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STUDIES ON *LIGULARIA SIBIRICA* (L.) CASS. IN ITS SOUTHERN POINT IN ARGEŞ COUNTY, BRUSTURETULUI GORGES

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Abstract
The community importance species, Ligularia sibirica (L.) Cass. it is located in its southern point in Romania, in Brusturetului Gorges in Arges County. In NATURA 2000 habitat, 3220 Alpine rivers and herbaceous vegetation along their banks, it is present the species of community importance Ligularia sibirica (L.) Cass. in the plant association: Carici remotae-Calthetum laethae Coldea (1972) 1978 ligularietosum sibiricae Alexiu et Stancu 2003. Habitat description and qualitative and quantitative analysis of association flora, it has an important role in establishing the conservation status of relict species Ligularia sibirica (L.) Cass. Through obtained results, the present paper is contributing to the existent information related to the studied species and to the presentation of its preservation nowadays. Ligularia sibirica (L.) Cass. species require real protective measures at the site.

Keywords: Ligularia sibirica, habitat, population, Brusturetului Gorges

1. INTRODUCTION

Brusturetului Gorges is located in Piatra Craiului National Park, at the junction of Valea cu Apă with Valea Seacă a Pietrelor, on a 5 km distance, covering an area of approximately 80 ha (Alexiu 2000, Pop 2006). In Brusturetului Gorges, *Ligularia sibirica* (L.) Cass. species it is integrated into subassociation *Carici remotae-Calthetum laethae* Coldea (1972) 1978 *ligularietosum sibiricae* Alexiu et Stancu 2003. The community importance taxon is initially identified by Drăghici in 1967 (Drăghici, 1980), and further by Alexiu and Stancu in 1998, 2000, 2001 (Alexiu, 2003). The species was mentioned by Pop in 2006 (Pop, 2006), and the field identification in 2015 was made by the author of this paper.

2. MATERIALS AND METHODS

Identification of the characteristic natural habitat to which it is integrated the relict species *Ligularia sibirica* (L.) Cass. from Brusturetului Gorges was done in the 2014-2015 period as a part of a comprehensive study on the species.

To achieve the aim of the present paper were made phytosociological surveys using Zürich-Montpellier phytosociology school methods. Habitat codes used in the present paper correspond to the Natura 2000 network, the Romanian system and EUNIS classification system. For habitat description were taking into account the following: name and habitat features, category from Carpathians Red List of habitats, presentation of characteristic species, protected, rare, endangered and endemic species from described habitat, habitat distribution in Romania and in Carpathian

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Mountains, conservation degree in Brusturetului Gorges, conservation importance, habitat and the *Ligularia sibirica* (L.) Cass. vulnerability by comparing the floristic analysis from the 1998-2001 period conducted by Alexiu and Stancu with the one carried out by the author, including the presentation of possible management and conservation issues.

In order to characterize the association and habitat, for qualitative and quantitative analysis were used: *Flora Europaea* (Tutin et al., 1964-1980), *Les associations végétales de Roumanie* (Coldea, 1997), *Manual de Interpretare a Habitatelor Natura 2000* (Gafta et Mountford coord., 2008), *Flora Ilustrată a României* (Ciocârlan, 2009), *Rezerva□iile naturale ale jude□ului Argeş* (Alexiu, 2000), *Studiul corologic al categoriilor sozologice din flora Judetului Arges pentru refacerea fitopopulatiilor periclitate prin metode conventionale si biotehnologice de inmultire* (Alexiu et al., 2011), *Characterisation of the flora and vegetation of the upper stream of Dambovita* (Alexiu, 2003), *Fitotaxoni amenintati la nivel global, european si national, identificati in judetul Arges (*Alexiu, 2008), *Cormoflora judetului Arges* (Alexiu, 2008), *Categorii sozologice din cormoflora jude□ului Argeş* (Alexiu, 2011), *Red List of the Carpathian Non-forest Biotopes (Habitats)* (Barančok et al. 2014), *Fitosociologie* (Cristea et al, 2004), *Phytosociological study concerning associations with Ligularia sibirica (L.) Cass. in Romania* (Matei, 2014), *Ghidul de monitorizare a speciilor de plante de interes comunitar din România* (Mihăilescu et al, 2015), *Identification of important plant areas (IPAs) within Piatra Craiului National* Park (Pop, 2006), *Fitocenozele din România* (Sanda, 2008).

Abbreviations: K - constancy, ADm – abundance-dominance average.

3. RESULTS AND DISCUSSIONS

NATURA 2000 Habitat - 3220 *Alpine rivers and herbaceous vegetation along their banks*

Correspondent:

- EUNIS: C3.55 *Sparsely vegetate driver gravel banks*
- EMERALD 54.1 *Springs*
- Romanian system of classifying habitats: R5423 – *South-east Carpathian springs and streams communities with Carex remota and Caltha laeta.*

The habitat in the Carpathian Mountains occupies small areas in countries such as Slovakia, Czech Republic and Romania. In *Red List of the Carpathian Non-forest Biotopes (Habitats)* developed by Barančok and al. (2014), the habitat presented at the European level, belongs to the category - near threatened NT.

In Romania the habitat, it is distributed in Maramureş Mountains, Mureş Gorge, Gurghiului Valley, Mount Siriu, Azuga Valley, Dâmbovicioarei-Brusturet Gorges and Plopiş Mountains.

NATURA 2000 habitat: 3220 *Alpine rivers and herbaceous vegetation along their banks* in Brusturetului Gorges, Argeş County, Romania.

The habitat location in Piatra Craiului National Park in Argeş County is 45^{o}27’15’’N, 25^{o}13’12’’E.

In Brusturetului Gorges the habitat is situated at an altitude of 810 m, in the lower mountain stage, the average annual temperature reaches values of 7°C, while the average annual rainfall ranges between 750 and 1 000 mm. In terms of edaphic factors, habitat is located on rendzinas, lithosoil, black or brown acid soils, and acidic podzols.

The main species found in the studied habitat are key species (edifying or characteristic species) for the association *Carici remotae-Calthetum laethae* Coldea (1972) 1978 *ligularietosum sibiricae* Alexiu et Stancu 2003: *Carex remota* and *Caltha palustris* subsp. *laeta*, *Cratoneuron commutatum* and *Chrysosplenium alternifolium.*

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The importance of this habitat is attributed to many rare, endemic, endangered species and to those of community or even global importance. Taking into consideration the special importance on European and Global level, we can mention the presence of the endangered species *Liparis loeselii* (L.) L.C.M. Richard and *Ligularia sibirica* (L.) Cass. .
Also, in this habitat can be found **rare species** such as:

- *Sempervivum montanum* L. subsp. *carpaticum* Wettst. ex Hayek
- *Ligularia sibirica* (L.) Cass.

Global and European threatened taxa:

- *Campanula patula* L. subsp. *abietina* (Griseb.) Simonk.
- *Campanula serrata* (Kit.) Hendrych.
- *Ligularia sibirica* (L.) Cass.
- *Liparis loeselii* (L.) L.C.M. Richard
- *Sempervivum montanum* L. subsp. *carpaticum* F. Wettst. Et Hayek.

The **endemic species** present in habitat are:

- *Anthemis tinctoria* L. subsp. *fussii* (Griseb.) Beldie
- *Dianthus henteri* Heuff. ex Griseb. & Schenk

From coenotic point of view, in Brusturetului Gorges 3220 habitat *Alpine rivers and herbaceous vegetation along their banks* it is associated to the *Carici remotae-Calthaetum laetae* Coldea (1972) 1978 *ligularietosum sibiricae* Alexiu et Stancu 2003 coenotaxon.
The land use in the studied habitat is represented by tourism, grazing and conservation.
The habitat has a high conservation value, in places where *Ligularia sibirica* (L.) Cass. species is still present, with a population that decreases from year to year. The habitat is vulnerable because of tourism and grazing pressure that in time can lead to habitat fragmentation.
Mapping habitat species it is also a necessary step in habitat biodiversity protection.

***Ligularia sibirica* (L.) Cass. – Brusturetului Gorges**

In 3220 *Alpine rivers and herbaceous vegetation along their banks* habitat the *Ligularia sibirica* (L.) Cass. species of community importance it is present in: *Carici remotae-Calthetum laethae* Coldea (1972) 1978 *ligularietosum sibiricae* Alexiu et Stancu 2003 association, Figure 1.
In this site, the relict species is currently in danger of extinction. Population development over time, according to *Studiul corologic al categoriilor sozologice din flora Jude□ului Argeş pentru refacerea fitopopulatiilor periclitate prin metode conven□ionale si biotehnologice de înmul□ire* (Alexiu et al., 2011), being as following: in 2004 there were registered 244 individuals, their number was later rising to 670 individuals in 2008, while in 2015 were identified in the field no more than six individuals in vegetative state.
It is considered that the numerical decline of the population individuals of *Ligularia sibirica* (L.) Cass. is caused by anthropogenic factors: excessive tourism activities that includes camping and throwing garbage in the taxon's area of vegetation and also overgrazing, being observed numerous traces of cattle in the field. Currently, the species requires real and urgent protective measures to prevent its extinction, building a fence for protection being one of them.

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Figure 1. Ligularia sibirica (L.) Cass. - Argeş County

The comparative analysis of flora of *Carici remotae - Calthetum laetae* Coldea (1972) 1978 *ligularietosum sibiricae* Alexiu et Stancu 2003 association, evaluated in 2003 by Alexiu and Stancu, with the one identified in 2015 by the author, revealed a number of qualitative and quantitative changes.

Thus from the taxonomic analysis performed on association, in 2015 had resulted 46 taxa, compared with the 28 taxa identified in 1998, 2000 and 2001; the new species present in association are: *Viola biflora, Geranium phaeum, Carex echinata, Crepis paludosa, Galium uliginosum, Juncus effusus, Mentha longifolia, Ranunculus acris, Cardamine pratensis, Geranium robertianum, Luzula luzuloides, Prunella vulgaris, Tussilago farfara, Lychnis flos-cuculi, Rumex obtusifolius, Myosotis sylvatica, Equisetum arvensis, Mycelis muralis, Salvia glutinosa*.

From bioforms analysis it can be observed, that hemicryptophytes has a constant percentage followed by the geophytes. The studied floral elements fund is dominated by Eurasian species followed by circumpolar, Central-European and Cosmopolite elements. Significant variations from the initial and 2015 subassociation study, arise from Cosmopolite and circumpolar elements. Thus the higher percentage of Cosmopolite elements from 2015 shows the appearance of characteristic elements of stagnant waters and ruderal areas, while it can be observed the decrease of circumpolar elements characteristic for tundra and peat bogs.

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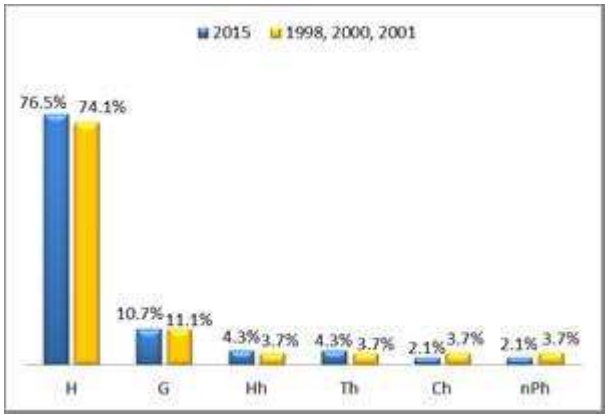

Figure 2. Bioforms analysis of Carici remotae - Calthetum laetae Coldea (1972) 1978 ligularietosum sibiricae Alexiu et Stancu 2003 subassociation

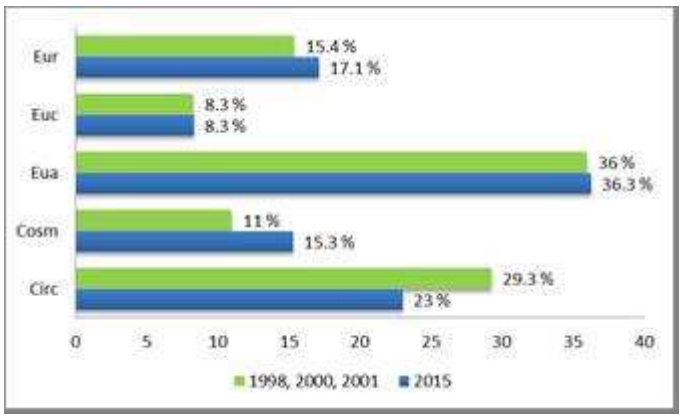

Figure 3. Geo-elements analysis of Carici remotae - Calthetum laetae Coldea (1972) 1978 ligularietosum sibiricae Alexiu et Stancu 2003 subassociation

The comparative analysis of soil and climatic factors (Figure 4.) like humidity, temperature and soil reaction reveals a high proportion of the next elements: meso-hygrophilic, micro-mesotherms and acid-neutrophilous species. It should be noted that from the humidity point of view, the percentage varies quite a lot on mesophilic and meso-hygrophilic species. In 2015 the mesophilic species percentage increases, while the meso-hygrophilic species percentage decreases, due to the reducing phenomenon of wet area in which *Ligularia sibirica* (L.) Cass. vegetate.

By using the Diemont method, we found out the quantitative variation in bioforms biodiversity of habitat phytocoenosis where *Ligularia sibirica* (L.) Cass. species is present. As a result it can be observed the increased density of hemicryptophytes in *Carici remotae - Calthetum laetae* Coldea (1972) 1978 *ligularietosum sibiricae* Alexiu et Stancu 2003 subassociation (Figure 5).

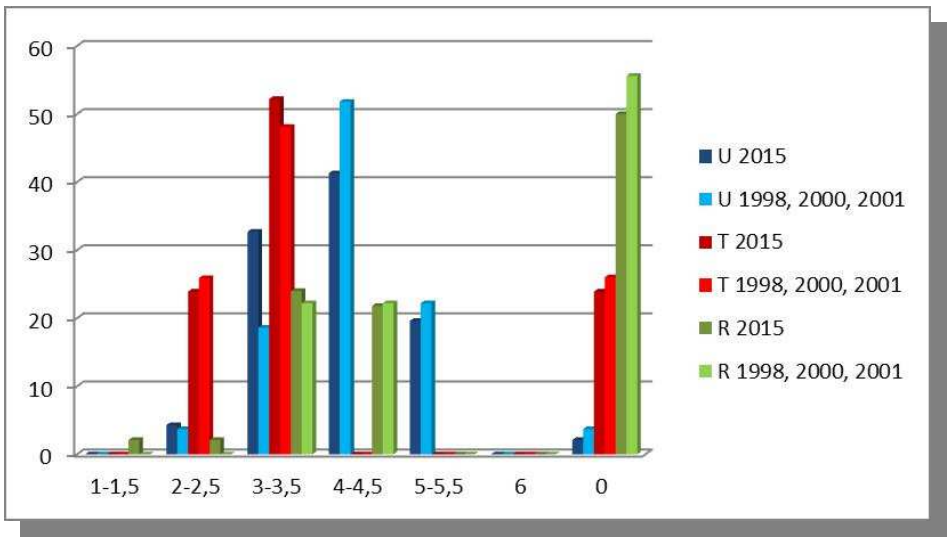

Figure 4. Flora analysis by ecological indices in Carici remotae - Calthetum laetae Coldea (1972) 1978 ligularietosum sibiricae Alexiu et Stancu 2003 subassociation

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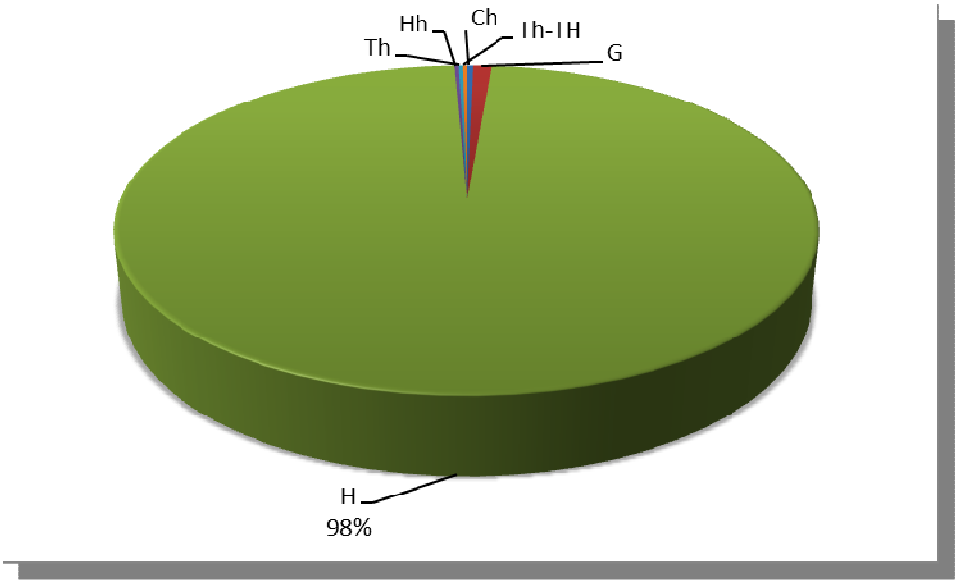

Figure 5. Diemont method - Carici remotae - Calthetum laetae Coldea (1972) 1978 ligularietosum sibiricae Alexiu et Stancu 2003 subassociation

Table 1. Survey of Carici remotae - Calthetum laetae Coldea (1972) 1978 ligularietosum sibiricae Alexiu et Stancu 2003 at Brusturetului Gorges: 1-5, K1, ADm - Matei 7.06.2015, 24.07.2015, 30.08.2015; K2 – 5 reference surveys after Alexiu V. & Stancu I. 11.06.1998, 5.07.2000, 10.08.2001.

***Carici remotae - Calthetum laetae* Coldea (1972) 1978 *ligularietosum sibiricae* Alexiu et Stancu 2003**								
Survey number	**1**	**2**	**3**	**4**	**5**			
Altitude (m.s.m.)	810	810	810	810	810			
Surface (m2)	20	20	20	20	20			
Coverage of the herbaceous layer (%)	97	81,5	91,5	87,5	88,5	**K1**	**K2**	**ADm**
Characteristic species of the association								
Caltha palustris subsp. *laeta*	4	3	3	3	4	V	V	47,5
Carex remota	2	2	2	2	1	V	V	15
Diff. subass.								
Ligularia sibirica	-	-	+	-	-	I	V	0,1
Montio-Cardaminetalia								
Cardamine pratensis subsp. *matthioli*	1	2	2	2	1	V	V	12,5
Cardamine amara	+	+	1	1	+	V	-	2,3
Chrysosplenium alternifolium	-	-	+	-	+	II	II	0,2
Adenostyletalia								
Stellaria nemorum	1	+	+	+	1	V	IV	2,3
Chaerophyllum hirsutum	+	+	+	+	+	V	IV	0,5
Veronica beccabunga	-	-	+	+	+	III	II	0,3
Viola biflora	-	-	+	+	-	II	-	0,2
Carduus personata	-	-	-	+	+	II	II	0,2
Geranium phaeum	-	-	-	-	+	I	-	0,1
Calthion								
Myosotis scorpioides	+	-	+	+	+	IV	III	0,4
Lysimachia nummularia	-	+	+	+	-	III	II	0,3

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Juncus articulatus	-	-	-	+	+	II	II	0,2
Poa trivialis	-	-	+	+	-	II	I	0,2
Carex echinata	-	+	+	-	-	II	-	0,2
Crepis paludosa	-	+	-	-	+	II	-	0,2
Scirpus sylvaticus	+	-	-	-	+	II	II	0,2
Galium uliginosum	+	-	+	-	-	II	-	0,2
Juncus effusus	-	-	+	-	+	II	-	0,2
Geum rivale	-	+	-	-	-	I	II	0,1
Varia								
Ranunculus repens	+	+	1	+	+	V	IV	1,4
Mentha longifolia	+	+	-	+	+	IV	-	0,4
Ranunculus acris	+	-	+	-	+	III	-	0,3
Adoxa moschatellina	-	+	-	+	+	III	III	0,3
Equisetum palustre	+	-	-	+	-	II	II	0,2
Filipendula ulmaria	+	-	+	-	-	II	II	0,2
Lythrum salicaria	-	-	+	-	+	II	III	0,2
Primula elatior	-	+	+	-	-	II	II	0,2
Mentha aquatica	+	-	-	-	+	II	II	0,2
Lotus corniculatus	-	+	-	+	-	II	II	0,2
Urtica dioica	+	-	-	-	+	II	II	0,2
Cardamine pratensis	-	-	-	+	+	II	-	0,2
Geranium robertianum	-	-	+	+	-	II	-	0,2
Luzula luzuloides	+	+	-	-	-	II	-	0,2
Prunella vulgaris	-	-	+	-	+	II	-	0,2
Tussilago farfara	+	+	-	-	-	II	-	0,2
Lychnis flos-cuculi	-	+	-	-	+	II	-	0,2
Rumex obtusifolius	-	+	+	-	-	II	-	0,2
Myosotis sylvatica	-	+	-	-	+	II	-	0,2
Dactylorhiza maculata	-	-	-	+	-	I	II	0,1
Luzula campestris	-	-	-	+	-	I	II	0,1
Equisetum arvensis	-	+	-	-	-	I	-	0,1
Mycelis muralis	-	-	-	+	-	I	-	0,1
Salvia glutinosa	-	-	-	+	-	I	-	0,1
Daphne mezereum	-	-	-	-	-	-	II	-

4. CONCLUSIONS

Loyal taxa with a high ADm index during studied periods in subassociations are: *Caltha palustris* subsp. *laeta, Carex remota, Cardamine pratensis* subsp. *matthioli, Stellaria nemorum, Chaerophyllum hirsutum, Myosotis scorpioides* and *Ranunculus repens.*

Soil moisture loss can be another factor that led to diminishing population of *Ligularia sibirica* (L.) Cass. in the subassociation studied in Brusturetului Gorges.

By using the Diemont method, was observed the presence of a climate with water and temperature deficiency, and the abundance of herbaceous formations edified by perennials asteracee, lamiacee and juncacee.

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The population of *Ligularia sibirica* (L.) Cass. is in decline, mainly due to anthropogenic pressure resulting from tourism activities but also because of overgrazing. It is necessary to take measures of protection for the relict species as soon as possible, in order to avoid its extinction.

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