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## BRYOFLORESTICAL DATA FROM THE APUSENI MOUNTAINS (ROMANIAN WESTERN CARPATHIANS, TRANSILVANIA)

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**Abstract:** The main aim of this study was to explore the bryophyte diversity and distribution patterns in the Apuseni Mountains. From our collections hitherto 108 bryophyte species were identified. The 31 Marchantiophyta and 77 Bryophyta species belong to 74 genera of 40 families. Among them the endangered *Campylium protensum*, *Didymodon cordatus* and the critically endangered *Ditrichum gracile* and *Schistidium robustum* are to be mentioned.

**Keywords:** bryoflora, rare species, Apuseni Mts., Romania

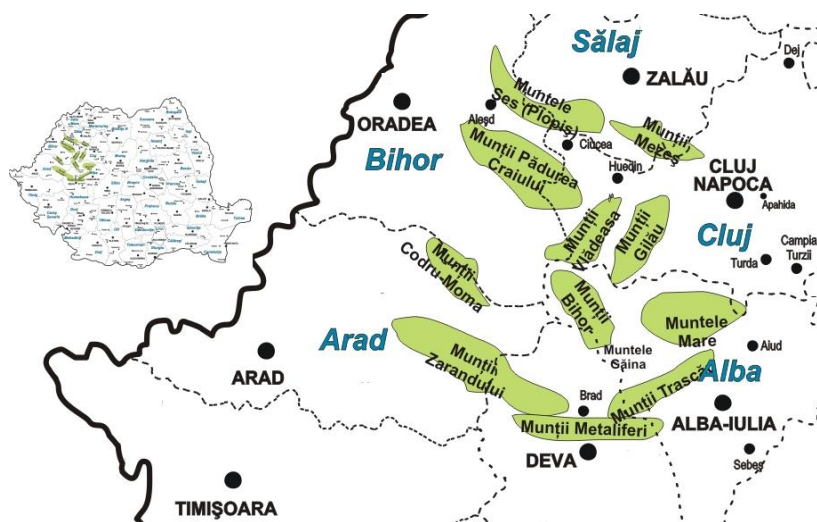
### INTRODUCTION

The bryological research of the climatologically and geologically very variable and biologically very rich Apuseni Mountains started at the beginning of XX<sup>th</sup> century but till now its investigation is far from complete (Gyórfy 1903; Péterfi 1908, 1910; Boros 1942a, 1942b, 1951; Páll 1960, 1962, 1963; Colectiv 1966; Boros and Vajda 1967, 1974; Ștefureac 1975, 1977; Plămadă and Goia 1994). Investigations have continued intensively in the past twenty years (Goia 2001, 2005; Goia and Mătase 2001; Jakab 1999, 2000; Goia and Schumaker 2000, 2002, 2003a, 2003b, 2004; Goia and Ștefănuț 2004; Plămadă *et al.* 2000; Lüth 2002, and others). The enumeration below shows, that many places are still unexplored and still there are just a few data from the Codru-Moma Mountains (Mohan 1996, Ardelean 2006) and Pădurea Craiului (Rațiu and Boșcaiu 1967). Csűrös (1981) gave a wide overview of the natural conditions and of Apuseni Mountains and its flora and fauna. Touristic travelers find a professional guide in Mátyás (1988). We started our intensive bryological exploration in 2002 and published a series of papers from this area, some of them as result of the

fruitful cooperation with Irina Goia, bryologist at the Babeş-Bolyai University (Orbán and Sass-Gyarmati 2003, Pócs 2005, Pócs *et al.* 2002, Sass-Gyarmati *et al.* 2005a, 2005b, Sass-Gyarmati *et al.* 2008a, 2008b).

### Study area

The Bihar Mountains occupy a central position within the Apuseni mountains range (*Plate I. photo 1*). The characteristic karstic topography is widely developed, parallel to places with other sedimentary and volcanic bedrocks. The Bihar Massif is the highest part of the Apuseni Mountains, part of the western Carpathians. It is roughly 25 km long from northwest to southeast and 14 km wide. The summit is gently sloping, broken by a few peaks and carved out by two glacial valleys. Cucurbăta Mare (1849m) is the highest point. Gârda Seacă valley is a narrow canyon with up to 250m high walls cut into the limestone bedrock. Coteţul Dobreştilor spring is the main outlet of the Ocoale-Coteţul Dobreştilor aquifer in the Gârda Seacă valley. The Gârda-Ocoale area almost entirely consists of sedimentary deposits ascribed to the Bihar Unit (Orăşeanu *et al.* 2007). The Pădurea Craiului group are in the northwestern part, while the Codru-Moma massif are the southwestern part of the Apuseni Mountains (*Figure 1*).



**Figure 1.** Detailed map of the investigated area

## MATERIAL AND METHODS

Authors visited the Apuseni Mountains between 22-27 June 2006. The collection was made in the various vegetation types: bogs, meadows, beech and spruce forests and subalpine belts. The specimens were collected by Tamás and Sarolta Pócs, Andrea Sass-Gyarmati, András Vojtkó and identified by Tamás Pócs and Andrea Sass-Gyarmati. The Romanian distribution of mosses was established from Plămadă (1998) and Mohan (1998), while that of the liverworts from Ștefănuț (2008). The nomenclature of liverworts follows Ștefănuț (2008), modified by Söderström *et al.* (2016), nomenclature of mosses follows Hill *et al.* (2006). The classification of liverworts (Marchantiophyta) follows Söderström *et al.* (2016), while the classification of mosses (Bryophyta) follows Goffinet and Shaw (2009). The species in each family are arranged in alphabetical order. Species names are followed by the collecting site number, and by the substrate on which they were grown. The collected specimens are deposited in the Herbarium of Eger (EGR). The list of collecting sites are listed in the Appendix.

## RESULTS

### List of species

During the field study, 108 bryophyte species were found in the investigated area. The 31 Marchantiophyta and 77 Bryophyta species belong to 74 genera of 40 families.

#### *Marchantiophyta*

##### Pelliaceae

*Pellia endiviifolia* (Dicks.) Dumort. – 1, 6: on soil

##### Conocephalaceae

*Conocephalum conicum* (L.) Dumort. – 2: on irrigated rocks

##### Anastrophyllaceae

*Barbilophozia lycopodioides* (Wallr.) Loeske – 10: on granitic rocks

***Barbilophozia sudetica*** (Nees ex Huebener) L.Söderstr. – 10: on rocks

***Mesoptychia bantriensis*** (Hook.) L.Söderstr. et Váňa – 5: on limestone rocks

***Sphenolobus minutus*** (Schreb. ex D.Crantz) Berggr. – 10: on granitic rocks

Lepidoziaceae

***Bazzania trilobata*** (L.) Gray. – 21: on soil

Calypogeiaceae

***Calypogeia muelleriana*** (Schiffn.) Müll. Frib. – 11: on soil

Cephaloziaceae

***Cephalozia bicuspidata*** (L.) Dumort. – 11: on transitional bog

***Cephalozia pleniceps*** (Austin) Lindb. – 18: on vertical cliff

Scapaniaceae

***Diplophyllum albicans*** (L.) Dumort. – 1, 2: on rocks

***Diplophyllum taxifolium*** (Wahlenb.) Dumort. – 10: on granitic rock

***Scapania aequiloba*** (Schwägr.) Dumort. – 5: on rocks

***Scapania aspera*** H. Bernet et M. Bernet – 5: on rocks

***Scapania undulata*** (L.) Dumort. – 1, 2, 11: on irrigated rocks

Jubulaceae

***Frullania dilatata*** (L.) Dumort. – 1, 3, 16, 18: on bark

Jungermanniaceae

***Jungermannia atrovirens*** Dumort. – 1: on rocks

***Jungermannia hyalina*** Lyell – 1: on soil

***Syzygiella autumnalis*** (DC.) K.Feldberg, Váňa, Hentschel et Heinrichs – 1: on rocks

***Tritomaria exsectiformis*** (Breidl.) Loeske – 1: on rocks

***Tritomaria exsecta*** (Schmidel) Schiffn. ex Loeske – 2: on irrigated rocks

***Leiocolea badensis*** Jörg. – 4: on limestone rocks

Lophocoleaceae

***Lophocolea heterophylla*** (Schrad.) Dumort. – 3: on decaying log

Plagiochilaceae

***Pedinophyllum interruptum*** (Nees) Kaal. – 1, 4: on rocks

***Plagiochila porelloides*** (Torr. ex Nees) Lindenb. – 2: on irrigated rocks; 5: on soil

Lejeuneaceae

***Cololejeunea calcarea*** (Lib.) Schiffn. – 18: on rocks

***Lejeunea cavifolia*** (Ehrh.) Lindb. – 1, 2: on irrigated rocks; 10: on rocks; 16: bark of *Carpinus*

Radulaceae

***Radula complanata*** (L.) Dumort. – 1, 3: bark of *Acer* sp.; 7: bark of *Viburnum lantana*; 17: bark of *Fagus*; 16, 18: on bark

Metzgeriaceae

***Metzgeria conjugata*** Lindb. – 2: on irrigated rocks; 18: on bark

***Metzgeria furcata*** (L.) Dumort. – 16: bark of *Carpinus*; 21: bark of *Fagus*

***Metzgeria violacea*** (Ach.) Dumort. – 7: bark of *Viburnum*; 18: bark of *Acer campestre*

Bryophyta

Sphagnaceae

***Sphagnum capillifolium*** (Ehrh.) Hedw. – 11: on turf

***Sphagnum centrale*** C.E.O. Jensen – 11: on turf

***Sphagnum magellanicum*** Brid. – 11: on turf

***Sphagnum russowii*** Warnst. – 10, 11: on turf

Andreaeaceae

***Andreaea alpestris*** (Thed.) Schimp. – 10: on rocks; 11: on irrigated rocks

***Andreaea rupestris*** Hedw. var. ***rupestris*** – 10: on rocks

Polytrichaceae

***Pogonatum urnigerum*** (Hedw.) P. Beauv. – 9: on earth covered rocks

***Polytrichastrum alpinum*** (Hedw.) G. L. Sm. – 10, 11: on rocks

***Polytrichastrum longisetum*** (Sw. ex Brid.) G. L. Sm. – 1: on soil

***Polytrichum piliferum*** Hedw. – 9: on earth covered rocks; 10: on soil

Encalyptaceae

***Encalypta streptocarpa*** Hedw. – 4: on limestone rock

***Encalypta rhaptocarpa*** Schwaegr. – 13: on soil

***Encalypta vulgaris*** Hedw. – 3: on rocks

Grimmiaceae

***Racomitrium sudeticum*** (Funck) Bruch. & Schimp. – 9, 11: on rocks

***Schistidium apocarpum*** (Hedw.) Bruch & Schimp. – 4: on rocks

***Schistidium robustum*** (Nees & Hornsch.) H. H. Blom – 1: on stonebridge

Seligeriaceae

***Seligeria acutifolia*** Lindb. – 18: on vertical cliff

***Seligeria patula*** (Lindb.) I. Hagen – 7: on vertical cliff

***Seligeria pusilla*** (Hedw.) Bruch & Schimp. – 13: on earth covered rocks

Fissidentaceae

***Fissidens adianthoides*** Hedw. – 17: on rocks

***Fissidens crispus*** Mont. – 13: on rocks

***Fissidens dubius*** P. Beauv. – 4, 5: on limestone rocks

Dicranaceae

***Dicranella heteromalla*** (Hedw.) Schimp. – 1: lignicolous; 9: on earth covered soil

***Dicranum scoparium*** Hedw. – 1: on bark; 6, 17: on soil

***Dicranum montanum*** Hedw. – 1: on bark

***Paraleucobryum longifolium*** (Hedw.) Loeske – 1: on soil

Ditrichaceae

***Ceratodon purpureus*** (Hedw.) Brid. – 9: on soil

***Ditrichum gracile*** (Mitt.) Kuntze – 4: on rocks; 5: on soil

Rhabdoweisiaceae

***Dichodontium palustre*** (Dicks.) M. Stech. – 8, 12: on irrigated rocks

***Rhabdoweisia fugax*** (Hedw.) Bruch & Schimp. – 10: on rocks

Pottiaceae

- Barbula convoluta*** Hedw. – 5, 13: on earth covered soil  
***Didymodon cordatus*** Jur. – 3: on vertical cliff  
***Didymodon tophaceus*** (Brid.) Lisa – 4: on rocks  
***Tortula muralis*** Hedw. – 20: on rocks  
***Tortella tortuosa*** (Hedw.) Limpr. – 3, 5, 17: on rocks  
***Weissia*** sp. Hedw. – 1: on rocks (without capsules)

Cinclidotaceae

- Cinclidotus aquaticus*** (Hedw.) Bruch & Schimp. – 7: on submerged limestone rock  
***Cinclidotus fontinaloides*** (Hedw.) P. Beauv. – 7, 14: on irrigated limestone rock

Orthotrichaceae

- Orthotrichum diaphanum*** Schrad. ex Brid. – 3: bark of *Salix*  
***Orthotrichum lyellii*** Hook. & Taylor – 3: bark of *Salix*  
***Orthotrichum obtusifolium*** Brid. – 3: bark of *Acer pseudoplatanus*  
***Orthotrichum speciosum*** Nees – 19: bark of *Salix*  
***Ulota crispa*** (Hedw.) Brid. – 16: on bark; 19: bark of *Salix caprea*;  
21: bark of *Fagus*

Bartramiaceae

- Bartramia halleriana*** Hedw. – 1, 11: on rocks  
***Bartramia pomiformis*** Hedw. – 4, 5: on rocks  
***Philonotis fontana*** (Hedw.) Brid. – 6: on marshy meadow  
***Plagiopus oederianus*** (Sw.) H. A. Crum & L. E. Anderson – 5: on rocks

Bryaceae

- Bryum capillare*** Hedw. var. ***capillare*** – 13: on limestone rocks  
***Bryum elegans*** Nees – 13: on rocks  
***Bryum pseudotriquetrum*** (Hedw.) P. Gaertn. – 1: on irrigated rocks  
***Bryum rubens*** Mitt. – 5: on rocks

Mniaceae

- Mnium lycopodioides*** Schwaegr. – 1, 4: on limestone rocks  
***Plagiomnium undulatum*** (Hedw.) T. J. Kop. – 1, 6: on earth covered rocks  
***Pohlia nutans*** (Hedw.) Lindb. – 9, 10: on earth covered rocks

***Pohlia wahlenbergii*** (F. Weber & D. Mohr.) A. L. Andrews – 2, 10:  
on rocks

***Rhizomnium punctatum*** (Hedw.) T. J. Kop. – 1, 2: on irrigated rocks

Amlystegiaceae

***Campylium protensum*** (Brid.) Kindb. – 6: on marshy meadow

Hylocomiaceae

***Hylocomium splendens*** (Hedw.) Schimp. – 1, 2: on rocks

***Pleurozium schreberi*** (Willd. ex Brid.) Mitt. – 11: on soil

Leskeaceae

***Pseudoleskeella catenulata*** (Brid. ex Schrad.) Kindb. – 7, 13: on  
rocks

Thuidiaceae

***Abietinella abietina*** (Hedw.) M. Fleisch. – 16: on soil

***Thuidium delicatulum*** (Hedw.) Schimp. – 4, 13: on rocks

***Thuidium tamariscinum*** (Hedw.) Schimp. – 2: on rocks

Brachytheciaceae

***Eurhynchium striatum*** (Hedw.) Schimp. – 6: on marshy meadow

***Homalothecium sericeum*** (Hedw.) Schimp. – 13: on limestone rock

Plagiotheciaceae

***Plagiothecium denticulatum*** (Hedw.) Schimp. – 5: on rocks

Climaciaceae

***Climacium dendroides*** (Hedw.) F. Weber & D. Mohr – 6: on soil

Hypnaceae

***Campylophyllum halleri*** (Hedw.) M. Fleisch. – 5: on vertical cliff

***Ctenidium molluscum*** (Hedw.) Mitt. – 4: on rocks

***Hypnum cupressiforme*** Hedw. – 20: on rocks

***Hygrohypnum luridum*** (Hedw.) Jenn. – 5: on irrigated rocks

***Orthothecium rufescens*** (Dicks. ex Brid.) Schimp. – 5: on rocks  
(Plate I, photo 3)

***Ptilium crista-castrensis*** (Hedw.) De Not. – 5, 17: on rocks

Neckeraceae

***Neckera crispa*** Hedw. – 4: on limestone rock



**Neckera complanata** (Hedw.) Hüb. – 1: on bark; 5: bark of *Acer*; 19: on rocks

**Thamnobryum alopecurum** (Hedw.) Gangulee – 15: on rocks

Anomodontaceae

**Anomodon viticulosus** (Hedw.) Hook & Taylor – 13: on limestone rock

## DISCUSSION

The results of this study suggest that the bryophyte diversity is quite high in the Apuseni Mountains. The main reason for that can be the several habitat types that can be found in this area.

**Metzgeria violacea** (Ach.) Dumort. – (*Plate I, photo 5*) – is an oceanic („atlantic”) geographical element – vulnerable (Ştefănuţ and Goia 2012) in Romania. It is known from Cobleş Valley, Arieşeni (Goia 2001, Goia and Ştefănuţ 2004, Goia and Schumaker 2004). We reported it from several localities from the Bihor and Pădurea Craiului Mountains as result of our collection trip. (Pócs 2006 as *M. temperata*, Sass-Gyarmati *et al.* 2007, 2008a, 2008b). The species was known earlier from Romania in the Cindrel Mts. (Boros and Vajda 1967 as *M. fruticulosa*, Gündisch 1977, Ştefureac 1986, Drăgulescu 2003).

**Cephalozia pleniceps** (Austin) Lindb. – rare liverwort from Bihor Mts. known only from Galbena valley and Padiş (Jakab 2000). According to Ştefănuţ (2008) it is distributed both in the Eastern and Southern Carpathians.

**Leiocolea badensis** Jörg. – known only from two localities from Bihor Mountains: Vadu Crişului, Casa Zmăului (Boros 1942a, b; Boros 1951) and Şuncuiuş (Boros 1942b, 1951). Rare species distributed just in a few localities in Romania: Harghita County – Topliţa; Bucegi Massif – Bucşoiu Peak, Retezat Mountains, toward Custura Peak and Argeş County - Great Gorges of Dâmboviţa River (Ştefănuţ 2008).

***Lophozia sudetica*** (Nees ex Huebener) Grolle – it is known only from two localities – Galbena Valley (Goia 2001) and Arieșul Mare Basin (Goia and Schumacker 2002). We have collected it on the rocks from the Cucurbăta Mare peak. Rare species distributed in Rodna, Căliman, Ciucaș, Făgăraș Mountains, Bucegi Massif, Cozia Mountain and Sibiu County: Cisnădioara and Sadu Valley (Ștefănuț 2008).

***Cinclidous aquaticus*** (Hedw.) Bruch & Schimp. – has been indicated as vulnerable species – we have found it on permanently irrigated rocks at Izvorul Coteșul Dobreștilor. *C. fontinaloides* (Hedw.) P. Beauv. is a relatively rare species in Bihor Mountains, occurring on temporary irrigated rocks. (Plate I, photo 4). Both species have scattered distribution in the Romanian Carpathians.

***Seligeria acutifolia*** (Lindb.) Broth. (Plate I, photo 2) – is a mainly sub-Mediterranean and montane taxon (Düll 1984). It is scattered throughout Europe. Besides on Sicily it has also been found on the Italian mainland, in Belgium, (former) Czechoslovakia, France, Germany, Great Britain and Greece, in Ireland, Norway, Poland, Romania, Sweden and former Yugoslavia (Düll 1985). It occurs in limestone rock crevices, data deficient (DD) in Romania (Ștefănuț and Goia 2012). We have found it on a shaded limestone rocks at Poarta lui Ionel Cave in the Ordâncușa Valley.

***Seligeria patula*** (Lindb.) Broth. – is an Alpine-Carpathian species, it was observed at several other places in the Bihor Mts., as in Ordâncușa Valley, Galbena gorge, at Barsa ice cave, and from Boghii Valley, near the Oșelu waterfall (Pócs 2006). *Seligeria patula*, similarly to *S. tristicha*, is always embedded in a thin or thick layer of cryptobiotic crust dominated by cyanobacteria.

***Ditrichum gracile*** (Mitt.) Kuntze (syn.: *D. crispatisimum* C. Müll. Hall.) Paris – a critically endangered species which requires constant humidity, *D. flexicaule* is more drought resistant (Casas *et al.* 1990). As it was not distinguished for long time from *D. flexicaule*, therefore its Romanian distribution should be investigated.

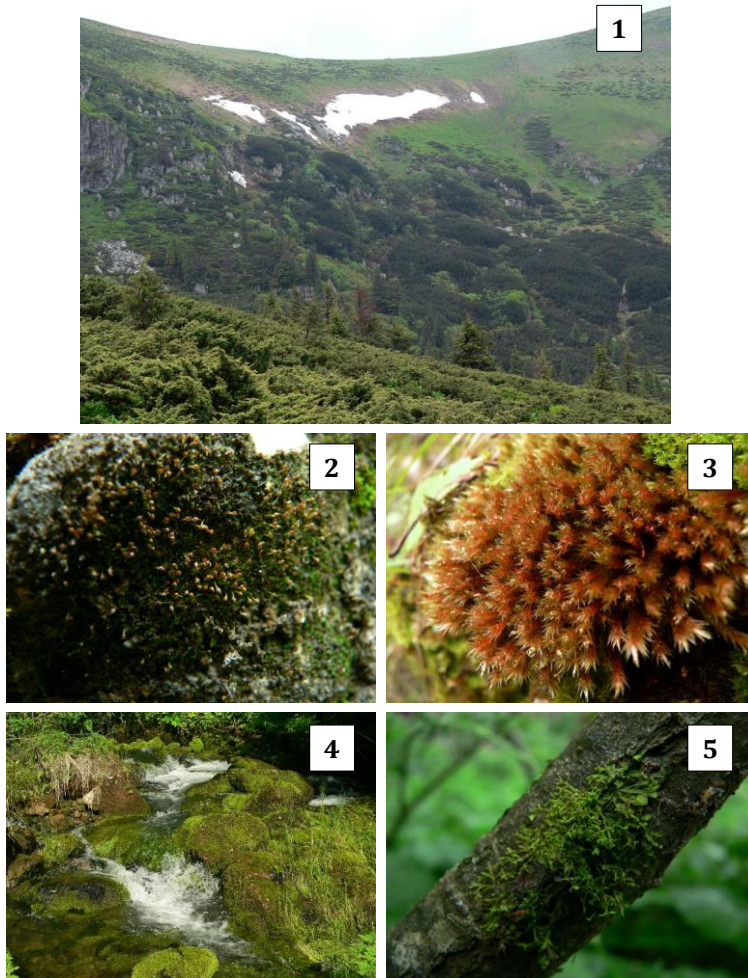
***Mnium lycopodioides*** Schwaegr. – vulnerable species, so far it was known only from a single locality in the Bihor Mountains – Stâna de Vale (Péterfi 1908). Based on Mohan (1998) it is distributed in a few localities in the Retezat and Bucegi Mountains, Strunzinu in Maramureş and Codrul secular Slătioara in Jud. Suceava.

***Didymodon cordatus*** Jur. – endangered species, a member of the southern-temperate European element, it is widespread in southern Europe, extending N to Germany and Belgium and E to the Caucasus and Turkey. According to Mohan it occurs only in Vidra in the Munţii Apuseni, furthermore on Cetate Deva and at Lapuş in Maramureş.

***Campylium protensum*** (Brid.) Kindb. – is an endangered species in Romania, many bryfloristical works did not separated it from its very close relative and more frequent *C. stellatum*. The high red list category of *C. protensum* should be reevaluated after taxonomical revision of herbarium specimens and future fieldworks, to provide the reliable distribution.

***Schistidium robustum*** (Nees & Hornsch.) Blom – critically endangered species in Romania (Ştefănuţ and Goia 2012), which is communicated in the country only from two localities: Mt. Rarău in the Eastern and Dâmbovicioara (Piatra Craiului Mts.) in the Southern Carpathians (Blom 1996). It is a calciphilous element known from the higher mountains and boreal parts of Europe and North America, from the Yukon area to the Caucasus Mountains. These records well reflect the multilateral character of the flora of Apuseni Mountains (see also Ştefureac 1975). Csergő (2002) has written an interesting study on the possible places of preglacial, interglacial and glacial relic populations of calciphilous flora in Apuseni Mountains. She emphasized the importance of peatlands, sheltered valleys, gorges, rockslides, rock faces and scree, as refugium areas, where relic populations could survive. We definitely should add to these the caves and cave entrances, with their special microclimate (very steady temperature, continuous high air moisture and limited light conditions). The steady temperature seems to be very cool in summertime, approaching the annual mean temperature, but this has great significance in wintertime, when in many caves frost does not occur. This seems to

ensure the life possibilities of Atlantic and Mediterranean elements, both plants and animals. (It is well known, that the caves in Apuseni Mountains have an invertebrate fauna very rich in endemics). These findings should enhance the knowledge of bryoflora, our results emphasizes the importance of further research in this highly valuable area.



**Plate I. Photo 1.** View from the Cucurbăta Mare summit. **Photo 2.** *Seligeria acutifolia* (Lindb.) Broth. **Photo 3.** *Orthothecium rufescens* (Brid.) B.S.G. **Photo 4.** *Cinclidotus aquaticus* (Hedw.) Bruch & Schimp. and *C. fontinaloides* (Hedw.) P. Beauv. **Photo 5.** *Metzgeria violacea* (Ach.) Dumort.

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## REFERENCES

- ARDELEAN, A. (2006). *Flora și vegetația județului Arad*. București. Editura Academiei Române, 508 pp.
- BLOM, H.H. (1996). A revision of the *Schistidium apocarpum* complex in Norway and Sweden. *Bryophytorum Bibliotheca* **49**: 1–333.
- BOROS, Á. (1942a). Bryologische Studien am Rande des Bihargebirges. *Scripta Botanica Musei Transsilvanici* **1**: 31–37.
- BOROS, Á. (1942b). A Sebes Kőrös menti barlangok szádájának növényvilága. (Die Vegetation der Höhleneingänge längs des Flusses Sebes Kőrös im Bihargebirge.) *Scripta Botanica Musei Transsilvanici* **1**: 152–156.
- BOROS, Á. (1951). Bryologische Beiträge zur Kenntnis der Flora von Ungarn und der Karpaten. *Acta Biologica Academiae Scientiarum Hungaricae* **2**(1-3): 369–409.
- BOROS, Á. & VAJDA, L. (1967). Bryologische Beiträge zur Kenntnis der Flora Transilvaniens. *Revue Bryologique et Lichénologique* **35**(1-4): 216–253.
- BOROS, Á.† & VAJDA, L. (1974). Bryogeographische Forschungen im Karstgebiet des Bihar-Gebirges. *Acta Botanica Academiae Scientiarum Hungaricae* **20**(1-2): 3–11.
- CASAS, C, BRUGUÉS, M. & CRÛS, R.M. (1990). *Ditrichum flexicaule* (Schwaegr.) Hampe y *D. crispatissimum* (C. Muell.) Par. en la península ibérica e islas baleares. *Botánica pirenaicocantábrica*, Jaca y Huesca, pp. 35–41.
- COLECTIV (1966). Flora și vegetația „Defileul Crisul Repede”. Flora briologică. *Contribuții Botanice Universității „Babeș-Bolyai”*, Grădina Botanică Cluj.
- CSERGŐ, A.M. (2002). The problem of the refugia of certain preglacial and glacial relict populations from the calciphilous flora of the Apuseni Mountains (Romania). *Contribuții Botanice* **37**: 251–262.
- CSÛRÖS, I. (1981). *A Nyugati-Szigethegység élővilágáról*. Tudományos és Enciklopédiai Könyvkiadó, Bukarest, 303 pp.
- DRĂGULESCU, C. (2003). Bryoflora județului Sibiu. *Acta oecologica. Studii și comunicări de ecologie și protecția mediului* **10**(1-2): 5–84.
- DÜLL, R. (1984). Distribution of the European and Macaronesian mosses (Bryophytina) I. *Bryologische Beiträge* **4**: 1–110.
- DÜLL, R. (1985). Distribution of the European and Macaronesian Mosses (Bryophytina), Part II. *Bryologische Beiträge* **5**: 101–232.
- GOFFINET, B. & SHAW, A.J. (eds.) (2009). *Bryophyte biology*. Cambridge University Press, Cambridge, 565 pp.
- GOIA, I. (2001). *Brioflora de pe substrat lemnos din bazinul superior al Arieșului. Studii briotaxonomice, corologice, ecologice și cenologice*. Cluj-Napoca (PhD Thesis). 312 pp.

- GOIA, I. (2005). Distribution of some rare bryophytes from Romania, identified from the upper basin of the Arieş River (II). *Contribuții Botanice* **40**: 101–104.
- GOIA, I. & MĂTASE, D. (2001). Bryofloristical research in the Someșul Cald gorges. *Contribuții Botanice* **36**: 15–24.
- GOIA, I. & SCHUMACKER, R. (2000). Researches on the bryophytes from rotten wood in the Arieșul Mic Basin. *Contribuții Botanice* **1**: 15–22.
- GOIA, I. & SCHUMACKER, R. (2002). The Bryophytes from rotten wood in the Arieșul Mare Basin. *Contribuții Botanice* **37**: 85–94.
- GOIA, I. & SCHUMACKER, R. (2003a). The study of corticolous bryophyte communities from the Ariesul Mic basin. *Contribuții Botanice* **38**: 57–68.
- GOIA, I. & SCHUMACKER, R. (2003b). Decaying wood communities from the upper basin of the Aries River conserving rare and vulnerable bryophytes. *Contribuții Botanice* **38**: 173–181.
- GOIA, I. & SCHUMACKER, R. (2004). The study of corticolous bryophyte communities from the Arieșul Mare Basin. *Contribuții Botanice* **39**: 57–68.
- GOIA, I. & ȘTEFĂNUȚ, S. (2004). Rare bryophytes from Romania, identified from the upper basin of the Arieș river. *Contribuții Botanice* **39**: 33–36.
- GÜNDISCH, F. (1977). Beitrag zu einer Moosflora des Zibin-Gebirges. *Studii și comunicări. Științe naturale* **21**: 43–77.
- GYÖRFFY, I. (1903). Bryológiai jegyzetek. Bryologische Notizen. *Magyar Botanikai Lapok* **2**: 146–150.
- HILL M.O., BELL N., BRUGEMAN-NANNENGA M.A., BRUGUÉS M., CANO M.J., ENROTH J., FLATBERG K.I., FRAHM J.-P., GALLEGO M.T., GARILLETI R., GUERRA J., HEDENÁS L., HOLYOAK D.T., HYVÖNEN J., IGNATOV M.S., LARA F., MAZIMPAKA V., MUÑOZ J. & SÖDERSTRÖM L. (2006). An annotated checklist of the mosses of Europe and Macaronesia. *Journal of Bryology* **28**: 198–267.
- JAKAB, G. (1999). Three bryophytes new to Romania. *Studia Botanica Hungarica* **30-31**: 87–94.
- JAKAB, G. (2000). Adatok a Pádis karsztvidékének (Bihari-hegység) mohafldrájához. *Crisicum* **3**: 65–72.
- LÜTH, M. (2002). *Dicranum transsylvanicum* (Musci, Dicranaceae), a new species from Romania. *Cryptogamie, Bryologie* **23**(1): 17–21.
- MÁTYÁS, V. (1988). *Bihar-hegység turistakalauz*. Sport Kiadó, Budapest, 213 pp.
- MOHAN, G. (1996). Briofite din Munții Codru-Moma. *Acta Botanica Horti Bucurestiensis*. Lucrările Grădinii Botanice **1994-1995**: 47–54.
- MOHAN, G. (1998). Catalogul briofitelor din România. *Acta Botanica Horti Bucurestiensis*. Ed. Univ. București, 432 pp.
- ORĂȘEANU, I., PARICHI, M. & SCRĂDEANU, D. (2007). Intrinsic vulnerability of Cotețul Dobreștilor Karst aquifer (Bihor Mountain, Romania). *Environmental Geology* **51**(5): 713–718.
- ORBÁN, S. & SASS-GYARMATI, A. (2003). Új adatok a Retyezát hegység mohafldrájához. (New data to the bryophyte flora of Retezat Mountains). *Acta Academiae Paedagogicae Agriensis, Sectio Biologiae* **24**: 137–145.
- PÁLL, Ș. (1960). Contribuții la cunoașterea brioflorei din Cheia Turului, Cheile Turzii, Colții Trascăului și Munții Bedeleului. (Contribution à la connaissance de la bryoflore de Cheia Turului, de Cheile Turzii, de Colții Trascăului et des Monts de Bedeleu.) *Studia Universitatis "Babeș-Bolyai", Cluj, Series Biologia* **2**(2): 1–5.

- PÁLL, Ş. (1962). Contribuţii la cunoaşterea brioflorei de pe Muntele Pietrele Albe (Masivul Vlădeasa). *Studii şi cercetări de biologie – Seria biologie vegetală* **14**: 30–32.
- PÁLL, Ş. (1963). Contribution à l'étude de la bryoflore des monts Apuseni (Depression de Padis et Izbucl Ponorului). *Studia Universitatis "Babeş-Bolyai", Cluj, Series Biologia* **1**: 7–12.
- PÉTERFI, M. (1908). Adatok a Biharhegység mohafldrájának ismeretéhez. *Mathematikai és Természettudományi Közlemények* **30**: 261–332.
- PÉTERFI, M. (1910). Adatok Magyarország mohafldrájához. (Beiträge zur Kenntnis der Moosflora Ungarns.) *Magyar Botanikai Lapok* **9**(10-12): 1–14.
- PLĂMADĂ, E. (1998). Flora briologica a României, Clasa Musci. Vol. I. Fasc. I. *Sphagnales – Andreaeales – Tetraphidales – Buxbaumiales – Schistostegales – Polytrichales – Fissidentales – Archidiales – Seligeriales*. Cluj-Napoca: Presa Universitară Clujană, 230 pp.
- PLĂMADĂ, E. & GOIA, I. (1994). Flora şi vegetaţia briofitică din rezervaţia naturală Cheile Turzii. (The bryophytic flora and vegetation in the natural reservation Turda Canyon.) *Contribuţii Botanice 1993-1994*: 85–95.
- PLĂMADĂ, E., GOIA, I. & DUMITRU, C. (2000). New or extremely rare species recorded in the Romanian bryoflora. *Contribuţii Botanice 1999-2000*: 23–34.
- PÓCS, T. (2005). Aerophytic cyanobacteria from the Munţii Apuseni (Romanian Western Carpathians, Transylvania), I. The epilithic crusts at the entrance of Huda lui Păpară Cave. *Kanitzia* **13**: 99–108.
- PÓCS, T. (2006). Adatok az Erdélyi Szigethegység mohafldrájának ismeretéhez. (Contribution to the Bryoflora of Romanian Western Carpathians.) In: KALAPOS T. (ed.): *Jelez a Flóra és a Vegetáció. A 80 éves Simon Tibort köszöntjük*. – Scientia, Budapest, pp. 9–24.
- PÓCS, T., GOIA, I., KIS, G., ORBÁN, S., SASS-GYARMATI, A. & VAN ZANTEN, B.O. (2002). *Hilpertia velenovsky* (Schiffn.) Zander and other pottioid mosses (Bryophyta) new to Romania. Studies on the cryptogamic vegetation on loess cliffs, IX. *Contribuţii Botanice* **37**: 13–24.
- RĂŢIU, O. & BOŞCAIU N. (1967). Vegetaţia mlaştinilor de pe Valea Ieduţului. *Studia Universitatis "Babeş-Bolyai", Cluj, Series Biologia* **12** (2): 33–38.
- SASS-GYARMATI, A., MOLNÁR, K., ORBÁN, S., PÓCS, T. & ERZBERGER, P. (2005a). *The cryptogamic flora of the Zgurasti Cave and surroundings (Apuseni Mountains, Romania)*. XVII International Botanical Congress. Vienna, Austria: Austria Center Vienna, 17–23 July 2005 Abstracts, p. 619.
- SASS-GYARMATI, A., PÓCS, T. & ORBÁN, S. (2005b). Contribution to the knowledge of the bryoflora of Natural Reserve Detunata (Metaliferi Mountains, Romania). *Studia Botanica Hungarica* **36**: 123–130.
- SASS-GYARMATI, A., GOIA, I. & PÓCS, T. (2007). *The distribution of Metzgeria violacea (Ach.) Dumort in the Apuseni Mountains (Romanian Western Carpathians)*. European Committee for the Conservation of Bryophytes, 7th Conference. Bryophyte Conservation. Kolozsvár, Romania, 2–7 September 2007, p. 13.
- SASS-GYARMATI, A., GOIA, I. & PÓCS, T. (2008a). The distribution of *Metzgeria violacea* in the Apuseni Mountains (Romanian Western Carpathians). *Folia Cryptogamica Estonica* **44**: 121–124.

- SASS-GYARMATI, A., MOLNÁR, K., ORBÁN, S., PÓCS, T. & ERZBERGER, P. (2008b). The cryptogamic flora of the Zgurăști Sinkhole System and its surroundings. (Apuseni Mountains, Romania). *Kanitzia* **16**: 25–44.
- SÖDERSTRÖM, L., HAGBORG, A., VON KONRAT, M., BARTHOLOMEW-BEGAN, S., BELL, D., BRISCOE, L., BROWN, E., CARGILL, D.C., COSTA, D.P., CRANDALL-STOTLER, B.J., COOPER, E.D., DAUPHIN, G., ENGEL, J.J., FELDBERG, K., GLENNY, D., GRADSTEIN, S.R., HE, X., HEINRICH, J., HENTSCH, J., ILKIU-BORGES, A.L., KATAGIRI, T., KONSTANTINOVA, N.A., LARRAÍN, J., LONG, D.G., NEBEL, M., PÓCS, T., PUCHE, F., REINER-DREHWALD, E., RENNER, M.A.M., SASS-GYARMATI, A., SCHÄFER-VERWIMP, A., MORAGUES, J.G.S., STOTLER, R.E., SUKKHARAK, P., THIERS, B.M., URIBE, J., VÁÑA, J., VILLARREAL, J.C., WIGGINTON, M., ZHANG, L. & ZHU, R.-L. (2016): World checklist of hornworts and liverworts. *PhytoKeys* **59**: 1–828.
- ȘTEFĂNUȚ, S. (2008). *The Hornwort and Liverwort Atlas of Romania*. Edit. Ars Docendi – Universitatea din București, București, 510 pp.
- ȘTEFĂNUȚ, S. & GOIA, I. (2012). Checklist and Red List of Bryophytes of Romania. *Nova Hedwigia* **95**(1-2): 59–104.
- ȘTEFUREAC, T. (1975). Consideration sur le caractère bryogeographique des Monts Apuseni (Carpathes Occidentales) de Roumanie. *Revue Bryologique et Lichénologique* **41**(3): 309–314.
- ȘTEFUREAC, T. (1977). Noi contribuții la ecologia și corologia Sfagnaceelor din România. *Studii și Comunicari Muz. Șt. Nat. Bacău* **1976-1977**: 97–112.
- ȘTEFUREAC, T. (1986). Briofite de reală valoare științifică din flora Carpaților României. Ocrotirea și conservarea lor. Lucrările Grădinii Botanice din București. *Acta Botanica Horti Bucurestiensis* **1985-1986**: 187–199.

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## APPENDIX

List of collecting sites from the Apuseni Mts. (Nyugati Szigethegység)

1. Munții Bihorului (Bihar Hegység), Headwaters of Crișul Negru (Fekete Körös) River on the NW slope of Vf. Cucurbăta Mare (Nagy Bihar csúcs), at 1050 m alt. N 46°26'53.2", E 22°40'06.8" Hab.: *Abieti-Fagetum* on schist bedrock. Coll.: S. & T. Pócs, A. S.-Gyarmati. Date: 22.06.2006. No. 06025
2. Munții Bihorului (Bihar-hegység), Headwaters of Crișul Negru (Fekete-Körös) river on the NW slope of Vf. Cucurbăta Mare (Nagy Bihar csúcs), below the Amazon Falls, at 946 m alt. N 46°27'08.9", E 22°39'54.1" Hab.: Shady gorge with *Alnus viridis* bushes. Coll.: S. & T. Pócs, A. S.-Gyarmati. Date: 22.06.2006. No. 06026
3. Munții Bihorului (Bihar-hegység), 1.5 km NW of Gârda de Sus village near Dobrești, in the Gârda Seacă Valley at 765 m alt. N 46°28'36.1", E 22°48'43.8". Hab.: Riverine *Salix* bush and calcareous cliffs. Coll.: S. & T. Pócs, A. S.-Gyarmati. Date: 23.06.2006. No. 06027
4. Munții Bihorului (Bihar-hegység), Gârda Seacă Valley, 6 km NW of Gârda de Sus village, at 816-825 m alt. N 46°29'42.6", E 22°47'12.9". Hab.: E facing limestone cliff in the river gorge. Coll.: S. & T. Pócs, A. S.-Gyarmati. Date: 23.06.2006. No. 06028
5. Munții Bihorului (Bihar-hegység), Gârda Seacă Valley, 7 km NW of Gârda de Sus village, at 840 m alt. on the E foot of Dosul Hodobanii. N 46°29'50.8", E 22°47'03.4". Hab.: E facing limestone cliff in the river gorge, covered partly by *Seslerietum rigidae* sward. Coll.: S. & T. Pócs, A. S.-Gyarmati. Date: 23.06.2006. No. 06029
6. Munții Bihorului (Bihar-hegység), Gârda Seacă Valley, E of Hodobani village and of the Piatra Tăuzului summit, at 920 m alt. N 46°30'50", E 22°47'10.1". Hab.: Meadows, spring bog and *Abieti-Fagetum*. Coll.: S. & T. Pócs, A. S.-Gyarmati. Date: 23.06.2006. No. 06030
7. Munții Bihorului (Bihar-hegység), Izbuc Cotețul Dobreștilor, 3 km NW of Gârda de Sus and 1 km from Dobrești, in the Gârda Seacă Valley at 770 m alt. N 46°28'40.9", E 22°48'32.8". Hab.: In shady cliffs along streamlet. Coll.: S. & T. Pócs, A. S.-Gyarmati Date: 23.06.2006. No. 06031
8. Munții Bihorului (Bihar-hegység), in the saddle between Vf. Cucurbăta Mică and Vf. Cucurbăta Mare (Kis és Nagy Bihar csúcok), at 1690 m alt. N 46°26'07", E 22°41'. Hab.: In a snow valley, at the edge of melting snow, on dripping granitic rocks. Coll.: S. & T. Pócs, A. S.-Gyarmati Date: 24.06.2006. No. 06032
9. Munții Bihorului (Bihar-hegység), on the summit ridge of Vf. Cucurbăta Mare (Nagy Bihar csúcs), at 1840 m alt. N 46°26'20", E 22°41'24.8". Hab.: Subalpine grassland and granitic scree. Coll.: S. & T. Pócs, A. S.-Gyarmati. Date: 24.06.2006. No. 06033
10. Munții Bihorului (Bihar-hegység), on the NNE slope of the summit ridge of Vf. Cucurbăta Mare (Nagy Bihar csúcs), at 1830 m alt. N 46°26'20", E 22°41'24.8". Hab.: On granitic cliffs. Date: 24.06.2006. Coll.: T. Pócs, A. S.-Gyarmati and A. Vojtkó. No. 06034
11. Munții Bihorului (Bihar-hegység), in the NE facing glacial valley (V. Cepilor) below Vf. Cucurbăta Mare (Nagy Bihar csúcs), at 1554 m alt. N 46°26'39.1", E

- 22°41'45.3". Hab.: Subalpine dwarf pine (*Pinus mugo*) bush interwoven by streamlets and transitional bogs. Date: 24.06.2006. Coll.: T. Pócs, A. S.-Gyarmati and A. Vojtkó. No. 06035
12. Munții Bihorului (Bihar-hegység), in Valea Cepilor 3 km NE of Vf. Cucurbăta Mare (Nagy-Bihar csúcs), at 1150 m. N 46°26'59.2", E 22°42'33.03". Hab.: On the irrigated stones of rivulet at the lower limit of spruce forest belt. Coll.: T. Pócs. Date: 24.06.2006. No. 06036
13. Pădurea Craiului (Király-erdő). Cheile Albioarei gorge in the valley of Roșia streamlet N of Țarina village, 5-6 km WNW of Roșia, at 380m alt. N 46°50'26.3", E 22°22'16.8". Hab.: *Asplenio-Seslerietum rigidae* swards on limestone cliffs, with many pine trees and *Ceterach officinarum*. Coll.: S. & T. Pócs, A. S.-Gyarmati. Date: 25.06.2006. No. 06038
14. Pădurea Craiului (Király-erdő). Cheile Albioarei gorge near Peștera Jofi (Zsófi bg.), in the Roșia valley N of Țarina village, 6 km WNW of Roșia, at 400 m alt. N 46°50'54.3", E 22°22'09.4". Hab.: Calcicolous swards surrounded by mesic forest. Coll.: T. Pócs Date: 25.06.2006. No. 06039
15. Pădurea Craiului (Király-erdő). Sohodol Valley (Aszövölgy) near Albioara Forest House, at 420 m alt. N 46°50'59", E 22°22'12". Hab.: *Phyllitidi-Fagetum*. Coll.: S. & T. Pócs, A. S.-Gyarmati. Date: 25.06.2006 No. 06040
16. Pădurea Craiului (Király-erdő). V. Toplița (Tapolca) E of Lacul Vida above Luncasprie village, at 250-270 m alt. N 46°51'47", E 22°19'05" Hab.: *Carpino-Fagetum* with scattered *Abies alba*, along streamlet, on red sandstone. Coll.: S. & T. Pócs, A. S.-Gyarmati. Date: 25.06.2006. No. 06041
17. Munții Bihorului (Bihar-hegység), on the carstic plateau, at the top of E edge of Cheile Ordâncușii gorge, 1 km NNW of Scărișoara (Aranyosfő), at 1090-1125 m altitude, N 46°28'25.6", E 22°51'36.4". Hab.: Montane beach forest (*Abieti-Fagetum*) on calcareous, rocky soil. Coll.: T. Pócs, A. S.-Gyarmati Date: 27.06.2006. No. 06043
18. Munții Bihorului (Bihar-hegység), in limestone gorge of Cheile Ordâncușii NE of Gârda de Sus, near the Poarta lui Ionel Cave, at 775 m alt. N 46°27'59.05", E 22°50'17.55". Hab.: *Asplenio-Poëtum nemoralis* and *Seslerietum rigidae transsilvanicum* on the half shady, vertical cliffs. Coll.: T. Pócs, A. S.-Gyarmati. Date: 27.06.2006. No. 06044
19. Munții Bihorului (Bihar-hegység), near the upper end of Cheile Ordâncușii gorge NE of Gârda de Sus, at 862 m alt. N 46°28'42.09", E 22°50'36.07". Hab.: *Asplenio-Poëtum nemoralis* and *Seslerietum rigidae transsilvanicum* on the half shady, vertical cliffs. Coll.: T. Pócs, A. S.-Gyarmati. Date: 27.06.2006. No. 06045
20. Munții Codru-Moma (Béli-hegység). At the entrance of Câmpineasca Cave (Jókai bg.) at N end of Izbuc village, at 410 m alt. N 46°27'09.2", E 22°27'44.8". Hab.: Dry limestone rocks with xerothermic vegetation. Coll.: T. Pócs, A. S.-Gyarmati. Date: 27.06.2006. No. 06046
21. Munții Codru-Moma (Béli-hegység). Dosul Laurului Reserve 8 km NNW of Zimbru village, 15 km N of Gurahonț town, jud. Arad, at 550-600 m alt. N 46°23'52", E 22°22'50". Hab.: *Carpino-Fagetum*, only locality of *Ilex aquifolium* in Romania. Coll.: T. Pócs, A. S.-Gyarmati. Date: 27.06.2006. No. 06047