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MOSSES WITH SPECIALIZED ASEXUAL PROPAGULES IN ARABLE FIELDS OF LITHUANIA

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Twenty moss species with asexual propagules were recorded as a result of bryological investigations carried out in 1998–2002 in arable fields of Lithuania. The species frequency, distribution through the country, life history strategies, occurrence in different habitats and in the fields with different soils are discussed.

Key words: mosses, asexual propagules, gemmae, bulbils, arable fields, Lithuania

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Introduction

Arable land is an environment with frequent, regular and large-scale disturbances (Lososowa et al. 2006). It is colonized by bryophyte species adapted to regular disturbance by virtue of ephemeral lifestyles and compressed life-histories (Porley 2001). Various specialized asexual propagules are among the adaptation means (Whitehouse 1966, Nordhorn-Richter 1982, Shaw 1981). They form a persistent diaspore bank in the soil which is important in enabling the plants to persist unfavourable periods and rapidly colonize new ground when conditions become suitable (Bisang 1996; During 1979, 1995; During & ter Horst 1983; During & van Tooren 1988; During et al. 1988). Thus, arable land is a good study area for investigations of the diversity of species more frequently existing like diaspore bank in the soil. Nevertheless agricultural environments are often neglected by scientists regarding investigations of species richness (Zechmeister et al. 2003b). Although a wide range of investigations on bryophyte distribution was recently performed in agricultural landscapes of Europe (Sauberer et al. 2004; Zechmeister & Moser 2001; Zechmeister et al. 2002; Zechmeister et al. 2003a; Zechmeister et al. 2003b), bryophyte diversity of arable fields is still poorly known. More exhaustive lists of bryophytes occurring in arable land are known from Slovakia (Whitehouse 2001) and Great Britain (Porley 2001). No special investigations of bryophytes of arable land were carried in the Baltic countries; phytocoenological descriptions of agrophytocoenoses (Stancevičius 1959; Rašomavičius & Biveinis 1996) included several widely distributed species. Diversity and distribution pattern of mosses that disperse and reproduce more often by vegetative means are insufficiently investigated in the region (Söderström 1996, 1998).

This paper, focused namely on mosses with specialized asexual propagules, presents a small part of investigations on bryoflora of arable fields of Lithuania carried out in 1998–2002. The main objectives of the study were: to identify bryophyte diversity in arable fields of Lithuania, to ascertain the main regularities of species

distribution in relation to different habitats, soil mechanical structure and soil pH and to ascertain frequency and the main tendencies of geographical distribution of the species. While studying mosses with asexual propagules, we tried additionally to answer the question what are the differences among of occurrence of shoots with asexual propagules and shoots with sporophytes in various habitats and in different season time as well as to ascertain frequency of the species with particular asexual propagules.

Methods and materials

Farming land covers nearly 54% of the total area of Lithuania with arable land and grasslands accounting for 70.5% (Kavaliauskas & Baškytė, 2000).

At the time of investigations there were some differences in the management of arable land in Lithuania comparing with that of nowadays due to economic and social conditions. Since 1990 the areas of managed arable land had the tendency to decrease. In 1999 it was by 500 thousand ha less comparing with that of 1990 (http://www.stat.gov.lt/lt). Fallows were usual phenomenon in the fields of Lithuania. At the moment of the investigations the most cultivated in the territory were cereals (60-65%), potatoes (about 7%), rapes (5%), beetroots (about 5%). The majority of fields (90%) were up to 20 ha, more than half of them – up to 10 ha (http://www.stat.gov.lt/lt).

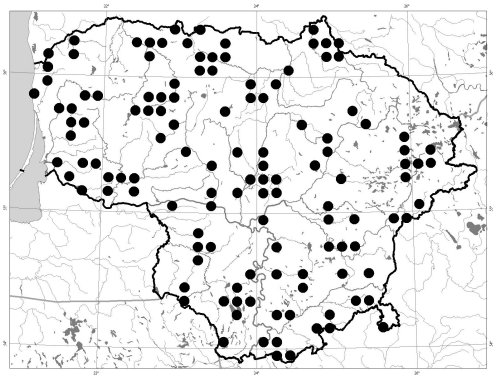

Fig. 1. Distribution of study sites.

The investigations were carried out throughout the country (Fig. 1), 333 fields for a random procedure were investigated. Bryophytes were collected and registered in several places in each field – at the margin of the field and up to 20 m to the middle of it.

Our study covered 15 different types of crops, stubbles, clover fields and fallow land. According to habitat longevity (time between ploughing and harvesting) we distinguished two types of annual crops: spring crops (longevity of habitat till five months) and winter crops (longevity of habitat till 12 months). They include cereals and other types of crops (root crops, potatoes, rapes etc.). Stubbles and clover fields start their existence as habitats after harvesting of cereals without interruption of cultivation. Stubbles as the habitat usually exist for three months (if they are ploughed in autumn) or till 7 – 8 months, if they are ploughed in spring. Clover is usually sown into cereals and only after their harvesting we have recognised clover fields as habitats usually existing up to 2 years. Over-wintered stubbles that were not ploughed in spring we treated as fallow land. Our investigations covered fallows till 3 years old (i.e. 4 years after last cultivation). Thus in total five types of habitats (spring crops, winter crops, stubbles, clover fields and fallows) differing in the origin and the time passed after cultivation of the ground are recognised in our study.

Moss species were attributed to particular life history strategies (During 1992) according to ecological catalogue by K. Dierāen (2001). The same catalogue as well as ecological catalogue of Swedish mosses (Hallingbäck 1996) was used for comparing ecological characteristics of the species.

Soil pH measurements of 38 fields were performed at the Laboratory of Chemical Analyses of the Institute of Botany by potentiometry (pH_{KCl}).

Table 1. List of moss species recorded in arable fields of Lithuania with asexual propagules

Species	Asexual	Number of records with gemmae	Number of records with sporophytes	All records	Life strategy category	Sexuality
a Hedw.	tubers	41	2	43	c	dioi
ı Hedw.	bulbils	5	8	106	c	dioi
ım Hedw.	bulbils, tubers	5	-	5	cp	dioi
ens R.Wilczek & Demaret	bulbils	2	-	2	c	dioi
ffii Schimp.	tubers	43	-	43	ce	dioi
v. ex anon.	axillary gemmae	1	-	1	s	dioi
tt.	tubers	25	-	25	ce	dioi
Crundw. & Nyholm	tubers	2	-	2	ce	dioi
utum Hampe	tubers	51	-	51	ce	dioi
n Podp.	axillary gemmae	3	-	3	c	dioi
Crundw. & Nyholm	tubers	23	-	23	ce	dioi
ens (Dicks.) Schimp.	tubers	1	5	6	ce	dioi
lina H.Whitehouse	tubers	78	-	78	ce	dioi
(Hedw.) Schimp.	tubers	27	18	50	ce	dioi
icum (Hedw.) Grout	tubers	60	4	68	c	dioi
m (Hedw.) Hampe	tubers	4	1	5	c	dioi
orme (Hedw.) Wilson	tubers	14	1	19	f	syno
Hedw.) Lindb.	bulbils	2	-	2	cp	dioi
chela (Renauld & Cardot) Broth.	bulbils	7	-	7	c	dioi
lii (Müll.Hal.) A.L.Andrews	bulbils	1	-	1	c	dioi

c - colonists, ce - ephemeral colonists, cp - pioneer colonists, s- short-lived shuttle, dioi - dioecious, syno - synoecious

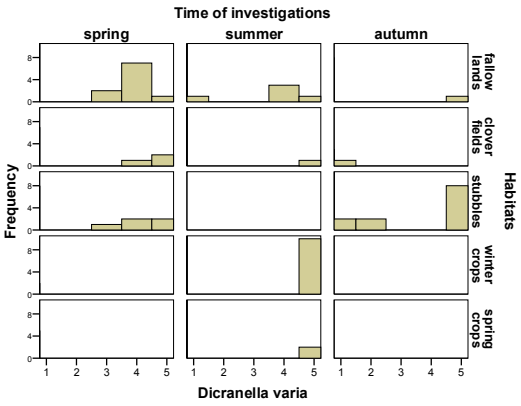

Fig. 2. Number of records of *Dicranella varia*: 1 – without tubers and sporophytes; 2 –– with immature sporophytes; 3 – with mature sporophytes; 4 – with post-mature and dehiscet sporophytes; 5 – with tubers

Distribution of bryophyte species is mapped using grid system. Squares are arranged according to geographical coordinates with sides 6' latitude and 10' longitude (11. 2X10.4 km in the Northern part and 11.2X11.0 km in the Southern part of Lithuania). The area of squares varies from 116.5 to 123.2 km^2. The territory of Lithuania is divided into 597 squares (Gudžinskas, 1993). All localities found in the same square are marked by one point.

The names of the species follow M. O. Hill et al. (2006).

Over 2000 specimens of bryophyte species were collected. Voucher specimens are deposited in the herbarium of the Institute of Botany (BILAS). Comparisons of the presence or absence of the species in different habitats were made by crosstabulation chi-square tests (SPSS 16). All differences were considered significant at the

level $p<0.05$. For determination of the effect size, Contingency Coefficients (CC) were examined.

Results

Diversity of mosses with specialized asexual propagules

The list of mosses with specialized asexual propagules recorded in the studied fields is presented in Table 1. Twenty species are concentrated in six genera: *Bryum* (10 species), *Pohlia* (3 species), *Dicranella* (3 species), *Ditrichum* (2 species), *Barbula* (one species), *Leptobryum* (one species). The species were recorded with three types of specialized vegetative propagules. The most frequent are rhizoid gemmae occurring in all genera of the mosses. Less species, only from the *Bryum* and *Pohlia* genera, were recorded with axillary bulbils. Only two species (*Bryum moravicum* and *Bryum pallens*) were recorded with axillary filamentous gemmae.

Life history strategies

According to life history strategies (Table 1) nearly all species, except for *Leptobryum pyriforme*, are colonists s.l., representing ephemeral colonists (species with rhizoid gemmae), pioneer colonists (the majority of species bearing axillary bulbils), colonists s.s. (*Bryum argenteum* and species with filamentous gemmae). Fugitives and annual shuttles are represented by single species *Leptobryum pyriforme* and *Bryum pallens*, accordingly.

Frequency of the species

Mosses with vegetative propagules were recorded in about 60% of the fields. In more than half of all studied fields 1–3 species were ascertained (Table 2).

The most frequent species with asexual propagules in arable fields of Lithuania is *Dicranella staphylina*, followed by *Ditrichum cylindricum*, *Barbula convoluta*, *Dicranella varia*, species of *Bryum erythrocarpum* complex, especially *Bryum klinggraeffii* and *B. subapiculatum* (Table 1). Although *Bryum argenteum* is one of the most common species in arable fields of Lithuania, it has been rarely recorded with bulbils. The rarest are species with filamentous gemmae – *Bryum pallens* was recorded only once and with small amount of propagules.

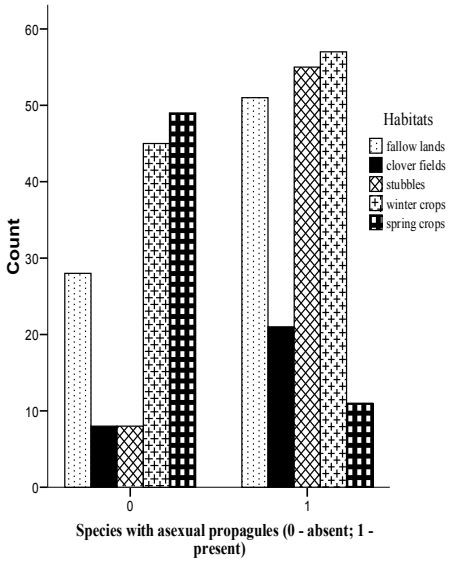

Fig. 3. Frequency (number of records) of moss species with asexual propagules in different habitats of arable fields

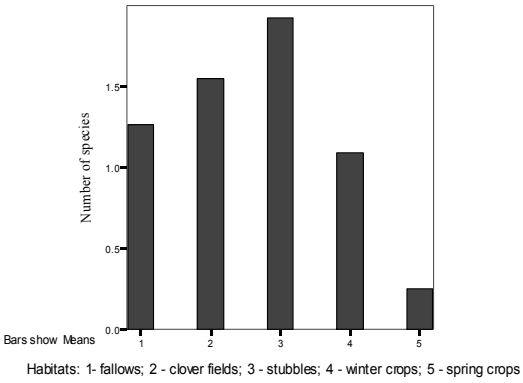

Fig. 4. Average number of moss species with asexual propagules in various habitats of arable fields

Table 2. Frequency of records of species with asexual propagules in arable fields of Lithuania

Number of species		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	138	41.4	41.4	41.4
	1	76	22.8	22.8	64.3
	2	66	19.8	19.8	84.1
	3	37	11.1	11.1	95.2
	4	11	3.3	3.3	98.5
	5	3	.9	.9	99.4
	7	2	.6	.6	100.0
	Total	333	100.0	100.0	

Asexual propagules and sporophytes

Only six species (*Leptobryum pyriforme*, *Bryum argenteum*, *B. pallens*, *Dicranella varia*, *Ditrichum cylindricum*, *D. pussillum*) were recorded with both sporophytes and specialized asexual propagules (Table 1). Sporophytes were more frequent than gemmae among few records of *Dicranella rufescens*. *Leptobryum pyriforme* and *Dicranella varia* in arable fields were more frequently found with rhizoid gemmae. *Bryum argenteum* was more often recorded with gametangia – without sporophytes and gemmae.

Differences in the occurrence of tubers and sporophytes in different season time and habitats are illustrated by *Dicranella varia* (Fig. 2). Shoots with asexual propagules have been recorded in the habitats of various age during the season, while plants with sporophytes occur in older habitats and are restricted to certain season time.

Similar regularities were ascertained for other most common moss species with specialized asexual propagules recorded in arable fields of Lithuania.

Distribution in various habitats

Presence and absence of the species with asexual propagules significantly differed in particular habitats (p=0.00; CC=0.405) being the largest in the stubbles (87 % of all studied fields with mosses bearing asexual propagules) and sands (82 % of all studied fields without species bearing asexual propagules) (Fig. 3). The number of species with asexual propagules increases with the age of habitat (from spring crops to stubbles), but later, when the stubbles remain uncultivated for a year or more, it has a tendency to decrease (Fig. 4). Similarly, significant differences were ascertained while comparing frequency of more common tuberous species: *Dicranella staphylina* (p=0.00; CC=0.260), *Dicranella varia* (p=0.02; CC=0.223), *Barbula convoluta* (p=0.01; CC=0.228), *Ditrichum cylindricum*, (p=0.02;

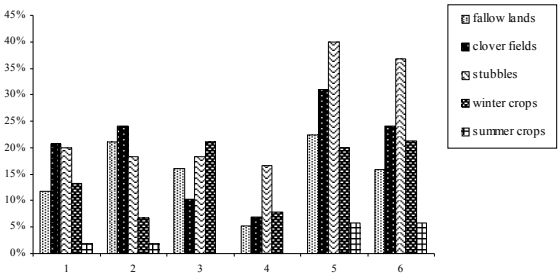

Fig. 5. Distribution of *Bryum klinggraeffii* (1), *Barbula convoluta* (2), *Bryum subapiculatum* (3), *Bryum violaceum* (4), *Dicranella staphylina* (5), *Ditrichum cylindricum* (6) in different habitats of arable fields

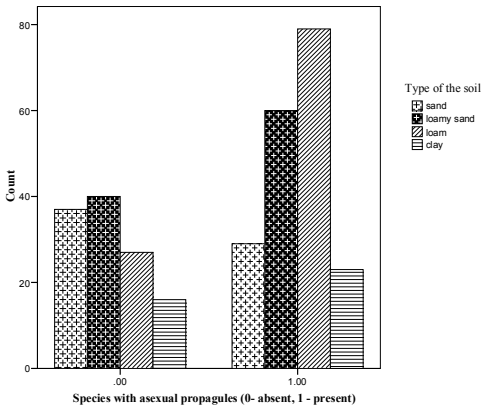

Fig. 6. Frequency (number of records) of moss species with asexual propagules in fields with different types of soils

CC=0.221) *Bryum klinggraeffii* (p=0.041; CC=0.170), *Bryum subapiculatum* (p=0.009; CC=0.198) and *Bryum violaceum* (p=0.015; CC=0.189) (Fig. 5). Only for *Barbula convoluta* the percentage of presence in fallow lands is significantly higher (p=0.00; CC=0.232) comparing with other habitats, including stubbles.

Moss species with axillary bulbils have been recorded in all habitats except for spring crops. The number of records is too small to fully ascertain distribution regularities.

Restriction of species to certain types of the soil

Presence and absence of the species with asexual propagules significantly differed in fields with various soils (p=0.01), meanwhile the differences were not so distinct (CC=0.229) as in case of stubbles. Most frequently the species were found in fields with prevailing loams and sandy loams (Fig. 6). Mosses with asexual propagules were found in 75% and 60% of all studied fields, accordingly.

No significant differences were ascertained for distribution of *Barbula convoluta* (p=0.185), *Bryum klinggraeffii* (p=0.088), *Bryum violaceum* showing slight preference to loams, *Bryum rubens* (p=0.01, CC=0.225) to clays and *Dicranella staphylina* (p=0.015, CC=0189) to loams and loamy sands (Fig. 7).

The majority of species was ascertained to grow in the fields with soils of wide pH range (Fig. 8). Only *Bryum rubens* and *Dicranella varia,* that

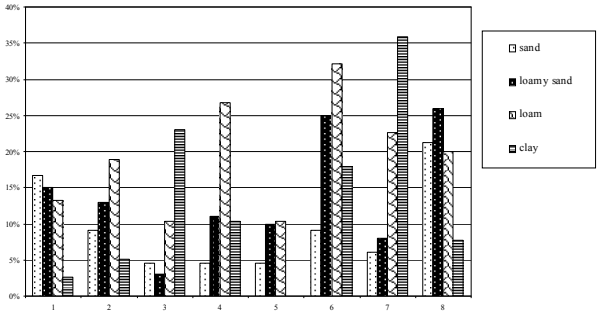

Fig. 7. Distribution of moss species with asexual propagules *Barbula convoluta*(1) , *Bryum klinggraeff i* (2) , *Bryum rubens* (3) , *Bryum subapiculatum* (4) , *Bryum violaceum* (5) , *Dicranella staphylina* (6) , *Dicranella varia* (7) , *Ditrichum cylindricum* (8) in fields with different type of soils

(p=0.113), *Ditrichum cylindricum* (p=0.123) and a certain type of soil. Statistically significant differences in distribution in various types of the soil reveal *Dicranella varia* (p=0.00, CC=0.270) and *Bryum subapiculatum* (p=0.01, CC=0.240)

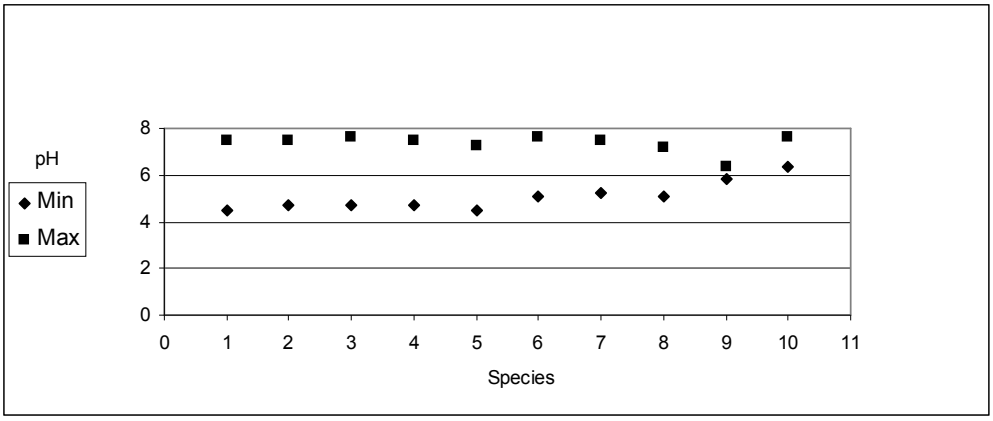

Fig. 8. pH ranges of *Ditrichum cylindricum* (1) , *Barbula convoluta* (2), *Bryum klinggraeffii* (3), *Dicranella staphylina* (4) , *Leptobryum pyriforme* (5) , *Bryum violaceum* (6), *Bryum argenteum* (7), *Bryum subapiculatum* (8) , *Bryum rubens* (9), *Dicranella varia* (10)

are restricted to loams and clays, were found in the fields with soils of quite narrow pH range.

Distribution of the species in the territory

The majority of moss species bearing rhizoidal gemmae in arable fields of Lithuania seemed to be widespread in the territory (Fig. 9). *Bryum rubens,* which is known from less localities comparing with other species of *Bryum erythrocarpum* complex, is distributed throughout the territory as well. The only *Bryum ruderale* is known from a single locality.

Moss species with axillary bulbils have been reported from single localities.

Discussion

Vegetative reproduction is a popular phenomenon among bryophytes, meanwhile specialized asexual propagules are characteristic to about 50 moss species (about 15%) of Lithuanian bryoflora. So, arable fields harbour half of them. Such species as *Leptobryum pyriforme* and *Dicranella varia,* commonly having sporophytes in other habitats, in our study more often have been reported with rhizoid gemmae. This confirms a statement of H. Zechmeister and D. Moser (2001) that there are significant correlations between the mean hemerobic state and all other parameters, except for asexual reproduction.

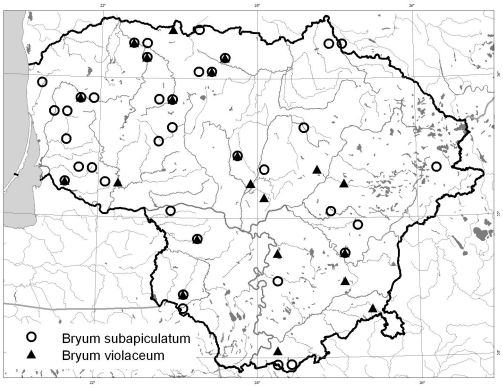

Fig. 9. Distribution of *Bryum subapiculatum* and *Bryum violaceum* in arable fields of Lithuania

Due to lack of knowledge on mosses of arable fields in many European countries, the species pool of mosses with asexual propagules could be compared only with that of Great Britain (Porley 2001) and Slovakia (Whitehouse 2001). The diversity of such species in Great Britain is significantly higher comparing with our country. 7 moss species with asexual propagules – *Bryum gemmiferum* R. Wilczek & Demaret, *Bryum riparium* I. Hagen, *Bryum sauteri* Bruch et Schimp., *Leptophascum leptophylum* (Müll. Hall.) J. Guerra, *Didymodon tomaculosus* (Blockeel) M.F.V. Corley, *Hennediella stanfordensis* (Steere) Blockeel, *Pohlia lutescens* (Limpr.) H. Lindb. – that are rare in Great Britain or uncommon in arable fields were not recorded from arable fields in Lithuania. Additionally, *Dicranella schreberiana, Pohlia lescuriana* and *Pohlia melanodon,* unlike in Great Britain, were recorded in Lithuania without tubers. Only 2 species of *Bryum erythrocarpum* complex (*Bryum demaretianum* Arts and *Bryum tenuisetum* Limpr.), ascertained for arable fields of Slovakia, were not recorded in Lithuania (Great Britain as well). Some of the species not recorded in Lithuania (e.g. *Bryum gemmiferum*, *Bryum demaretianum, Pohlia lutescens*) are distributed in temperate zone and to the south of it (Dierāen 2001). On the other hand, *Bryum gemmilucens* occurring in arable land of the country is of similar distribution pattern – with the range from Mediterranean to temperate zone covering from oceanic to suboceanic sections (Dierāen 2001). So occurrence of new moss species with asexual propagules in Lithuanian arable land in future is quite possible. In any case, it should be no common species. In arable fields of Lithuania the most predictable is the occurrence of cosmopolite *Bryum sauteri* and *Bryum tenuisetum,* which in Northern hemisphere is distributed from Mediterranean to Boreal zones (Dierāen 2001).

Ecological characteristics (restriction to mechanical structure of the soil and soil pH) ascertained for most common species were compared with those provided by T. Hallingbäck (1996) and K. Dierāen (2001). Some discrepancies

in ecological characteristics of *Bryum rubens*, *Bryum violaceum* and *Barbula convoluta* were ascertained. According to T. Hallingbäck, *Bryum rubens* and *Bryum violaceum* are restricted to acid soils. K. Dierāen provides a wider range of soils for both species – from moderately acid to basic (*Bryum rubens*) and from moderately acid to subneutral (*Bryum violaceum*). During our study *Bryum violaceum* was ascertained growing in habitats with acid to neutral soils. So, the results are similar to those provided by K. Dierāen. In the case of *Bryum rubens,* we did not find it growing in acid soils; it was found in arable fields where exclusively subneutral clayey soils prevail. Meanwhile, we ascertained *Barbula convoluta* growing in the habitats with soils ranging from moderate acid to basic, nevertheless the majority of the species localities have been recorded from the habitats with neutral soils, exactly as indicated by T. Hallingbäck and K. Dierāen. It is likely that restriction of species to particular types of soils also influences their distribution throughout the country. Widely distributed species show no preference to certain types of the soils or are restricted to loamy sands or loams, i.e. most common soils in Lithuania (http://www.stat.gov.lt/lt). *Bryum rubens* restrictions to clays (7% of all soils of Lithuania) may influence its limited distribution throughout the territory.

We found stubbles to be the richest habitats in moss species with asexual propagules. The average number of species and frequencies of particular species are higher in both younger (spring crops and winter crops) and older (clover fields and fallows) habitats. Slightly different tendencies were observed for general number of bryophyte species during investigation in Europe's agricultural landscapes; it was ascertained that the richest in bryophyte species are more than three years old fallows (Zechmeister et al. 2003b). It seems that competition with vascular plants and bryophytes of other life history strategies in more stable habitats (clover fields, fallows) leads to a decrease of colonists, especially ephemeral colonists. And the colonist life history strategy is dominating among the studied mosses. Abundant vegetative propagules are one of the adaptation means for colonization of new ground (During 1992).

Wide distribution of ephemeral colonists (mainly tuberous mosses) is matter-of-course and is determined by their biology and adaptation to regular disturbed habitats. Subterranean tubers often form a considerable diaspore bank in the soil, while their above-ground populations are extremely sparse. In regularly disturbed habitats shoot densities may be considerably higher (During 1995). Exposure to light, especially after disturbance of ground, stimulates growth of shoots from tubers (During 1995). Basing on this, we expected tuberous mosses to be more frequent in the fields of spring and winter crops. Nevertheless, only in solitary cases shoots with tubers of some mosses (more often *Dicranella staphylina* and *Ditrichum cylindricum*) were found in the fields of spring crops, i.e. 3–4 months after ground cultivation. Meanwhile, they were found to be more frequent at the same time (July) in the fields of winter crops (e.g. *Dicranella staphylina* in 16% of all winter crops in July) and the most frequent in autumn in stubbles (e.g. *Dicranella staphylina* in about 40% of all studied stubbles). It may be explained by the ways of development of shoots from tubers so far. Summarizing all known data about the development of tubers, S. Risse (1987) affirmed that tubers may develop directly into leafy shoots or produce new plants indirectly by first developing protonema. R. N. Chopra and M.S. Rawat (1973), while studying developing tubers of *Bryum klinggraeffii in vitro,* ascertained that the first multiplication of this species starts underground by protonema producing secondary gemmae instead of gametophytic buds which were not produced even after ten weeks. In nature this behaviour is helpful in multiplication, dispersal, and prolongation of the period of perennation.

As tuberous shoots in the fields of annual crops are quite rare comparing with older habitats, this confirms some perturbations about depletion of diaspore bank in the soil of intensively managed fields over time (Porley 2001). Despite of this, reproduction and multiplication of diaspore bank

by vegetative propagules in intensively managed habitats are superior than by the spores. Sporification of *Dicranella varia* in arable fields of Lithuania is the illustration of this. Formation of its sporophytes is possible in older and more stable habitats (over-wintered stubbles, clover fields and fallows). Species produce tubers at an early stage of growth and are able to survive even where they are able not to sporulate (Risse 1987). Especially that most of the tuber-bearing mosses are dioecious (in our study all except *Leptobryum pyriforme*) and most of them only rarely produce spores (Longton and Schuster 1983). Furthermore, tubers possess larger amounts of nutritive substances than spores and so have a better chance of producing new plants (Schofield 1981).

We found pioneer colonists (the majority of mosses with axillary bulbils) to be very rare in arable fields of Lithuania. The most frequent is *Pohlia camptotrachela*. In arable land of Great Britain they are uncommon (*Pohlia camptotrachela*) or unknown (*Pohlia annotiina*, *Pohlia drummondii*), the only *Bryum dichotomum* is a characteristic species. Moreover, no species with axillary bulbils registered in arable fields of Lithuania have been ascertained in cultivated land of Slovakia. Such distribution pattern may be determined by several reasons; at first by their common distribution pattern within their range and by their biological features as weak competitors (Dierāen 2001). On the other hand, subjective reasons should be also taken into account. Bulbils can be easily dislodged and plants without propagules are difficult to distinguish (Dolnik 2006), so the rarity of such bryophytes may depend on insufficient knowledge of their distribution due to their inconspicuousness. Actually our database contains more records of *Pohlia* sp. comparing with the records of *Pohlia* identified as particular species.

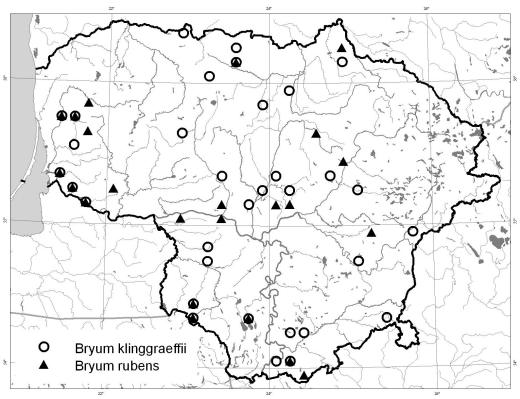

Fig. 9. Distribution of mosses *Bryum klinggraeffii* and *Bryum rubens* in arable fields of Lithuania

Bryum moravicum and *Bryum argenteum* are colonists *sensu stricto*. Their potential life span tends to be moderately long, their growth rate is usually high, and investment in both sexual and asexual reproduction is often quite high. Gemmae production may serve as a rapid way of population expansion during colonizing episodes (During 1992). *Bryum argenteum* is common in arable fields of Lithuania, while occurrence of *Bryum moravicum* and a short lived shuttle *Bryum pallens* (with filamentous gemmae as well) is occasional and uncommon. They have not been reported in arable land of other European countries.

The only fugitive among the species is *Leptobryum pyriforme*. Unlike of colonists, potential life span shorter than one year is characteristic for individuals of fugitive species, and it fits well in short-existing habitats (During 1992). It is a common species of arable fields in our country and Europe.

Due to life strategy, biological and ecological features, the majority of species with vegetative propagules seemed to be widespread in arable fields of Lithuania (Andriušaitytė 2002; Jukonienė 2003; Fig), though half of them have not been reported in Lithuania before (Söderström 1996, 1998). Furthermore, the majority of them are still unknown or rare in other Baltic countries (Latvia and Estonia) and neighbouring Belarus (Ignatov et al. 2006). *Dicranella staphylina,* which is distributed throughout the country (Andriušaitytė 2002), and *Bryum violaceum* have not been reported from the mentioned countries yet. *Bryum subapiculatum* is still not reported

from Latvia and Belarus, *Bryum klinggraeffii* – from Latvia. In most cases it is also true for moss species that have been reported from single localities. It is likely that our data about distribution of moss species occurring in arable fields of Lithuania are important for evaluating their possible distribution in adjacent territories. The non occurrence of rare moss species in other habitat types (Jukonienė 2008) emphasizes the importance of arable land for maintenance of the diversity of bryophytes with asexual propagules as well.

Conclusions

In conclusion, arable land as a habitat with large-scale disturbances is important in providing suitable habitats for bryophytes with specialized asexual propagules, especially those bearing rhizoidal tubers, which, due to their life history strategies and competition abilities, have no possibility for distribution in natural habitats. As the majority of the species occurring in arable fields of Lithuania are restricted to a wide range of soils (mechanical structure, pH) similar to those in other European countries and distributed in various habitats, it is likely that their distribution pattern in adjacent territories is similar to that of Lithuania, though they have not been recorded there yet.

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