

## **Bryophyte Flora of South Banat (Vojvodina, Yugoslavia)**

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**Abstract** – As a result of field surveys during 2001, the bryophyte flora of South Banat (Serbia N, Yugoslavia) is reported to include 167 taxa (161 mosses and 6 liverworts), of which 130 are new to the region of Banat, 113 new to the province of Vojvodina (Serbia N), 22 new to Serbia and 10 new to the Federal Republic of Yugoslavia. Some aspects of their biogeography and ecology are discussed.

**Résumé** – Suite à l'étude des récoltes effectuées au cours de l'année 2001, il est établi que la flore des bryophytes de Banat du sud (Serbie N, Yougoslavie) comprend 167 taxons (161 mousses et 6 hépatiques), dont 130 sont nouveaux pour la région de Banat, 113 pour la province de Vojvodina (Serbie N), 22 pour la Serbie et 10 pour la République Fédérale de Yougoslavie. Certains aspects de la biogéographie et de l'écologie de cette bryoflore sont analysés.

**Flora / Bryophytes / South Banat / Serbia / Yugoslavia**

### **INTRODUCTION**

This study provides a floristic catalogue of the bryophyte taxa recorded in South Banat during 2001, together with those quoted in the bibliography for the region. The catalogue adds substantially to the records already known for the province of Vojvodina (70 new moss species and 10 liverworts).

The region of South Banat is situated in the province of Vojvodina in northern Serbia (Fig. 1). This province occupies the southernmost part of the Great Pannonian plain.

The study area is *ca* 80 km<sup>2</sup> in extent, and is situated south of the rivers Tamiš and Begej, east of the rivers Tisa and Danube, north of the Danube, and west of the Romanian border. The localities surveyed were chosen to cover as many different biotypes and ecosystems and as many microhabitats and specific niches as possible.

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The average altitude is 80 m a.s.l. Most of the surface of South Banat is cultivated for cereals. Only one large expanse remains with relatively spontaneous vegetation, the Deliblatska Sands. Today, Deliblatska Sands is a nature reserve consisting of forest - steppe areas and planted pine forest. Deep soils overlie much of Banat, but they are poorly developed in the region of Deliblatska Sands, where sands predominate. The highest peak of Vojvodina (Vršачki breg, the Vršачke Mountains) is situated in the eastern part of South Banat, at 641 m a.s.l. Only the southern and some of the western slopes of the Vršачke Mountains belong to the investigated area. This area is interesting not only for its altitude but also for its siliceous geological formations; in the rest of South Banat these are basic to sub-neutral.

The climate in the investigated area is continental, with hot and dry summers and cold and mostly dry winters. Precipitation peaks in June, while July, August and September are characterised by a period of drought. The Vršачke Mountains have a somewhat milder climate. The southern boundary of the investigated area is the R. Danube, and though degraded the river banks support riparian vegetation and in some places inundated willow and poplar forests.



Fig. 1. The position of the investigated area (Southern Banat, Vojvodina) in the Federal Republic of Yugoslavia shown in circumference on the UTM map (34T) 100 × 100 km. Mountain areas above 1000 m appear in grey. (Abbreviations: AL: Albania; BiH: Bosnia & Herzegovina; BG: Bulgaria; H: Hungary; HR: Croatia; MK: The Former Yugoslav Republic of Macedonia; RO: Romania; YU: The Federal Republic of Yugoslavia (Serbia and Montenegro)).

## SITES STUDIED

Appendix 1 lists the 73 sites sampled. They were selected to provide the widest climatic, geological, edaphic and altitudinal diversity obtainable in the area of study, and they include most of the habitats suitable for the development of bryophytes, considering that most of the surface is used for the cultivation of crops and native habitats are largely destroyed. In the following catalogue the site numbers of species recorded during the recent survey are listed after the name of the species. The remaining records are based on the literature cited.

## FLORISTIC CATALOGUE

The floristic catalogue of the study area consists of 167 taxa of which 161 are mosses and 6 are liverworts. On the basis of Sabovljević and Stevanović (1999) and Sabovljević (2000) one hundred and thirty taxa are new to the region of Banat (\*), 113 new to the province of Vojvodina, N. Serbia (♦), 22 new to Serbia (♠) and 10 new to the Federal Republic of Yugoslavia (♣). The localities for each taxon are listed using the reference numbers in Appendix 1. All specimens are deposited in the author's private herbarium and in BEOU (Institute of Botany, University of Belgrade). A duplicate of *Aloina obliquifolia* is also deposited in MUB. The catalogue also includes bibliographic references for taxa known previously in the province of South Banat, a brief description of the habitat or habitats in which the taxa have been collected and, in some cases, additional comments. The catalogue has been arranged in alphabetical order. The nomenclature for liverworts follows Grolle and Long (2000) and for the mosses Corley *et al.* (1981) and Corley & Crundwell (1991). Genus *Hypnum* is treated following Smith (1997).

Some species from the Red Data Book of European Bryophytes have been found in the study area (ECCB, 1995). These are: *Amblystegium saxatile* (European rare species = R), *Campylium elodes* (regionally threatened throughout Europe = RT), *Hilpertia velenovskyi* (European rare species = R) and *Zygodon forsteri* (European vulnerable species = V).

## LIVERWORTS

\**Frullania dilatata* (L.) Dumort. — 1, 9, 17, 18, 21, 23, 25, 35, 49, 50, 55, 67, 68, 72. Tree bark.

\**Pellia endiviifolia* (Dicks.) Dumort. — 72. Permanently wet soil.

*Porella platyphylla* (L.) Pfeiff. — 1, 3, 7, 9, 17, 18, 21, 23, 25, 35, 49, 50, 55, 67, 68, 72. Tree trunk. Reported by Pavletič (1955: loc. 17)

\**Radula complanata* (L.) Dumort. — 1, 4, 7, 9, 17, 18, 21, 23, 25, 35, 49, 50, 55, 67, 68, 72, 73. Tree trunk.

♦ *Riccia fluitans* L. — 36. Wet soil by water.

♦ *Riccia sorocarpa* Bisch. — 50. Wet shaded soil.

## MOSSES

*Abietinella abietina* (Hedw.) Fleisch. — 2, 14, 15, 17, 18, 20, 21, 22, 23, 25, 27, 38, 41, 45, 47, 54, 55, 60, 61, 64, 73. Grassland. Previously reported by Soška (1949) and Pavletić & (1955: loc. 17)

♠ *Aloina aloides* (K. F. Schultz) Kindb. — 1, 2, 17, 20, 22, 41, 47, 52. Loess cliffs.

\**Aloina ambigua* (Bruch & Schimp.) Limpr. — 1, 17, 20, 41, 52. Loess cliffs.

♣ *Aloina obliquifolia* (Müll. Hal.) Broth. — 47. Sandy soil.

◆ *Amblystegium fluviatile* (Hedw.) Bruch, Schimp. & GümbeL — 50. Wet and shaded base of stump in inundation zone.

◆ *Amblystegium humile* (P. Beauv.) Crundw. — 50, 62. Wet and shaded base of willow in inundation zone.

◆ *Amblystegium riparium* (Hedw.) Bruch, Schimp. & GümbeL — 30, 50. Wet riparian forest, on tree bases.

◆ *Amblystegium saxatile* Schimp. — 24. Wet ground in forest. European rare species.

*Amblystegium serpens* (Hedw.) Bruch, Schimp. & GümbeL — 1, 5, 6, 8, 10, 12, 13, 14, 19, 26, 28, 29, 31, 32, 34, 35, 37, 38, 42, 43, 44, 47, 49, 54, 56, 59, 64, 57, 64, 66, 68, 69, 70, 72. Rock, tree trunks and bases, shaded stone walls, sometimes fences and concrete. Reported by Soška (1949) and Pavletić (1955: loc. 69)

◆ *Amblystegium subtile* (Hedw.) Bruch, Schimp. & GümbeL — 50. Tree bases.

◆ *Amblystegium tenax* (Hedw.) C. Jens. — 50, 67, 68. Periodically submerged tree bases.

◆ *Amblystegium varium* (Hedw.) Lindb. — 22, 30, 37, 57. Decaying wood and wet soils.

*Anomodon viticulosus* (Hedw.) Hook. & Tayl. — 14, 25, 72. Walls and tree bases.

\**Atrichum angustatum* (Brid.) Bruch — 68. Acid soil in woods.

\**Atrichum undulatum* (Hedw.) P. Beauv. — 26. Woodland soils.

◆ *Barbula convoluta* Hedw. — 1, 14, 64. Soil on waste ground.

*Barbula unguiculata* Hedw. — 1, 3, 4, 7, 9, 10, 11, 14, 18, 20, 24, 28, 33, 38, 39, 43, 44, 46, 48, 51, 53, 56, 57, 59, 62, 63, 69, 71. Soil on waste ground, paths, tracks and arable fields. Previously reported by Soška (1949) and Pavletić (1955: loc. 69)

◆ *Brachythecium albicans* (Hedw.) Bruch, Schimp. & GümbeL — 4, 16, 22, 24, 30, 31, 54, 61, 67. Soil, gravel and sand dunes.

◆ *Brachythecium erythrorrhizon* Bruch, Schimp. & GümbeL — 68. Woodland track edge.

◆ *Brachythecium glareosum* (Spruce) Bruch, Schimp. & GümbeL — 26, 37, 47, 54, 61. Soil and rocks, open or wooded.

◆ *Brachythecium mildeanum* (Schimp.) Schimp. ex Milde — 1, 14, 21, 72. Damp soil and moist ground.

♠ *Brachythecium plumosum* (Hedw.) Bruch, Schimp. & GümbeL — 14, 25. Wet soils.

*Brachythecium populeum* (Hedw.) Bruch, Schimp. & GümbeL — Previously reported by Soška (1949) and Pavletić (1955: loc. 67).

*Brachythecium rivulare* Bruch, Schimp. & GümbeL — Report by Soška (1949) and Pavletić (1955 — loc. 69).

\**Brachythecium rutabulum* (Hedw.) Bruch, Schimp. & GümbeL — 18, 24, 40, 54, 61. Soil and tree boles in woods.

*Brachythecium salebrosum* (Web. & Mohr) Bruch, Schimp. & GümbeL — 14, 26, 30, 54, 67, 68. shaded soil in woods. previously reported by Soška (1949) and Pavletić (1955: loc. 69).

\**Brachythecium velutinum* (Hedw.) Bruch, Schimp. & GümbeL — 2, 10, 26, 30, 31, 68, 72, 73. Shaded tree boles, paths and soil by woodland tracks.

◆ *Bryoerythrophyllum recurvirostre* (Hedw.) P. C. Chen — 47, 68. Sand dunes and soil.

◆ *Bryum algovicum* Sendtn. — 14. Sand.

*Bryum alpinum* With. — Report by Soška (1949) and Pavletić (1955: loc. 67).

◆ *Bryum argenteum* Hedw. — 1, 2, 3, 4, 6, 7, 8, 11, 12, 13, 14, 16, 18, 22, 23, 27, 30, 31, 36, 39, 50, 58, 63, 67, 68, 71. Soil on waste ground, paths, tracks and arable fields.

◆ *Bryum argenteum* Hedw. var. *lanatum* (P. Beauv.) Hampe — 1, 11, 16. Loess cliffs, rock walls and dry concrete crevices.

◆ *Bryum bicolor* Dicks. — 14, 18, 30, 55, 60, 61, 67, 68. Soil.

*Bryum caespiticium* Hedw. — 2, 14, 62. Soil and walls. Report by Soška (1949) and Pavletić (1955: loc. 69)

◆ *Bryum capillare* Hedw. var. *rufifolium* (Dix.) Podp. — 1. Soil at the edge of a wall.

\**Bryum capillare* Hedw. — 1, 2, 9, 11, 14, 18, 22, 23, 25, 30, 31, 36, 37, 47, 49, 50, 54, 55, 57, 60, 61, 64, 67, 72. Proto soils and soils.

◆ *Bryum elegans* Nees — 14, 33, 60. Rock crevices and walls.

◆ *Bryum imbricatum* (Schwägr.) Bruch & Schimp. — 60. Sandy soil.

◆ *Bryum pallens* Sw. — 72. Soil.

◆ *Bryum pallescens* Schleich. ex Schwägr. — 25. Sandy soil.

◆ *Bryum subelegans* Kindb. — 10, 14, 22, 26, 37, 47, 50, 52, 67, 68, 72. Roofs, decaying wood and tree boles.

◆ *Bryum torquescens* Bruch & Schimp. — 8. Soil in grassland.

◆ *Bryum uliginosum* (Brid.) Bruch & Schimp. — 60. Sandy soil.

◆ *Callicladium haldanianum* (Grev.) Crum — 50, 54. Wet soil.

*Calliergonella cuspidata* (Hedw.) Loeske — 2, 14. Grassland. Previous report by Soška (1949) and Pavletić (1955: loc. 17).

♣ *Campylium elodes* (Lindb.) Kindb. — 72. Moist sand. Species regionally threatened throughout Europe.

◆ *Campylium stellatum* (Hedw.) J. Lange & C. Jens. — 1. Grassland by woods.

◆ *Campylophyllum calcareum* Crundw. & Nyholm — 14. Soil.

◆ *Campylium chrysophyllum* Crundw. & Nyholm — 36, 57. Grassland.

◆ *Ceratodon purpureus* (Hedw.) Brid. — 7, 8, 26, 34, 36, 38, 39, 46, 49, 51, 56, 62, 63, 64, 66, 69, 71, 73. Proto soil, in urban and periurban areas.

◆ *Cirriphyllum crassinervium* (Tayl.) Loeske & Fleisch. — 68. Soil in wood.

◆ *Cirriphyllum tommasinii* (Boulay) Grout — 30. Moist rock and peripheral soil.

♣ *Crossidium crassinerve* (De Not) Jur. — 1. Loess cliff.

◆ *Dicranella heteromalla* (Hedw.) Schimp. — 25, 68. Soil.

◆ *Dicranella varia* (Hedw.) Schimp. — 55. Soil.

◆ *Dicranum scoparium* Hedw. — 54, 72. Woodland soil.

◆ *Didymodon cordatus* Jur. — 1, 2, 17, 20. Loess cliffs.

◆ *Didymodon insulanus* (De Not.) M. Hill — 9. Proto soil.

◆ *Didymodon luridus* Hornsch. ex Spreng. — 2, 21, 38, 52, 60. Proto soil.

◆ *Didymodon rigidulus* Hedw. — 1, 14, 47. Dry soil.

◆ *Didymodon vinealis* (Brid.) Zander — 1, 47. Dry soil.

*Drepanocladus aduncus* (Hedw.) Warnst. — 1, 17, 50. Sand dune and damp tracks. Previous report by Soška (1949) and Pavletić (1955: loc. 17).

◆ *Encalypta streptocarpa* Hedw. — 14, 49. Soil slopes.

◆ *Encalypta vulgaris* Hedw. — 22, 55, 60, 70, 73. Sand dunes.

♠ *Enthostodon attenuatus* (Dicks.) Bryhn — 37. Soil.

*Enthostodon fascicularis* (Hedw.) Müll.Hal. — 14, 61. Sandy soils. Previous report by Soška (1949) and Pavletić (195 : loc. 69).

◆ *Eurhynchium hians* (Hedw.) Sande Lac. — 64, 68. Grassland.

◆ *Eurhynchium meridionale* (Bruch, Schimp. & Gümbe) De Not. — 30. Wet grassland.

*Eurhynchium praelongum* (Hedw.) Bruch, Schimp. & Gümbe — 18, 26, 40, 64. Grassland.

◆ *Eurhynchium schleicheri* (Hedw. f.) Jur. — 26, 30. Grassland.

◆ *Eurhynchium speciosum* (Brid.) Jur. — 9. Soil by lakes.

◆ *Eurhynchium striatum* (Hedw.) Schimp. — 14, 24, 61. Sandy grassland.

◆ *Fissidens dubius* P. Beauv. — 68. Soil in wood.

♠ *Fissidens viridulus* (Sw.) Wahlenb. var. *tenuifolius* (Boul.) A.J.E. Smith — 68. Soil banks in wood.

*Funaria hygrometrica* Hedw. — 14, 36, 49, 50. Burnt areas, and sandy soils. Reported by Soška (1949) and Pavletić (1955: loc. 69).

◆ *Grimmia orbicularis* Bruch ex Wils. — 10. Concrete wall.

*Grimmia pulvinata* (Hedw.) Sm. — 9, 14, 16, 18, 30, 31, 37, 65. Roofs, concrete, rocks. Previous report by Soška (1949) and Pavletić (1955: loc. 69).

◆ *Grimmia trichophylla* Grev. — 52. Stone wall.

◆ *Gymnostomum calcareum* Nees & Hornsch. — 18, 67. Dry rocky paths.

◆ *Hedwigia ciliata* (Hedw.) P. Beauv. — 67. Siliceous rock outcrop in wood.

◆ *Herzogiella seligeri* (Brid.) Iwats. — 14. Tree stump.

\**Hilpertia velenovskyi* (Schiffn.) Zander — 1. Loess cliff. Rare European species.

♣ *Homalothecium aureum* (Spruce) H. Rob. — 22. Rocky ground.

*Homalothecium lutescens* (Hedw.) H. Rob. — 2, 14. Soils. Previous report by Soška (1949) and Pavletić (1955: loc. 17).

*Homalothecium sericeum* (Hedw.) Bruch, Schimp. & Gümbe — 14, 54, 67, 68. Rock walls. Previous report by Soška (1949) and Pavletić (1955: loc. 67).

*Homomallium incurvatum* (Brid.) Loeske — 72. Shaded rock.

◆ *Hypnum callichroum* Brid. — 72. Shaded soil.

*Hypnum cupressiforme* Hedw. — 1, 14, 21, 24, 26, 36, 37, 39, 54, 55, 60, 61, 67, 68, 72. Tree bark, bases, rocks, walls. Previous report by Soška (1949) and Pavletić (1955: loc. 17).

◆ *Hypnum lacunosum* (Brid.) G. F. Hoffman — 61. Tree base.

◆ *Hypnum lindbergii* Mitt. — 37. Tree base.

♣ *Hypnum mammillatum* (Brid.) Loeske — 14, 21. Tree trunk.

♣ *Hypnum resupinatum* Tayl. — 14, 55. Tree trunk.

*Isothecium myosuroides* Brid. — 10. Tree trunk.

\**Leskea polycarpa* Hedw. — 1, 10, 14, 18, 24, 26, 30, 31, 33, 35, 36, 37, 50, 67, 68. Tree trunk and rocks.

\**Leucodon sciuroides* (Hedw.) Schwaegr. — 24, 54, 67, 68, 72. Tree trunk.

◆ *Mnium marginatum* (Dicks.) P. Beauv. — 40, 49. Wet soil in forest.

◆ *Orthotrichum affine* Brid. — 14, 24. Tree trunk.

◆ *Orthotrichum anomalum* Hedw. — 16. Rock.

◆ *Orthotrichum diaphanum* Brid. — 1, 30, 52. Tree trunk.

◆ *Orthotrichum lyellii* Hook. & Tayl. — 1, 18, 24, 50, 54, 67. Tree trunk.

◆ *Orthotrichum pallens* Bruch ex Brid. — 24, 35, 47, 55. Tree trunk.

◆ *Orthotrichum pulchellum* Bunt. — 26. Tree trunk.

*Orthotrichum pumilum* Sw. — 1, 72. Tree trunk. Previous report by Soška (1949) and Pavletić (1955: loc. 17).

◆ *Orthotrichum rupestre* Schleich. ex Schwägr. — 16. Rock wall.



- ◆ *Orthotrichum speciosum* Nees — 54. Tree trunk.
- ◆ *Orthotrichum stellatum* Brid. — 18 Tree trunk.
- ◆ *Phascum cuspidatum* Hedw. — 14, 18, 22, 24, 52. Disturbed soil.
- ♣ *Phascum piptocarpum* Durieu & Mont. — 22. Disturbed sandy soil.
- ◆ *Physcomitrella patens* (Hedw.) Bruch & Schimp. — 36, 50, 62. Wet, periodically inundated soil by the rivers Danube and Tamis.
- Plagiomnium cuspidatum* (Hedw.) T. Kop. — 14, 21, 25, 54. Shaded soil. Previous report by Soška (1949) and Pavletić (1955 — loc. 17).
- Plagiomnium rostratum* (Schrad.) T. Kop. — 2, 25, 55. Shaded soil. Previous report by Soška (1949) and Pavletić (1955: loc. 17).
- \**Plagiomnium undulatum* (Hedw.) T. Kop. — 14, 18, 25. Shaded soil.
- ♣ *Plagiothecium latebricola* Bruch, Schimp. & Gümbeľ — 54, 72. Soil in the wood.
- ◆ *Platygyrium repens* (Brid.) Bruch, Schimp. & Gümbeľ — 50. Tree trunk in woodland.
- ◆ *Pleurochaete squarrosa* (Brid.) Lindb. — 14, 18, 22, 23, 61. Grassland and sand dunes.
- \**Pleurozium schreberi* (Brid.) Mitt. — 54, 61. Grassland.
- Pogonatum urnigerum* (Hedw.) P. Beauv. — Record by Soška (1949) and Pavletić (1955: loc. 67).
- Polytrichum juniperinum* Hedw. — Record by Pavletić (1955: loc. 67).
- Polytrichum piliferum* Hedw. — 67, 68. Acid soil. Previously reported by Soška (1949) and Pavletić (1955: loc. 69)
- ◆ *Pottia lanceolata* (Hedw.) Müll. Hal. — 9, 14, 22, 37. Rock crevices and proto-soils.
- Pottia truncata* (Hedw.) Bruch & Schimp. — 14, 64, 67, 68. Disturbed soil. Previously reported by Soška (1949) and Pavletić (1955: loc. 67).
- ◆ *Pseudocrossidium hornschuchianum* (Schultz) R. H. Zander — 1, 14, 68. Proto-soil.
- ♠ *Pseudocrossidium revolutum* (Brid.) R. H. Zander — 1. Proto-soil.
- Pseudoleskeella nervosa* (Brid.) Nyholm — 1, 37, 67, 68. Tree trunk.
- Pseudoscleropodium purum* (Hedw.) Fleisch. ex Broth. — 14, 72. Grassland and woodland edges. Previously reported by Soška (1949) and Pavletić (1955: loc. 67).
- ♣ *Pterygoneurum lamellatum* (Lindb.) Jur. — 37. Loess cliff.
- \**Pterygoneurum ovatum* (Hedw.) Dixon — 1. Loess cliff.
- ◆ *Pylaisia polyantha* (Hedw.) Schimp. — 1, 14, 26, 30, 37, 50, 54. Tree trunks and stumps.
- ♣ *Rhodobryum ontariense* (Kindb.) Kindb. — 14, 17, 18, 25, 49, 54, 55, 61. Sandy soils, in open grassland and shaded dunes.
- Rhodobryum roseum* (Hedw.) Limpr. — Cited by Pavletić (1955: loc. 17); excluded from Vojvodina, since all *Rhodobryum* recorded belong to *R. ontariense*.
- ◆ *Rhynchostegiella tenella* (Dicks.) Limpr. — 10, 24. Wet rocks.
- ♠ *Rhynchostegium confertum* (Dicks.) Bruch, Schimp. & Gümbeľ — 14, 18, 67, 68, 72. Tree bases.
- ◆ *Rhynchostegium megapolitanum* (Web. & Mohr) Bruch, Schimp. & Gümbeľ — 62. Wet soil.
- ♠ *Scorpiurium circinatum* (Brid.) Fleisch. & Loeske — 14, 47. Rocky soil.
- Schistidium apocarpum* (Hedw.) Bruch & Schimp. — 26, 30, 31, 65. Stone and concrete walls.
- ♠ *Schistidium elegantulum* Blom var. *elegantulum*: 16. Wet concrete.
- ♠ *Schistidium crassipilum* Blom — 30, 31. Concrete.
- ♣ *Syntrichia calcicola* Amann — 62. Proto-soil on concrete.

- ◆ *Syntrichia laevipila* Brid. — 35. Poplar tree trunk.
- ◆ *Syntrichia latifolia* (Bruch ex Hartm.) Huebener — 24, 37, 52. Tree bases and trunks, sometimes in flooded zones.
- Syntrichia papillosa* (Wils.) Jur. — 1, 21, 31, 33, 37, 50. Tree bases, branches and boles.
- ◆ *Syntrichia princeps* (De Not.) Mitt. — 30, 31. Concrete.
- ◆ *Syntrichia ruraliformis* (Besch.) Cardot — 1, 2, 9, 18, 30, 31, 52. Sandy soil.
- Syntrichia ruralis* (Hedw.) Web. & D. Mohr — 23, 14, 16, 55, 61, 67, 68. Concrete and rocks, walls. Cited by Soška (1949) and Pavletić (1955: loc. 17).
- ◆ *Syntrichia virescens* (De Not.) Ochyra — 65. Tree trunk.
- ◆ *Taxiphyllum wissgrillii* (Garov.) Wijk & Marg. — 25. Tree stump.
- Thuidium delicatulum* (Hedw.) Mitt. — 14. Grassland soil.
- Thuidium recognitum* (Hedw.) Lindb. — Record by Soška (1949) and Pavletić (1955: loc. 17).
- \**Thuidium tamariscinum* (Hedw.) Bruch, Schimp. & Gumbel — 14, 54, 55. Woodland soil.
- ◆ *Tomentypnum nitens* (Hedw.) Robins. — 67, 68. Woodland soil.
- ◆ *Tortella flavovirens* (Bruch) Broth. — 1, 72. Sandy soil.
- \**Tortella inclinata* (R. Hedw.) Limpr. — 14, 54, 55, 60. Soil. Recorded by Soška (1949) and Pavletić (1955: loc. 17).
- Tortella tortuosa* (Hedw.) Limpr. — 60. Sandy soil. Recorded by Soška (1949) and Pavletić (1955: loc. 17).
- ♠ *Tortula cuneifolia* (Dicks.) Turner — 62. Shaded rock crevices.
- ◆ *Tortula muralis* Hedw. — 1, 2, 3, 4, 5, 6, 7, 8, 12, 14, 15, 16, 17, 18, 19, 20, 24, 30, 32, 34, 37, 38, 39, 42, 43, 44, 45, 47, 48, 51, 52, 56, 57, 60, 63, 64, 85, 66, 69, 71. Mortar, concrete, rocks, walls.
- Tortula subulata* Hedw. — 14, 25, 21, 68. Soil in woods. Recorded by Soška (1949) and Pavletić (1955: loc. 69).
- ◆ *Tortula subulata* Hedw. var. *subinermis* (Brid.) Wilson — 50. Soil.
- ◆ *Trichostomum brachydontium* Bruch — 1, 22, 24. Path edge, soil.
- ◆ *Trichostomum crispulum* Bruch — 14, 18, 23, 52, 60, 61, 64, 68. Dry soil.
- ◆ *Trichostomum crispulum* Bruch var. *brevifolium* (Müll Hal.) Bruch & Schimp. — 14. Soil.
- ◆ *Weissia controversa* Hedw. 14, 50, 61. Soil
- ♠ *Zygodon forsteri* (With.) Mitt. — 65. Tree trunk. Species vulnerable in Europe.

## ANALYSIS OF THE CATALOGUE

The low proportion of liverworts (Marchantiopsida 3.64%) stands in strong contrast to the mosses (Bryopsida), which represent 96.36% of the total taxa recorded. These values indicate that the investigated area is arid.

Within the liverworts the Marchantiales and Jungermanniales are equally represented at 50%.

Within the mosses the orders Pottiales and Hypnobryales are dominant in the flora of South Banat, with 28.93% and 28.30% respectively of the total number (Fig. 2). The orders with the next highest proportion of taxa are the Bryales (12.58%) and Orthotrichales (8.18%). The equal presence of the Pottiales and Hypnobryales may be attributed to the marked contrast between the regions neighbouring the Danube and the arid interior, with a sharp transition between the two.



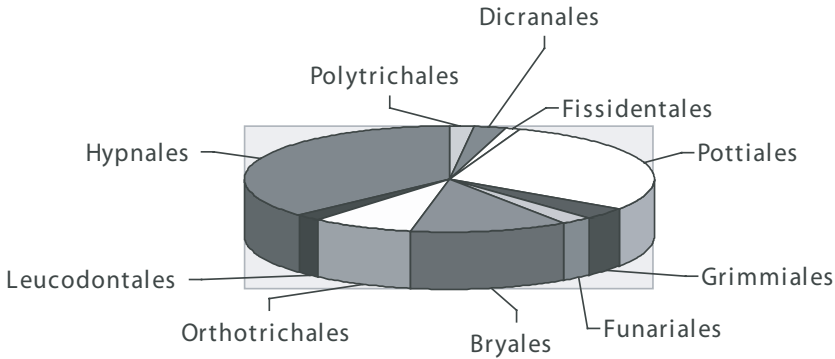


Fig. 2. Ratio of moss orders represented in the study area.

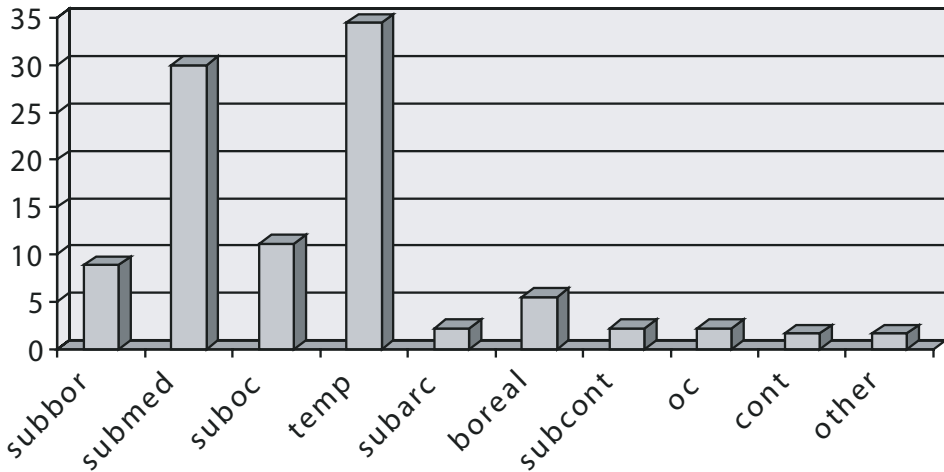


Fig. 3. Distribution type of bryophytes in investigated area.

In general these results are to be expected, considering the climatic conditions of the area, and the potential substrata for bryophytes.

A biogeographical analysis of the main chorological elements represented in the investigated area was performed by estimating the percentages belonging to different distributional types. These types have been taken from Düll (1983, 1984, 1985, 1992) and Düll *et al.* (1999). The taxa belong to 22 different chorological elements. In view of the similarities of many of these elements, they have been united for statistical and graphical purposes into nine general chorological groupings (Fig. 3): boreal, continental, oceanic, subarctic, subboreal, subcontinental, submediterranean, suboceanic, temperate and other distributions.

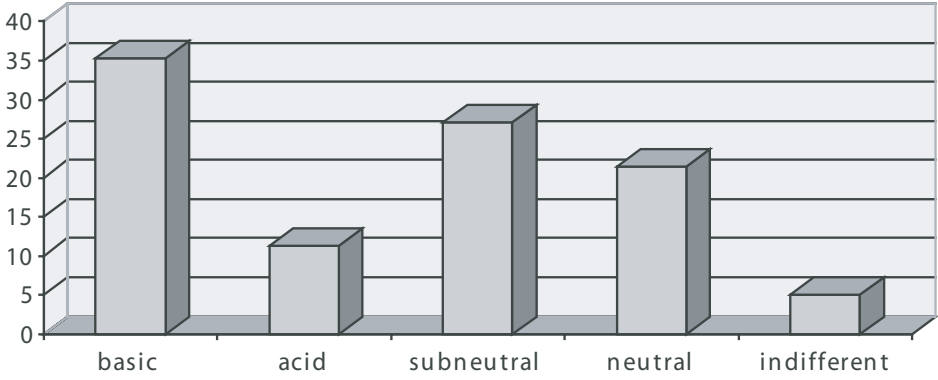


Fig. 4. Preferential pH of bryophytes in the study area.

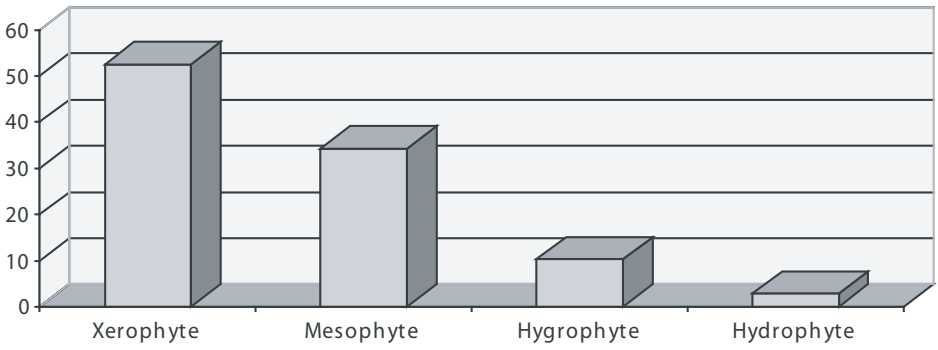


Fig. 5. Groups of bryophyte affinity for humidity preferential in the study area.

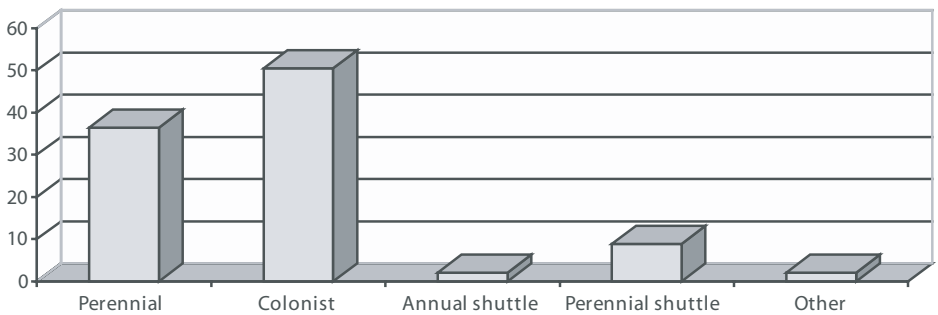


Fig. 6. Life strategy among bryophytes in the study area.

Many species with temperate (34.44%) and submediterranean (30.00%) distributions are found. There is also a relatively high presence of suboceanic (11.11%) and subboreal (8.89%) elements. The remaining distribution types have lower percentages, 5.56% for boreal and less than 5% each for the remainder.

The analysis of distribution types is consistent with what might be expected within the study area. The influence of the Danube in the sites by the river explains the presence of suboceanic elements. The presence of submediterranean elements is high because of the prolonged period of summer drought (annual precipitation *ca* 600 mm), and the absence of Mediterranean elements is probably due to the softening of Mediterranean conditions due to the combined effects of the Danube river and the Euro-Siberian climate. A high percentage of temperate elements is to be expected since South Banat lies in the temperate zone.

The ecological characteristics of the bryophytes of the study area have been assessed using Hallingbäck (1996) for pH preferences, Ingerpuu *et al.* (1994) for water requirements, and Sándor (1984) for life strategies.

The bryophyte flora of South Banat shows a preference for basic to sub-neutral habitats (Fig. 4).

As might be expected from the climate, xerophytic bryophytes (52.57%) are prevalent in the investigated region. These are followed by the mesophytes (34.29%), and then hygrophytes (10.28%), which mostly occur in sites exposed to the influence of the Danube river, and in forests (Fig. 5).

The predominant life strategy (Fig. 6) is the colonist (50.52%), which is to be expected in view of the agricultural impact of the study area. Perennials (36.46%) are the second in frequency, being mostly represented in semi-natural and natural zones.

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### APPENDIX 1. DETAILS OF THE STUDY SITES

1. Alibunar. 34TDQ99.
2. Banatska Palanka. 34TFP01.
3. Banatska Subotica. 34TEQ39.
4. Banatski Brestovac. 34TDQ59.
5. Banatski Karlovac. 34TEQ40.
6. Banatsko Novo Selo. 34TDQ74.
7. Bavanište. 34TDQ19.
8. Bela Crkva. 34TEQ23.
9. Belocrkvanska lakes. 34TEQ22.
10. Besni Fok. 34TDQ24.
11. Borča. 34TDQ65.
12. Crepaja. 34TDQ78.
13. Crvena Crkva. 34TEQ22.
14. Čardak. 34TEQ07.
15. Češko Selo Village. 34TDQ78.
16. Čenta. 34TDQ58.
17. Deliblato. 34TEQ10.
18. Devojački bunar. 34TDQ98.
19. Dobričevo. 34TEQ27.
20. Dolovo. 34TDQ79.
21. Dragića Hat. 34TEQ26.
22. Dubovac. 34TEQ16.
23. Dubovačke ponds. 34TEQ16.
24. Dunavac. 34TDQ66.
25. Flamunda. 34TEQ07.
26. Frikom – PKB. 34TDQ66.
27. Gaj. 34TEQ18.
28. Glogonj. 34TDQ67.
29. Izbište. 34TEQ18.
30. Jabučki rit. 34TDQ77.
31. Jabuka. 34TDQ77.
32. Jasenov. 34TEQ37.
33. Kačarevo. 34TDQ77.
34. Kaludjerovo. 34TEQ47.
35. Karaš (by the river). 34TEQ36.
36. Kotež. 34TDQ65.
37. Kovačica. 34TDQ96.
38. Kovin. 34TDQ95.
39. Krnjača. 34TDQ65.
40. Kruščica by Bela Crkva. 34TEQ37.
41. Mramorak. 34TDQ97.
42. Nikolinci. 34TEQ08.
43. Omoljica. 34TDQ85.
44. Opovo. 34TDQ57.
45. Orešac – DTD. 34TEQ28.
46. Ovča. 34TDQ65.
47. Padina. 34TPQ97.
48. Padińska Skela. 34TDQ65.
49. Paja Marganović - Deliblatska sands. 34TEQ07.
50. Pančevački rit - 34TDQ77.
51. Pančevo. 34TDQ76.
52. Parta. 34TEQ23.
53. Perlez. 34TDQ55.
54. Rošijana. 34TEQ06.
55. Rujeve urvine. 34TEQ17.
56. Sefkerin. 34TDQ86.
57. Skrobara. 34TDQ67.
58. Starčevo. 34TDQ76.
59. Štraža. 34TEQ27.
60. Šumarak. 34TEQ16.
61. Šušara. 34TEQ17.
62. Tamiš. 34TDQ66.
63. Uljma. 34TEQ18.
64. Vladimirovac. 34TDQ98.
65. Vlajkovac – DTD. 34TEQ29.
66. Vojlovica. 34TDQ77.
67. Vršačke planine - by the tower. 34TEQ48.
68. Vršačke planine - by the refuge. 34TEQ48.
69. Vršac. 34TEQ47.
70. Vračev Gaj. 34TEQ26.
71. Vrbovsko. 34TDQ66.
72. Vrelo. 34TDQ97.
73. Zagajica. 34TEQ27.