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RESEARCHES ON THE BRYOPHYTES FROM ROTTEN WOOD IN THE ARIEȘUL MARE BASIN

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Abstract: The saprolignicolous bryoflora of the Arieșul Mare Basin includes 150 species (56 liverworts, 94 mosses), nine varieties (two liverworts, seven mosses) and one form (mosses), belonging to 35 families and 14 orders. 56 taxa are new for the basin of the Big Arieș River (47 species, eight varieties and one form). According to the European Red List of Bryophytes *Buxbaumia viridis* is vulnerable and *Lophozia ascendens* is rare.

The species richness is higher in shaded, humid and colder habitats, where boreal, subboreal, suboceanic and oceanic species are well represented.

Even if the abandoned wood reveal a deficiency of the silvocultural management in the study area, it is favourable for the development of the saprolignicolous bryophytes. The forest microclimate changes after silvocultural management and forest fragmentation are less suitable for bryophytes, fungi or invertebrates living on decaying wood. A future, more successfully management should protect the largest and richest forests lots, connected by corridors with smaller forest patches and preserve some fallen trees all over the area.

Introduction

The Arieșul Mare basin (420 km²) is located in the north-western part of Romania and belongs to the Apuseni Mountains. Administratively, the studied area cover the north-western part of Alba district, only a small area of Gârda Seacă Basin belong to the Bihor district.

The Arieșul Mare river cross the studied area from west to east. The valley is 36.2 km length. The geomorphologic features are the same as for the whole Apuseni Mountains: small and medium altitudes (with the highest altitude in Biharia Peak 1849 m a. s. l.), absence of the glacial relief, substituted by the periglacial and crionival one, a good conservation of the geomorphologic surfaces and a pregnant and spectacular development of limestones relief.

Dominants are the crystalline rocks, well represented are the sedimentary ones. Magmatites occur sporadically, over restricted area.

The petrographic diversity generated a mosaic of soils consisting of brown acid, brown clay-iluvial, brown eu-mesobasic, podzol soils, together with azonal alluvial and peaty soils and intrazonal "terra rosa" and rendsins soils occurring in limestone's regions.

The region has a mountain climate, with mean annual temperature of 7,46 °C and mean annual precipitation of 724 mm. The high altitude determines a change

of this climatic factors, mean annual temperature decreasing from the base of the mountain (7,46 °C), towards the top (3 °C).

The vegetation is mainly represented by beech forests, mixed forests and spruce forests. Along the rivers are small patches of alder forests.

Method

The bryofloristical samples were collected and identified between 1994 -1999. The results of our identification were compared with those from literature. There are a lot of publications which mention some bryophyte species from this region [3, 16, 17, 18, 20, 22, 25, 26, 27], some of them dealing with cormophyte vegetation [5, 8, 23]. The most important study has been carried out by Péterfi Marton [21]. Our list compile literature and our own results. All new records are marked by *, those indicated only in literature, but not yet found in the field by bus are marked by #.

The species nomenclature was updated according to Grolle [14] for liverworts and Corley & al. and Corley & Crundwell [6, 7] for mosses, patronym abbreviation follow Brummit & Powell [4]. The ecological preferences has been established according Ellenberg scale, based on the data published by Düll [13], Boros [2], Orbán [19] and our own pH records.

The phytogeographical elements were analyzed following Düll [9, 10, 11, 12] synthesis.

Species conspect

HEPATICAE

METZGERIALES

Metzgeriaceae: 1. *Metzgeria conjugata* Lindb., 2. *Metzgeria furcata* (L.) Dumort., 3. *Apometzgeria pubescens* (Schrank) Kuwah. (syn. *Metzgeria pubescens* (Schrank) Raddi); **Aneuraceae:** 4. *Riccardia latifrons* (Lindb.) Lindb., 5. **Riccardia palmata* (Hedw.) Carruth.; **Pelliaceae:** 6. **Pellia neesiana* (Gott.) Limpr.; **Pallaviciniaceae:** 7. **Moerckia hibernica* (Hook.) Gott. (syn. *Moerckia flotoviana* (Nees) Schiffn.);

JUNGERMANNIALES

Lophoziaaceae: 8. **Barbilophozia attenuata* (Mart.) Loeske (syn. *Barbilophozia gracilis* (Schleich. ex Steph.) K. Müll.), 9. **Lophozia ascendens* (Warnst.) Schust., 10. **Lophozia bantriensis* (Hook.) Steph. (incl. *L. collaris* (Nees) Schljak.), 11. **Lophozia excisa* (Dicks.) Dumort., 12. **Lophozia incisa* (Schrad.) Dumort., 13. **Lophozia longidens* (Lindb.) Macoun, 14. **Lophozia longiflora* (Nees) Schiffn., 15. **Lophozia sudetica* (Nees ex Hüb.) Grolle, 16. *Lophozia ventricosa* (Dicks.) Dumort., 17. **Anastrophyllum michauxii* (F. Web.) Buch, 18. # *Anastrophyllum minutum* (Schreb.) Schust. (syn. *Sphenolobus minutus* (Schreb.) Berggr.), 19. **Tritomaria exsecta* (Schrad.) Loeske; **Jungermanniaceae:** 20. # *Jamesoniella autumnalis* (DC.) Steph., 21. *Jungermannia gracillima* Sm., 22. **Jungermannia hyalina* Lyell, 23. *Jungermannia leiantha* Grolle (syn. *Jungermannia lanceolata* auct.), 24. *Jungermannia sphaerocarpa* Hook. (syn. *Solenostoma sphaerocarpum*

(Hook.) Steph.), **Gymnomitriaceae**: 25. *Marsupella emarginata* (Ehrh.) Dumort.; **Plagiochilaceae**: 26. *Pedinophyllum interruptum* (Lindb.) Lindb., 27. *Plagiochila porelloides* (Torrey ex Nees) Lindenb.; **Geocalycaceae**: 28. *Lophocolea bidentata* (L.) Dumort. *- var. *rivularis* (Raddi) Warnst., 29. **Lophocolea heterophylla* (L.) Dumort., 30. *Chiloscyphus polyanthos* (L.) Corda, 31. *Harpanthus scutatus* (Web. et Mohr) Spruce; **Scapaniaceae**: 32. *Diplophyllum albicans* (L.) Dumort., 33. **Diplophyllum obtusifolium* (Hook.) Dumort., 34. *Scapania aequiloba* (Schwägr.) Dumort., 35. **Scapania apiculata* Spruce, 36. **Scapania helvetica* Gott., 37. # *Scapania irrigua* (Nees) Nees, 38. *Scapania nemorea* (L.) Grolle, 39. **Scapania scandica* (H. Arn. et Buch) Macv., 40. **Scapania umbrosa* (Schrad.) Dumort., 41. *Scapania undulata* (L.) Dumort.; **Cephaloziaceae**: 42. **Cephalozia bicuspidata* (L.) Dumort. *- var. *lammersiana* (Hüb.) Breidl., 43. **Cephalozia catenulata* (Hüb.) Lindb., 44. **Cephalozia leucantha* Spruce, 45. **Cephalozia lunulifolia* (Dumort.) Dumort., 46. **Nowelia curvifolia* (Dicks.) Mitt.; **Lepidoziaceae**: 47. *Lepidozia reptans* (L.) Dumort., 48. **Bazzania trilobata* (L.) S. Gray; **Calypogeiaceae**: 49. *Calypogeia azurea* Stotler et Crotz (syn. *Calypogeia trichomanis* auct.), 50. **Calypogeia fissa* (L.) Raddi, 51. **Calypogeia muelleriana* (Schiffn.) K. Müll., 52. *Calypogeia suecica* (H. Arn. et J. Perss.) K. Müll.; **Pseudolepicoleaceae**: 53. *Blepharostoma trichophyllum* (L.) Dumort; **Ptilidiaceae**: 54. *Ptilidium ciliare* (L.) Hampe, 55. *Ptilidium pulcherrimum* (G. Web.) Vainio; **Radulaceae**: 56. *Radula complanata* (L.) Dumort;

MUSCI

S P H A G N A L E S

Sphagnaceae: 57. **Sphagnum quinquefarium* (Lindb. ex Braithw.) Warnst.;

T E T R A P H I D A L E S

Tetraphidaceae: 58. *Tetraphis pellucida* Hedw.;

P O L Y T R I C H A L E S

Polytrichaceae: 59. *Pogonatum urnigerum* (Hedw.) P. Beauv., 60. *Polytrichum alpinum* Hedw., 61. *Polytrichum formosum* Hedw., 62. *Polytrichum juniperinum* Hedw., 63. *Atrichum undulatum* (Hedw.) P. Beauv.;

B U X B A U M I A L E S

Buxbaumiaceae: 64. *Buxbaumia viridis* (Moug. ex Lam. & DC.) Brid. ex Moug. & Nestl.;

F I S S I D E N T A L E S

Fissidentaceae: 65. *Fissidens dubius* Wils. ex Mitt. (syn. *Fissidens cristatus* Wils. ex Mitt.), 66. *Fissidens taxifolius* Hedw.;

D I C R A N A L E S

Dicranaceae: 67. # *Leucobryum glaucum* (Hedw.) Ångstr., 68. # *Paraleucobryum longifolium* (Hedw.) Loeske, 69. # *Dicranum flexicaule* Brid. (*D. congestum* auct.), 70. *Dicranum fuscescens* Sm., 71. *Dicranum majus* Sm., 72. *Dicranum montanum* Hedw., -*var. *pulvinatum* (Pfeffer) Broth. 73. **Dicranum muehlenbeckii* B., S. & G., 74. *Dicranum scoparium* Hedw. -*var. *orthophyllum* Brid. , 75.# *Campylopus*

pyriformis (K. F. Schultz) Brid., 76. *Dicranodontium denudatum* (Brid.) Britt., 77. *Dicranella heteromalla* (Hedw.) Schimp., 78. *Ceratodon purpureus* (Hedw.) Brid. - var. *flavisetus* Limpr., 79. *Ditrichum flexicaule* (Schwägr.) Hampe, 80. **Ditrichum heteromallum* (Hedw.) Britt., 81. *Ditrichum pusillum* (Hedw.) Hampe;

POTTIALES

Pottiaceae: 82. *Tortula ruralis* (Hedw.) Gaertn., 83. **Didymodon ferrugineus* (Schimp. ex Besch.) M. Hill, 84. *Tortella tortuosa* (Hedw.) Limpr. -*var. *tenella* (Walth. et Mol).;

GRIMMIALES

Grimmiaceae: 85. *Schistidium apocarpum* (Hedw.) B. & S.;

FUNARIALES

Splachnaceae: 86. **Tayloria tenuis* (With.) Schimp., 87. **Splachnum sphaericum* Hedw.;

BRYALES

Bryaceae: 88. *Pohlia elongata* Hedw., 89. *Pohlia nutans* (Hedw.) Lindb. .- *f. *caespitosa* (H. et H.) Broth., 90. *Pohlia wahlenbergii* (Web. & Mohr.) Andr. (syn. *Pohlia albicans* (Wahlenb.) Lindb., 91. *Bryum capillare* Hedw., 92. **Bryum elegans* Nees ex Brid., 93. *Bryum pseudotriquetrum* (Hedw.) Gaertn., Meyer & Schreb., 94. *Bryum subelegans* Kindb. (syn. *Bryum flaccidum* Brid.); **Mniaceae:** 95. **Mnium hornum* Hedw., 96. *Mnium thomsonii* Schimp. (syn. *Mnium orthorrhynchum* auct.), 97. *Rhizomnium punctatum* (Hedw.) T. Kop., 98. *Plagiomnium cuspidatum* (Hedw.) T. Kop., 99. *Plagiomnium rostratum* (Schrad.) T. Kop.; **Bartramiaceae:** 100. *Plagiopus oederiana* (Sw.) Crum & Anderson;

ISOBRYALES

Climaciaceae: 101. *Climacium dendroides* (Hedw.) Web. & Mohr.; **Leskeaceae:** 102. # *Leskea polycarpa* Hedw., 103. *Pseudoleskeella nervosa* (Brid.) Nyh., 104. *Pterigynandrum filiforme* Hedw.; **Thuidiaceae:** 105. *Anomodon attenuatus* (Hedw.) Hüb., 106. *Thuidium abietinum* (Hedw.) Bruch. & al., 107. # *Thuidium delicatulum* (Hedw.) Mitt., 108. *Thuidium philibertii* Limpr., 109. # *Thuidium recognitum* (Hedw.) Lindb., 110. # *Thuidium tamariscinum* (Hedw.) Bruch. & al.;

HYPNOBRYALES

Amblystegiaceae: 111. *Cratoneuron filicinum* (Hedw.) Spruce, 112. *Campylium halleri* (Hedw.) Lindb., 113. *Campylium sommerfeltii* (Myr.) J. Lange, 114. *Campylium stellatum* (Hedw.) J. Lange & C. Jens., 115. *Amblystegium serpens* (Hedw.) Bruch. & al., 116. **Amblystegiella confervoides* (Brid.) Loeske, 117. *Amblystegiella subtilis* (Hedw.) Loeske, 118. *Sanionia uncinata* (Hedw.) Loeske (syn. *Drepanocladus uncinatus* (Hedw.) Warnst.), 119. *Calliergonella cuspidata* (Hedw.) Loeske (syn. *Acrocladium cuspidatum* (Hedw.) Lindb.); **Brachytheciaceae:** 120. *Isothecium alopecuroides* (Dubois) Isov. (syn. *Isothecium viviparum* Lindb., *Isothecium myurum* Brid.) -* var. *longicuspis* Schiffn, 121. *Homalothecium sericeum* (Hedw.) Bruch. & al. *- var. *tenellum* Lange, 122. *Brachythecium populeum* (Hedw.) Bruch. & al., 123. *Brachythecium rivulare* Bruch. & al., 124. *Brachythecium rutabulum* (Hedw.) Bruch. & al., 125.

Brachythecium salebrosum (Web. & Mohr) Bruch. & al. - *var. *angustifolium* Warnst., 126. *Brachythecium velutinum* (Hedw.) Bruch. & al., 127. **Rhynchostegiella tenuicaulis* (Spruce) Kartt., 128. **Cirriphyllum piliferum* (Hedw.) Grant., 129. **Rhynchostegium murale* (Hedw.) Bruch. & al., 130. **Eurhynchium angustirete* (Broth.) T. Kop. (syn. *Eurhynchium zetterstedtii* Størm.), 131. *Eurhynchium hians* (syn. *Eurhynchium swartzii* (Turn.) Curn.), 132. # *Eurhynchium praelongum* (Hedw.) Bruch. & al. (syn. *Eurhynchium stokesii* H. Wint.); **Plagiotheciaceae**: 133. **Plagiothecium curvifolium* Schlieph. ex Limpr., 134. # *Plagiothecium denticulatum* (Hedw.) Bruch. & al., 135. *Plagiothecium laetum* Bruch. & al., 136. *Plagiothecium nemorale* (Mitt.) Jaeg. (syn. *Plagiothecium sylvaticum* auct., *Plagiothecium neglectum* Mönk.), 137. **Plagiothecium platyphyllum* Mönk., 138. **Plagiothecium succulentum* (Wils.) Lindb., 139. *Herzogiella seligeri* (Brid.) Iwats. 140. *Isopterygiopsis pulchella* (Hedw.) Iwats.; **Hypnaceae**: 141. *Orthothecium rufescens* (Brid.) Bruch. & al., 142. *Pylaisia polyantha* (Hedw.) Schimp., 143. *Platygyrium repens* (Brid.) Bruch. & al., 144. *Hypnum cupressiforme* Hedw., 145. **H. mammillatum* (Brid.) Loeske, 146. **Hypnum pratense* (Rabenh.) W. Koch ex Hartm., 147. *Rhytidiadelphus loreus* (Hedw.) Warnst., 148. *Rhytidiadelphus squarrosus* (Hedw.) Warnst., 149. *Rhytidiadelphus triquetrus* (Hedw.) Warnst., 150. *Pleurozium schreberi* (Brid.) Mitt.

Analysis of the bryoflora

The present paper records 150 species (56 liverworts, 94 mosses), nine varieties (two liverworts, seven mosses) and one form (mosses), belonging to 35 families and 14 orders. We consider that the species inventory is rich, comparing with the Arieşul Mic basin [15].

The following 56 taxa are new for the upper basin of Arieş river (47 species, eight varieties and one form): *Riccardia palmata*, *Pellia neesiana*, *Moerckia hibernica*, *Barbilophozia attenuata*, *Lophozia ascendens*, *L. bantriensis*, *L. excisa*, *L. incisa*, *L. longiflora*, *L. longidens*, *L. sudetica*, *Anastrophyllum michauxii*, *Tritomaria exsecta*, *Jungermannia hyalina*, *Lophocolea bidentata* var. *rivularis* *Lophocolea heterophylla*, *Diplophyllum obtusifolium*, *Scapania apiculata*, *S. helvetica*, *S. scandica*, *S. umbrosa*, *Cephalozia bicuspidata*, *C. bicuspidata* var. *lammersiana*, *C. catenulata*, *C. leucantha*, *C. lunulifolia*, *Nowellia curvifolia*, *Bazzania trilobata*, *Calypogeia fissa*, *C. muelleriana*, *D. fuscescens*, *D. majus*, *D. montanum* var. *pulvinatum*, *D. muehlenbeckii*, *D. scoparium* var. *orthophyllum*, *Ditrichum heteromallum*, *Tortella tortuosa* var. *tenella*, *Didymodon ferrugineus*, *Tayloria tenuis*, *Splachnum sphaericum*, *Pohlia nutans* f. *caespitosa*, *Bryum elegans*, *Mnium hornum*, *Amblystegiella confervoides*, *Isothecium alopecuroides* var. *longicuspis*, *Homalothecium sericeum* var. *tenellum*, *B. salebrosum* var. *angustifolium*, *Rhynchostegiella tenuicaulis*, *Cirriphyllum piliferum*, *Rhynchostegium murale*, *Eurhynchium angustirete*, *Plagiothecium curvifolium*, *P. platyphyllum*, *P. succulentum*, *H. mammillatum*, *H. pratense*.

The following taxa (22 species, 3 varieties) cited in literature weren't retrieved on wood substrate: *Anastrophyllum minutum*, *Jamesoniella autumnalis*, *Scapania irrigua*, *Leucobryum glaucum*, *Paraleucobryum longifolium*, *Dicranum flexicaule*, *Campylopus pyriformis*, *Leskea polycarpa*, *Thuidium delicatulum*, *T. recognitum*, *T. tamariscinum*, *Eurhynchium praelongum*, *Plagiothecium denticulatum*. Most of this species prefer a saxicolous or terricolous substrate, only occasionally occurring on wood substrate (*Thuidium delicatulum*, *T. recognitum*), which were retrieved by us on soil or stones.

According to the European Red List of Bryophytes *Buxbaumia viridis* is vulnerable and *Lophozia ascendens* is rare.

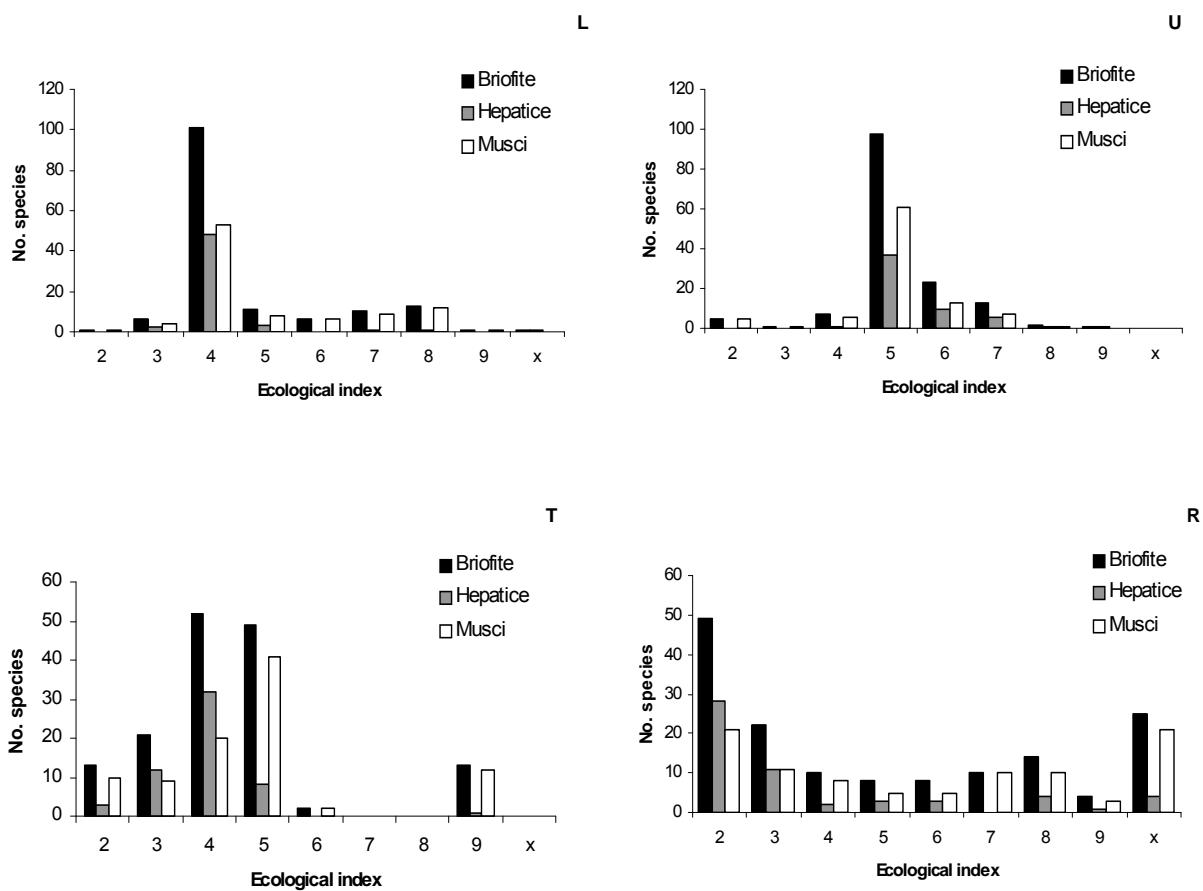


Fig.1. The ecological spectrum towards light (L), humidity (U), temperature (T) and chemical characteristic of the substrate (R)¹

¹ **The ecological characters :** L - light: 1, 2 – strong sciaphilous; 3, 4– sciaphilous; 5, 6– sciaphotophilous; 7– photosciaphilous; 8 – photophilous; 9 – strong photophilous; x– euryphotic; U – humidity: 1 – strong xerophilous; 2 ,3 – xerophilous; 4 – xero-mesophilous; 5 – mesophilous; 6 – meso-higrophilous; 7 – higrophilous; 8 – higo-hidrophilous; 9 – hidrophilous; x – euryhygrous; T – Temperature: 1, 2 – criophilous; 3, 4 – microthermal; 5, 6 – micro-mesothermal; 7,8 – moderately thermophilous; 9 - thermophilous; x – eurythermic; R – the chemical characteristics of the substrate: 1 – strong acidophilous; 2, 3 – acidophilous; 4, 5 –

Concerning the ecological preferences (Fig. 1) of the identified species towards light, the majority of them are schiaphilous (L3, L4) preferring shaded habitats. Very few species (especially mosses) are schiaphotophilous (L7), photoschiaphilous (L8) or photophylous (L9).

The behaviour of the species in relation with humidity show the prevalence of mesophilous (U5) species, followed by meso-higrophilous (U6) and higrophilous (U7) ones, the last two categories occurring along the rivers or close to springs. While mosses are more resistant to desiccation (from xero-mesophilous to higrophilous), the hepatics are dependent of air and substrate humidity (from xero-mesophilous to hidrophilous). The strictly dependence of bryophytes towards humidity is relevant due the absence of eurihydrous species.

In relation with temperature, the predominance of microthermal (T3, T4) followed by micro-mesothermal (T5) and criophilous (T2) species, is closely dependent on the mountain climate conditions. Hepatics show preferences for colder habitats than mosses, habitats, which are more humid, too.

The spectrum of chemical characteristic of the substrate is larger than the other ecological histograms, induced by the chemical content diversity (as a result phorophyte specificity, sometimes covered by flood transported material) and decaying degree of the wood. As we expected dominant are the acidophilous (R2, R3) species. In the limestones areas the sand deposits on the wood surface

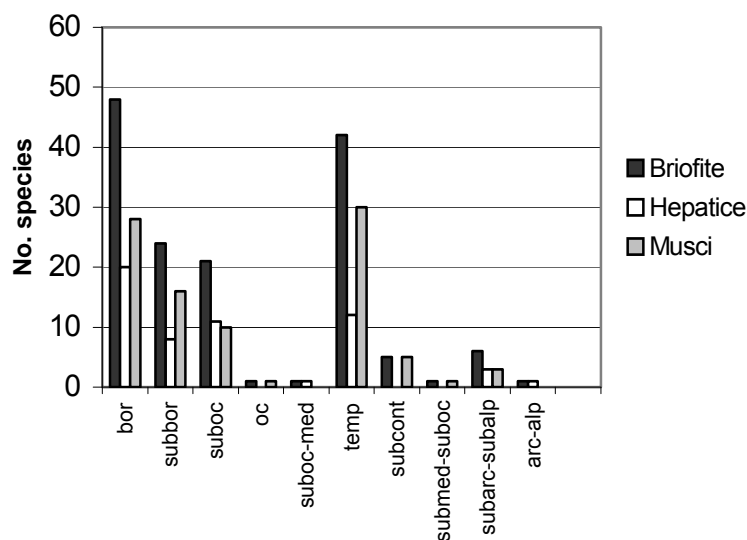


Fig. 2. Phytogeographical spectrum

favoured the occurrence of the neutro - basiphilous (R8) and calciphilous (R9) species.

moderately acidophilous; **6** – weakly acidophilous; **7** – weakly acid-neutrophilous; **8** – neutrobaziphilous; **9** – baziphilous / calciphilous; **x** - amphitolerant (euryionic).

The diversity of microhabitats is also reflected in the phytogeographical spectrum (Fig.2). The larger number of phytogeographical categories has been grouped in 9 categories. The boreal elements, which are dominant, together with the subboreal suboceanic and oceanic elements are favoured by the mountain climate more humid in the upper valleys of the Big Arieş River.

Conclusions

The strong human impact on European temperate forests is obvious in the study area by relatively high number of species (150 species, nine varieties and one form). Most of them has been collected from abandoned logs, branches, stumps or snags, part of the wood substrate have a wind-fall provenience.

The species richness is higher in shaded, humid and colder habitats, where boreal, subboreal, suboceanic and oceanic species are well represented. Even if the abandoned wood reveal a deficiency of the silvocultural management in the study area, it is favourable for the richness of the saprolignicolous bryophytes. The removal of fall trees reduce the diversity of the epixylic species [1]. The forest microclimate changes after silvocultural management and forest fragmentation are less suitable for bryophytes, fungi or invertebrates living on decaying wood [24].

A future, more successfully management should protect the largest and richest forests lots, connected by corridors with smaller forest patches and preserve some fallen trees all over the area.

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CERCETĂRI BRIOFLORISTICE PE LEMNE PUTREDE DIN BAZINUL ARIEȘULUI MARE

(Rezumat)

Brioflora de pe lemnele aflate în diferite stadii de putrezire, din bazinul Arieşului Mare cuprinde 150 specii (56 hepatic, 94 musci), nouă varietăți (un hepatic, 7 musci) și o formă, încadrați în 35 familii și 14 ordine. Dintre aceștia, 56 taxoni sunt noi pentru bazinul Arieşului Mare (47 specii, 8 varietăți și o formă). Conform Listei Roșii a Briofitelor din Europa *Buxbaumia viridis* este vulnerabilă și *Lophozia ascendens* este considerată rară.

Cele mai multe specii se instalează în habitate umbrase, umede și reci, unde speciile boreale, subboreale, suboceanice și oceanice sunt bine reprezentate.

Chiar dacă abandonarea resturilor lemnoase în urma exploatării pădurilor este consecința unui management silvic deficitar, până în prezent acesta pare favorabil dezvoltării unui număr mare de specii de briofite pe lemne putrede. Modificările microclimatice, consecință a managementului forestier și a fragmentării pădurilor, afectează briofitele, funghi și nevertebratele dependente de acest substrat, printr-o reducere a numărului de specii. Un management eficient trebuie să asigure protecția pădurilor ce se întind pe suprafețe mari, mai ales când se constată o mai mare bogăție în specii, conectate cu trupurile izolate de pădure printr-o rețea de coridoare forestiere, în care să nu se curețe total pădurea de copacii căzuți.