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CONTRIBUTIONS TO THE FLORA OF THE BIHARIA MASSIF (ROMANIA)

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Abstract: The Biharia Massif situated in the southwestern part of the Apuseni Mountains, with its highest peaks, Bihor-Cucurbăta Mare (1849 m) and Cucurbăta Mică (1769 m), provides favorable ecological conditions for the survival of some arctic-alpine and Carpathian-Balkan species of particular phyto-geographic importance for this region. During our field work, in 2005-2006 we have identified some new plant taxa for the Biharia Massif or the Apuseni Mountains, such as: *Allium victorialis, Allium schoenoprasum* ssp. *sibiricum, Hieracium alpinum, Hypochoeris uniflora,* and some rare species cited before from this location in the botanical literature. From this group of rare and vulnerable species we mention: *Silene pusilla, Lilium carniolicum* ssp. *jankae, Carex atrata, Trifolium pallescens, Swertia perrenis* ssp. *punctata, Festuca supina and Saxifraga stellaris* ssp. *robusta*. The study of the ecology, coenology and chorology of these species in the area of the Apuseni Mountains reveals the phytocoenotic connections to the Eastern and Southern Carpathians and indicates the necessary actions for the "in situ" conservation of these species.

Keywords: Romania, Apuseni Mountains, Biharia Massif, Montane-sub-alpine flora, priority habitats, priority plant taxa, rare plant species, vulnerable species, plant communities, chorology,

Introduction

The Biharia Massif, part of the Bihor Mountains is situated in the South-Western part of the Apuseni Mountains. The Cucurbăta Mare Peak (also called Bihor Peak) with an altitude of 1849 m, represents the highest peak from the area of the Apuseni Mountains. On its North-Eastern slope, at 1750m altitude there are the remnants of a glacial cirque.

From a floristic and coenological perspective the region is scarcely known as there are few publications from the area [4, 16, 17].

The field research that we have conducted until this moment indicate the massif as a conservative area for rare and endangered species and priority habitats, included both in the European and the national legislation. The most important habitats (according to "Natura 2000" codes [18]) to be found here are:

- 6230* Species-rich *Nardus* grassland, on siliceous substrates in mountain areas,
- 6150 Siliceous alpine and boreal grasslands,
- 4070* Bushes with *Pinus mugo* and *Rhododendron hirsutum,*
- 3220 Alpine rivers and the herbaceous vegetation along their banks,
- 6430 Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels,
- 4060 Alpine and Boreal heaths.

In the high area of the Biharia Massif, there can be found plant species of European interest (from the European Red List) as *Arnica montana, Tozzia alpina, Campanula abietina, Campanula serrata* and *Lilium carniolicum* ssp. *jankae,* with priority in the conservation actions. The habitats from above, marked with asterisk have the same priority status. The lack of botanical information regarding the higher interfluve of the rivers Arieşul Mare and Arieşul Mic has determined us to select it for an intensive phytocoenological study.

Materials and Method

Between the years 2004-2006, taking part in the European project IntraBioDiv (GOCE-CT-2003-505376-INTRABIODIV), we have built up a floristic database including the distribution of the sub-alpine and alpine species in the Romanian Carpathians on a grid system with cells of 140 square kilometers. In this longitude-latitude grid used for the research in the IntraBioDiv project, the Biharia Massif is included in grid cell K: 56, base square 3/c. The studied area lies above the tree line, beyond 1600m altitude.

The Biharia Massif offers favorable conditions for the survival of some Carpathian-Balkan species with great phytogeographical importance for the region. The most important parts of the massif, floristically and phytocoenologically are its high peaks Cucurbăta Mare, Cucurbăta Mică, and the glacial cirque under the Cucurbăta Mare Peak, unique in the Apuseni Mountains, with particular environmental conditions, preserving snow even in June.

Concerning the geological structure, the massif is dominated by acidic rocks, in its highest part being constituted exclusively of andesites and crystalline schists from the series of Biharia. [10] The acidic substrate of the massif is the cause of its floristic poverty in comparison with the mountains dominated by calcareous rocks.

For the field research of the plant communities we have used the method elaborated by J. Braun-Blanquet (1928, 1964), adapted by Al. Borza (1934) to the specific of the Romanian vegetation by marking in the releve, with the second figure, the local frequency of the species (1-5 scale). The habitat types were established on the basis of the floristic structure of the plant communities and their soil type and ecology particularities. Their coding was done according to the European standards. As taxonomical reference we have used the work of V. Ciocârlan [3] and a recent work for the genus *Crocus* [9].

Results and Discussion

The study of the botanical literature and the field research carried on until the autumn of 2006, have permitted us to characterize the flora of the Biharia Massif. 73 plant species considered as "High Mountain Taxa" have been identified here so far. Besides these, another 37 mountain species vegetate in the area, summing up to 110 phanerogam species.

At the uppermost limit of the spruce forests (1.650-1.800 m), in the microthermic stations there can be found communities with *Pinus mugo* (mugo pine), *Alnus viridis* (green alder) and *Juniperus nana* (juniper), having few (24-32) species. The boreal-mountain species, as: *Salix silesiaca, Rubus idaeus, Huperzia selago, Hypericum richerii* ssp. *grisebachii, Vaccinium myrtillus, V. vitis-idaea, Athyrium distentifolia, Senecio subalpinus, Rumex alpestris, Homogyne alpina, Soldanella oreodoxa, Achillea distans, Calamagrostis villosa, Campanula abietina, Veratrum album* ssp. *lobelianum, Festuca supina, Scorzonera rosea* etc. are dominant in their floristic structure [6].

On the summit of the massif, where the bushy vegetation was cleared to increase the area of pastures, now there are grasslands dominated by *Nardus stricta, Festuca nigrescens* and *Festuca supina*, with microthermic species as *Potentilla ternata, Laserpitium krapfi, Ligusticum mutellina, Vaccinium gaultherioides, Hieracium alpinum, Scorzonera rosea, Campanula serrata, C. abietina, Phleum commutatum, Viola declinata*, that allow the regional differentiation of these coenoses from the ones from Central Europe [4, 11]. The secondary character of these grasslands is revealed by the sporadic presence of remnant species from the sub-alpine bushes as: *Juniperus communis* ssp. *nana, Vaccinium myrtillus, Vaccinium vitis-idaea, Soldanella oreodoxa* and *Homogyne alpina*

Around the springs from the glacial cirque under the Cucurbăta Mare Peak there are plant communities dominated by *Saxifraga stellaris* ssp. *robusta*, with very few (14) species, which include: *Caltha palustris, Silene pusilla, Epilobium nutans, Viola biflora, Swertia perrenis* ssp. *punctata, Senecio subalpinus, Juncus filiformis, Philonotis serriata* and *Scapania undulata* [5].

The sub-alpine and alpine taxa are represented by a group of microthermic and mesophyte species growing at high altitudes (1000-2000 m), such as: *Juniperus communis* ssp. *nana, Asplenium viride, Arnica montana, Bruckenthalia spiculifolia, Cicerbita alpina, Doronicum austriacum, Epilobium nutans, Festuca supina, Hieracium alpinum, Hypochoeris uniflora, Hypericum richeri* ssp. *grisebachii, Huperzia selago, Ligusticum mutellina, Laserpitium krapfi, Luzula sudetica, Potentilla ternata, Poa chaixi, Rumex arifolius, Senecio subalpinus, Trifolium pallescens* and *Vaccinium gaultherioides.* This group of species reveals the montane-sub-alpine character of the plant communities that they are part of.

The syntaxonomical units (mostly according to Coldea (1991)) that include the rare and vulnerable species are presented at the end of table 1., as well as the date and place of the releves.

Table 1: Floristic structure of the sub-alpine plant communities from the Biharia Massif

Relevé	1	2	3	4	5	6	7
Altitude (m)	1840	1790	1650	1700	1760	1730	1720
Aspect	NE	NV	S	E	NE	NE	E
Slope (°)	10	5	10	10	15	25	30
Cover (%)	80	80	85	75	90	100	100
Surface (m²)	25	25	100	20	100	400	400
Character species							
Festuca supina	4.5	+2	-	-	-	-	-
Potentilla ternata	1.5	+3	+3	-	+	-	-
Festuca nigrescens	+	3.5	1.2	-	1.3	-	-
Scorzonera rosea	-	1.4	+2	-	+	+	+
Nardus stricta	+	+	4.5	+	+	-	-
Viola declinata	-	-	1.5	-	-	-	+
Caltha palustris	-	-	-	3.5	-	-	-
Philonotis serriata	-	-	-	2.5	-	-	-
Juniperus communis ssp. nana	-	-	-	-	4.5	1.2	1.3
Campanula abietina	-	+	1.2	-	+5	+	+
Pinus mugo	-	-	-	-	-	5.5	+
Alnus viridis	-	-	-	-	-	+	5.5
Salix silesiaca	-	-	-	-	-	+	+
Dominant and companion species							
Polytrichum juniperinus	2.4	1.2	-	-	-	-	-
Vaccinium gaultherioides	1.3	-	-	-	+3	-	-
Ligusticum mutellina	1.3	-	-	+	-	-	-
Avenula flexuosa	+	2.5	+	-	+3	1.5	1.5
Luzula luzuloides	-	2.3	+	-	1.3	1.3	+
Hypericum richerii ssp. grisebachii	-	1.5	-	-	+	-	-
Thymus bihoriense	-	1.4	+3	-	+3	+	-
Laserpitium krapfi	+	1.2	+2	-	+	+	+
Vaccinium vitis-idaea	+	+	+	-	+	+	-
Veratrum album	-	+	-	-	+	+	1.3
Anthennaria dioica	+	+	+	-	+2	-	-
Achillea distans	-	+2	-	-	-	+	+
Campanula serrata	-	+	-	-	+	+	-
Potentilla erecta	-	+	+	-	-	-	-
Crocus exiguus	-	+	+	-	-	-	-
Hieracium alpinum	+	-	-	-	-	-	-
Carex atrata	+	-	-	-	-	-	-
Carex ovalis	+	-	-	-	-	-	-

Trifolium pallescens	+	-	-	-	-	-	-
Hypochoeris uniflora	-	+	-	-	-	-	-
Hieracium auricula	-	-	1.2	-	-	-	-
Veronica officinalis	-	-	1.3	-	-	-	-
Trifolium repens	-	-	+3	-	-	-	-
Veronica serpyllifolia	-	-	+	-	-	-	-
Campanula rotundifolia	-	-	+	-	-	-	-
Gnaphalium norvegicum	-	-	+	-	-	-	-
Silene pusilla	-	-	-	2.5	-	-	-
Saxifraga stellaris ssp. robusta	-	-	-	2.5	-	-	-
Swertia perrenis ssp. punctata	-	-	-	2.5	-	+	-
Viola biflora	-	-	-	1.3	-	+	-
Deschampsia caespitosa	-	-	-	1.2	+	-	1.3
Scapania undulata	-	-	-	1.2	-	-	-
Senecio subalpinus	-	-	-	+	+	+	-
Parnassia palustris	-	-	-	+	-	-	-
Epilobium nutans	-	-	-	+	-	-	-
Orchis maculata	-	-	-	+	-	-	-
Allium schoenoprasum ssp. sibiricum	-	-	-	+	-	-	-
Vaccinium myrtillus	-	-	-	-	2.5	3.5	2.5
Calamagrostis villosa	-	-	-	-	1.3	1.5	2.5
Homogyne alpina	-	-	-	-	1.3	+5	-
Hypericum maculatum	-	-	-	-	+	+	1.4
Soldanella oreodoxa	-	-	-	-	+3	+3	-
Melampyrum silvaticum	-	-	-	-	+	+	-
Rumex arifolius	-	-	-	-	-	+	1.5
Athyrium distentifolium	-	-	-	-	-	+	+
Doronicum austriacum	-	-	-	-	-	+	+
Gentiana asclepiadea	-	-	-	-	-	+	+
Rubus idaeus	-	-	-	-	-	+	+
Senecio ovatus	-	-	-	-	-	+	+
Huperzia selago	-	-	-	-	-	+	-
Oxalis acetosella	-	-	-	-	-	+	-
Solidago virgaurea	-	-	-	-	-	+	-
Adenostyles alliariae	-	-	-	-	-		+
Allium victorialis	-	-	-	-	-	-	+
Phleum commutatum	-	-	-	-	-	-	+

Place and date of the relevés: Rel. 1, 2, 4, 6, 7: Bihor Mountains, Cucurbăta Mare Peak, 05. 06. 2005; Rel. 3, 5: Bihor Mountains, Cucurbăta Mică Peak, 25.07.2006

The correspondence between the relevés and plant communities

Rel. 1: As. *Potentillo ternatae-Festucetum supinae* Boscaiu 1971

Rel. 2: As. *Scorzonero-Festucetum nigrescentis* (Puscaru et al. 1956)Coldea 1987

Rel. 3: As. *Violo declinatae – Nardetum* Simon 1966

Rel. 4: As. *Philonotido-Calthetum laetae* (Krajina 1933) Coldea 1991

Rel. 5: As. *Campanulo abietinae- Juniperetum* Simon 1966

Rel. 6: As. *Vaccinio myrtilli- Pinetum mugo* Hadac 1956

Rel. 7: As. *Salici-Alnetum viridis* Colic et al. 1962

From the cormophyte species considered as rare or very rare for the Apuseni Mountains we mention: *Saxifraga stellaris* ssp. *robusta, Silene pusilla, Carex atrata, Festuca supina, Hieracium alpinum, Adenostyles alliariae* and *Saxifraga adscendens*.

Another important group includes the Dacian-Balkan species, such as: S*axifraga marginata, Campanula serrata, C. abietina, Phleum commutatum, Scorzonera rosea, Soldanella*

oreodoxa, Swertia perrenis ssp. *punctata, Viola declinata, Potentilla ternata, Thymus bihorensis, Hieracium transsilvanicum, Leucanthemum rotundifolium, Pulmonaria rubra, Dentaria glandulosa, Symphytum cordatum* and *Telekia speciosa.* These species confer a Carpathian-South-Eastern European specific to the plant communities that they inhabit.

On the base of these regional species, some plant communities from the region of the Apuseni Mountains are considered as geographical vicariants to the communities from Central and Western Europe [5, 6, 11].

During our field research we have found more plant species with particular importance for the region, some of which had not been mentioned in the existing botanical literature for the Apuseni Mountains or at least for the Biharia Massif [8, 12-17], such as:

- *Allium schoenoprasum* L. subsp. *sibiricum* (L.) Hartman

The species is not mentioned in the Romanian Flora [6] for the Bihor Mountains and there is no herbarium material from this region (all the mentions to "herbarium material" from this paper refer to the herbarium of the Babeş-Bolyai University Cluj, the most significant for this area). We have only found one population, on the moist rockeries from the left side of the glacial cirque under the Cucurbăta Mare Peak, on Valea Cepilor. The species vegetates in the phytocoenoses of the association *Phyllonotido-Calthetum laetae*. (Fig. 1, Tab. 1-Relevé 4).

- *Allium victorialis* L.

It is not mentioned in the Romanian Flora for the Bihor Mountains, and there is no herbarium material from the Bihor Mountains. We have identified a small population, of just a few individuals, on the left slope of the glacial cirque under the Cucurbăta Mare Peak, in the phytocoenoses of the association *Salici-Alnetum viridis* (Fig. 2, Tab. 1-Relevé 7)

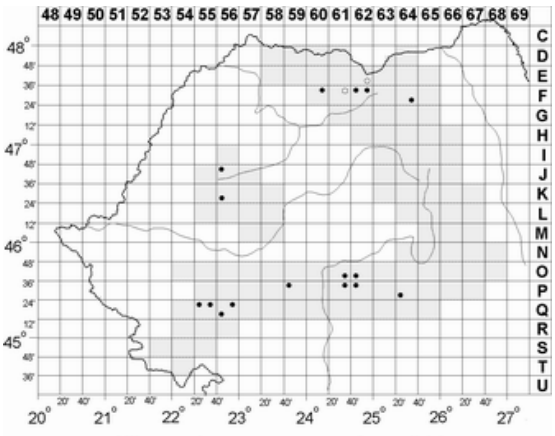

Fig 1: Distribution of the species *Allium schoenoprasum* ssp. *sibiricum* in the Romanian Carpathians

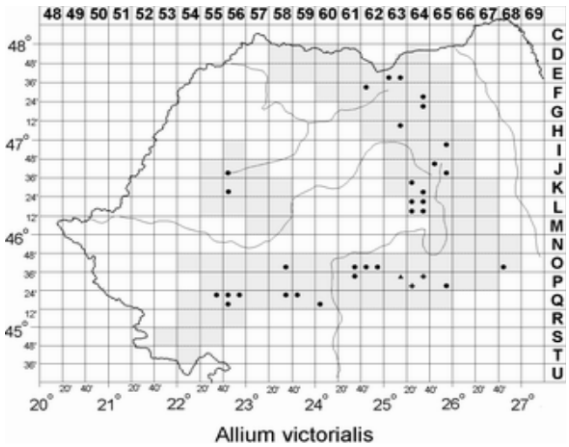

Fig 2: Distribution of the species *Allium victorialis* in the Romanian Carpathians

- *Hypochoeris uniflora* Vill.

The species is not cited in the Romanian Flora for the Bihor Mountains, there is herbarium material from the Cârligați Massif but it was not known in the Biharia Massif. We have found dispersed individuals under the summit of the Cucurbăta Mare Peak in the phytocoenoses of the association *Scorzonero roseae- Festucetum nigrescentis* (Fig. 3, Tab. 1-Relevé 2)

- *Hieracium alpinum* L.

It is not mentioned in the Romanian Flora for the Bihor Mountains and there is no herbarium material from this region. We have found a few individuals on the summit of Cucurbăta Mare

Peak, in the phytocoenoses of the association *Potentillo ternatae-Festucetum supinae* (Fig. 4, Tab. 1-Relevé 1)

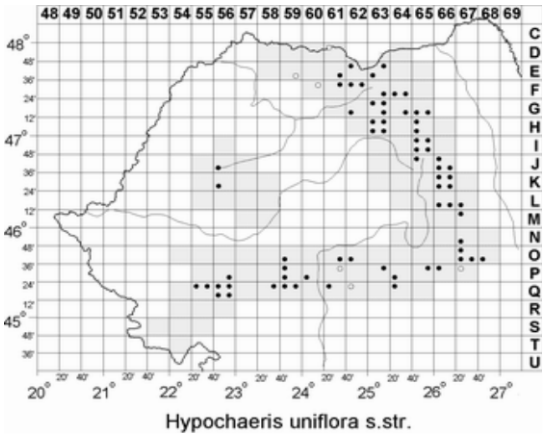

Fig 3: Distribution of the species *Hypochoeris uniflora* in the Romanian Carpathians

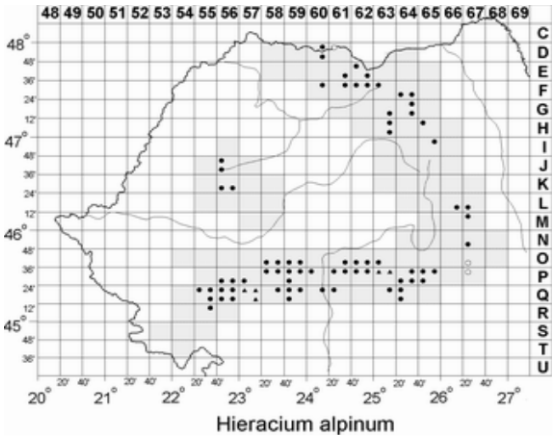

Fig 4: Distribution of the species *Hieracium alpinum* in the Romanian Carpathians

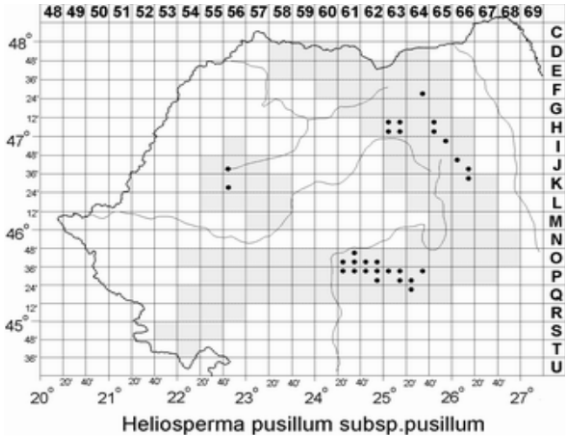

Fig 5: Distribution of the species *Silene pusilla* in the Romanian Carpathians

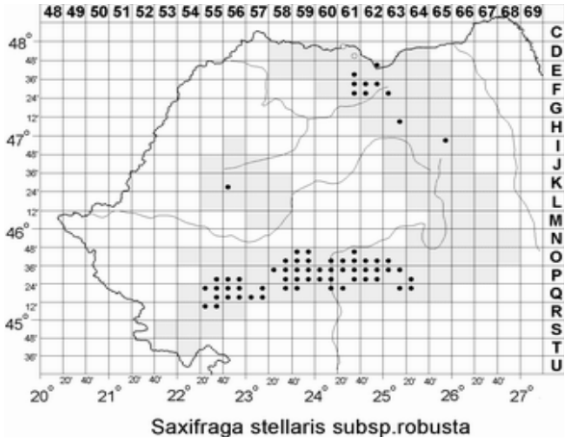

Fig 6: Distribution of the species *Saxifraga stellaris* ssp. *robusta* in the Romanian Carpathians

Another group includes the species that have already been cited in botanical literature for this region and were confirmed during our field work in the area. From this category we mention:

- *Silene pusilla* Waldst. & Kit.

The species is not mentioned in the Romanian Flora for the Apuseni Mountains and there is no herbarium material from this region. It is cited from the Vlădeasa Massif [15] and more recently from the Biharia Massif [4, 5, 6]. It is frequent on the moist rockeries from the glacial cirque and around the springs from Valea Cepilor in the phytocoenoses of the association *Phyllonotido-Calthetum laetae*. (Fig. 5, Tab. 1-Relevé 4)

- *Saxifraga stellaris* L. ssp. *robusta* (Engler) Gremli (subsp. *alpigena* Temesy)

The species is not mentioned in the Romanian Flora for the Bihor Mountains and there is no herbarium material from the Apuseni Mountains. Communities with this species have recently been published from the area [5]. It populates the banks of the springs from the glacial cirque and from Valea Cepilor, in the phytocoenoses of the association *Phyllonotido-Calthetum laetae*. It is the only known presence of this species in the Apuseni Mountains. (Fig. 6, Tab. 1-Relevé 4)

- *Festuca supina* Schur , cited in the Romanian Flora as “common in the alpine area of the Carpathians” is, nevertheless, rare for the Apuseni Mountains. There is herbarium material from the Vlădeasa Massif.

- *Carex atrata* L., is mentioned in the Romanian Flora from Cucurbăta Mare and Valea Cepilor, with no herbarium material. It has been found in the coenoses with *Festuca supina*.

- *Lilium carniolicum* Bernh. ssp. j*ankae* (A. Kerner), mentioned in the Romanian Flora from Valea Cepilor, under the Cucurbăta Mare Peak, where we have found more dispersed individuals. There is herbarium material only from the Cârligați Massif.

- *Swertia perrenis* L. ssp. *punctata* (Baumg.) Ciocarlan, mentioned in the Romanian Flora for Cucurbăta Mare, was found in the glacial cirque, in the communities of the association *Phyllonotido-Calthetum laetae*.

- *Trifolium pallescens* Schreb. is cited in the Romanian Flora from Cucurbăta. We have found it on the Cucurbăta Mare Peak.

- *Lycopodium alpinum* L. is cited in the Romanian Flora on Valea Cepilor. We have also found it there, at the edge of some juniper bushes.

Conclusion

The territory from the Southern part of the Biharia Massif, including the Cucurbăta Mare and Cucurbăta Mica peaks has many sub-alpine-alpine habitats that host plant communities of European, national and regional interest. The detailed knowledge of the floristic structure and ecology of these communities will permit the elaboration of efficient strategies for “in situ” conservation of these habitats and thus, of the rare and vulnerable species from this region.

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CONTRIBUȚII LA CUNOAŞTEREA FLOREI MASIVULUI BIHARIA (ROMÂNIA)

(**Rezumat**)

Masivul Biharia, situat în partea sud-vestică a Munților Apuseni, cu vârfurile sale cele mai înalte, Cucurbăta Mare (1849 m) şi Cucurbăta Mică (1769 m) oferă condiții ecologice prielnice dezvoltării unor specii arctic-alpine şi carpato-balcanice, cu importanță fitogeografică deosebită pentru regiune.

În cercetările de teren efectuate în 2005-2006 identificat unii taxoni vegetali noi pentru Masivul Biharia sau Munții Apuseni cum sunt: *Allium victorialis, Allium schoenoprasum* ssp. *sibiricum, Hieracium alpinum, Hypochoeris uniflora* şi am regăsit câteva specii rare semnalate în această zonă cu mai mult timp în urmă.

Dintre aceste specii rare şi vulnerabile menționăm: *Lilium carniolicum* ssp. *jankae, Allium sibiricum, Alium victorialis, Hypochoeris uniflora, Carex atrata, Trifolium pallescens, Swertia perrenis* ssp. *punctata, Festuca supina, Saxifraga stellaris* ssp. *robusta*. Studiul ecologiei, cenologiei şi corologiei acestor specii în zona Munților Apuseni evidențiază, pe de o parte, legăturile fitocenotice cu Carpații Meridionali şi Orientali iar, pe de alta, indică acțiunile necesare pentru conservarea "in situ" a acestor specii.

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