocarpae Vanden Bergen in Lebrun et al. 1949
Ass. Caricetum rostratae Osvald 1923 em. Dierssen 1982

CONCLUSIONS

The studied spring communities are assigned to the Montio-Cardaminetea, alliance Caricion remotae, association Cardamino–Chrysosplenietum alternifolii.

Spring communities may be a part of a complex that includes also spring fens vegetation of spring mires in the Scheuchzerio-Caricetea fuscae (Caricetum rostratae) and tall-sedge community of Phragmito-Magnocaricetea *(*Caricetum paniculatae*)*. There is a dynamic relationship between the spring and spring mire vegetation.

In total 162 vascular plant and bryphyte species were recognized in the studied sites that included 210 relevés.

The results reveal that near the springs, specific plant communities occur that have an international value because that have become rare in many European countries. Springs are included in the list of the protected habitats in Latvia and the studies of such habitat are to be continued in Latvia.

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Avoksnāju veģetācija Gaujas Nacionālajā parkā

Māra Pakalne, Ilze Čakare

Kopsavilkums

Atslēgas vārdi: avoksnāju veģetācija, Montio-Cardaminetea, Cratoneurion commutati, Caricion remotae.

Gaujas nacionālajā parkā pirmo reizi Latvijā pētīta avoksnāju veģetācija Vaives upes krastā pie Dāvida dzirnavām, Amatas mežniecības 510. un 512. kvartālā, Pērļupes ielejā, Sudas upes nogāzēs, Amatas upes krastā pie Vizuļu ieža, Roču un Nurmižu rezervātos, Kumadas krastā pie Ieriķiem, pie Līču-Laņģu un Rakšupes klintīm, kā arī Kazugravā. Veikti 210 veģetācijas apraksti pēc Brauna-Blankē metodes.

Avoksnāji Gaujas nacionālajā parkā aizņem nelielas (pāris kvadrātmetru) teritorijas avotiem, bet vietumis arī lielākas platības tur, kur zāļu purva veģetācija mijas ar avoksnāju veģetāciju un tekoša ūdens straumēm.

Konstatētās augu sabiedrības avoksnājos un avotainos purvos pieder klasei Montio-Cardaminetea (Cratoneureto filicinae–Cardaminetum, P*alustriella commutata* sabiedrība, kā arī Cardamino-Chrysosplenietum alternifolii), klasei Phragmito-Magnocaricetea (Caricetum paniculatae) un klasei Scheuchzerio-Caricetea fuscae (Caricetum rostratae).

Pētījuma rezultāti liecina, ka ap avotiem sastopamas savdabīgas fitocenozes, kurām ir starptautiska nozīme, jo daudzās Rietumeiropas valstīs šie biotopi jau ir kļuvuši reti.