

THE MOSS FLORA IN THE CENTRAL URBAN AREA OF BELGRADE

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Abstract - In floristic research on mosses in the central urban area of Belgrade, the presence of 58 species classified into 23 genera and 12 families was verified. The mosses occur in different specific and extreme microhabitats. Diversity of the bryoflora in urban ecosystems can be explained in terms of the large number of different habitats found on large greens, old fortress ruins, and roofs, as well as in gardens in the center of the Old Town.

Key words: Mosses, Bryophyta, biodiversity, habitat diversity, Belgrade, Serbia

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INTRODUCTION

Research on mosses in Serbia commenced in the mid-19th century, when Griesebach discovered the species *Madotheca navicularis* N.E. in 1843 (Jurišić, 1899). Later, significant research on mosses in the Belgrade area was carried out and published by Simić and Jurišić in the Spomenica of the Serbian Academy of Science in 1901. In 1949 Soška gave a survey of mosses and lichens in the Belgrade area, and the bryoflora of Belgrade was also treated by Rajevski, Kriger, and Meandžija (Grebensčikov, 1949).

Only a few works on the topic have been published since the mid-19th century. A noteworthy contribution was made by Pavlečić, who in his works *Prodromus of the Flora of Bryophytae in Yugoslavia* (1955) and *The Flora of Mosses in Yugoslavia* (1968) gives a synthesis of all the then known moss species and their distribution in the area of the former Yugoslav republics, in Serbia and in Belgrade.

Having consulted the bryological literature, we did not find a single work dealing solely and comprehensively with research on mosses in the area of Belgrade and its surroundings.

The city of Belgrade lies on the border of the Pannonian Plain and Šumadija. Its coordinates are N 44° 48' and E 20° 28'. The average elevation above sea level is

132 m (minimum of 60 m, maximum of 253 m).

Belgrade is under the influence of continental climate. Mean annual air temperature is 11.88°C. Mean temperature of the air in January is 0.34°C, while in July it is 21.6°C.

Mean annual relative humidity in Belgrade is 71% and mean annual precipitation is 681.57 mm.

MATERIALS AND METHODS

Mosses were collected by the transect method in the area of 103 streets, from the greens in Upper and Lower Kalemegdan Parks, in the Botanical Garden, in the New Cemetery, and in Pioneer Park and Tašmajdan Park. Bryophyte material was collected in the course of 1994 and 1995 on various types of habitats: soil, dust and detritus accumulated along walls and pavements, dust and detritus in between cobble stones, cracks in concrete, rock piles, railway ties, stumps, tombstones, concrete walls, brick walls, tiled roofs, steps, flower beds, rainwater pipes at the point of contact with the pavement, etc.

The moss collection from the central area of Belgrade is housed in the Herbarium of the Botanical Institute and the Jevremovac Botanical Garden, Faculty of Biology, University of Belgrade. Selected material was verified by bryologist Dr Harald Kurschner in Berlin in

1996, whose help we acknowledge here.

RESULTS AND DISCUSSION

On various types of habitats in the central area of Belgrade, we recorded the presence of 58 species and varieties of mosses. All species belong to the class of mosses (*Bryopsida*) and are classified into 23 genera and 12 families.

A survey of the moss flora in the central area of Belgrade is as follows:

AMBLYSTEGIACEAE

1. *Amblystegium serpens* (Hedw.) B., S. & G.
2. *Amblystegium varium* (Hedw.) Lindb.
3. *Amblystegium tenax* (Hedw.) C. Jens
4. *Amblystegium riparium* (Hedw.) B., S. & G.

BRACHYTHECIACEAE

5. *Brachythecium albicans* (Hedw.) B., S. & G.
6. *Brachythecium populeum* (Hedw.) B., S. & G.
7. *Brachythecium rivulare* B., S. & G.
8. *Brachythecium rutabulum* (Hedw.) B., S. & G.
9. *Brachythecium salebrosum* (Web. & Mohr) B., S. & G.
10. *Brachythecium velutinum* (Hedw.) B., S. & G.
11. *Eurhynchium hians* (Hedw.) Sande Lac.
12. *Eurhynchium hians* (Hedw.) Lac. var. *swartzii* (Turn.) Frahm.
13. *Eurhynchium meridionale* (B., S. & G.) De Not.
14. *Eurhynchium praelongum* (Hedw.) B., S. & G.
15. *Eurhynchium pulchellum* (Hedw.) Jenn.
16. *Eurhynchium striatum* (Schreb.) Schimp.
17. *Homalothecium lutescens* (Hedw.) Robins.
18. *Homalothecium sericeum* (Hedw.) B., S. & G.
19. *Rhynchostegiella jacquinii* (Garon.) Limpricht.
20. *Rhynchostegium confertum* (Dicks.) B., S. & G.
21. *Scleropodium tourretii* (Brid.) L. F. Koch

BRYACEAE

22. *Bryum algovicum* Sendt. & C. Mull.
23. *Bryum argenteum* L.
24. *Bryum bicolor* Dicks.
25. *Bryum caespiticium* Hedw.
26. *Bryum caespiticium* Hedw. aff. *Bryum badium* (Brid.) Schimp.
27. *Bryum capillare* Hedw.

28. *Bryum creberrimum* Tayl.
29. *Bryum erythrocarpum* Schwägr.
30. *Bryum kunzei* Hornsch.
31. *Bryum pallescens* Schleich. & Schwägr.
32. *Bryum weigelii* Spreng.

DICRANACEAE

33. *Ceratodon purpureus* (Hedw.) Brid.

FUNARIACEAE

34. *Funaria hygrometrica* Hedw.

GRIMMIACEAE

35. *Grimmia pulvinata* (Hedw.) Sm.
36. *Schistidium apocarpum* (Hedw.) B., S. & G.

HYPNACEAE

37. *Ctenidium molluscum* (Hedw.) Mitt.
38. *Hypnum cupressiforme* Hedw.

LEMBOPHYLLACEAE

39. *Isoetecium alopecuroides* (Dubois.) Isov.

LESKEACEAE

40. *Leskea polycarpa* Hedw.

MNIACEAE

41. *Plagiomnium cuspidatum* (Hedw.) T. Kop.

ORTHOTRICHACEAE

42. *Orthotrichum anomalum* Hedw.
43. *Orthotrichum cupulatum* Brid.
44. *Orthotrichum diaphanum* Brid.

POTTIACEAE

45. *Barbula convoluta* Hedw.
46. *Barbula unguiculata* Hedw.
47. *Didymodon cordatus* Jur.
48. *Didymodon luridus* Hornsch. ex Spreng.
49. *Didymodon rigidus* Hedw.
50. *Didymodon vinealis* (Brid.) Zander

51. *Phascum cuspidatum* Hedw.
52. *Tortula inermis* (Brid.) Mont.
53. *Tortula muralis* Hedw.
54. *Tortula muralis* Hedw. var. *aestiva* Hedw.
55. *Tortula princeps* De Not.
56. *Tortula ruralis* (Hedw.) Gaertn., Mayer & Scherb
57. *Trichostomum brachydontium* Bruch
58. *Trichostomum crispulum* Bruch

In the moss flora in the central area of Belgrade, the families with the highest number of species such are Brachytheciaceae (17), Pottiaceae (14), and Bryaceae (11) (Table 1).

Among the most common genera the most prominent is the genus *Bryum*, with 11 species, followed by the genera *Brachythecium* and *Eurhynchium*, with six species each (Table 2). The remaining 15 genera are represented by only one species each.

The greatest number of species are found on large greens in parks, the so-called green oases of the city, where various moss species thrive in conditions favorable for growth and development. These places include large areas in Upper and Lower Kalemegdan Parks, the Botanical Garden, New Cemetery, and different parks and promenades.

In the researched area of Belgrade mosses are most numerous in the Botanical Garden, where 25 different moss species were found. There are 23 moss species in Lower Kalemegdan Park, 22 species in Upper Kalemeg-

dan Park, 19 species in the New Cemetery, and 10 species in the Danube Quay.

Comparison of moss species and their localities showed that one third of the total number of recorded moss species were found in habitats on different streets of the city where conditions for their development were unfavorable, i.e. there was a high concentration of aerosolized particles and low precipitation. The most common moss species are given in Table 3.

Species identified at a large number of localities in the central area of Belgrade were found in rather specific habitats with highly adverse conditions for growth and development of other plants. Mosses require very little to inhabit a particular area, survive, and create conditions for the development of 'succeeding' species. That is why mosses are pioneering species in the true sense of the word.

With its historical, geographical, climatic, geomorphological, hydrological, and other features, the central area of Belgrade is characterized by a diverse moss flora.

The habitats where mosses were found are extremely diversified: soil, rocks, concrete, bricks, concrete walls, brick walls, stone walls, roofs, tree trunks, dust and detritus along the line of contact between buildings and sidewalk, cracks in the sidewalk, dust accumulated in between cobble stones, tombstones, staircases, etc.

Finally, it should be pointed out that further floristic,

Table 1. Survey of all moss species (by families) in the researched area of Belgrade and comparison with the number of species in Serbia and Serbia and Montenegro.

Family	Belgrade	Serbia	Serbia & Montenegro
<i>Brachytheciaceae</i>	17	27	36
<i>Pottiaceae</i>	14	34	42
<i>Bryaceae</i>	11	57	93
<i>Amblystegiaceae</i>	4	37	39
<i>Orthotrichaceae</i>	3	20	24
<i>Grimmiaceae</i>	2	17	19
<i>Hypnaceae</i>	2	16	17
<i>Ditrichaceae</i>	1	12	13
<i>Funariaceae</i>	1	10	12
<i>Lembophyllaceae</i>	1	1	1
<i>Leskeaceae</i>	1	7	7
<i>Mniaceae</i>	1	14	14

Table 2. Survey of moss species (by genera) in the central area of Belgrade and comparison with the number of species in Serbia and Serbia and Montenegro.

Genus	Belgrade	Serbia	Serbia & Montenegro
<i>Bryum</i>	11	21	23
<i>Brachythecium</i>	6	10	13
<i>Eurhynchium</i>	6	12	12
<i>Tortula</i>	5	13	20
<i>Amblystegium</i>	4	9	9
<i>Didymodon</i>	4	10	11
<i>Orthotrichum</i>	3	16	16
<i>Barbula</i>	2	5	5
<i>Homalothecium</i>	2	3	3
<i>Trichostomum</i>	2	2	2

Table 3. Moss species present at 10 localities.

Species	No. of localities	%
<i>Bryum argenteum</i> L.	99	87.6
<i>Ceratodon purpureus</i> (Hedw.) Brid.	47	41.6
<i>Tortula muralis</i> Hedw.	37	32.7
<i>Funaria hygrometrica</i> (L.) Sibth.	28	24.8
<i>Bryum caespiticium</i> Hedw.	20	17.7
<i>Bryum bicolor</i> Dicks.	17	15.0
<i>Amblystegium serpens</i> (Hedw.) B.S.G.	12	10.6
<i>Eurhynchium hians</i> (Hedw.) Lac. var. <i>swartzii</i> (Turn.) Frahm	12	10.6
<i>Barbula unguiculata</i> Hedw.	12	10.6
<i>Bryum kunzei</i> Hornsch.	11	9.7
<i>Grimmia pulvinata</i> (Hedw.) Sm.	11	9.7

environmental, and particularly eco-physiological research on mosses in the whole city of Belgrade and its surroundings is needed, as it will contribute to full recognition of moss biodiversity and the environmental value of individual moss species in the specific conditions characteristic of the city area.

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ФЛОРА МАХОВИНА УЖЕГ ГРАДСКОГ ПОДРУЧЈА БЕОГРАДА

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Површина ужег подручја Београда обухваћена овим истраживањима захвата простор шест градских Општина: Стари Град, Савски Венац, Врачар и делови општина Палилула, Звездара и Вождовац.

На ужем подручју Београда утврђено је присуство 58 врста. Све врсте маховина утврђене на истраженом подручју града Београда припадају класи *Bryopsida*. Укупан број од 58 врста маховина, обухваћен је у 23 рода и 12 фамилија. Међу најзаступљенијим фамилијама истичу се *Brachytheciaceae* (17), *Bryaceae* (14) и *Pottiaceae* (14). Најзаступљенији су родови *Bryum* (14), *Brachythecium* (6) и *Eurhynchium* (6).

На ужем подручју града Београда забележене су 2 нове врсте за Србију (*Rhynchostegium confertum* и *Didymodon cordatus*), као и 2 нове за територију Србије и Црне Горе (*Rhynchostegiella jacquinii* и *Bryum kunzei*).

Највећи број врста маховина констатован је у Ботаничкој башти "Јевремовац" (укупно 25 врста), затим на просторима доњег Калемегдана (24) и горњег

Калемегдана (23) врсте. На Новом гробљу утврђено је 19 врста, а на простору Дунавског кеја -11 врста маховина.

Највећи број врста маховина забележен је на камену (39 врста), затим на земљишту - 29 врста, на бетону - 27 врста, и на зидовима од цигле - 12 врста.

Најраспрострањеније врсте маховина на ужем подручју града су: *Bryum argenteum* (на 99 локалитета), *Ceratodon purpureus* (на 47 локалитета), *Tortula muralis* (на 37 локалитета), *Funaria hygrometrica* (на 28 локалитета), *Bryum caespiticium* (на 20 локалитета) и *Bryum bicolor* (на 17 локалитета).

На крају треба истаћи да су неопходна даља флористичка, еколошка а посебно екофизиолошка истраживања маховина на целом подручју града Београда и његове околине, која ће допринети комплетнијем познавању биодиверзитета маховина, као и познавању еколошке валенце појединих врста маховина у односу на специфичне услове који владају у градском подручју.