

**Description of the bryoflora and bryophyte vegetation of Kékes North Forest
Reserve in Mátra mountains (N-Hungary)**

Péter Ódor

Department of Plant Taxonomy and Ecology, Loránd Eötvös University, H-1083
Budapest, Ludovika tér 2.

Abstract

The aim of the present study is a qualitative description of the bryophyte vegetation of the Kékes North Forest Reserve. Abiotic and biotic conditions of the study area as well as the bryophyte vegetation are described, and the species found in the area are listed. Abundance, ecological requirements, substrate specificity of the species are described, and in some cases they are compared to the findings observed in other parts of Hungary. The importance of the reserve in biological conservation is emphasised on the basis of the bryophyte vegetation.

In the 64 ha core area, 20 liverwort species and 48 moss species are found. One liverwort species is new to the Hungarian flora (*Anastrophyllum hellerianum* (Nees ex Lindenb.) Schust.), and five other liverwort species for the Mátra mountains (*Calypogeia muelleriana* (Schiffn.) K. Müll., *Calypogeia suecica* (H. Am et j. Press.) K. Müll., *Lophozia ascendens* (Warnst.) Schust., *Lophozia longiflora* ((Nees.) Schiffn., *Nowellia curvifolia* (Dicks.) Mitt. in Godman). *Lophozia ascendens* is the only *Lophozia* species in Hungary that is categorised as “rare” by the European Red Data Book of Bryophytes. Although a diverse bryophyte vegetation can be found in the fissures of andesite outcrops in ravine-like sites, it is the vegetation occurring on decaying logs that makes the reserve unique.

Nomenclature: Simon (1992) for vascular plants, Grolle (1983) for liverworts, Corley et al. (1981) and Corley and Crundwell (1991) for mosses.

Introduction

This study characterises the environmental features and vegetation of the Kékes North Forest Reserve, describes the bryophyte vegetation and lists the bryophyte species found in the area. Abundance, ecological requirements, substrate specificity of the species are given in detail. For some species local abundance is compared to Hungarian and European conditions. These statements are based on field studies and collections having been carried out since 1996 in the area, on previous literature (e.g. Boros 1968, Orbán and Vajda 1983) and on a quantitative study investigating substrate specificity and structure of bryophyte vegetation (Standovár et al. 1999, Ódor and Standovár 1999, 2000).

Environmental and biological features of the reserve

The area is located in the Mátra mountains on the northern slope of Kékes peak at 700-950 m above sea level. The size of the reserve is 143 ha (core area 64 ha, buffer zone 79 ha), its shape is elongated in east-west direction. It has been legally protected since 1986 and since 1990 it has been a forest reserve (Czájlik et al. 1993). Generally, the exposition is northerly, at the eastern side north-easterly, at the western side north-westerly, although it varies considerably because of small gorges and crests. The slope is very steep: its angle is cc. 32-33°. There are four rows of rock walls along the slope. The bedrock is andesite (Dávid 1992). The soil is thin (0-80 cm) due to the steepness slope, it is acidic clay rinsed brown forest soil or ranker soil. The ground is covered by rocks, which often build continuous outcrops and boulder-stones. The climate is Central European montane (Székely 1964, Pászty 1998, Czájlik et al. 1993), mean annual temperature is 5.7 °C, mean temperature in July 15.5 °C, in January -4.4 °C. Annual precipitation is 784 mm, number of snow covered days is 112. Mean air humidity is 83% on Kékes peak (in the reserve it could be higher).

The area is covered by forest, whose composition of tree species varies according to environmental heterogeneity and forest developmental conditions. The stand is basically a mosaic of three forest community types: montane beech forest (*Aconito-Fagetum*), humid ravine-like forest (*Phyllitidi-Aceretum subcarpaticum*) and dry boulder-stone forest (*Mercuriali-Tilietum*). Kovács (1958, 1964, 1968, 1975) and Szujkó-Lacza (1962) give a phytosociological description of these communities.

Pászty (1998) mapped the vegetation types of the reserve using finer categories, and also described its vascular flora. Ravine-like stands occur mainly in deep rocky fissures with high air humidity. Besides beech (*Fagus sylvatica*), early maple (*Acer platanoides*), sycamore (*Acer pseudoplatanus*) and lime (*Tilia platyphyllos*) are important in the tree layer; in the shrub layer witch elm (*Ulmus glabra*) and *Sambucus racemosa* occur; the cover of ground layer is high, and is dominated by ferns (*Athyrium filix-femina*, *Dryopteris filix-mas*, rarely *Polystichum braunii*) as well as by *Urtica dioica*, *Solanum dulcamara*, *Impatiens noli-tangere*, *Geranium robertianum* and *Oxalis acetosella*. Bryophyte vegetation is abundant and rich in species. The proportion of canopy gaps is high, in which the amount of coarse woody debris is considerable. In beech dominated parts the soil is deeper and the amount of outcrops is reduced, the undergrowth is dominated by early spring flowering herbs (*Galanthus nivalis*, *Corydalis cava*, *Dentaria bulbifera*) and other *Fagetalia* species (*Galium odoratum*, *Mercurialis perennis*, *Viola sylvestris*, *Carex pilosa*). *Senecio nemorensis* ssp. *fuchsii* and *Polygonatum verticillatum* show the montane character of these stands. Boulder-stone forests are dryer than ravine-like forests (although the cover of rocks is similar), the most common trees are lime and common maple (*Acer campestre*), the undergrowth is less abundant, besides *Fagetalia* species *Campanula rapunculoides* and *Impatiens parviflora* also occur. Dry acidic open shrub-forests appear in small patches (*Deschampsio-Fagetum*) on the top of rock walls, where *Deschampsia flexuosa*, *Calamagrostis aundinacea* and *Luzula luzuloides* are common and *Valeriana tripteris* can rarely be observed.

In the core area forest management activities have never been carried out, apart from a cc. 18 ha patch cut over in 1960's. Its natural stand structure has a very high conservation and scientific value. This site could be a reference for natural stand structure and stand dynamics investigations. In this stand it is possible to investigate the effect of natural stand-structure on regeneration as well as on herbaceous and bryophyte layer. The comparative studies between this reserve and managed stands show the biological impact of certain stand-structural elements eliminated by forest management. These studies can serve as a scientific basis for near natural management. Stand structural studies in the area have been going on since 1989 coordinated by the Vásárhelyi István Conservation Group (NGO, Czájlik et al. 1993) and researchers of Department of Plant Taxonomy and Ecology of ELTE. Czájlik et al. (1996) describes the stand structure and hypothetical dynamics of different forest

developmental phases. Standovár and his colleagues compared the stand structure of the reserve to managed stands of different ages analysing maps of trees (Gálhidy 1999). In the reserve the size distribution of trees follows a negative exponential function whereas in managed stands a normal function. The reserve shows a greater variety of size categories, and large trees, which are missing from managed stands, also occur. The spatial pattern of tree regeneration is clustered following the structure of the canopy gaps. More heterogeneous light conditions in the reserve have a considerable effect on herbaceous undergrowth, which has higher cover and heterogeneity (Gálhidy 1999, Standovár et al. 1999). The large amount of coarse woody debris is very important for bryophytes (Ódor and Standovár 1999, 2000). In large gaps of the reserve the amount of dead wood can be 300 m³/ha, while this value is cc. 30 m³/ha in “old” managed stands. The proportion of large trees is considerable in the reserve and all stages of decay occur. These features are very important in the composition and diversity of bryophyte vegetation (Ódor and Standovár 2000). Woody debris and humus accumulating among rock significantly increase the diversity of epilithic bryophyte vegetation (Ódor and Standovár 1999). Dead wood bears considerable importance for the diversity of fungi. In the reserve large snags can also be found, which are very important for the survival of some bat species, e.g. for *Nyctalus lasiopterus* (Czárlik 1997a). Compared to its size the small mammal fauna of the reserve is very rich in species (Czárlik 1997b).

Description of the bryophyte vegetation of the reserve

The cover of epigeic bryophyte vegetation is low in the reserve, as in other deciduous forests, because litter accumulation on the forest floor prohibits the development of a continuous bryophyte layer. Bryophytes can colonise the soil only at the places where litter cover is missing, e.g. at trunk bases or at scarps of forest roads. On these sites mainly acrocarp species like *Pohlia nutans*, *Ceratodon purpureus*, *Polytrichum formosum*, *Atrichum undulatum*, *Pogonatum urnigerum*, *P. aloides* grow. The majority of the bryophyte biomass occurs on rocks (epilithic bryophytes). Although the biomass of bryophytes is lower on dead wood (epixilic species) and on bark (epiphytes), these assemblages could be very rich in species.

Bryophyte cover on extended flat dry rock surfaces is large but poor in species, and it is dominated by *Grimmia hartmanii*, *Paraleucobryum longifolium*, *Isothecium*

alopecuroides and *Hypnum cupressiforme*. The less frequent *Hedwigia ciliata*, *Schistidium apocarpum* and *Pterigynandrum filiforme* also appear on this substrate.

On the outcrops of humid ravine-like habitats a species rich bryophyte cover can be found. In the fissures of these humus rich rocks as many as 5-6 species can grow in a 10-cm-diameter patch. Because of the accumulated woody material the species composition of these outcrops overlap considerably with that of dead wood (Ódor and Standovár 1999). Frequent species of this assemblage are *Metzgeria furcata*, *Plagiochila porelloides* and *Plagiothecium* species, with *Rhizomnium punctatum* and *Bryum flaccidum* often occurring on dead wood. Less common characteristic species are *Homalia trichomanoides*, *Tritomaria quinquedentata*, *Barbilophozia barbata* and *Cynodontium polycarpon*. Besides these epilithic species there are some bryophytes that occur only in the fissures of high shaded rock walls, like e.g. *Lejeunea cavifolia*, *Rhabdoweisia fugax*, *Bartramia ithyphylla*, *B. halleriana*, *Metzgeria conjugata*.

Epiphytic vegetation is relatively poor in species, since a lot of epiphytes in this climate do not favour the smooth bark of beech. On the bottom part of trunks mainly *Pterigynandrum filiforme* and *Hypnum cupressiforme* can be observed. On the bark of other tree species, mostly on maple species, more epiphytes can be found. Bark inhabiting bryophytes exhibit higher cover on lying trees (logs with bark) than on standing trees, because of the more favourable microclimatic conditions at the forest floor. Frequent epiphytes are *Pseudoleskeella nervosa*, *Leucodon sciuroides*, *Ortotrichum stramineum*, *Pterigynandrum filiforme*, *Bryum flaccidum*, and occasionally *Sanionia uncinata*.

In the reserve, the most unique bryophyte vegetation occurs on dead logs, where the proportion of liverworts is very high. On well-decayed logs the most common species are *Lophocolea heterophylla*, *Herzogiella seligeri*, *Sanionia uncinata*, *Rhizomnium punctatum*, *Brachythecium rutabulum*, *B. salebrosum*, *B. velutinum* and *Plagiothecium* species. A lot of epixilic species grow on coarse wood debris, rare in Hungary, like *Lophozia ascendens* (included in the Red Data Book of European Bryophytes, ECCB 1995), *Anastrophyllum hellerianum* (new species to the Hungarian flora, Ódor 2000), *Blepharostoma trichophyllum*, *Nowellia curvifolia*, *Calypogeia suecica*, *C. muellerana* and *Lophocolea minor*. The most diverse mats occur on large logs, where rare species are more common. These large well-decayed logs are missing from managed forests.

Most common species of the reserve is *Hypnum cupressiforme*, which is very common on all substrate types building extended mono-dominant patches.

List of bryophytes occurring in the reserve

In this section, bryophytes found in the reserve by the author are listed using the nomenclature given at the beginning of the paper. Whenever the nomenclature used differs from Orbán and Vajda (1983), which is the most common identification book in Hungary, old names are given as synonyms. Identification of specimens is based on the following books: Orbán and Vajda (1983), Smith (1990), Smith (1978), Frahm and Frey (1992), Landwehr (1966) and Schuster (1969). For all species the following features are given: abundance, substrate preference, habitat preference in the reserve and in Hungary. “Dead wood” as a substrate means mainly logs and stumps lying on the floor. Abundance estimation of species is categorised by the following attributes: dominant (the species is frequent with a large cover), frequent (the species is frequent but its cover is low), slightly frequent (the species is not common but easy to find), rare (the species occurs rarely). Fig 1. shows the relative frequency relations of some species in the reserve. Distribution and abundance of species in Hungary are based on Boros (1968) and Orbán and Vajda (1983). Voucher specimens are deposited in the collections of Natural History Museum, Budapest and in the collections of the author.

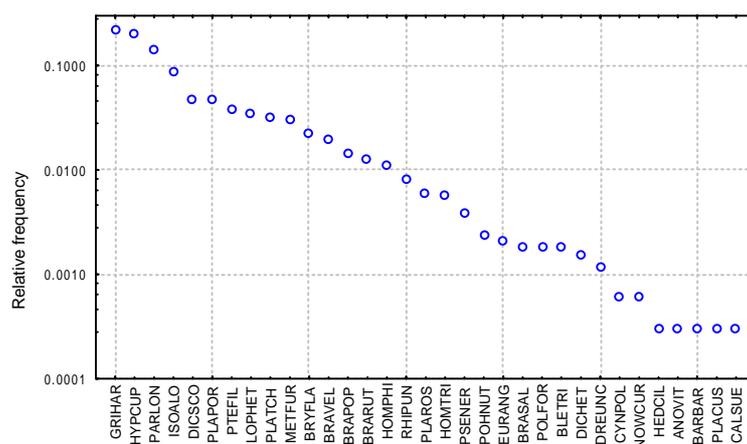


Fig. 1. Rank-relative frequency curve among the species living in the reserve, based on 1508 100 cm² plots arranged systematically in a 120 by 120 m stand. The stand is a

mosaic of ravine-like outcrops and montane beech forest. The codes were made up from first three letters of the genus and species names.

Liverworts

1. *Anastrophyllum hellerianum* (Nees ex Lindenb.) Schust. Rare in the reserve, occurring only on one well-decayed log (61 cm in diameter). It occurs together with *Lophozia ascendens*, *Lophozia longiflora*, *Calypogeia suecica*, *Nowellia curvifolia*. This species is new to the Hungarian flora, its description and distribution can be found in Ódor (2000). The collected specimen was revised by Tamás Pócs and Jiří Vana.
2. *Barbilophozia barbata* (Schmid ex Schreb.) Loeske. Rare in the reserve, occurring in shaded humus-rich fissures of rocks, mostly in ravine-like habitats. In Hungary, it can be found in mountains and in the southern and western parts.
3. *Blepharostoma trichophyllum* (L.) Dum. Rare in the reserve, occurring on well-decayed logs, mainly together with other bryophytes. In Hungary, it lives in mountains and in the southern and western part of the country, rare.
4. *Calypogeia muelleriana* (Schiffn.) K. Müll. Rare in the reserve, occurring only in one well-decayed log. This species is new to the Mátra mountains, in Hungary it lives in Vendvidék and Vasi-hegyhát (western Hungary). It is rare, usually occurring on wet acidic soil along streams and forestry roads. The collected specimen was revised by Tamás Pócs and Jiří Vana.
5. *Calypogeia suecica* (H. Am et J. Press.) K. Müll. Rare in the reserve, occurring only on one well-decayed log (61 cm in diameter). It co-occurs with *Lophozia ascendens*, *Lophozia longiflora*, *Anastrophyllum hellerianum*, *Nowellia curvifolia*. It appears on the vertical side of the log, mainly in fissures. In Hungary, it is very rare, disappeared from the Bükk mountains, it lives only in the Zemplén mountains and the Kőszegi mountains in ravines on dead wood. This species is new to the Mátra mountains. The collected specimen was revised by Tamás Pócs and Jiří Vana.
6. *Conocephalum conicum* (L.) Underw. Rare in the reserve, occurring in a wet fissure of a rock wall. In Hungary it is frequent in mountains and in the western part along streams and in ravines on wet rocks.

7. *Frullania dilatata* (L.) Dum. Slightly frequent in the reserve, epiphyte; common in Hungary.
8. *Lejeunea cavifolia* (Ehrh.) Lindb. Slightly frequent in the reserve, occurring in wet fissures of rock walls. In Hungary it is rare, living in ravines of mountains, mainly on volcanic rocks.
9. *Lophocolea heterophylla* (Schrad.) Dum. Frequent or dominant in the reserve, occurring mainly on well-decayed logs. In Hungary it is frequent except for the Great Plain, where it is rare.
10. *Lophocolea minor* Nees. Slightly frequent in the reserve, occurring on well-decayed logs. Except for the Great Plain it occurs everywhere in Hungary, mainly on rocks and soil.
11. *Lophozia ascendens* (Warnst.) Schust. Rare in the reserve, occurring on well-decayed logs, together with *Calypogeia suecica*, *Lophozia longiflora*, *Anastrophyllum hellerianum*, *Nowellia curvifolia*. In Hungary it is very rare, it lives in the Zemplén mountains and in the Bükk mountains, new to the Mátra mountains. The collected specimen was revised by Tamás Pócs and Jiří Vana. It is rare in Europe restricted to old-growth forests. According to Red Data Book of European Bryophytes (ECCB 1995) it belongs to the “rare” IUCN category. This is the only *Lophozia* species in Hungary included in this book.
12. *Lophozia longiflora* ((Nees.) Schiffn. (Syn.: *Lophozia guttulata* (Lindb. et h. Arn.) evans.). Rare in the reserve, occurring only on one well-decayed log (61 cm in diameter). It co-occurs with *Lophozia ascendens*, *Calypogeia suecica*, *Anastrophyllum hellerianum*, *Nowellia curvifolia*. In Hungary it is very rare, previously described for the Bükk mountains (although probably extinct since then) and in the Mecsek mountains. It is new to the Mátra mountains.
13. *Metzgeria conjugata* Lindb. Slightly frequent in the reserve, occurring in wet fissures of rock walls. In Hungary, it occurs in mountains and in the western part in ravines and along streams on wet rocks, not rare.
14. *Metzgeria furcata* (L.) Dum. Frequent in the reserve, living in wet fissures of outcrops, mainly in ravine-like habitats, and sometimes it also appears on bark. In Hungary, it is frequent on rocks and bark; in the Great Plain it is rare.
15. *Nowellia curvifolia* (Dicks.) Mitt. in Godman. Rare in the reserve, occurring on large, well-decayed logs. It can also be found with gemmae, which are relatively

rare in Hungary. In Hungary it is rare, living in mountains and in the western part; it is new to the Mátra mountains.

16. *Plagiochila porelloides* (Torrey ex Nees) Lindenb. Frequent in the reserve, living in wet fissures of outcrops, mainly in ravine-like habitats. In Hungary it is frequent in mountains.
17. *Porella platyphylla* (L.) Pfeiff. Slightly frequent in the reserve, occurring on shaded rock walls. In Hungary it is frequent occurring on rock and bark.
18. *Ptilidium pulcherrimum* (g. Web.) Vainio. Very rare in the reserve, occurring on the bark of an early maple log. In Hungary it is rare, occurring in mountains and in western part.
19. *Radula complanata* (L.) Dum. Slightly frequent in the reserve, occurring on bark, mainly on maple species. It is frequent in Hungary, epiphyte.
20. *Tritomaria quinquedentata* (Huds.) Buch. Slightly frequent in the reserve, living in wet fissures of outcrops, mainly in ravine-like habitats and on rock walls. In Hungary it lives in mountains.

Mosses

1. *Amblystegium serpens* (Hedw.) Br. Eur. Slightly frequent in the reserve, occurring on decaying logs; frequent in Hungary.
2. *Amblystegium subtile* (Hedw.) B., S. & G. (Syn.: *Platydictya subtilis* (Hedw.) Crum.). Rare in the reserve, occurring in one decaying log; slightly frequent in Hungary.
3. *Anomodon viticulosus* (Hedw.) Hook. & Tayl. Slightly frequent in the reserve, living in wet fissures of outcrops, mainly in ravine-like habitats; frequent in Hungary occurring on rock and bark.
4. *Atrichum undulatum* (Hedw.) Br. Eur. Slightly frequent in the reserve occurring on soil at tree bases and along roads; frequent in Hungary.
5. *Bartramia halleriana* Hedw. Rare in the reserve, occurring in wet fissures of rock walls. In Hungary it is rare, occurring in the northern mountain chain.
6. *Bartramia ithyphylla* Brid. Rare in the reserve, occurring in wet fissures of rock walls. In Hungary it is rare, occurring in mountains.
7. *Bartramia pomiformis* Hedw. Slightly frequent in the reserve, occurring on rocks. In Hungary it is frequent in volcanic mountains.

8. *Brachythecium populeum* (Hedw.) B., S. & G. Slightly frequent in the reserve, occurring on rocks; frequent in Hungary.
9. *Brachythecium rutabulum* (Hedw.) B., S. & G. Frequent in the reserve, occurring on dead wood or in wet, humus-rich fissures of outcrops; frequent in Hungary.
10. *Brachythecium salebrosum* (Web. & Mohr.) B., S. & G. Slightly frequent in the reserve occurring on dead wood; frequent in Hungary.
11. *Brachythecium velutinum* (Hedw.) B., S & G. Frequent in the reserve occurring on dead wood; frequent in Hungary.
12. *Bryum flaccidum* Brid. Frequent in the reserve occurring on dead wood, bark and in wet, humus-rich fissures of outcrops; frequent in Hungary.
13. *Ceratodon purpureus* (Hedw.) Brid. Slightly frequent in the reserve occurring on rocks, soil and bark; frequent in Hungary.
14. *Cynodontium polycarpon* (Hedw.) Schimp. Slightly frequent in the reserve occurring on rock walls and in wet fissures of outcrops, mainly in ravine-like habitats. *C. strumiferum* is missing from Hungary, but the capsule of some *C. polycarpon* specimens show a transition to it. In Hungary it occurs on volcanic rocks in mountains.
15. *Dicranella heteromalla* (Hedw.) Schimp. Slightly frequent in the reserve occurring on rocks and on soil at tree bases; frequent in Hungary.
16. *Dicranum montanum* Hedw. Rare in the reserve, occurring on rock and bark. Rare in Hungary, it lives in mountains, although in the western part it is frequent.
17. *Dicranum scoparium* Hedw. Common in the reserve mainly in ravine-like habitat types on rocks and dead wood; frequent in Hungary except for the Great Plain.
18. *Eurhynchium angustirete* (Broth.) t. Kop. (Syn.: *Eurhynchium striatum* ssp. *zetterstedtii* (Stoerm.) Podp.). Rare in the reserve, occurring in wet fissures of outcrops in ravine-like habitats. In Hungary it is frequent in mountains.
19. *Fissidens dubius* p. Beauv (Syn.: *F. cristatus* Wils.) Rare in the reserve, occurring on rock walls. In Hungary it is frequent in mountains.
20. *Grimmia hartmanii* Schimp. Dominant: it is the most common species in the reserve. It makes extended patches on dry rock surfaces, the first coloniser of rocks. It occurs in monospecific patches or together with *Paraleucobryum longifolium* or *Hypnum cupressiforme*. It colonises the rocks by gemmae, and does not make sporophytes. Frequent in Hungary in mountains on andesite rocks.

21. *Hedwigia ciliata* (Hedw.) P. Beauv. Slightly frequent in the reserve, occurring on dry rock surfaces; frequent in Hungary in mountains.
22. *Herzogiella seligeri* (Brid.) Iwats. Slightly frequent in ravine-like habitats, occurring on well-decayed logs; frequent in Hungary.
23. *Homalia trichomanoides* (Hedw.) Brid. Slightly frequent in the reserve, occurring in wet fissures of outcrops in ravine-like habitats. It is frequent in Hungary (except for in Great Plain), but it lives mainly on bark and not on logs as in the reserve.
24. *Homalothecium philippeanum* (Spruce.) B., S. & G. Slightly frequent in the reserve on rocks; frequent in Hungary in mountains occurring mainly on calcareous rocks.
25. *Homalothecium sericeum* (Hedw.) B., S. & G. Rare in the reserve occurring on bark and dead wood; frequent in Hungary in mountains.
26. *Hypnum cupressiforme* Hedw. It is dominant species in the reserve occurring all substrate types. It often make extended monospecific patches. It is very varied morphologically; frequent in Hungary.
27. *Isothecium alopecuroides* (Dubois) Isov. (*Isothecium viviparum* (Neck.) Lindb.) It is dominant species in the reserve occurring on rocks, mainly in ravine-like habitats; frequent in Hungary in mountains.
28. *Leucodon sciuroides* (Hedw.) Schwaegr. Slightly frequent in the reserve. Epiphyte, it prefers the bark of mixing trees (sycamore, maple and lime); frequent in Hungary in mountains.
29. *Mnium stellare* Hedw. Rare in the reserve, occurring in wet fissures of outcrops in ravine-like habitats; frequent in Hungary in mountains.
30. *Ortotrichum stramineum* Hornsch. ex Brid. Slightly frequent in the reserve. Epiphyte, it prefers the bark of mixing trees (sycamore, maple and lime); frequent in Hungary.
31. *Paraleucobryum longifolium* (Hedw.) Loeske. Dominant in the reserve, making extended patches on dry rock surfaces, occurring in monospecific patches or together with *Grimmia hartmanii* or *Hypnum cupressiforme*. Frequent in Hungary on rocks in mountains.
32. *Plagiomnium cuspidatum* (Hedw.) T. Kop. Frequent in the reserve, occurring in wet fissures of outcrops and on dead wood mainly in ravine-like habitats; frequent in Hungary.

33. *Plagiomnium rostratum* (Schrad.) T. Kop. Slightly frequent in the reserve, occurring in wet fissures of outcrops and on dead wood mainly in ravine-like habitats; frequent in Hungary in mountains.
34. *Plagiothecium denticulatum* (Hedw.) B., S. & G.
35. *Plagiothecium nemorale* (Mitt.) Jaeg. (Syn.: *Plagiothecium neglectum* Moenk.).
36. *Plagiothecium succulentum* (Wils.) Lindb.
- Plagiothecium* species are slightly frequent species in the reserve, occurring in wet fissures of outcrops and on dead wood mainly in ravine-like habitats. It is difficult to distinguish these species on the field, and it is also difficult to estimate their abundance. Probably *P. denticulatum* is the most frequent species. In Hungary they are frequent everywhere, *P. nemorale* mainly in mountains.
37. *Pogonatum aloides* (Hedw.) P. Beauv. Slightly frequent in the reserve occurring on acidic dry soil on the top of rock walls or on scarps of forestry roads; frequent in Hungary in mountains and in the western parts.
38. *Pogonatum urnigerum* (Hedw.) P. Beauv. Slightly frequent in the reserve, occurring on acidic dry soil on the top of rock walls; rare in Hungary occurring in mountains and in the western part.
39. *Pohlia nutans* (Hedw.) Lindb. Slightly frequent in the reserve, occurring on acidic soil at tree bases; frequent in Hungary.
40. *Polytrichum formosum* Hedw. (Syn.: *Polytrichastrum formosum* (Hedw.) G. L. Smith). Slightly frequent in the reserve, occurring on acidic soil at tree bases; frequent in Hungary in mountains, but rare in the Great Plain.
41. *Polytrichum piliferum* Hedw. Slightly frequent in the reserve, occurring on acidic dry soil on the top of rock walls or on scarps of forestry roads; frequent in Hungary occurring mainly in mountains and in the western part.
42. *Pseudeskeella nervosa* (Brid.) Nyh. (Syn.: *Leskeella nervosa* (Brid.) Loeske). Frequent in the reserve. Epiphyte, it prefers the bark of mixing trees (sycamore, maple and lime); frequent in Hungary in mountains.
43. *Pterigynandrum filiforme* Hedw. Frequent in the reserve, epiphyte, mainly at bases of beech trees, sometimes occurs also on dry rock surfaces; frequent in Hungary in beech forests.
44. *Rhabdoweisia fugax* (Hedw.) B., S. & G. Rare in the reserve, occurring in wet fissures of rock walls. In Hungary it is rare, occurring in the Zemplén, Bükk, Mátra, Börzsöny and Mecsek mountains.

45. *Sanionia uncinata* (Hedw.) Loeske. Slightly frequent in the reserve, occurring in wet fissures of outcrops and on dead wood mainly in ravine-like habitats. In Hungary it is rare, occurring in mountains and in the western part, mainly in ravines.
46. *Schistidium apocarpum* (Hedw.) B. & S. Rare in the reserve, occurring on dry rock surfaces together with *Grimmia hartmanii*; frequent in Hungary.
47. *Tortula ruralis* (Hedw.) Gaertn. Rare in the reserve, occurring on bark; frequent in Hungary occurring on different substrates.
48. *Tortula subulata* Hedw. Rare in the reserve, occurring only in wet fissures of rock walls, where it is dominant; frequent in Hungary in mountains.

Discussion

Altogether 20 liverwort and 48 moss species were found in 64-ha the core area of the reserve. From these species six are new to the Mátra mountains (*Anastrophyllum hellerianum*, *Calypogeia muelleriana*, *Calypogeia suecica*, *Lophozia ascendens*, *Lophozia longiflora*, *Nowellia curvifolia*) and one is new to the Hungarian flora (*Anastrophyllum hellerianum*, Ódor 2000). The Hungarian bryoflora contains 566 species (Orbán and Vajda 1983), and the reserve contains 12% of this species pool. It is important to note that there are no wetlands (mire, stream, swamp) in the reserve, therefore this species pool only consists of forest species occurring on rock, dead wood, bark and forest soil. Consequently, this reserve is a hotspot of forest bryophyte biodiversity in Hungary especially compared to other stands of similar size. There are three important features in the background of this high diversity: geomorphological heterogeneity, microclimatic heterogeneity and forest naturalness. In the case of epilithic vegetation, the high diversity of different rocky microhabitats (open rock surfaces, wet crevices among outcrops, dry boulder-stones and high shaded rock walls) bears great importance. The humid climate of the reserve supports the establishment of montane-boreal species. In wet fissures among rocks in ravine-like stands, air humidity is very high and the amount of dead wood is large accumulating woody material and humus among outcrops. This habitat exhibits very diverse epilithic bryophyte vegetation.

The most special bryophyte assemblages occur on coarse woody debris, and all species new to this region were epixylic. These epixylic liverworts are very rare in

Hungary, only a few occurrences were reported in the past, and taking the biological features of these species into account, the persistence of the old data is questionable. The life span of the local populations is limited by the life span of their log as a substrate. The turnover of the species on decayed log surfaces is very high. For the survival of these populations the continuous presence of well-decayed logs is essential, where the high mortality rate of local populations is compensated by regular colonisation (Söderström 1989, Söderström and Herben 1997). More species can be found on large logs, which also serve as unique habitats for rare species, because they decay slower, exist longer as a potential substrate, and the species has more time for colonisation. The presence of large well-decayed logs in a forest stand is a necessary but not sufficient condition for the colonisation of rare epixylic species. They request the continuously cool climate with high level of air humidity, which below 1000 m in Central Europe is only possible in ravines and northern slopes. We can easily observe this effect comparing the log inhabiting bryophyte vegetation of the Óserdő Forest Reserve (a zonal beech stand in the Bükk mountains) and the Leány Forest Reserve (a ravine stand in the Bükk mountains). Species richness is much higher in Leány Forest Reserve, although the amount of dead wood is high in both stands. However, dead wood is very important for bryophyte diversity in zonal stands, too. If managed stands could contain permanently more woody material, the abundance of a lot of species would be higher (e.g. *Lophocolea heterophylla*, *Herzogiella seligeri*, *Rhizomnium punctatum*, *Sanionia uncinata*, *Brachythecium* species, *Amblystegium serpens*). Besides bryophytes, dead wood is also vital for thousands of other living organisms (e.g. fungi, invertebrates, birds, small mammals; Harmon et al. 1986).

Acknowledgements

I am especially grateful to Zoltán Tóth, Péter Erzberger, Tamás Pócs, Jiří Vana and Beáta Papp for helping with bryophyte identification. I got a lot of help both at field work and at scientific discussions from my colleagues: Tibor Standovár, Erzsébet Szurdoki, László Gálhidy, Réka Aszalós. I would like to express my thanks to Tamás Pócs for his useful comments on the manuscript. This work was supported by the grants OTKA F029762 (leader: Péter Ódor), OTKA F21300 and OMF B EU-98-D10-109 (leader: Tibor Standovár).

References

- Boros Á. (1968): Bryogeographie und Bryoflora Ungarns. - Akadémiai Kiadó, Bp., 466 pp.
- Corley, M.F.V. and Crundwell, A.C. 1991. Additions and amendments to the mosses of Europe. - J. Bryol. 16: 337-356.
- Corley, M.F.V., Crundwell, A.C., Düll, R., Hill, M.C. and Smith, A.J.E. 1981. Mosses of Europe and the Azores; an annotated list of species, with synonyms from the recent literature. - J. Bryol. 11: 609-689.
- Czajlik P., Gergely, Z. and Tulipánt, T. (1993): "Kékes-észak" egy létesítendő erdőrezervátum. - Környezet és Fejlődés 4 (3-4): 64-66.
- Czajlik, P. (1996): Koreloszlás és szukcesszió háborítatlan erdőállományokban: esettanulmány. - In: Mátyás Cs. (ed.): Erdészeti ökológia. Mezőgazdasági Kiadó, Bp., pp.: 84-92.
- Czajlik, P. (1997a): Adatok Kékes Észak erdőrezervátum denevér faunájához. - Fol. Hist. Nat. Mus. Mat. 22: 345-348.
- Czajlik, P. (1997b): Kékes Észak erdőrezervátum emlős faunája. - Fol. Hist. Nat. Mus. Mat. 22: 349-355.
- Dávid, L. (1992): A Mátra északi lejtőjének csuszamlásos felszínfejlődése. Fol. Hist. Nat. Mus. Mat. 17: 9-27.
- ECCB (European Comitee for Conservation of Bryophytes) (1995): Red Data Book of European Bryophytes. - ECCB (ed.), Trondheim, 291 pp.
- Frahm, J.P. and Frey, W. (1992): Moosflora. - Eugen Ulmer GmbH & Co., Stuttgart. 516 pp.
- Gálhidy, L. (1999): Természetközeli és gazdasági erdők szerkezetének összehasonlító vizsgálata. - Kézirat. Szakdolgozat, ELTE Növényrendszertani és Ökológiai Tanszék.
- Grolle, R. (1983): Hepatics of Europe including the Azores: an annotated list of species, with synonyms from the recent literature. - Journal of Bryology. 12: 403-459.
- Harmon, M.E., Franklin, J.F., Swanson, F.J., Sollins, P., Gregory, S.V., Lattin, J.D., Anderson, N.H., Cline, S.P., Aumen, N.G., Sedell, J.R., Lienkaemper, G.W., Cromack, K.Jr. and Cummins, K.W. (1986): Ecology of Coarse Woody Debris in Temperate Ecosystems. - Advances in Ecological Research 15: 133-276.

- Kovács, M. (1958): A Mátra újabb cönológiai és florisztikai adatai. - Botanikai Közlemények 47: 356-358.
- Kovács, M. (1964): Zönologische und experimentell- ökologische Untersuchungen in der Umgebung von Paráds. - Acta Botanica Sci. Hung. 10: 175-211.
- Kovács, M. (1968): Die Acerionpseudoplatani- Wälder (*Mercuriali-Tilietum* und *Phyllitidi-Aceretum*) des Mátra-Gebirges. - Acta Botanica Acad. Sci. Hung. 14: 331-350.
- Kovács, M. (1975): Beziehung zwischen Vegetation und Boden. Die Bodenverhältnisse der Waldgesellschaften des Mátragebirges. - Akadémiai Kiadó, Bp., 365 pp.
- Landwehr, J. (1966): Atlas van de nederlandse bladmosse. - K.N.N.V., Amsterdam, 558 pp.
- Ódor, P. and Standovár, T. (1999): Substrate specificity and community structure of bryophyte vegetation in a near-natural montane beech forest. - Kézirat.
- Ódor P. and Standovár T. (2000): Richness of bryophyte vegetation in near-natural and managed beech stands: The effects of management-induced differences in dead wood. - Kézirat.
- Ódor, P. (2000): Új májmohafaj a magyar flórában: *Anastrophyllum hellerianum* (Nees ex Lindenb.) Schust. - *Kiaibelia*.
- Orbán, S. and Vajda, L. (1983): Magyarország mohaflórájának kézikönyve. Akadémiai Kiadó, Bp., 518 pp.
- Pászty, G. 1998. A Kékes Észak erdőrezervátum vegetációtérképe. - Kézirat. Szakdolgozat, ELTE Növényrendszertani és Ökológiai Tanszék.
- Schuster, R.M. (1969): The Hepaticae and Anthocerotae of North America. East of the Hundreth Meridian. Vol. II. - Columbia Univ. Press., New York & London.
- Simon, T. 1992. A magyarországi edényes flóra határozója. - Tankönyvkiadó, Budapest.
- Smith, A.J.E. (1978): The mossflora of Britain and Ireland. - Cambridge Univ. Press, Cambridge, pp. 706.
- Smith, A.J.E. (1990): The liverworts of Britain and Ireland. - Cambridge Univ. Press, Cambridge, pp. 362.
- Söderström, L. and Herben, T. 1997. Dynamics of bryophyte metapopulations. - *Advances in Bryology* 6: 205-240.

- Söderström, L. (1989): Regional distribution patterns of bryophyte species on spruce logs in northern Sweden. - *The Bryologist* 92: 349-355.
- Standovár, T., Ódor, P. and Aszalós, R. (1999): Diversity measures for assessing forest naturalness: limitations, possibilities, and a case study in a Hungarian semi-natural beech forest. - *Kézirat*.
- Székely, A. (1964): A Mátra természeti földrajza. - *Földrajzi Közlemények* 12 (88): 199-218.
- Szujkó-Lacza, J. (1962): Die Buchenwalder des Börzsöny- und Mátragebirges. - *Acta Botanica Acad. Sci. Hung.* 8: 441-471.