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Bio-geographical interpretation of climate data in Latvia: multidimensional analysis

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Abstract

Data of the Climate Atlas of Latvia were analysed for biogeographical interpretation of climatic parameters using regular geographic grid system (with 263 cells sized 15.2×18.6 km). For each grid cell values of 25 climatic parameters were determined using the Climate Atlas. Additionally, height above the sea level and distance from the sea were measured using topographical maps. Most important climatic parameters were determined using multivariate analysis. As a result, Latvia was divided into sectors of continentality, as well as zones with different sums of effective temperatures and amount of precipitation were delimited.

Influence of the Atlantic Ocean and the Baltic Sea results in expressive western-eastern gradient of continentality and amount of precipitation. Southern-northern gradient is observed in temperature regime of a warm season.The most important factor influencing the diversity of vascular plants is climate continentality. Density of localities of continental and oceanic species, as well as biogeographical lines – A.Rasiņš's and K.Kupffer's phytogeographical borders – have close relationship with sectors of continentality.

Keywords: Continentality, effective temperatures, precipitation, multivariate analysis, Latvia

INTRODUCTION

Distribution of terrestrial plants and animals depends on different environmental factors among which the climate is of particular importance (Dahl 1921; Kotilainen 1933; Tuhkanen 1980). Climate involves long-term periodical changes of a set of environmental factors such as temperature, precipitation, wind a. o. As a rule, species geographical distribution is determined not by a single climatic factor but by a complex of factors. Therefore, maps of distribution of simple climatic parameters mostly are weak predictors of distribution of biota on a regional scale and integrated climate indicators should be worked out.

Elaboration of integrated climate indicators, which could be used in geographical districting, is of particular importance nowadays in the context of changing global climate. Such indicators could be used in prediction of regional changes in biota and have practical significance in agriculture, forestry and nature conservation. Due to big differences in climate of various regions of the world, evidently not a unified indicator system exists. Each region should have different indicator system. At the same time, it does not exclude using of common principles and approaches in the selection of the indicators.

There are several kinds of climatic indicators in biogeography. Most frequently used are sums of effective temperatures (e. g. temperatures above +5 °C), sums of precipitation, ratio precipitation/evaporation, aridity index as ratio of precipitation and temperature, departures from many-year mean temperature a. o. However, these indicators provide satisfactory prediction mainly on a large geographic scale, such as biomes and nature zones, and they can not be used on a regional scale (Tuhkanen 1984).

Air temperature and moisture, and interactions between these factors within the landscape are known to be vitally important for the biota, but at the same time biota in particular vegetation has also backward impact on the regional climate. Interactions of climatic factors and biota have been widely investigated all over the world (Tuhkanen 1980; 1984; Кожаринов 1989). In Latvia, studies have been performed in two directions. Firstly, relationships between some climatic characteristics (minimal air temperature, January mean temperature) and distribution of selected plant species (*Taxus baccata* and *Erica tetralix*) have been studied (Kupffer 1911; Riekstiņš, Laiviņš 1984). Secondly, possibilities of using various integrated characteristics as indicators of continentality and oceanality of climate such as hydrothermical coefficient and amplitudes of temperature and precipitation have been studied with the aim of climatic districting of the territory considering implications of plant species distribution (Zemīte 1947; Темникова 1957; Rasiņš 1962; Расиньш 1960; 1964).

Complexity of interactions of various climatic factors responsible for species regional distribution implies using of multidimensional methods in selecting of climatic indicators. Most suitable for this purpose are methods of Factor Analysis, Principal Component Analysis (PCA), and Cluster Analysis. PCA has been most widely used as a tool of searching for hidden complex variables within a data set and ordination of variables and objects within the space of these hidden factors. Cluster analysis is being used for classification of variables and objects on the basis of similarity and distance metrics. Selecting of climatic indicators evidently demands both approaches. Method combining PCA and cluster analysis is the oblique component cluster analysis (Harman 1976). This paper discusses the use of this method in the analysis of climatic parameters of Latvia.

The main objective of our research is to study climate data as the multidimensional system, trying to identify the most informative group and its territorial diversification.

MATERIAL AND METHODS

Climatic data

In order to study climate parameters from bio-geographic viewpoint the Climate Atlas of Latvia (it was compiled, summarizing data of meteorological observations fixed until the year 1968) (Фомина 1972) was used. Climate parameters were taken from 263 cells (15.2×18.6 km) of regular geographic grid, usually used for inventory and mapping of localities of plant species. Values of 25 climate parameters (minimal, maximal and an average temperature of January, July and a whole year, absolute minimal and maximal temperature, quantity of precipitation in warm and cold season and in a year, sums of active temperatures, etc.) were determined from the Atlas maps for each cell. According to the topographic map the absolute height of cell and the shortest distance to the sea were fixed, as well.

Multivariate analysis

VARCLUS is a type of oblique component cluster analysis related to multiple group factor analysis (Harman 1976; Anonymous 1988). The VARCLUS procedure divides a set of variables into non-overlapping clusters in such a way that each cluster can be interpreted as essentially unimodal. For each cluster, VARCLUS computes the first principal component and tries to maximize the sum across clusters of the variation accounted for by the cluster components. A given number of cluster components does not generally explain as much variance as the same number of principal components, but the cluster components are usually easier to interpret than the principal components, even if the latter are rotated.

Interpretation of clusters has been performed by using cluster summary (Table 1) and cluster listing (Table 2, 3). The cluster summary gives the numbers of variables in each cluster and the variation explained by the cluster component. The proportions value is obtained by dividing the variance explained by the total variance.

Table 1

Cluster summary for 4 clusters calculated by oblique component cluster analysis for climatic data of Latvia

Cluster	Members	Cluster Variation	Variation Explained	Proportion Explained
1	15	15.0	11.364	0.437
2	6	6.0	4.697	0.181
3	3	3.0	2.100	0.081
4	2	2.0	1.241	0.048
Total	26	26.0	19.402	0.747

The cluster structure (Table 2) gives the variables in each cluster, correlation coefficient (loadings), $R_{Own\ Cluster}$ of each variable with the first cluster component for each cluster, the next highest correlation $R_{Next\ Closest}$ of the variable with cluster number of which is given in parenthesis, and ratio of $(1-R^2_{Own\ Cluster})/(1-R^2_{Next\ Closest})$ characterising "position" of the variable within the system of clusters. Considering the three parameters mentioned above it is possible to judge about "importance" of a particular variable in the cluster. The higher the $R^2_{Own\ Cluster}$, and the lower the ratio, the most meaningful is the variable in interpreting the cluster.

Table 2

Structure of 4 clusters calculated by oblique component cluster analysis for climatic data of Latvia

Variable	R		$(1-R^2_{Own\ Cluster})/$
	$R_{Own\ Cluster}$	$R_{Next\ Closest}$	$(1-R^2_{Next\ Closest})$
Cluster 1			
January mean temperature	–0.975	–0.473 (4)	0.0636
Year mean temperature	0.928	0.386 (4)	0.1622
Absolute minimal temperature	–0.848	–0.466 (4)	0.3583
Number of days with temperature above 0 C°	–0.528	–0.234 (4)	0.7628
Number of days with temperature above 5 C°	–0.790	0.312 (2)	0.4166
Water content in snow cover before melting	0.919	0.250 (4)	0.1658
Number of days with snow cover	0.957	0.298 (4)	0.0932
Maximal depth of soil freezing	0.898	0.593 (4)	0.2977
Depth of freezing of loamy soil	0.981	0.501 (4)	0.0496
Depth of freezing of loamy soil 75% P	0.975	0.501 (4)	0.0657
Depth of freezing of loamy soil 1% P	0.945	0.502 (4)	0.1425
Number of days without frost	–0.628	0.558 (2)	0.8796
Absolute air minimal mean temperature	–0.949	–0.490 (4)	0.1314
Height above the sea level	0.791	–0.127 (2)	0.3799
Distance from the sea	0.797	0.480 (4)	0.4748
Cluster 2			
Number of days with temperature above 10 °C	0.927	0.368 (4)	0.1623
Number of days with temperature above 15 °C	0.936	0.593 (4)	0.1903
Sum of mean air temperatures above 0 °C	0.594	–0.400 (1)	0.7703
Sum of mean air temperatures above 5 °C	0.903	–0.303 (1)	0.2039
Sum of mean air temperatures above 10 °C	0.966	0.407 (4)	0.0813
Sum of mean air temperatures above 15 °C	0.928	0.603 (4)	0.2185
Cluster 3			
Precipitation in summer	0.613	0.488 (1)	0.8198
Precipitation in winter	0.881	–0.475 (1)	0.2893
Year's precipitation	0.974	–0.359 (4)	0.0589
Cluster 4			
July mean air temperature	0.788	0.528 (2)	0.5262
Absolute maximal temperature	0.788	0.190 (2)	0.3935

Correlation of cluster components is reflected by Inter-Cluster Correlation matrix (Table 3).

Correlation matrix was used in the analysis. Output matrix of standardized scoring coefficients and standardized data matrix (mean=0, variance=1) was used as input data to SAS procedure VARCLUS for calculation of components scores. Values of components scores assigned to the coordinates of the regular geographical network, and charts of spatial distribution of "weight" of each cluster component were produced by using Microsoft Office EXCEL (Fig. 1–4). Prior to mapping the range of variation of score values was split in 4–5 classes of equal size.

Table 3

Inter-cluster correlations calculated by oblique components cluster analysis for climatic data of Latvia

Cluster	1	2	3	4
1	1.00000	–0.03583	–0.11894	0.43573
2		1.00000	–0.27315	0.45571
3			1.00000	–0.33836
4				1.00000

RESULTS

In order to figure out the most informative climate data and to study out their territorial differentiation the first four clusters which explain 75% of dispersion of data matrices were used (Table 4).

The most important group of changing climate indications in Latvia (48% of total dispersion) are air temperatures of winter and variables related to them (Table 2). The level of climate continentality and its growth in the eastern direction together with increase of the distance to the sea are characterized by minimal temperature of winter months, number of days with snow cover, depth of freezing of soil. According to the heterogeneity of this most informative group (Table 4) four sectors of climate continentality appear (Figure 1).

Low climate continentality (maritime climate) is fixed in Western part of Latvia along the western and southern Baltic Sea coast and the Riga Gulf (territory up to 50 km from the sea inside the country). The area covers only 17% of the country's whole territory.

The Rietumkursa Upland, the Austrumkursa Upland and Rietumzemgale, as well as narrow zone of the east coast of the Riga Gulf lie in the sector of moderate climate continentality (25% of the area of Latvia). The sector with medium climate continentality covers Ziemeļvidzeme, a part of the Vidzeme Upland, Dienvidvidzeme,

Table 4

An average level of most informative climate parameters in continentality sectors

Level of continentality	Air temperature °C: an average in January	Air temperature °C: year's average	Air temperature °C: Absolute minimal	Air temperature °C: An average minimal in a year	Maximal depth of soil freezing, cm	Number of days with snow cover	Water content in snow cover, mm	Height above the sea level, m	Distance from the sea, km
Weak	–3.7	5.8	–33.6	–22.2	38.4	87	39	32	13
Moderate	–5.2	5.5	–35.5	–25.5	44.8	97	49	54	46
Medium	–6.6	5.1	–39.6	–27.8	53.7	114	71	98	109
Strong	–7.4	4.9	–40.5	–29.2	57.8	123	89	154	186

Austrumzemgale and the largest territory of the Aiviekste Lands (35%). The highest climate continentality is in Eastern Latvia (23%) – the Latgale Upland, Austrumvidzeme, Austrumlatgale, and the central part of the Vidzeme Upland.

The next component (17% of dispersion) reflects resources of biologically active warmth and duration of vegetation period. The best informative sources are sums of air temperature in the periods with the average air temperature above 0°, 5°, 10° and 15 C (Table 5). Rietumzemgale, Austrumzemgale, Augšzeme and the Daugava River valley (24% of the territory) are the warmest regions of Latvia with the longest vegetation period, while the northern part of the Vidzeme Upland, Austrumvidzeme and Austrumkursa (13%) are the coldest ones (Figure 2). The southwest part of Latvia incl. the Latgale Upland and the Coastal Lowland (22%) has medium biologically active resources of warmth. However, in large part of the country (41%) these indicators are moderate.

The quantity of precipitation represents cluster having insignificant informative value (the third component, 6% of dispersion). After studying this component, the country has been divided into 5 regions (Figure 3) – the lowest level of precipitation

Table 5

An average value of the most important climate data in sectors of warmth

Level of warmth	Sum of temperature in period, when an average day and night temperature is: t>0°	t>5°	t>10°	t>15°	Number of days: t>10°	t>15°
Slight	2356	2229	1817	854	130	53
Moderate	2412	2286	1891	950	132	58
Medium	2456	2355	1982	1055	136	63
High	2500	2393	2035	1138	139	69

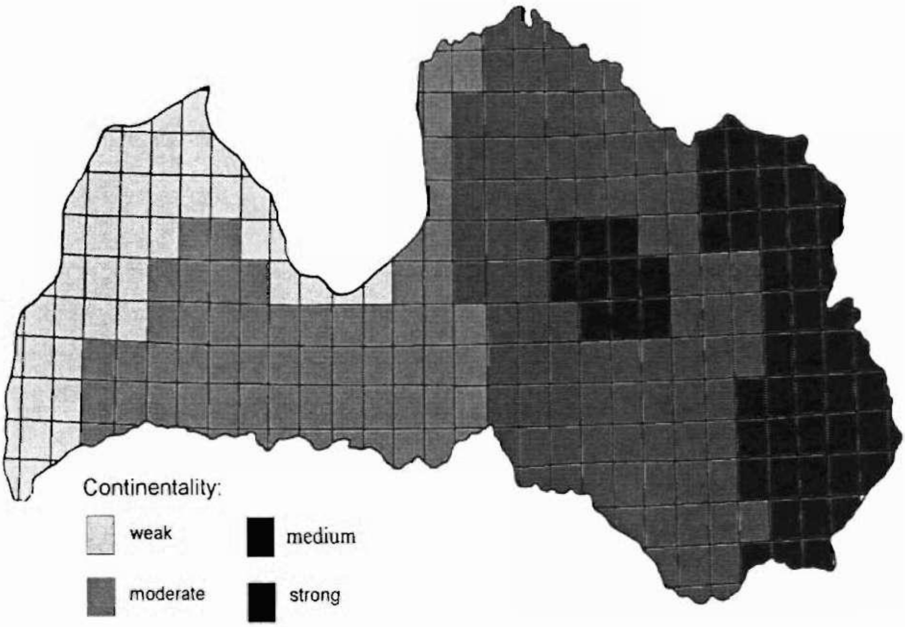

Fig. 1. Sectors of continentality obtained by procedure VARCLUS. Continentality classes have been obtained by splitting the range of variation of score values of cluster component 1

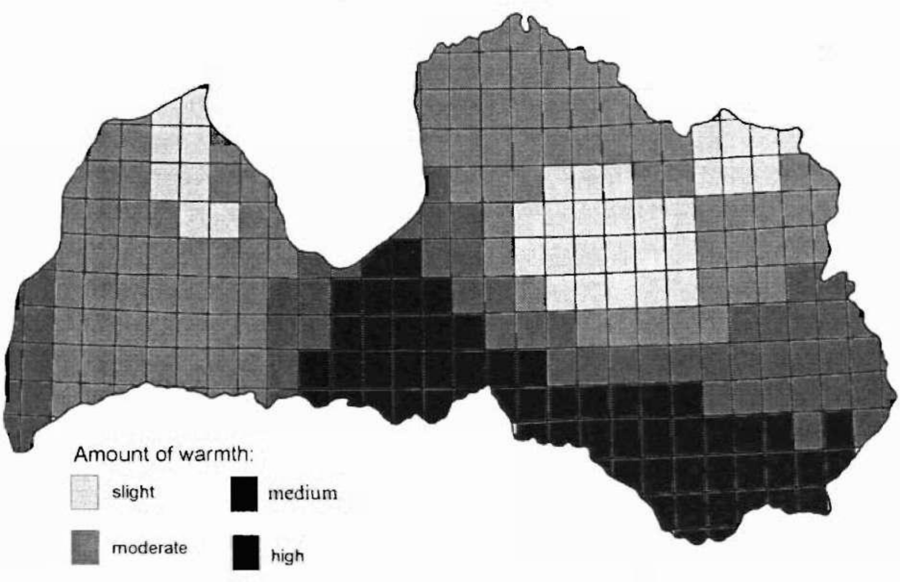

Fig. 2. Zones of biologically active temperatures obtained by procedure VARCLUS. Classes of amount of warmth have been obtained by splitting the range of variation of score values of cluster component 2

has been observed in the lee-side of Uplands – in Rietumzemgale and the Aiviekste Lands (14% of the territory), moderate volume – in the largest part of the territory (46%), medium – in several elevated areas and slopes (20%), high level of precipitation is on the hillsides and uplands lying opposite to the dominant west winds (17%), very high level – in the central part of the Vidzeme Upland (3%) (Table 6).

Table 6

An average values of most informative climate data in precipitation areas

Level of precipitation in area	Precipitation, mm		
	warm months (IV-X)	cold months (XI-III)	per year
Low	463	214	666
Moderate	494	239	721
Medium	503	279	795
High	516	323	856
Very high	583	324	909

The fourth component (4% of dispersion) is related to summer temperatures. An average and maximal air temperature in the hottest summer month July are the best informative indices (Table 7). In Vidzeme and the Ziemeļvidzeme Uplands (13% of the territory), there are the coolest summers; in the largest part of the Kurzeme and Vidzeme Uplands (25%) summers are moderate cool; summers are moderate warm in the largest part of Latvia (59%), while just in a very small part of central area of the Augšzeme Upland (3%) to the south from Daugavpils there are warm summers (Figure 4).

Table 7

Air temperatures of July and character of summer

Climate of summer	Air temperatures, °C	
	July average	Absolute maximal
Cool	16.5	32.9
Moderate cool	16.5	34.2
Moderate warm	17.0	34.3
Warm	17.0	36.0

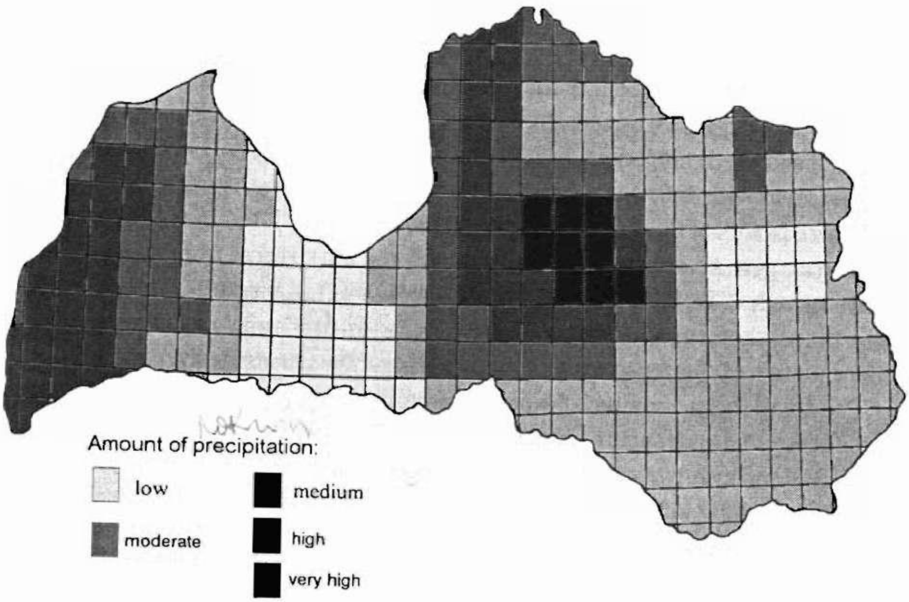

Fig.3. Distribution of precipitation obtained by procedure VARCLUS. Classes of amount of precipitation have been obtained by splitting the range of variation of score values of cluster component 3

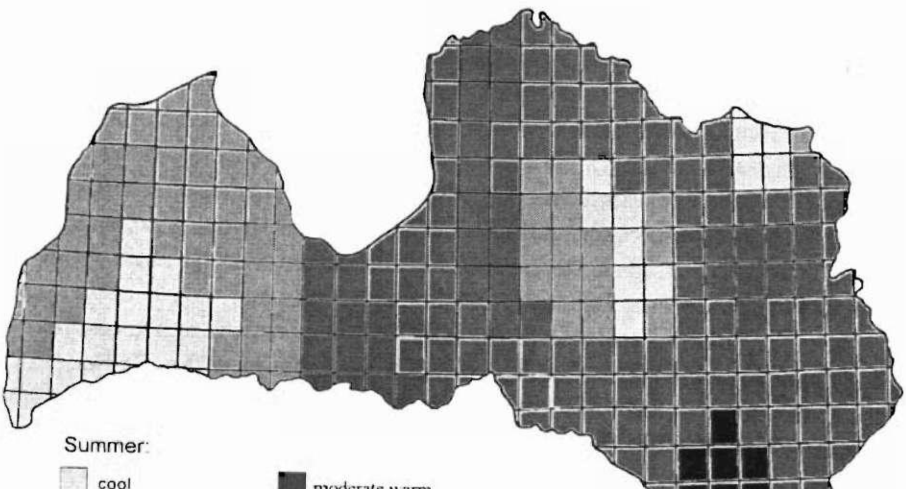

Fig.4. Areas with different summer temperatures obtained by procedure VARCLUS. Classes of summer temperatures have been obtained by splitting the range of variation of score values of cluster component 4

DISCUSSION

Strong west-east gradient characterizes both climate continentality (basically determined by the minimal temperatures of winter months) and distribution of precipitation (first and third component, 54% of total dispersion) in Latvia. Continentality sectors and areas with different volume of precipitation in Latvia are directly influenced by climate factors of the Atlantic ocean and the Baltic sea. It testifies once again that the climate genesis of Latvia is determined by the air-streams from the sea in temperate latitudes (Темникова 1958; Zirnītis 1956, 1963; Kalniņa 1995). On the other hand, the south-north configuration of uplands and lowlands plays an important role in differentiation of climate when moving away from the sea inside the continent.

The temperature regime of warm season is characterized by the south-north gradient (second and fourth component, 21% of total dispersion) usually observed in the middle and east part of Latvia, less – in Kurzeme and the western part of Latvia due to the stronger influence of the Baltic sea. The largest sums of biologically active temperatures and maximal temperatures of summer months are characteristic for the Middle- and Eastern Latvia to the south of the Daugava, Zemgale (western part up to the Austrumkursa Upland), the Daugava River valley and the southern hillside of the Latgale Upland.

Latvia is situated in the area where the ocean climate meets the continental one: in the western part there is a milder sea climate while in the east the continental climate dominates. The relevance between the climate sectorality and the biota in Latvia is shown by prevalence of the rare plant species of both oceanic and continental area, as well as by the most important phytogeographical boundaries.

In order to analyse the peculiarities of species' prevalence we have chosen 179 species of vascular plants. 94 of them have oceanic distribution area, 81 – continental distribution area (appendix 1). In the geographical longitude zones with band width of 75 minutes we did a research on the density of the mentioned species with oceanic and continental prevalence (in localities of 70.7 km^2). The research was carried out in the territory from the sea side to the eastern border of the country. The maps elaborated by I.Fatare were used (Fatare 1992).

The major density of species with oceanic area is in a narrow littoral zone (width of 6 km) from Nida to Pāvilosta – 17.7 localities of plant species within 70.7 km^2. The density decreases gradually if moving away from the coast into the country – Kurzeme and Zemgale (Figure 5). There is an increasing density of localities of oceanic species between Engure and Ķemeri (6.0–6.8 localities on 70.7 km^2) and along Vidzeme coast of the Rīga Gulf (4.8–5.1 localities). Further to the east the density decreases gradually. Thus, the density of species localities increases if moving away from the coast. It is more unsteady in the western part of Latvia mainly due to the local substrate differences on the Kurzeme coast of the Riga Gulf.

The density of continental plant species in the direction to the east and west varies largely (Figure 6). There is a larger density in the very east of the country

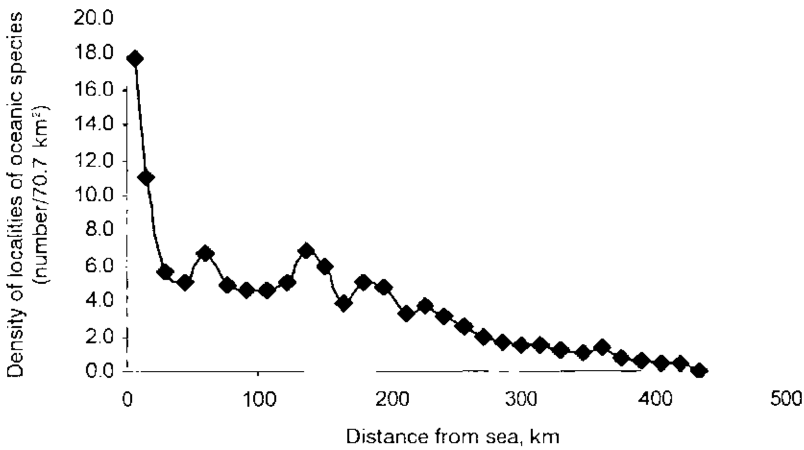

Fig.5. Relationship between density of localities of oceanic species and distance from the sea

(6.0 localities on 70.7 km²), in the western part – the Latgale Upland and the Aiviekste Lands – it decreases, however in the Vidzeme Upland, especially on its eastern and western slopes there is an increased density again (5.7–6.5 localities). The lowest density of continental plant species is in Kurzeme, while in the coastal zone it increases rapidly (5.4 localities). The way of fluctuations is connected to the local geographical structures – ranges of hills and eskers (Greblis Hill, Numerne, Madona-Trepe Earthwork, Lielie Kangari and Ogre Kangari, etc.), the river valleys (the Daugava, the Gauja, the Lielupe, the Venta, the Abava, mainly) and dolomite outcrops, which have appropriate conditions for prevalence of continental species. On the coast, the favourable conditions for continental species are secured by open sandy territories, which become very hot during summer days and chill during nights. Thus, the sites with more continental micro- and meso- climate of the day and the season take shape. The salty substrate favours prevalence of several continental species along the coast, as well.

Prevalence of the ocean and continental species in Latvia depends on climate parameters, especially on temperature amplitudes and minimal temperature, fluctuation of temperature in the coastal zone in the west and inland territories in the east. It affects mostly the oceanic species which have larger density in Piejūra, Kurzeme and Zemgale and less on the east line Aloja-Sigulda-Ķegums-Skaistkalne. This coincides largely with a border between Eastern and Western subprovinces of the Eastern Baltic phytogeographical province proposed by A.Rasiņš (Расиньш 1964). This line was drawn taking into consideration the changes in amount of oceanic species. K.Kupffer (Kupffer 1925) took into consideration the decrease in total number of vascular plants and drew the line separating subprovinces of the Baltic flora province:

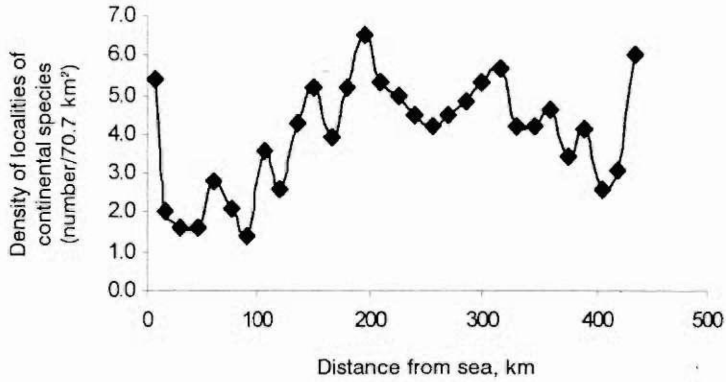

Fig. 6. Relationship between density of localities of continental species and distance from the sea

Zaiceva – Rēzekne – Krāslava. The phytogeographical line of A.Rasiņš coincides with the zones of temperate and medium continental climate, while the line of K.Kuppfer coincides with the zones of medium and strong continental climate (Figure 7).

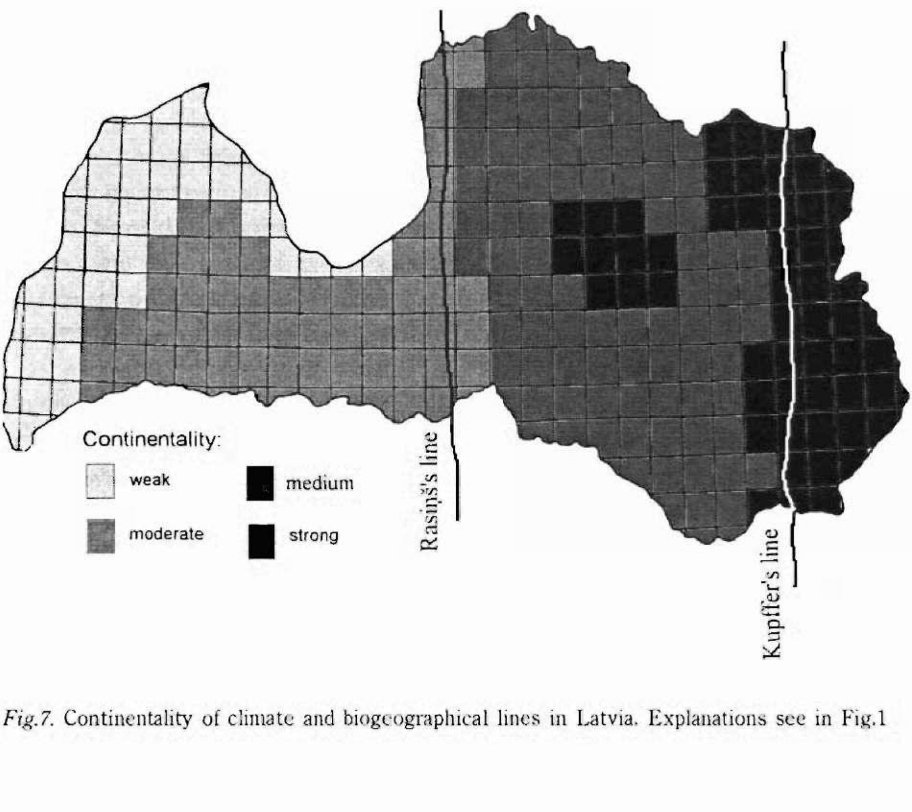

Fig.7. Continentality of climate and biogeographical lines in Latvia. Explanations see in Fig.1

The variations in amount of localities with species of oceanic and continental area, as well as the compatibility of A.Rasiņš's and K.Kuppfer's phytogeographical lines with borders of continental climate show the essential west-east gradient as far as climate, biota and conditions of forests' growth concerns (Залитис 1983).

Thus, the analysis of integral climate parameters clearly shows that the differentiation of climate parameters is much stronger in the west-east direction than in the north-south direction. The same is true for differentiation of biological diversity, which is mainly connected with the east-west gradient of continentality (Kupffer 1925; Расиньш 1964).

As showed by the studies of climate data trends (Treiliba 1995; Laiviņš 1998; Draveniece 2000; Lizuma 2000), during last 30 years climate data have changed essentially and climate system in general has becamc less stable. We expect that analysing data of the last decade and comparing with the results of the current analysis could show changes in spatial distribution of climate parameters. The quantity of changes would reveal climate transformation in Latvia in general and would be very important in predicting dynamics of biogeographic parameters.

REFERENCES

Anonymous 1988. *SAS/STAT User's Guide, Relase 6.03 Edition, SAS Institute Inc.* Cary, NC: SAS Institute Inc. 1028 pp.

Dahl, F. 1921. *Grundlagen einer ökologischen Tiergeographie.* Verlag von Gustav Fischer, Jena. 113 S.

Draveniece, A. 2000. Trends of Meteorological Elements and Air Mass Frequency in Latvia: Some Preliminary Findings. *Ģeogrāfiski Raksti/ Folia Geographica.* Latvijas Ģeogrāfijas Biedrība, Rīga, VIII: 61–68.

Harman, H.H. 1976. *Modern Factor Analysis.* Chicago, University of Ghicago Press.

Kalniņa, A. 1995. Klimats. (Climate). *Latvijas Daba.* Latvijas Enciklopēdija, Rīga. 2: 247–251 (in Latvian).

Kārkliņš, J. 1962. Latvijas PSR teritorijas rajonēšana pēc augļu koku ziemcietības. (Districting of Latvian SSR according to winterhardy of fruit trees). Gr. *Augu ziemcietība, aukstumizturība un to kāpināšanas iespējas.* Latvijas PSR Zinātņu akademijas izdevniecība, Rīga. 31-50 lpp. (in Latvian).

Kotilainen, M.J. 1933. Zur Frage der Verbreitung des atlantischen Florenelements Fennoskandias. *Annales Botanici Societatis Zoologicae&Botanicae Fennicae Vanamo,* 4,1: IV+75 S.

Kupffer, K. 1911. *Baltische Landeskunde.* Riga, 557 S.

Kupffer, K. 1925. Grundzüge der Pflanzengeographie des Ostbaltischen Gebietes. *Abhandlungen des Herder-Instituts zu Riga* Bd.1., No.6, 224 S.

Laiviņš, M. 1998. Latvijas boreālo priežu mežu sinantropizācija un eitrofikācija. (Synantrophication and eutrophication of boreal pine forests in Latvia). *Latvijas Veģetācija,* 1, 137 lpp. (in Latvian).

Lizuma, L. 2000. An Analysis of a Long-Term Meteorological Data Series in Riga. *Ģeogrāfiski Raksti/Folia Geographica*. Latvijas Ģeogrāfijas Biedrība, Rīga. VIII: 53–60.

Rasiņš, A. 1962. Augu ģeogrāfijas, klimata un kokaugu apsalšanas sakarības Latvijas PSR apstākļos. (Correlations of plant geography, climate and getting frozen of trees in Latvian SSR). Gr. *Augu ziemcietība, aukstumizturība un to kāpināšanas iespējas*. Latvijas PSR Zinātņu akadēmijas izdevniecība, Rīga. 161–16 lpp. (in Latvian).

Riekstiņš, I. & Laiviņš, M. 1984. Ogu īves izplatība Latvijā un tās saistība ar klimatiskajiem un edafiskajiem faktoriem. (Distribution of *Taxus baccata* in Latvia and its relationship to climatic and edaphic factors). *Jaunākais Mežsaimniecībā*, 26: 29–32 (in Latvian).

Treiliba, M. 1995. Analysis of Meteorological Observation Series in Latvia. In: Heikinheimo P. (Ed.) *International Conference on Past, Present and Future Climate*. Helsinki. 258–261 p.

Tuhkanen, S. 1980. Climatic parameters and indicies in plant geography. *Acta Phytogeographica Suecica*. 67, 110 p.

Tuhkanen, S. 1984. A circumboreal system of climatic-phytogeographical regions. *Acta Botanica Fennica* 127: 1–50

Zemīte, A. 1947. Latvijas PSR teritorijas rajonēšana pēc klimatiskajiem apstākļiem un augsnes īpašībām. (Districting of Latvian SSR according to climatic conditions and soil properties). *Latvijas PSR Zinātņu Akadēmijas Vēstis*, 4: 109–151 (in Latvian).

Zirnītis, A. 1956. Daži pētījumi par Latvijas PSR bioklimatu. (Some studies on bioclimate of Latvian SSR). *Latvijas Valsts Universitātes Zinātniskie Raksti, VII, Ģeogrāfijas zinātnes*. 1, 4: 71–92 (in Latvian).

Zirnītis, A. 1963. *Latvijas PSR klimats*. (Climate of Latvian SSR). Latvijas Valsts Izdevniecība, Rīga. 90 lpp. (in Latvian).

Залитис П.П. 1983. *Основы рационального лесоосушения в Латвийской ССР*. (The Principles of Rational Forest Draining). Зинатне, Рига, 230 стр.

Кожаринов А.В. 1989. *Климато-хорологический анализ популяций лесных растений Белоруссии*. (Climatic-chorological analysis of populations of forest plants in Belarus). Наука и техника, Минск. 176 стр. (in Russian).

Фомина Л.М. 1972. *Климатичкский атлас Латвийской ССР*. (Climatic Atlas of Latvian SSR). Звайгзне, Рига. 145 с. (in Russian).

Расиньш А. 1960. Некоторые связи климатических факторов с биогеографией в условиях Латвийской ССР. (Some relationships of climatic factors to biogeography in Latvian SSR). In: *Краткие итоги научных исследований по защите растений в Прибалтийской зоне СССР в 1960 году*. Рига. с. 299–300 (in Russian).

Расиньш А. 1964. Материалы к фитогеографическому делению Латвийской ССР. (Materials on phytogeographical districting of Latvian SSR). В кн. *Изучение растительного покрова острова Саарема*. Тарту, с.7–30 (in Russian).

Темникова Н.С. 1957. К вопросу о генезисе климата Латвийской ССР. (On the Genesis of climate in Latvian SSR). *LTSR MA Geologijos ir Geografijos Institutas. Moksliniai Pranesimai, Geofizika ir Klimatologija,* V: 89–113 (in Russian).

Темникова Н.С. 1958. *Климат Латвийской ССР.* (Climate of Latvian SSR). Издательство АН Латвийской ССР, Рига. 231 стр. (in Russian).

Klimata parametru bioģeogrāfiska interpretācija Latvijā: daudzdimensiju analīze

Kopsavilkums

Klimata parametru bioģeogrāfiskai interpretācijai izmantoti Latvijas klimata atlanta dati regulārā ģeogrāfisko koordinātu tīklā (15.2×18.6 km, pavisam 263 šūnas). Katram tīkla taisnstūrim, izmantojot klimatisko atlantu, atrastas 25 klimatisko parametru vērtības, kā arī topogrāfiskajā kartē noteikts augstums virs jūras līmeņa un attālums no jūras. Ar daudzdimensiju analīzes palīdzību Latvija diferencēta kontinentalitātes un nokrišņu apjoma sektoros, kā arī bioloģiski aktīvo temperatūru zonās.

Augu sugu daudzveidību noteicošais faktors ir klimata kontinentalitāte. Ar klimata kontinentalitātes sektoriem ir saistīts sugu ar okeānisku un kontinentālu izplatību atradņu blīvums, kā arī svarīgākās bioģeogrāfiskās līnijas – A.Rasiņa un K.Kupfera fitoģeogrāfiskās robežas.

Appendix 1

Oceanic species: *Aira chaerophyllea, Ajuga pyramidalis, Alliaria petiolata, Allium ursinum, Allium vineale, Anthyllis arenaria, Aphanes arvensis, Arctium nemorosum, Armeria maritima, Atriplex longipes, Blechnum spicant, Bromopsis ramosa, Bromus racemosus, Cardamine flexuosa, Carex davalliana, Carex demissa, Carex hostiana, Carex lepidocarpa, Carex pulicaris, Centunculus minimus, Circaea lutetiana, Cladium mariscus, Drosera intermedia, Eleocharis multicaulis, Elytrigia junceiformis, Erica tetralix, Eryngium maritimum, Euphrasia micrantha, Equisetum telmatea, Gagea spathacea, Galeopsis pubescens, Galium pumilum, Geranium dissectum, Hedera helix, Holcus mollis, Hordelymus europaeus, Hornungia petraea, Hydrocotyle vulgaris, Isoetes echinospora, Juncus bulbosus, Juncus squarrosus, Juncus subnodulosus, Lathyrus montanus, Linaria loeseli, Lolium temulentum, Lotus uliginosus, Lycopodiella inundata, Montia fontana, Myosotis discolor, Myosotis ramosissima, Myrica gale, Ononis repens, Papaver argemone, Papaver dubium, Phleum arenarium, Pilularia globolifera, Pinguicula vulgaris, Polygonatum verticillatum, Polystichum acuelatum, Polystichum lonchitis, Potentilla anglica, Ranunculus baudotii, Ranunculus bulbosus, Ranunculus hederaceus, Ranunculus peltatus, Rhynchospora fusca, Rorippa sylvestris, Rosa* *rubiginosa, Rosa vosagiaca, Rubus plicatus, Salix repens, Saxifraga granulata, Saxifraga tridactylites, Schoenus ferrugineus, Scirpus setaceus, Sedum sexangulare, Sesleria caerulea, Scherardia arvensis, Symphytum officinale, Taraxacum palustre, Taxus baccata, Teesdalia nudicaulis, Tillaea aquatica, Tragopogon heterospermus, Trifolium campestre, Trifolium dubium, Trisetum flavescens, Valerianella locusta, Veronica catenata, Veronica hederifolia, Veronica montana, Vicia lathyroides, Viola litoralis, Viola reichenbachiana, Zostera marina.*

Continental species: *Achillea cartilaginea, Agrimonia pilosa, Allium schoenoprasum, Alopecurus arundinaceus, Androsace septentrionalis, Anemone sylvestris, Aster tripolium, Astragalus danicus, Astragalus penduliflorus, Betula humilis, Blysmus rufus, Bolboschoenus maritimus, Carex atherodes, Carex brunescens, Carex disperma, Carex globularis, Carex heleonastes, Carex loliacea, Carex praecox, Carex rhizina, Carex rhynchophysa, Carex supina, Cenolophium denudatum, Centaurea stoebe, Centaureum pulchellum, Chamaedaphne calyculata, Cinna latifolia, Cnidium dubium, Delphinium elatum, Diphasiastrum complanatum, Draba nemorosa, Dracocephalum ruyschiana, Gagea erubescens, Galium rivale, Galium trifidum, Galium triflorum, Glaux maritima, Glyceria lithuanica, Gypsophila paniculata, Helichrysum arenarium, Herminium monorchis, Isatis tinctoria, Juncus atratus, Juncus gerardii, Koeleria cristata, Koeleria glauca, Lathyrus pisiformis, Ligularia sibirica, Lonicera caerulea, Moehringia lateriflora, Neottiante cucculata, Nuphar pumila, Onobrychis arenaria, Ononis arvensis, Pedicularis kaufmanii, Phleum phleoides, Pimpinella major, Plantago maritima, Polemonium caeruleum, Polygonum viviparum, Potentilla fruticosa, Pulsatilla patens, Rubus arcticus, Rubus chamaemorus, Rumex pseudonatronatus, Ruppia maritima, Salix dasyclados, Salix myrtilloides, Sanguisorba officinalis, Saussurea alpina, Senecio congestus, Silene chlorantha, Silene otites, Sparganium glomeratum, Spergularia marina, Thalictrum minus, Thesium ebracteatum, Triglochin maritimum, Trisetum sibiricum, Veronica dillenii, Viola epipsila.*

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The *Cladium mariscus L. (Pohl)* community in Latvia

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Abstract

Distribution, habitat preferences and species composition of *Cladium mariscus* community in Latvia was studied. The *Cladium mariscus* community was found in 26 localities, majority of which are concentrated in the Coastal Lowland where the most suitable climate for the species is found. The climate data of *Cladium* localities prove that the majority of Latvia's localities lie within the thermoclimatically optimal area of *Cladium mariscus*. The main species habitats are as follows: shallow lakes, different depressions, a dune slack, and springs. The following variants of the *Cladium mariscus* community based on TWINSPAN analysis are distinguished: var. *Scorpidium scorpioides*, var. *Schoenus ferrugineus*, var. *typicum*, var. *Myrica gale*, var. *Thelypteris palustris*, and var. *Sphagnum*. All the variants were assigned to the Association Cladietum marisci All.22. The main vegetation gradient reflected by the DCA was explained by wetness. The best examples of the Cladietum marisci in Latvia were found in large shallow lakes, where *Cladium* formed monodominant stands. Therefore, the Cladietum marisci in Latvia is to be included in the Alliance Phragmition. Water chemical characteristics of six lakes hosting *Cladium mariscus* ir presented.

Key words: *Cladium mariscus*, habitat preferences, vegetation classification, ordination

INTRODUCTION

The *Cladium mariscus* community has always been a popular study object in Europe and the most comprehensive paper on Cladietum marisci is published by Balátová-Tuláčková (Balátová-Tuláčková 1991). However, no data on Cladietum marisci in Latvia or in other Baltic States were used in this paper as it dealt only with the data from the main distribution area of the species. The main distribution area of *Cladium mariscus* lies within Central Europe (Meusel 1965), but in Latvia, the species grows close to the eastern limit of its distribution (Fatare 1992). Despite the fact, that many *Cladium mariscus* localities in Latvia are well known, the community descriptions are quite few. There is a publication on mire vegetation in Latvia that includes descriptions of Cladietum marisci (Pakalne 1994), but it concerns only a couple of localities in Latvia. Recently, the Cladietum marisci in Bušnieku Lake has been described (Eņģele pers.com.). Meanwhile, the studies of water chemistry of lakes hosting Cladietum marisci in Latvia have not been made so far. The aim of the study is to describe the *Cladium mariscus* community in Latvia, its distribution and floristical composition and also to analyse habitat preferences of the community. Specific questions addressed were:

1) Do Latvian localities lie within the thermoclimatically optimal area of *Cladium mariscus*?
2) Do local conditions favour the survival of the most continental localities of *Cladium mariscus* in Latvia?

MATERIALS AND METHODS

Sampling method

The studies presented in this paper were carried out in June and July 1999. Twenty-six localities of *Cladium mariscus* are known in Latvia and 16 localities have been visited. Information about the rest of them was obtained from personal communications.

The stratified random sampling (Causton 1988) followed by the Braun-Blanquet approach (Mueller-Dombois & Ellenberg 1974) (relevés of 1 m^2 size in the floristically homogeneous area) was used in the vegetation data sampling. The full data set consists of 152 relevés from 16 sites with a total of 109 species. All of the vascular plant and moss species were recorded, estimating their approximate cover in percentage.

Nomenclature follows Gavrilova *et al.* for vascular plants (Gavrilova, Šulcs 2000) and Āboliņa - for bryophytes (Āboliņa 2001). Syntaxonomy of the studied vegetation follows the Central European classification system (Dierssen 1982, Ellenberg 1996).

Chemical analyses

The water samples were collected from a shallow coastal lake, which is the most typical habitat of *Cladium mariscus* community in Latvia (Kaņieris Lake), from the most eastern locality (Motrines Lake) and the lake having the most dystrophic character (Kūdraines Lake). The water samples were taken at the *Cladium mariscus* stands using polyethylene bottles. Water samples were analysed the next day by the company Hidrostandarts using standard procedures. Additionally, water chemistry data on Lielais Plencis, Aklais and Bušnieku lakes obtained from Latvian Environmental Agency and personal communication were used (Anonymous 1992, Anonymous 1994, Līcīte pers.com.).

Data analysis

All the relevés were classified and ordinated on the basis of their vegetation. For vegetation classification, synoptic table processing and calculation of within-cluster qualitative homogeneity the programme TWINPAN by means of TURBO(VEG) was chosen (Henneken 1995). Ordinal scale 1 – 9 was used instead of percentage. The pseudospecies cut levels used were 0-3-4-7-9. For data ordination the programme DECORANA (Hill and Gauch 1980) was used. Ordination was performed using a PC-ORD 4.0. Downweighting of rare species was applied.

RESULTS

Distribution

Twenty-six localities of *Cladium mariscus* are known in Latvia. Most of the localities are located in the coastal area (18) and only three are found in Western Latvia and five in Eastern Latvia. Three areas of *Cladium mariscus* concentration were distinguished in Latvia. The first two were at the Baltic Sea – in the very southwest and in the northwest of Latvia and the third was found along the western coast of the Gulf of Rīga (Fig.1).

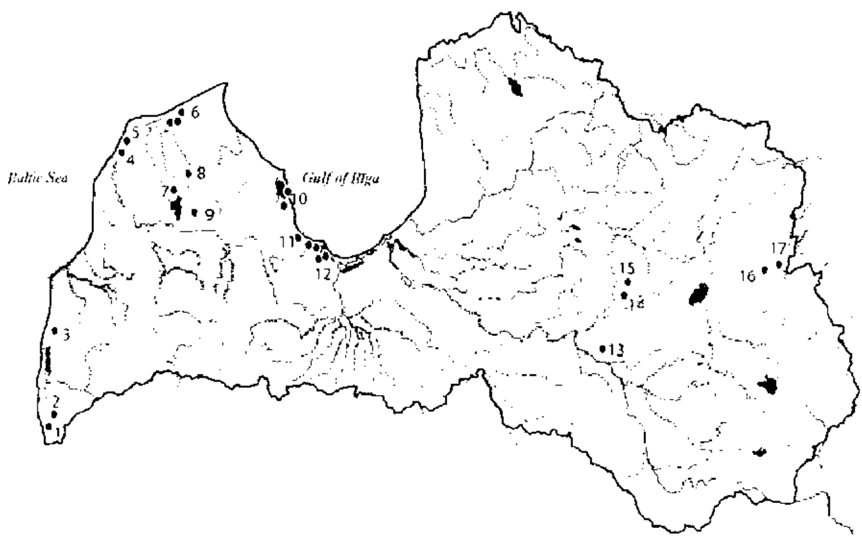

Fig. 1. Distribution of the *Cladium mariscus* community in Latvia
1 – Pape Lake, 2 – Ķirba Mire, 3 – Tosmare, 4 – Bušnieku Lake, 5 – Mazezers Lake, 6 – Dūmezers, Makšķerezers, Skarbes and Garezers lakes, 7 – Pelcene Lake, 8 – Seklene Lake, 9 – Vienīts Lake, 10 – Engure, 11 – Apšuciems, 12 – Raganu Mire, Aklais, Kaņieris, Dūņieris, Pušezers lakes, 13 – Baltiņš Lake, 14 – Lielais Plencis Lake, 15 – peninsula in Dreimaņu Lake, 16 – Mazais Kugriņu Lake, 17 – Motrines Lake

Climate

The majority of *Cladium mariscus* localities in Latvia are found in the Coastal Lowland characterised by the mildest and the most oceanic climate in Latvia (Strautnieks 1997) and only five localities are located in Eastern Latvia with continental climate. The mean temperature in July is ranging from 16.5 °C in the Bārtava, Engure, Ventava and Irve plains and the Arona Hilly Plain to 17 °C in the Adzele Elevation and 17.1 °C in the Rīgava Plain. The mean temperature of January is from – 3 °C in the Bārtava, Irve and Ventava plains to – 5 °C in the Rīgava Plain and – 7 °C in the Adzele Elevation. The southwest localities found in the Bārtava Plain have the maximum frost-free days in Latvia, namely 173. In the rest of the localities the frost-free period varies reaching the minimum in the Arona Hilly Plain where only 126–134 frost-free days are recorded (Strautnieks 1994a,b,c, 1995, 1998, Zelčs 1994a,b, 1998, Šķiņķis 1997). The temperature range in *Cladium mariscus* localities is from 19.5 °C in the Bārtava Plain to 24 °C in the Adzele Elevation (Table 1).

Table 1

Climate data of the Cladietum marisci localities in Latvia (Strautnieks, 1994a,b,c, 1995, 1998, Zelčs, 1994a,b, 1998, Šķiņķis, 1997)

Locality	Mean annual t°	Mean t° in July	Mean t° in February	Frost-free period, days
Bārta Plain (Pape, Tosmare, Ķirba Mire)	6.75	16.5	–3	173
Ventava and Irve plains (Bušnieku, Mazezers, Dūmezers, Makšķerezers, Skarbes, Garezers)	6.75	16.5	–3	150–160
Ugāle Plain (Pelcene, Seklene, Vienīts)	5.5	16.5	–3.9	133–145
Engure and Rīgava plains (Engure, Apšuciems, Raganu Mire, Aklais, Kūdraines, Dūņieris, Kaņieris, Pušezers)	6.25	16.5	–4	143–160
Arona Hilly Plain (Baltiņš, Lielais Plencis, Dreimaņu)	5.6	16.5	–6.8	126–134
Adzele Elevation (Mazais Kugriņu, Motrines)	4.8	17	–7	131–141

Habitats

The habitat supporting the largest *Cladium mariscus* stands in Latvia was shores of shallow coastal lakes that are lagoons by their origin (Pape, Kaņieris, and Dūņieris lakes). Among the other habitats, there were small shallow lakes between inter-coastal ridges (Mazezers, Dūmezers, Garezers, Skarbes, and Makšķerezers lakes) and in inland areas (Baltiņš, Lielais Plencis, Motrine, Mazais Kugriņu, Vienīts, Seklene and Pelcene lakes), depressions of different origin (near Engure Lake, on the peninsula in Dreimaņu Lake), a dune slack (Apšuciems locality), and springs (Raganu Mire). Remnant *Cladium mariscus* stands were also found within fens formed in the process of lake terrestrialization like in Engure, Kaņieris and Pape lakes. Pelcene locality represents a filling-in lake where *Cladium mariscus* community has remained in the centre surrounded by transitional mire. In a number of lakes, *Cladium mariscus* community formed only a fringe and was separated from the lake margin by fen, transitional mire and even raised bog vegetation like in Kūdraine Lake.

Cladium mariscus requires calcium-rich habitats (Balátová-Tuláčková 1991) and the origin of calcium varies among the localities in Latvia. It was dolomite close to the land surface (Kaņieris, Dūņieris, Pušezers, Aklais, and Kūdraines lakes), high concentration of shells in soil (depression near Engure Lake) and presence of calcareous gyttja layer (Motrines and Lielais Plencis lakes) (Anonymous 1999). The peninsula in Dreimaņu Lake was entirely formed of calcareous gyttja. However, the calcium content and its origin have not been studied in many localities (Vienīts, Pelcene, Tosmare, Makšķerezers, Dūmezers, Baltiņš, Bušnieku, Skarbe, Garezers, Seklene, Mazais Kugriņu, Mazezers, and Pape lakes, Ķirba Mire).

Water chemistry

Water chemistry results indicate that all six lakes have high calcium content (28–52 mg/l), except Kūdraines Lake (12 mg/l), and high pH ranging from 7.26 in Bušnieku Lake to 8.45 in Kaņieris Lake. The lowest nitrate concentration was in Kaņieris, Kūdraines and Motrines lakes (0.1 mg/l). The nitrate concentration was about three times higher in Bušnieks and Aklais lakes and about thirteen times higher in Lielais Plencis Lake than in the lakes mentioned before (Table 2). Aklais and Lielais Plencis lakes also had the highest phosphate concentration (0.014 mg/l; 0.017 mg/l).

Table 2

Water chemical composition of six lakes hosting *Cladium mariscus* community (Anonymous 1992, Anonymous 1994)

	Kaņieris	Kūdraines	Motrines	L.Plencis	Bušnieks	Aklais
Ca, mg/l	52	12	32	48.5	28.06	X
SO_4, mg/l	136	2.5	12	X	26.5	273
HCO_3, mg/l	122	65	159	183	77.7	179
NO_3-N, mg/l	0.1	0.13	0.1	1.4	0.35	0.39
NO_2-N, mg/l	0.005	0.005	0.005	0.022	0.004	X
NH_4-N, mg/l	0.25	0.5	0.05	0.39	0.23	0.36
pH	8.45	7.4	7.35	7.84	7.26	8.1
PO_4, mg/l	0.0045	X	X	0.017	0.008	0.014

X – no records exist

Vegetation classification and syntaxonomy

Six main clusters emerged from the four TWINSPAN divisions. The first TWINSPAN division separated relevés with a distinct brown moss layer from the relevés without them, which were mainly found in open water. The next division on the positive side divided moss-rich, albeit dry *Cladium* stands from the moss-rich wet stands. The next two TWINSPAN divisions on the negative side separated different types of *Cladium* dominated vegetation found in open water. The vegetation unit characterised by high cover of *Sphagnum spp.* emerged at the fourth level of TWINSPAN division.

Cluster 1 (45 relevés)

The Cluster 1 comprises *Cladium mariscus* community characterised by well-developed moss layer formed mainly by *Scorpidium scorpioides.* The most common associates were *Phragmites australis* and *Myrica gale.* The presence of species of the Class Oxycocco-Sphagnetea in this cluster is due to the nearby raised bog vegetation in Raganu Mire locality. This cluster had the highest homogeneity reaching 0.77. It was found in the shallowest parts of lakes where moss layer can develop and was also recorded in the periphery of springs and in remnant *Cladium* stands within calcareous fens. Localities: Kaņieris, Dūņieris, Pelcene, Engure and Lielais Plencis lakes, depressions near Engure Lake and sulphurous springs in Raganu Mire.

Cluster 2 (24 relevés)

The cluster represented relevés with high frequency of species of the Alliance Caricion davallianae such as *Schoenus ferrugineus, Drepanocladus revolvens, Campylium stellatum, Fissidens adianthoides* and *Bryum pseudotriquetrum* and low percentage of *Cladium mariscus*. The cluster homogeneity was 0.44. Found in a shallow depression, in a dune slack and in fen. Substrate is calcareous gyttja or a thin layer of fen peat. Localities: the peninsula in Dreimaņu Lake, the fen at Kaņieris Lake and the depression near Engure Lake.

Cluster 3 (22 relevés)

The cluster included mainly relevés with monodominant *Cladium mariscus* stands. Rarely *Phragmites australis* and different aquatics like *Utricularia vulgaris, U. intermedia* and *Chara* species (*Chara hispida, Ch. contraria, Ch. aspera, Ch. fragilis*) occur. Occasionally, *Carex elata* and *Carex lasiocarpa* were recorded. Found only in open water (shallow lakeshores or water filled depressions). Substrate is dolomite, often covered with mud of various depths (Kaņieris and Dūņieris lakes), sand with shells (depressions near Engure Lake), and gravel mixed with sand and mud (Pape Lake). Cluster homogeneity was 0.60. Found only in the Coastal Lowland where it covers large areas in coastal lakes and in Western Latvia. Localities: Kaņieris, Pape, Dūņieris and Pelcene lakes. Found also in depressions near Engure Lake.

Cluster 4 (23 relevés)

The cluster included relevés with high frequency and percentage of *Myrica gale*. Additionally, *Carex elata, Phragmites australis, Molinia caerulea,* and *Comarum palustre* were the most common species found there. The moss layer was absent. Found in places with changing water level passing through the dry phase. In the wettest phase water level variation may reach about 0.3–0.4 m above the ground. Cluster homogeneity was the lowest within the data set – 0.28. Found in a dune slack in Apšuciems and in Pape Lake.

Cluster 5 (31 relevés)

The cluster was characterised by high frequency of *Thelypteris palustris*. Among the other most common species *Comarum palustre, Phragmites australis, Typha latifolia, Carex rostrata, Lysimachia vulgaris,* and *Peucedanum palustris* are to be mentioned. *Myrica gale* was found in the relevés described in the Coastal Lowland. In all the localities, except one, *Cladium mariscus* community formes fringe, separated from the lake banks by mire vegetation. The cluster homogeneity was 0.41. Found in small coastal lakes of Latvia, also in Western and Eastern Latvia. Localities: Mazezers, Dūmezers, Makšķerezers, Vienīts, Kūdraines, Pušezers, Motrines, Lielais Plencis, and Mazais Kugriņu lakes.

Cluster 6 (7 relevés)

Relevés belonging to this cluster differ from the rest of the data set by having different *Sphagnum* species that are able to tolerate base-rich conditions. Hummocks of *Sphagnum palustre, Sph. warnstorfii* and *Sph. teres* and hollows with *Sphagnum flexuosum* and *Sph. contortum* were observed. The most common vascular plant species were *Phragmites australis, Myrica gale* and *Comarum palustre.* Invasion of *Sphagnum* has brought in the species of oligotrophic conditions such as *Drosera rotundifolia, Andromeda polifolia,* and *Oxycoccus palustris.* The cluster reflects development phase of *Cladium mariscus* community where *Sphagnum* has invaded *Cladium mariscus* stands. The cluster homogeneity was 0.43. Found only in Dūņieris Lake.

According to the Central European vegetation classification, all the clusters are assigned to the Association Cladietum marisci All.22. The following variants of the Association Cladietum marisci based on TWINSPAN analysis are distinguished: var. *Scorpidium scorpioides* (Cluster 1), var. *Schoenus ferrugineus* (Cluster 2), var. *typicum* (Cluster 3), var. *Myrica gale* (Cluster 4), var. *Thelypteris palustris* (Cluster 5), and var. *Sphagnum* (Cluster 6) (Table 3). Despite the low cover of *Cladium mariscus* and high proportion of species of the Alliance Caricion davallianae, the var. *Schoenus ferrugineus* is also assigned to the Association Cladietum marisci, because *Cladium* still determines the physiognomy of the plant community. Nevertheless, the best examples of Cladietum marisci in Latvia are found in shallow water bodies, where *Cladium* formed large monodominant stands, like *Phragmites australis,* in most of the lakes in Latvia. Therefore, the Association Cladietum marisci in Latvia is to be included in the Alliance Phragmition.

The most common species found in the whole data set were *Phragmites australis* (79 relevés), *Myrica gale* (62), *Scorpidium scorpioides* (61), *Campylium stellatum* (43), *Comarum palustre* (43), *Thelypteris palustris* (36), and *Drepanocladus revolvens* (34).

Ordination interpretation

Ordination by DCA reflects a wetness gradient – from *Cladium mariscus* stands found in open water to *Cladium* dominated fen vegetation. Relevés representing the driest *Cladium* dominated vegetation (fen-like) are placed in the right upper corner, while those recorded in wetter places have an equal position to the left from the

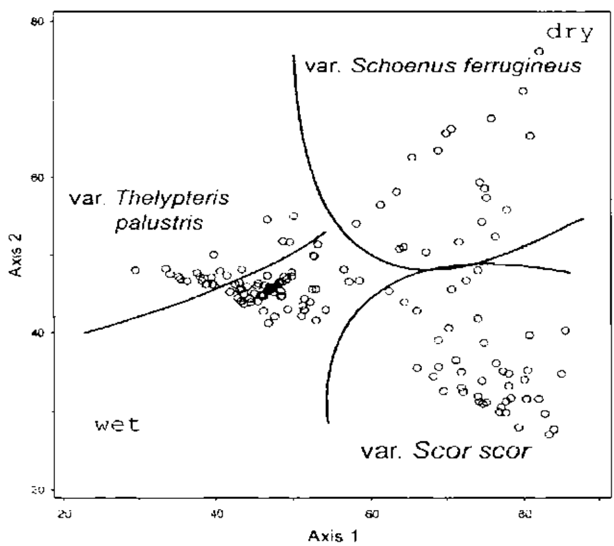

Fig.2. DCA ordination of *Cladium mariscus* dominated vegetation (DCA1 and DCA2)

diagonal of the diagram (Fig.2). Towards the right upper corner the proportion and percentage of species of the Caricion davallianae such as *Schoenus ferrugineus, Drepanocladus revolvens* and *Campylium stellatum* increased significantly. Var. *Thelypteris palustris* representing *Cladium* dominated fringe vegetation clustered at the left side of the diagram.

Three clusters obtained by TWINSPAN (var. *Schoenus ferrugineus,* var. *Thelypteris palustris,* and var. *Scorpidium scorpioides*) were used to partition the DCA space. The rest three clusters (var. *typicum,* var. *Myrica gale,* and var. *Sphagnum*) appeared to be very closely related.

DISCUSSION

Climate and ecology

Climate is one of the main factors influencing species distribution. It is known, that mainly low winter temperatures determine the north-east limit of *Cladium mariscus* distribution, because temperatures below –2 °C injure growing point of the species (Conway 1938). Therefore, the optimal climate conditions of *Cladium mariscus* is characterised by warm summers and lack of intensive frost in winter (Conway 1938), found in the parts of Europe lying within the west coast marine climate zone (Ahrens 1994). The climate data of the Latvia's localities (Table 1) and the map of the world climate zones (Ahrens 1994) prove, that Latvia's localities meet the optimal climate requirements of the species. Climate data from Latvia's localities also fit into the thermoclimatically optimal area of *Cladium mariscus* (Fig. 3). Only five eastern localities are located in regions where climate is not optimal for *Cladium mariscus* due to low winter temperatures (Table 1, Fig. 3).

However, the importance of local factors is to be taken into account here. Due to direct influence of springs, lakes could remain unfrozen for a longer time in comparison with the surroundings, thus making local conditions more favourable for survival of *Cladium mariscus* (Post von 1925). Indeed, it is a case of the most northern locality of *Cladium mariscus*, Joronoinen (Jalas, Okko 1951) and is true for one of the most eastern localities near St. Peterburough in Russia (Боч et al 1987). However, none of the eastern localities of *Cladium mariscus* community in Latvia is under direct influence of springs.

Later findings prove that water provides insulation thus protecting the frost sensitive growing point of *Cladium mariscus* (Conway 1938). In my opinion, that is the case for the most eastern localities of the Cladietum marisci in Latvia. All the eastern *Cladium mariscus* localities are permanently found in open water, except one, found in a temporary dry depression on the peninsula in Dreimaņu Lake, which represents also the less vital *Cladium* stands known in Latvia. Nevertheless, the depression is filled with water autumn and winter, which are the most unfavourable periods for

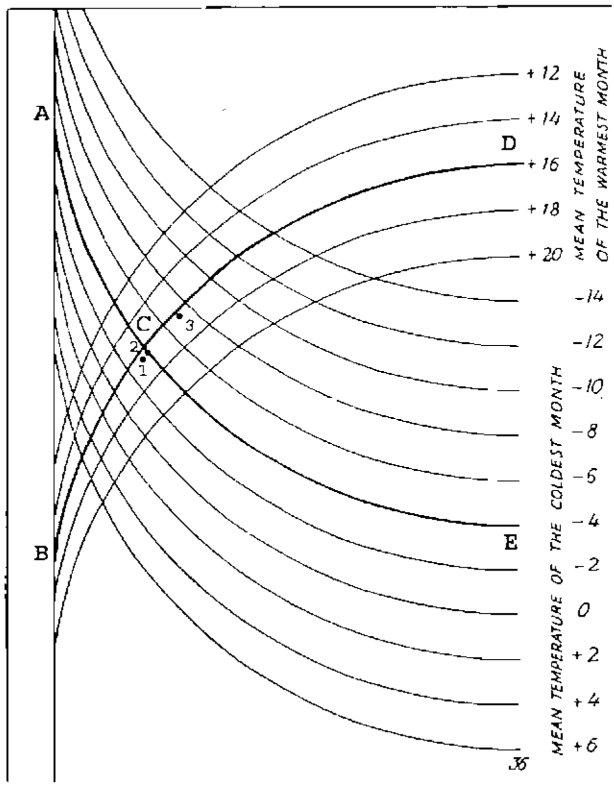

Fig.3. Thermoclimatic positions of *Cladium mariscus* localities in Latvia (after Jalas, Okko 1951, modified)

1 – *Cladium mariscus* localities in Bārtava, Irve and Ventava plains (–3 °C/16.5 °C); 2 – *Cladium mariscus* localities in Ugāle, Rīgava and Engure plains (–4 °C/16.5 °C); 3 – *Cladium mariscus* localities in Arona Hilly Plain (–6.8 °C /16.5 °C) and in Adzele Elevation (–7 °C /17 °C).

The *Cladium* localities in Rīgava Plain are located in the very west part of it. Therefore, the mean temperature was chosen as in the next-laying Engure Plain (– 4° C). The climate area south of the line BCE represents the thermo-climatically optimal area of *Cladium mariscus* (Jalas, Okko, 1951)

Cladium mariscus. To sum up, the majority of *Cladium mariscus* localities in Latvia are concentrated in the Coastal Lowland where the most suitable habitats for species (large shallow lagoon lakes) and the most suitable climate are found. Similar distribution pattern is found in other countries. Like in Latvia, *Cladium mariscus* in Estonia and Poland is more frequent in the western than in the eastern part of the country (Swieboda 1968, Paal et al. 1997). Whereas, almost all of 20 Lithuania's Cladietum marisci localities are found in the continental part of Lithuania (Балявичиене 1991).

Besides the temperature requirements, *Cladium mariscus* has also specific habitat requirements. The optimal *Cladium mariscus* habitat is shallow calcium-rich, albeit nutrient-poor water bodies (Balátová-Tuláčková 1991). The study confirmed it only

Table 3. Floristic composition of *Cladium mariscus* community

Number in table	var. *Scorpidium scorpioides*	var. *Schoenus ferrugineus*	var. *typicum*	var. *Myrica gale*	var. *Thelypteris palustris*	var. *Sphagnum*	
	1111111 111111111 111111	1111	1111111111	11	111111 1111	11111	
	11111226666667133344444224455555555666333555	112222222233114477744444	333444578822222222233	333337777788888888999900	8999000000 11111119990011	1334446	
	356890145678902789345673957123456789012234012	890124567802478978901243	121346890458234567890 1	567891235601234670124 37	967901245634567890123467358890 1	5560123	
Ch. Association Cladietum marisci							
Cladium mariscus	55332329999898699999999955469867694967997868 87	555484545659324699934553	999398896999999999999	999993455899999999999953	98999343249999999999999995898	9999999	Cladium mariscus (L.) Pohl.
Differential species of variants							
Scorpidium scorpioides	45999999999999995959999953.1899998998899959999	2121133556321599......	....	....	....	....	Scorpidium scorpioides (Hedw.) Limpr.
Campylium stellatum	11.211123..532........1.362........2..125	111 5411111.5.156322115	....	..........2.............	....................11.1	2	Campylium stellatum (Hedw.) J.Lange et C.Jens
Drepanocladus revolvens	392...111..112...................115	.959..353321599923191323	....	..........2.............	....	1	Drepanocladus species (C.Mull.) Roth
Schoenus ferrugineus	....11..............2.....1.........1.	1112121111.....11111.....	....1................	....	....	....	Schoenus ferrugineus L.
Thelypteris palustris	..............1...................	..........1.............	....	..................1.2...1	1111111111.1 6535346367812111.13	....	Thelypteris palustris Schott
Myrica gale	1121223 ......11341111....11111.......	.............211115.....	..........22.........	435245432134427372153131	....11111...........2.......	524331	Myrica gale L.
Sphagnum flexuosum	....	....	....	....	......5.......................	9999998	Sphagnum flexuosum Dozy et Molk.
Sphagnum contortum	........2.....999..	....	....	....	....	9	Sphagnum contortum K.F.Schultz
Sphagnum warnstorfii	...1.......................	....	....	....	....	1.1..9	Sphagnum warnstorfii Russ.
Sphagnum teres	..........2.....1..1........	....	....	....	....	515553	Sphagnum teres (Schimp.) Aongstr.
Sphagnum palustre	....	....	....	....	....	99.99	Sphagnum palustre L.
Ch. Order Caricetalia davallianae							
Aneura pinguis	....1....1......11..........	....	....	....	....	....	Aneura pinguis (L.) Dum.
Carex lepidocarpa	.......1.111..........3111111.....	...............1........	....	....	....	....	Carex lepidocarpa Tausch
Pinguicula vulgaris	......1.....................	....	....	....	....	....	Pinguicula vulgaris L.
Liparis loeselii	....	1.......................	....	....	....	....	Liparis loeselii (L.) Rich.
Parnassia palustris	....	...........1............	....	..........1....1.........	....	....	Parnassia palustris L.
Eleocharis quinqueflora	.....................111.	...11..1................	....	....	....	....	Eleocharis quinqueflora (F. X. Hartm.) O. Schwarz
Carex buxbaumii	....	..............32111.....	....	....	....	....	Carex buxbaumii Wahlenb.
Carex panicea	..............1..11.....1..	....	....	...1....................	....	....	Carex panicea L.
Juncus articulatus	...............11..211.....	....	....	....	....	....	Juncus articulatus L.
Fissidens adianthoides	......223311...............	..............124212....	....	....	....	....	Fissidens adianthoides Hedw.
Bryum pseudotriquetrum	..........1................	..............111.1	.1...................	....	.........................1....	....	Bryum pseudotriquetrum (Hedw.) Gaert., Meyer et Schr.
Riccardia latifrons	...1.1.....................	....	....	....	....	....	Riccardia latifrons (Lindb.) Lindb.
Epipactis palustris	....	..............111.1	....	....	..................1...........	....	Epipactis palustris (L.) Crantz
Ch. Class Scheuchzerio - Caricetea nigrae, Order Scheuchzerietalia palustris, Alliance Caricion lasiocarpae							
Menyanthes trifoliata	.......4111111.........112.	....	....	1.1.....................	.11..........1.1..............	3	Menyanthes trifoliata L.
Comarum palustre	1111111.......1111.......1..	...........11...........	....1...1............	.1..2..11.......1121.1	.2...11....1.........1.11..111111	1112.1	Comarum palustre L.
Carex diandra	......................1....	.........1..............	....	....	....	....	Carex diandra Schrank
Carex lasiocarpa	........1111111.....11......	..........1.............	...11111.............	...1....................	....	1	Carex lasiocarpa Ehrh.
Trichophorum alpinum	....11..11.................	....	....	....	....	2	Trichophorum alpinum (L.) Pers.
Eriophorum polystachyon	........................11.	....	....	....	....	....	Eriophorum polystachyon L.
Calliergon stramineum	..............1...11.......	....	....	....	....	111.11	Calliergon stramineum (Brid.) Kindb.
Ch. Alliance Magnocaricion elatae							
Carex elata	..............1.1.......11....112331.1224111	...........11...........	...11111.1...........	1.221111........1......	..................11.......1..	....	Carex elata All.
Carex acutiformis	....	....	....	....	......11.211..................	....	Carex acutiformis Ehrh.
Carex paniculata	....	....	....	....	2111..............1...........	....	Carex paniculata L.
Carex rostrata	..............1............	....	....	....	1......1.1....31.111...111....	....	Carex rostrata Stokes
Carex pseudocyperus	....	....	....	....	..1.....1.....................	....	Carex pseudocyperus L.
Lycopus europaeus	........1..................	....	....	....	1.................11..........	....	Lycopus europaeus L.
Cicuta virosa	....	....	....	....	...1....11....................	....	Cicuta virosa L.
Lysimachia vulgaris	....	....	....	..1..............11.1	...11111..........11..........	....	Lysimachia vulgaris L.
Peucedanum palustre	..............1........1...111	....	....	...............1..1....1	1111.1.11.................11..	....	Peucedanum palustre (L.) Moench
Galium palustre	.1...............11....11.1..1....1	..........1.11111.......	....	....	..................11..........	....	Galium palustre L.
Naumburgia thyrsiflora	..............1............	....	...1.................	....	....	....	Naumburgia thyrsiflora (L.) Rchb.
Ch. Class Phragmitetea, Alliance Phragmition							
Typha latifolia	....	....	......1..............	..........11.......1.2..	1.........122.1...1..12..1....	....	Typha latifolia L.
Typha angustifolia	....	....	....	1	......1.......................	....	Typha angustifolia L.
Scirpus tabernaemontani	...............1..........	....	...1.................	....	1.............................	....	Scirpus tabernaemontani C. C. Gmel.
Phragmites australis	1111..1.......11123321111.111..1122311111111	....1......11....11111.111111132	.111111.1..1.11.......	...1........121111.....	...........111...1........1111.	11121	Phragmites australis (cav.) Trin. ex Steud.
Scutellaria galericulata	...............1111.................1....	....	....	...................1....	....	....	Scutellaria galericulata L.
Rumex hydrolapathum	....	....	....	....	..................1...........	....	Rumex hydrolapathum Huds.
Equisetum fluviatile	...........1111...1.......	....	....	....	....	1	Equisetum fluviatile L.
Ch. Class Utricularietea intermedio-minoris							
Utricularia intermedia	........................111111111.........	11.111111122.......	.2111...1.....1......	....	...........1.1.......11.......	....	Utricularia intermedia Hayne
Utricularia minor	......111..................	....	....	1	...............111...11.......	....	Utricularia minor L.
Ch. Class Oxycocco - Sphagnetea							
Drosera rotundifolia	.1.11111.11.1..............	.......1................	....	....	....	111111	Drosera rotundifolia L.
Aulacomnium palustre	....	....	....	....	....	1..1	Aulacomnium palustre (Hedw.) Schwaegr.
Sphagnum fuscum	11.1.1.....................	....	....	....	....	....	Sphagnum fuscum (Schimp.) Klinggr.
Sphagnum rubellum	11..1......................	....	....	....	....	....	Sphagnum rubellum Wils.
Sphagnum magellanicum	....11.....................	....	....	....	....	....	Sphagnum magellanicum Brid.
Oxycoccus palustris	111.1111111111...1.1.1....	....	....	....	......1.......................	1322323	Oxycoccus palustris Pers.
Andromeda polifolia	.1.11.1....................	....	....	....	....	1..1	Andromeda polifolia L.
Other species							
Trees, shrubs							
Betula pubescens	..........1................	..............111.......	....	....	....	1	Betula pubescens Ehrh.
Pinus sylvestris	..1....11..................	............2.1.........	....	..........1.............	....	....	Pinus sylvestris L.
Salix pentandra	....	...................1....	....	....	....	....	Salix pentandra L.
Frangula alnus	......................1....	....	....	....	....	....	Frangula alnus Mill.
Betula humilis	....	....	....	....	................11............	....	Betula humilis Schrank
Salix cinerea	....	....	....	1.......................	................31............	....	Salix cinerea L.
Alnus glutinosa	....	....	....	......1.................	....	....	Alnus glutinosa (L.) Gaertn.
Lonicer caerule s. pal	....	....	......1..............	....	....	....	Lonicera caerulea L. ssp. pallasii (Ledeb.) Browicz
Juniperus communis	....	....	....	..........1.............	....	....	Juniperus communis L.
Salix rosmarinifolia	....	............2...........	....	....	....	....	Salix rosmarinifolia L.
Vascular plants							
Lemna trisulca	....	....	....1................	....	....	....	Lemna trisulca L.
Nuphar lutea	....	....	.......1.............	....	.....................1........	....	Nuphar lutea (L.) Smith
Ceratophyllum demersum	....	....	....	.................1......	...........1..................	....	Ceratophyllum demersum L.
Nymphaea candida	....	....	....	....	.1...1.11.....................	....	Nymphaea candida J. et C. Presl
Hydrocharis morsus-ranae	....	....	....	....	.2..............1.............	....	Hydrocharis morsus-ranae L.
Potamogeton natans	........1..................	1.......................	....	....	....	....	Potamogeton natans L.
Hottonia palustris	................1.1.1......	....	....	....	....................1.........	....	Hottonia palustris L.
Dryopteris cristata	....	....	....	....	...................1..........	....	Dryopteris cristata (L.) A. Gray
Calamagrostis neglecta	....	....	....	....	....	1......	Calamagrostis neglecta (Enrh.) Gaertn Mey. et Scherb.
Poa palustris	....	....	....	....	....	1......	Poa palustris L.
Moneses uniflora	....	....	....	....	....	.1.....	Moneses uniflora (L.) A. Gray
Viola palustris	....	....	....	....	....	11	Viola palustris L.
Lythrum salicaria	..........1.......1.......1..	....	.......1.............	....	....	....	Lythrum salicaria L.
Eupatorium cannabinum	.................1..1......	..........1....1........	....	....	....	....	Eupatorium cannabinum L.
Utricularia vulgaris	...............11..........	....	.1121...1....1.......	....	1.............................	....	Utricularia vulgaris L.
Potentilla erecta	..1........................	.........1..............	....	....	....	....	Potentilla erecta (L.) Raeusch.
Drosera anglica	.......1.1111..............	....	....	....	....	....	Drosera anglica Huds.
Thalictrum flavum	......................1....	....	....	....	....	....	Thalictrum flavum L.
Dactylorhiza maculata	.......1...................	....	....	....	....	....	Dactylorhiza maculata (L.) Soo
Dactylorhiza incarnata	....	........1...............	....	....	....	....	Dactylorhiza incarnata (L.) Soo
Galium trifidum	.........11................	....	....	....	....	....	Galium trifidum L.
Empetrum nigrum	..........1................	....	....	....	....	....	Empetrum nigrum L.
Molinia caerulea	....	.............111........	....	........111111..........	....	....	Molinia caerulea (L.) Moench
Thalictrum aquilegifolia	....	....	....	...1....................	....	....	Thalictrum aquilegifolium L.
Calystegia sepium	....................111...1..	....	....	....	....	....	Calystegia sepium (L.) R. Branth
Calluna vulgaris	..1.1......................	....	....	....	....	....	Calluna vulgaris (L.) Hull
Mosses							
Lophozia rutheana	........12111..............	....	....	....	....	....	Lophozia rutheana (Limpr.) Howe
Cinclidium stygium	.......111111.........51...	....	....	....	....	....	Cinclidium stygium Sw.
Kurzia pauciflora	.....11....................	....	....	....	....	....	Kurzia pauciflora (Dicks.) Grolle
Paludella squarrosa	..........1................	....	....	....	....	....	Paludella squarrosa (Hedw.) Brid.
Calliergon cordifolium	..............1............	....	.......1.............	............11..........	....	....	Calliergon cordifolium (Hedw.) Kindb.
Sphagnum squarrosum	.............1.1...........	....	....	....	....	.3.....	Sphagnum squarrosum Crome
Calliergoneil cuspidata	....	....	....	....	.1..........2.1.11............	....	Calliergonella cuspidata (Hedw.) Loeske
Calliergon giganteum	............8.......1......	.........1..............	....	....	5995	....	Calliergon giganteum (Hedw.) Kindb.

partly. All the studied lakes, except Kūdraines Lake, were calcium-rich and had high pH, but Cladietum marisci was found not only in nutrient-poor, but also in comparatively nutrient-rich waterbodies (Table 2); it contradicts the findings recorded elsewhere (Klosowski 1988).

Concerning the phosphate, it could be explained by the fact that in calcium-rich lakes the available phosphate is found in the form of tricalcium phosphate and in this form it can only be absorbed by plants in minimum amounts (Gessner 1939 in Ellenberg 1988).

Importance of wetness and water level fluctuation in determination of species composition in *Cladium mariscus* community have been stressed in a number of works (Burnett 1964, Swieboda 1968, Staniewska-Zatek 1977, Rodwell 1993, Meredith 1995). Not surprisingly, the main factor explaining the vegetation variation of Latvia's samples was also wetness reflected by the DCA (Fig. 2).

The species rich variants of *Cladium* community, placed in the periphery of the diagram, can only develop, when water level becomes lower (Rodwell 1993) and vigorous *Cladium* shoots become less dense allowing other species to penetrate. The presence of species-rich variants of the Cladietum marisci in Dūņieris, Kaņieris, and Lielais Plencis lakes might be due to lowering of water level in these lakes. Nevertheless, it was found out, that a moderate lowering of water level in lakes hosting *Cladium mariscus* favours expansion of *Cladium mariscus* by creating more space suitable for species. After the lowering of water level in Dūņieris and Lielais Plencis lakes in the 1930-s (Opmanis pers.com.), *Cladium* expanded gradually and by now it covers almost both the lakes. However, lowering of water level should not be considered as an appropriate *Cladium* management, because it is followed by lake eutrophication and peat formation, thus creating less suitable habitat for *Cladium mariscus*.

Vegetation classification and syntaxonomy

The core question of vegetation classification when dealing with the Cladietum marisci is its affinity to the Alliance Phragmition or the Alliance Magnocaricion. The basic information often used to take the final decision is the proportion and abundance of the Phragmition and the Magnocaricion species within the data set (Balátová-Tuláčková 1991, Görs 1975). In my opinion, it is rather ambitious, because different authors have assigned many species in different alliances. Consequently, the results depend on the data source and can be different. In my opinion, only species composition of community in its optimum habitat should be taken into account when deciding on the affinity to a given syntaxonomical unit. Other authors (Staniewska-Zatek 1977, Dierssen 1982) also state it.

There are a number of counterparts of the Cladietum marisci variants described in Latvia. The species composition of *Cladium mariscus – Myrica gale* sociation on lakeshores in Scotland (Burnett 1964) clearly shows similarity to the distinguished variants in Latvia (var. *typicum* and var. *Myrica gale*). The *Sphagnum* rich *Cladium maricus* community is described from a filling-in lake in Poland (Kepczynski, Ceynowa 1968, Jasnowska, Jasnowski 1991) and was also distinguished in Germany (Krausch 1964). The variant with *Thelypteris palustris* has been described in Poland (Kepczynski, Ceynowa 1968), in Germany (Krausch 1964) and in the United Kingdom (Rodwell 1993). The subassociation Cladietum marisci schoenetosum distinguished in the United Kingdom (Dierssen 1982) is similar to var. *Schoenus ferrugineus* in Latvia. The Association Scorpidio-Cladietum marisci Succow 1974 described in Poland (Balátová-Tuláčková 1991) probably is like the var. *Scorpidium scorpioides* in Latvia. The typical sub-units of the Cladietum marisci characterised by monodominant *Cladium* stands are distinguished almost in every country having this community (Krausch 1964, Görs 1975, Wheeler 1980, Dierssen 1982, Боч et al 1987, Balátová-Tuláčková and Venanzovi 1989, Балявичиене 1991).

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Cladium mariscus L. (Pohl) sabiedrība Latvijā

Kopsavilkums

Tika pētīta *Cladium mariscus* sabiedrības izplatība, biotopi un sugu sastāvs Latvijā. *Cladium mariscus* sabiedrība Latvijā konstatēta 26 vietās, galvenokārt Piejūras zemienē. Klimatiskie dati rāda, ka lielākā daļa no sabiedrības atrašanās vietām Latvijā atrodas *Cladium mariscus* klimatiskā optimuma teritorijā. Aslapes sabiedrība tika konstatēta dažādos biotopos. Tie bija sekli ezeri, dažādas izcelsmes reljefa pazeminājumi, starpkāpu ieplaka un avoti. Analizēti 152 dižās aslapes sabiedrības apraksti no 16 vietām Latvijā. Balstoties uz TWINSPAN analīzes rezultātiem tika izdalīti 6 augu sabiedrības varianti: var. *Scorpidium scorpioides*, var. *Schoenus ferrugineus*, var. *typicum*, var. *Myrica gale*, var. *Thelypteris palustris* un var. *Sphagnum*. Latvijā visbiežāk sastop var. *typicum* un var. *Scorpidium scorpioides*. Visi varianti pielīdzināti asociācijai Cladietum marisci All. 22. Veikta arī parauglaukumu ordinācija ar detrendēto korespondences analīzi. Galvenais gradients, kas izskaidro atšķirības veģetācijā ir mitrums. Vislielākās un vitālākās audzes dižās aslapes sabiedrība veidoja lielos seklos ezeros, kur tā izteikti dominēja un citu sugu klātbūtne bija nenozīmīga līdzīgi kā Phragmitetum australis un tāpēc Cladietum marisci tika pieskaitīta savienībai Phragmition. Rakstā analizēti arī sešu ezeru ar dižo aslapi hidroķīmiskie parametri.

REFERENCES

Āboliņa, A. 2001. Latvijas sūnu saraksts (List of bryophytes of Latvia). *Latvijas Veģetācija*, 3: 47 – 87.

Ahrens, D. 1994. *Meteorology Today. An introduction to weather, climate, and the environment.* West Publishing Company, New York, p.754.

Anonymous, 1992. Latvijas ezeru monitorings.1 (Lake monitoring in Latvia). ZA Bioloģijas institūts. Atskaite.

Anonymous, 1994. Ūdenstilpju monitorings Teiču Valsts rezervātā (Monitoring of waterbodies in Teiči Nature Reserve). ZA Bioloģijas institūts. Atskaite.

Anonymous, 1999. Pārskats par ezeru sapropeļa atradņu meklēšanas darbiem Alūksnes, Balvu, Gulbenes un Ludzas rajonos (Summary of lake mud survey in Alūksne, Balvi, Gulbene and Ludza districts). SIA Geokonsultants.

Balátová-Tuláčková, E. & Venanzoni, R. 1989. Sumpf- und Feuchtrasengesellschaften in der Verlandungszone des Kalterer Sees (Lago di Caldaro), der Montiggler (Monticolo) Seen und in der Etsch (Adige) Aue, Oberitalien. *Folia Geobotanica et Phytotaxonomica*, 24 (2), 113–224.

Balátová-Tuláčková, E. 1991. Cladietum marisci. *Veröffentlichungen des Geobotanishen Institutes des ETH, Stiftung Rübel Zürich,* 106, 7–34.

Burnett, H (ed.). 1964. *The vegetation of Scotland.* Oliver & Boyd Edinburgh and London. p. 632.

Causton, D.R. 1988. *Introduction to vegetation analysis*. Unwyn Hyman, London, p.433.

Conway, V. 1938. Studies in autoecology of Cladium Mariscus. *The New Phytology*, 37, 254–278, 312–327.

Dierssen, K. 1982. *Die wichtigste Pflanzengesellschaften der Moore NW-Europas*. Conservatoire et Jardin botaniques Genčve.

Ellenberg, H. 1988. *Vegetation ecology of Central Europe.* Cambridge University Press, Cambridge. p.731.

Ellenberg, H. 1996. *Vegetation Mitteleuropas mit den Alpen.* 5.Auflag. Verlag Eugen Ulmer, Stuttgart, S. 1095.

Fatare, I. 1992. Latvijas floras komponentu izplatības analīze un tās nozīme augu aizsardzības koncepcijas izstrādāšanā (Distribution analysis of Latvian flora and its role in the plant conservation). *Vides aizsardzība Latvijā*, 3. Rīga, 258. lpp.

Gavrilova, G., Šulcs, V. 1999. *Latvijas vaskulāro augu flora* (Flora of vascular plants in Latvia). Zinātne, Rīga, p.135.

Gessner, F. 1939. Die Phosphorarmut der Gewässer und ihre Beziehung zum Kalkgehalt. *Int. Rev. Ges. Hydrobiol. u. Hydrograph.* 38, 203–211.

Görs, S. 175. Das Cladietum marisci All. 1922 in Süddeutschland. *Beitr. Naturk. Forsch. Südw.-Dtl.*, 34, 103–123.

Hennekens, S.M. 1995. *TURBO(VEG). Software package for input, processing and presentation of phytosociological data.* IBN-DLO, Wageningen.

Hill, M.O., Gauch. H.G. 1980. Detrended correspondence analysis: an improved ordination technique. *Vegetatio*, 42, 47–58.

Jalas, J., Okko, V. 1951. Botanical and geological analysis of *Cladium mariscus* station in Joroinen. *Archivum Soc. Zool. Bot. Fennicae* 5(2), 82–101

Jasnowska, J., Jasnowski, M. 1991. Dynamika Rozwojowa Roslinnosci Torfotworczej w Rezerwacie "Klocie Ostrowickie". Cz.I. Szata Roslinna Torfowiska. Zeszyty Nr. 149, Naukowe Akademii Rolniczej w Szczecinie. str. 20–21.

Kenkel, N.C. 1987. Trends and interrelationships in boreal wetland vegetation. *Canadian Journal of Botany,* 65 (1), 12–22.

Kepczynski, K., Ceynowa, M. 1968. Zespol kloci wiechowatej Cladietum marisci (All. 1922) Zobrist 1935 na obszarze Borow Tucholskich. Nauki Matemayczno-przyrodnicze, Zeszyt 21, Biologia XI. str. 30–48.

Klosowski von, S. 1988. Ökologische Amplitude und Zeigerwert der häufigeren Röhrichtgesellschaften im nordöstlichen Teils Polens. *Limnologica,* 19 (2), 109–125.

Krausch, H.D. 1964. Der Pflanzengesellschaften des Stechlinsee-Gebietes. II Röhrichte und Grossegengesellschaften, Phragmitetea Tx. & Prsg.1942. *Limnologica,* 2 (4), 423–483.

Lang, G. 1973. Die Vegetation des westlichen Bodenseegebietes. *Pflanzensoziologie,* 17, 85–150.

Meredith, T.C. 1985. Factors affecting recruitment from the seed bank of sedge *(Cladium mariscus)* dominated communities at Wicken Fen, Cambridgeshire, England. *Journal of Biogeography,* 12, 463–472.

Meusel, H., Jäger E., Weinert E. 1965. *Vergleichende Chorologie der Zentraleuropäischen Flora*. VEB Gustav Fischer Verlag, Jena. Bd. I, S. 583.

Mueller-Dombois, D. & Ellenberg, H. 1974. *Aims and methods of vegetation ecology.* John Wiley & Sons, New York. p.879.

Paal, J., Ilomets, M., Fremstad, E., Moen, A., Børset, E., Kuusemers, V., Truus, L., Leibak, E. 1998. *Estonian Wetlands Inventory 1997.* Publication of the Project Estonian Wetlands Conservation and Management. Eesti Loodusfoto, Tartu, 166+xxviii p.

Pakalne, M. 1994. Rare rich fen and lake side communities of the Baltic Coast (Latvia, Coastal Lowland). Doctoral Thesis. Rīga, p.146.

Post von, L. 1925. Gotlands-agen (Cladium Mariscus R.Br.) I Sveriges postarktikum. *Ymer. Tidsk. utg.av Sv. Sällskap f. Antrop. o. Geogr.*

Rodwell, J.S. 1993. *British Plant Communities. IV. Aquatic communities, swamps and tall-herb fens.* Cambridge University Press, Cambridge. p.383.

Šķiņķis, P. 1997. Rīgavas līdzenums (Rīgava Plain) In: *Latvijas daba, 5.* Kavacs, G., Liepa, V., Placēns, V., Sirmā, D., Tidriķis, A., Velce, D. (eds.). Preses Nams, Rīga, 258. lpp.

Staniewska-Zatek, W. 1977. Zespol Cladietum marisci All. 1922 w Wielkopolsce. Badania Fizjograficzne nad Polska Zachodnia, Tom XXX, Seria B, Botanika. str. 69–82.

Strautnieks, I. 1994 a. Bārtavas līdzenums (Bārtava Plain). In: *Latvijas daba, 1.* Kavacs, G., Liepa, V., Placēns, V., Sirmā, D., Tidriķis, A., Velce, D. (eds.). Preses Nams, Rīga, 287. lpp.

Strautnieks, I. 1994 b. Engures līdzenums (Engure Plain). In: *Latvijas daba, 2.* Kavacs, G., Liepa, V., Placēns, V., Sirmā, D., Tidriķis, A., Velce, D. (eds.). Preses Nams, Rīga, 332. lpp.

Strautnieks, I. 1994 c. Irves līdzenums (Irve Plain). In: *Latvijas daba, 2.* Kavacs, G., Liepa, V., Placēns, V., Sirmā, D., Tidriķis, A., Velce, D. (eds.). Preses Nams, Rīga, 332. lpp.

Strautnieks, I. 1997. Piejūras zemiene (Coastal Lowland). In: *Latvijas daba, 4.* Kavacs, G., Liepa, V., Placēns, V., Sirmā, D., Tidriķis, A., Velce, D. (eds.). Preses Nams, Rīga, 348. lpp.

Strautnieks, I. 1998. Ventavas līdzenums (Ventava Plain) In: *Latvijas daba, 6.* Kavacs, G., Liepa, V., Placēns, V., Sirmā, D., Tidriķis, A., Velce, D. (eds.). Preses Nams, Rīga, 598.lpp.

Swieboda, M. 1968. Wystepowanie I Ochrona Kloci Wiechowatej *Cladium mariscus* (L.) Pohl. W Polsce. *Ochrona Przyrody, 33,* 124–137.

Wheeler, B.D. 1980. Plant communities of rich-fen systems in England and Wales. I Introduction. Tall sedge and reed communities. *Journal of Ecology, 68,* 365–395.

Zelčs, V. 1994 a. Adzeles pacēlums (Adzele Rise). In: *Latvijas daba, 1.* Kavacs, G., Liepa, V., Placēns, V., Sirmā, D., Tidriķis, A., Velce, D. (eds.). Preses Nams, Rīga, 287.lpp.

Zelčs, V. 1994 b. Aronas paugurlīdzenums (Arona Hilly Plain). In: *Latvijas daba, 1.* Kavacs, G., Liepa, V., Placēns, V., Sirmā, D., Tidriķis, A., Velce, D. (eds.). Preses Nams, Rīga, 287. lpp.

Zelčs, V. 1998. Ugāles līdzenums (Ugāle Plain). In: *Latvijas daba, 5.* Kavacs, G., Liepa, V., Placēns, V., Sirmā, D., Tidriķis, A., Velce, D. (eds.). Preses Nams, Rīga, 258. lpp.

Балявичиене, Ю. 1991. *Синтаксономо фитогеографическая структура растительности Литвы* (Vegetation syntaxonomy of Lithuania). Мокслас, Вильнюс. 220 с.

Боч, М.С., Смагин, В.А. 1987. Редкие ассоциации болот северо запада европейской части СССР (Rare associations in mires in the north-west of the European part of the USSR). *Бюл. Московск. о-ва испытателей природы. Отд. Биол.* 92 (4), 104–112.

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Sociology of *Armeria vulgaris* Willd. in Latvia

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Abstract

Armeria vulgaris Willd. is growing on its northeastern limit of the distribution area in Latvia. In 2000, nine of 18 known localities of *A. vulgaris* was inventoried to assess the present state of localities and to describe the sociology of the species.

A.vulgaris was vital and more abundant (in most cases dominant and subdominant) than in the previous inventories in all the sites visited. The species is found only in synanthropic habitats – dry grasslands and on railway embankments both in the communities of the Cl. Koelerio-Corynephoretea (Koelerion glaucae, Plantagini-Festucion) and Cl. Molinio-Arrhenatheretea (Cynosurion).

Results showed that the coenopopulations of *A.vulgaris* were stable with a tendency to spread. It is supposed that spreading of this species in Latvia is favoured by man's activities – railway and road embankments and also management (including frequent burning) of dry grasslands provide suitable habitats, which otherwise would be more rare in Latvia in natural conditions. Nevertheless, the species is endangered because of the changes in land use practices, namely by overgrowing of dry grasslands.

Keywords: *Armeria vulgaris*, sociology, synecology

INTRODUCTION

Armeria vulgaris (syn. *A.elongata*; *A.maritima* subsp. *elongata*) is a temperate suboceanic Central European species. From all the species of genus *Armeria* it has the most continental distribution: to the East it reaches southern Finnland, Estonia, Latvia, Smolensk and northwestern Hungary (Gams 1975).

In Latvia, *A.vulgaris* has 18 localities (one locality is 7.7×9.3 km in Latvian floristical mapping grid (Табака и др. 1988)), two of them were newly registered during this research.

A.vulgaris is a species with narrow ecological range. It is the character species of the Alliance (All.) Plantagini-Festucion (syn. Armerion elongatae) which belongs to the Order (O.) Festuco-Sedetalia, Class (Cl.) Koelerio-Corynephoretea and includes dry sandy grassland and gray dune vegetation (Pott 1995, Dierssen 1996).

Previous investigations on plant communities of the All. Plantagini-Festucion in Latvia (Jermacāne 2000; Jermacāne, Laiviņš 2001a; 2001b) have shown that assigning of communities described in Latvia to already existing syntaxa of the Braun-Blanquet system is difficult or even not possible. The same situation is also in other regions of Europe where climatic conditions and richness of flora differs from that of Central Europe (Bruun, Ejrnaes 2000; Diekmann 1997).

In Latvia, several higher syntaxa of dry grassland vegetation including also the All. Plantagini-Festucion have incomplete set of character species because these species do not reach territory of Latvia or they are very rare. It is well known that species ecology can differ considerably among the parts of its distribution area (Hollmann 1972; Ejrnaes 1998). Therefore investigations on distribution and sociology of such species are very important in order to ascertain the possibilities to use them as character species in the process of vegetation classification. Up to now, there are no research of sociology of *A.vulgaris* done in Latvia (Tabaka 2001).

The aim of this paper was to describe the plant communities with *A.vulgaris* and to clear up the sociological prevalences of the species in the territory of Latvia, as well as to analyse the stability of the species and factors endangering it.

MATERIAL AND METHODS

Study area

Latvia is located near the eastern coast of the Baltic Sea between 55°40'–58°05' N latitude and 20°58'–28°14' E longitude.

The climate is relatively mild maritime becoming slightly continental inland. The frost-free period lasts 150–160 days near the sea and 130–140 days in the east. The average precipitation is 600–650 mm per year, with less precipitation (500) in the Zemgale Lowland (Central Latvia) and more (800) in the Vidzeme Upland (North-eastern Latvia). The vegetation period extends for about 180–200 days, and the average temperature is 6 °C. Mean temperature of the coldest month January is –4 °C, the warmest month is July (+17 °C). In the beginning (end of May) and the end of the growing season (end of September), plants are exposed to frost during nights (Kalniņa 1995; 1998). Forests cover ~45% of the country, mires – 6%, agricultural lands – 38%, and semi-natural grasslands occupy about 1% of the territory (Anon. 1998).

Study sites

Only seven out of 16 localities of *A.vulgaris* were possible to locate and inventor (Fig.1.). Others did not have precise address so they were omitted from the inventory. Additionally, two new localities discovered during the research were described.

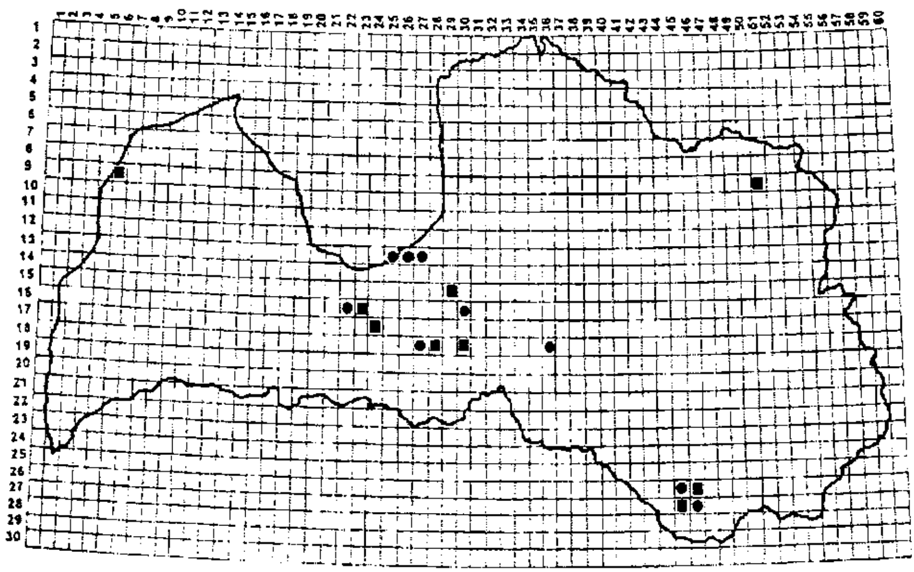

Fig.1. Distribution of *Armeria vulgaris* in Latvia. Squares – localities inventoried. (After: Tabaka 2001; unpublished data of Biology Institute, Laboratory of Botany for localities: 16/23 – Herbarium Latvicum (H LATV) Valgunde, dry grassland, S. Jermacāne 2002; 17/24 – H LATV Brankas, dry grassland. S.Jermacāne 2002; 26/45 – H LATV Daugavpils, Mežciems, dry grassland on the railway embankment, L.Tabaka 1981; 27/46 – H LATV Daugavpils, fortress, dry grassland, U.Suško 1990.)

09-06 (address of the locality in the grid net: the first number indicate grid line on the Axis *y* and the second number – grid line on the Axis *x*) – Ventspils. Northwestern part of the town's airfield. Dry grassland next to ruins of the individual farm. Abandoned for several years. Locality is inventoried in 1996.

09-51 – Mālupe. Dry floodplain grassland on the right bank of the Pededze River next to the bridge, 300 m to SE from the individual farm Lejmalas. A small part of the territory is grazed by sheep, the rest is abandoned for several years. Locality is inventoried in 2000.

15-29 – Saulkalne. Dry grassland developed on the place of sand pit next to the railway between Saulkalne and Ikšķile (2 km from the railway station Ikšķile near the individual farm Bulstrumi). Grassland is not managed but it is burned each year in spring. Locality is inventoried in 1998 and 2001.

16-23 – Valgunde. Dry sandy grassland close to the individual farm Zeltiņi 4 km to NE from Valgunde. Grassland is grazed in the second part of summer. Locality is inventoried in 2002.

17-24 – Brankas. Dry sandy grassland on the right bank of the Iecava River 3.5 km to SE from Brankas next to the individual farms Zemdari and Toņi. Abandoned. Locality is inventoried in 2002.

18-28 – Dzelzāmurs. Dry to mesic grassland on the left bank of the Misa River next to the individual farm Krastiņi. Partly mowed and partly grazed by horses (management was stopped in 2002 due to change of land renters). In places the territory have been plought up and after some years left as fallow-land and grazed. Locality is inventoried in 2001.

18-30 – Vecumnieki. Dry grassland next to soldier's graves 2.5 km on NE from Vecumnieki. Locality is inventoried in 2001.

26-46 – Daugavpils, Kūdraine. Dry grassland on the railway embankment 0.5 km to S from the railway station Kūdraine. Site is burned regularly. Locality is inventoried in 2001.

27-45 – Daugavpils, Mežciems. Dry grassland on the southern and northern slope of railway embankment 2 km to N from the railway station Mežciems. Locality is inventoried in 2001.

Methods

Inventory of localities and plant community description

The present state of *A.vulgaris* coenopopulations was assessed in each of inventoried localities. Share of each species in coenosis was evaluated using 3 grades: 1 – dominant (cover of *A.vulgaris* was higher than others or the same as some other species in the case if there were several dominant species), 2 – codominant (cover of *A.vulgaris* was only a little lower than that of dominant species), 3 – accompanying (cover of *A.vulgaris* was low).

48 phytosociological relevés (size of relevé – 3–25 m^2) were collected following the Braun-Blanquet approach (Braun-Blanquet 1964; Dierschke 1992; Kent, Coker 1994) to analyse sociological behavior of *A.vulgaris*. Data set was treated by the computer program TWINSPAN (Two-Way-INdicator-SPecies-ANalysis (Hill 1979)). The pseudospecies cut levels used were 0-0.6-6-26-51-76. TWINSPAN division levels were interpreted ecologically. Further levels were taken into account only if the ecological background for the differences in species composition among groups could be found. For this reason vegetation-environment relationships were examined using DCA (computer program DECORANA). Downweighting of rare species was not applied. Ellenberg indicator values (Ellenberg et al. 1992) and data of soil chemical and physical analysis were used to interpret the ordination.

The spectrum of phytogeographical elements (species distribution area types) was calculated using initial data from Meusel et al. (1965, 1978) and Hulten, Fries (1986), Ellenberg values were calculated weighted by coverage. Nomenclature: vascular plants – Gavrilova, Šulcs 1999; mosses – Āboliņa 2001, lichens – Piterāns 2001.

Soil analysis

Soil analysis were done in two localities – Saulkalne is representing plant communities of the Cl. Koelerio-Corynephoretea All. Plantagini-Festucion; Dzelzāmurs is representing plant communties of the Cl. Molinio-Arrhenatheretea, All. Cynosurion.

Soil pH was determined in distilled H_2O and 1 M KCl solutions, total acidity (extractant 1 M $NaCH_3COO$) (Kappen method), sum of exchangeable basic cations (method of Kappen-Gilkovich), plant available P and K – after Egner-Riem (DL) method, exchangeable Mg and Ca were determined by flame photometer (extractant 0,1 M KCl), soil organic matter after method of Tjurin (oxidation by $K_2Cr_2O_7.H_2SO_4$) and total nitrogen by Kjeldahl (Skujāns, Mežals 1964; Jēkabsone et al. 1997). Organic C is calculated dividing organic matter by the coefficient 1.724. Particle size analysis was made by sedimentation and pipette method after N. Kachinsky (Качинский 1958).

RESULTS

The state of localities

In all the localities inventoried, *A.vulgaris* coenopopulations were highly vital – *A.vulgaris* was flowering abundantly, in most cases it was dominant or codominant species in the coenosis (Table 1). In comparison with former investigations abundance of *A.vulgaris* was the same or even higher. For example, there were 2 specimens in Vecumnieki locality in 1983 (unpubl. data of Laboratory of Botany, Institute of Biology), but the species was growing abundantly in approximately 10 m^2 large area in 2001. The same situation is in Dzelzāmurs locality where *A.vulgaris* was accompanying species in 1954 but it was one of dominants (cover reached 45%) in 2001.

Table 1

Dominance of *A.vulgaris* in inventoried localities

Locality	Number of relevés where *A.vulgaris* is:			
	Dominant	Codominant	Accompanying	Not present
09-06 Ventspils (3 relevés)	–	1	2	–
09-51 Mālupe (7 relevés)	–	2	4	1
15-29 Saulkalne (8 relevés)	–	1	4	3
16-23 Valgunde (3 relevés)	–	3	–	–
17-24 Brankas (3 relevés)	–	1	1	1
18-28 Dzelzāmurs (14 relevés)	11	1	2	–
18-30 Vecumnieki (2 relevés)	–	–	2	–
26-45 Mežciems (5 relevés)	4	–	1	–
26-46 Kūdraine (3 relevés)	–	–	3	–

Consequently, coenopopulations of *A.vulgaris* can maintain for a very long time if the site conditions do not alter radically. The oldest locality well documented with herbaria specimens is Dzelzāmurs where the species is known from the year 1954.

Plant communities

In total, 150 vascular plant species and 25 moss and lichen species were encountered in 48 relevés. Species richness averaged 26 per 4 m^2 (it varied from 16 to 36 species). Nevertheless, only 9 species had constancy higher than 50% (*Armeria vulgaris, Galium album, Achillea millefolium, Poa angustifolia, Knautia arvensis, Festuca rubra, Pimpinella saxifraga, Agrostis tenuis* and *Dianthus deltoides*), 28 species were with constancy 20 to 50%, but the rest of species occurred sporadically (constancy less than 20%).

TWINSPAN classification resulted in 5 clusters (Fig.2.). First TWINSPAN division level separated 11 relevés with high constancy of xerothermophilous species *Helictotrichon pratense, Phleum phleoides, Carex caryophyllea*. Further division of this group emerged 3 relevés of Daugavpils-Kūdraine locality having very specific species composition with *Astragalus arenarius, Helichrysum arenarium, Silene otites* etc.

The next divisions separated the rest of relevés (37) into three main clusters. The set of indicator species for each cluster clearly showed differences in soil fertility and moisture conditions.

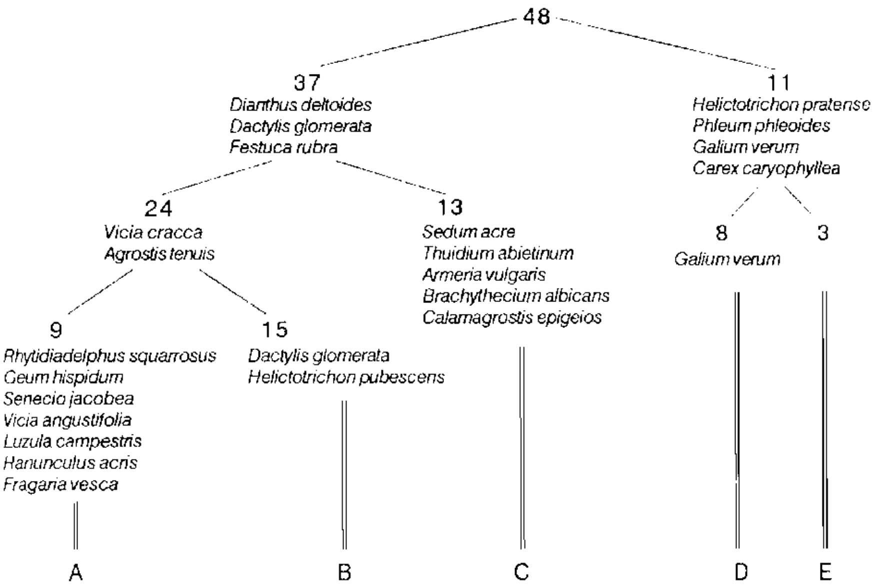

Fig.2. TWINSPAN dendrogramm

Group A includes 9 relevés which all were collected in Dzelzāmurs locality except of one from Valgunde locality and one from Brankas locality. Dominant species was *Armeria vulgaris* (cover varied from 0.5 to 35%, averaged – 17%), other abundant species were *Agrostis tenuis, Festuca rubra, Galium album, Poa angustifolia,* in places also *Trifolium repens, Briza media, Pilosella officinarum.* Moss layer was well developed with total cover exceeding 80% (average 45%) although the only species with high cover was *Rhytidiadelphus squarrosus*.

The core of the community includes the character species of the Cl. Molinio-Arrhenatheretea and the All. Cynosurion (Table 2., 3.). Syntaxonomically the group A is assigned to the Ass. Anthoxantho-Agrostietum tenuis, while the character species of the association *Agrostis tenuis* dominate and moss layer is developed by *Rhytidiadelphus squarrosus,* so characteristic for this association. Species of dry sandy habitats *Trifolium arvense, Potentilla argentea, Rumex acetosella, Poa angustifolia,* *Pilosella officinarum* and *Brachythecium albicans*, although with insignificant cover and frequency, links the community with the Cl. Koelerio-Corynephoretea. Similar communities but with absent *A.vulgaris* have been described in the Coastal Lowland (Jermacāne 1999).

Group B includes 15 relevés from different localities (Table 2., 3.). The group contains plant communities developed in comparatively more fertile and fresh sites. Vegetation is dominated by mesophilous grasses *Festuca rubra, Agrostis tenuis, Dactylis glomerata,* frequent and with rather high cover was also *Poa angustifolia* (average cover 8%). *Armeria vulgaris* had less cover than in previous group – it varied from 0 to 20% (averaged only 7%), it was absent in two relevés.

Majority of dominants were the character species of the Cl. Molinio-Arrhenatheretea. The group is classified as the O. Arrhenatheretalia community. Floristic composition indicates features both from the All. Arrhenatherion and Cynosurion. Presence of several mesophilous grasses (*Dactylis glomerata, Helictotrichon pubescens, Poa pratensis, Festuca pratensis*) is typical for the All. Arrhenatherion but dominance of such species as *Agrostis tenuis* and *Festuca rubra*, as well as high cover of *Plantago lanceolata, Phleum pratense, Taraxacum officinale* and *Briza media* is characteristic for the All. Cynosurion. Group B is very similar to the group A and it can be assigned to the Ass. Anthoxantho-Agrostietum tenuis.

Group C comprises 13 relevés mainly from the localities of Dzelzāmurs and Daugavpils-Mežciems. The group is distinguished by the dominance of *A.vulgaris* (cover varied form 6 to 45%, averaged – 22%). Other abundant species were *Pilosella officinarum* and *Poa angustifolia*, but *Dianthus deltoides, Pimpinella saxifraga, Galium album, Festuca rubra* had high cover only in some of relevés.

In contrary to previous groups, this group encounters plant communities with dominance of the character species of the Cl. Koelerio-Corynephoretea and its subordinate syntaxa as well as other species restricted to dry habitats, but species of mesophilous grasslands are poorly represented.

Syntaxonomically these relevés are classified as the community of the Cl. Koelerio-Corynephoretea, O.Festuco-Sedetalia, All. Plantagini-Festucion. Floristically and ecologically this group is close to the Ass. Diantho-Armerietum described in Central Europe. One of differences is that group C does not encounter *Festuca ovina* and *Agrostis tenuis* has small cover, but named species are dominants in this association (Pott 1995; Oberdorfer 1978; Jeckel 1975). The character species of the association *Armeria vulgaris* and *Dianthus deltoides* are with high constancy in the group C. Krausch (1968) has named also *Cerastium arvense* as the character species, but it was not present in our relevés.

Another difference is insignificant participation of therophytes in the relevés of the group C. It could be explained by the fact that the relevés were collected in habitats abandoned for some time. So there was no sufficient intensity of disturbances creating microniches for successful development of therophytes. Therophytes have less importance in the comunities of the All. Plantagini-Festucion also in the other parts of its distribution area, if compared with other syntaxa of the Cl. Koelerio-Corynephoretea (Dierssen 1996; Krausch 1968).

Table 2

The floristic composition of plant communities with *Armeria vulgaris* (Header data in the Table 3)

TWINSPAN group	A									Constancy	B															Constancy
Number of relevé	194	195	196	197	201	202	207	782	784		165	166	167	179	180	181	182	183	184	185	186	208	781	783	785	
All. Koelerion glaucae																										
Koeleria glauca	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Astragalus arenarius	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Silene otites	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Jovibarba globifera	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
All. Plantagini-Festucion																										
Armeria vulgaris	1	2	2	3	2	2	2	+	2	V	+	2	+	.	1	+	2	2	1	1	+	1	.	2	2	V
Dianthus deltoides	+	2	.	.	2	+	+	1	.	IV	+	+	+	2	1	1	+	+	2	.	.	1	+	.	+	V
Artemisia campestris	+	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	+	1	+	1	II
Phleum phleoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Viscaria vulgaris	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	I
Festuca trachyphylla	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Veronica spicata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	I
O. Festuco-Sedetalia																										
Trifolium arvense	.	.	.	+	+	.	1	.	.	II	+	1	.	.	.	.	.	.	.	.	.	.	+	.	.	II
Cerastium arvense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hylotelephium triphyllum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	I
Carex praecox	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Helichrysum arenarium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cl. Koelerio-Corynephoretea																										
Rumex acetosella	.	+	.	.	.	.	2	1	.	II	+	.	.	.	.	.	+	.	.	.	.	.	+	+	+	II
Potentilla argentea	.	+	.	+	.	.	.	.	+	II	+	.	.	.	+	+	.	.	+	.	.	.	+	.	+	III
Brachythecium albicans-ml	.	+	.	.	+	.	+	.	.	II	.	.	.	.	.	.	.	.	.	.	+	.	3	.	1	II
Ceratodon purpureus-ml	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	2	II

TWINSPAN group	C													Constancy
Number of relevé	187	188	189	190	198	199	200	203	204	205	206	209	780	
All. Koelerion glaucae														
Koeleria glauca	.	1	.	.	.	.	.	.	.	.	.	.	.	I
Astragalus arenarius	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Silene otites	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Jovibarba globifera	.	.	.	.	.	.	.	3	.	.	.	.	.	I
All. Plantagini-Festucion														
Armeria vulgaris	2	2	3	2	3	3	3	2	2	2	2	2	2	V
Dianthus deltoides	+	.	+	.	2	2	1	1	.	2	2	.	+	IV
Artemisia campestris	.	1	+	1	.	+	.	1	+	+	.	1	+	IV
Phleum phleoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Viscaria vulgaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Festuca trachyphylla	.	.	1	.	.	.	.	.	.	.	.	.	.	I
Veronica spicata	+	+	.	+	.	.	.	.	.	.	.	.	.	II
O. Festuco-Sedetalia														
Trifolium arvense	+	.	2	+	+	+	.	.	1	.	+	.	+	IV
Cerastium arvense	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hylotelephium triphyllum	.	.	.	.	.	.	.	.	.	.	.	+	.	I
Carex praecox	.	.	1	.	.	.	.	.	.	.	.	.	.	I
Helichrysum arenarium	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cl. Koelerio-Corynephoretea														
Rumex acetosella	.	+	+	1	+	+	.	+	+	2	1	.	+	IV
Potentilla argentea	.	.	1	1	1	1	1	.	+	.	+	.	.	III
Brachythecium albicans-ml	1	.	+	+	.	.	2	2	.	1	3	1	.	IV
Ceratodon purpureus-ml	2	1	+	1	.	.	.	.	.	.	.	.	2	II

TWINSPAN group	D								Constancy	E			Constancy
Number of relevé	168	169	170	171	172	176	177	178		191	192	193	
All. Koelerion glaucae													
Koeleria glauca	.	.	.	.	.	.	.	.	.	2	1	2	3
Astragalus arenarius	.	.	.	.	.	.	.	.	.	+	.	+	2
Silene otites	.	.	.	.	.	.	.	.	.	+	.	.	1
Jovibarba globifera	.	.	.	.	.	.	.	.	.	.	.	.	.
All. Plantagini-Festucion													
Armeria vulgaris	2	1	.	2	.	1	1	.	IV	+	+	1	3
Dianthus deltoides	.	.	.	.	.	.	+	.	I	.	.	.	.
Artemisia campestris	1	1	.	2	.	.	1	+	IV	1	1	1	3
Phleum phleoides	2	+	1	2	1	1	1	1	V	.	.	.	.
Viscaria vulgaris	2	2	.	+	.	.	1	.	III	.	.	.	.
Festuca trachyphylla	.	.	.	.	.	.	2	.	I	.	.	.	.
Veronica spicata	.	.	.	.	.	.	.	.	.	.	1	+	2
O. Festuco-Sedetalia													
Trifolium arvense	.	.	.	.	.	.	.	.	.	.	+	+	2
Cerastium arvense	.	.	.	.	.	+	+	+	II	.	.	.	.
Hylotelephium triphyllum	.	.	.	.	.	.	1	.	I	.	.	.	.
Carex praecox	.	.	.	.	.	.	.	.	.	2	2	+	3
Helichrysum arenarium	.	.	.	.	.	.	.	.	.	+	+	+	3
Cl. Koelerio-Corynephoretea													
Rumex acetosella	+	+	+	1	.	.	.	.	III	+	.	+	2
Potentilla argentea	+	.	.	+	.	.	.	.	II	.	.	+	1
Brachythecium albicans-ml	.	.	.	.	.	.	.	.	.	1	+	.	2
Ceratodon purpureus-ml	.	2	.	2	.	.	2	.	II	2	2	.	2

Table 2 (continuation)

TWINSPAN group	A	Constancy	B	Constancy	C	Constancy	D	Constancy	E	Constancy
Number of relevé	194 195 196 197 201 202 207 782 784		165 166 167 179 180 181 182 183 184 185 186 208 781 783 785		187 188 189 190 198 199 200 203 204 205 206 209 780		168 169 170 171 172 176 177 178		191 192 193	
Sedum acre	. . . .	.	. . . . + . + .	I	1 + + + + + 1 + . 1 + + 1	V	+ . . + ...	II	. . .	.
Arenaria serpyllifolia	. . . + ...	I	. . . .	.	+ + + 1 . + + ...	III	. . . .	.	. . .	.
Thymus serpyllum	. . . .	.	. . . .	.	. . . . 2 . . . 2	I	+ + + + . . + .	IV	. . 2	1
Jasione montana	 1	I	. . . . +	I	. . . . . + + . . . 1 . .	II	+ + . 1	II	. + +	2
Cladonia fimbriata-ml	. . . .	.	. . . .	.	1 . . . + + ...	II	. 2 . 1	II	+ + 2	3
Tortula ruralis-ml	. . . . . . + . .	I	. . . .	.	. . . . . + 2 2 . . . . +	II	. . . + ...	I	+ + 2	3
Veronica verna	. . . .	.	. . . .	.	+ + + ...	II	. . . .	.	2 . .	1
Polytrichum piliferum-ml	. . . .	.	. . . .	.	. + 1 + . . . 1	II	. . . .	.	. + .	1
Acinos arvensis	. . . .	.	. . . .	.	. + + ... + ...	II	. . . .	.	. + .	1
Racomitrium canescens-ml	. . . .	.	. . . .	.	. . . . 1	I	. . . .	.	+ + .	2
Dicranum scoparium-ml	. . . .	.	. . . .	.	+	I	. . . .	.	. . .	.
Peltigera rufescens-ml	 3	I	. . . .	.	. . + ...	I	. + ...	I	. . .	.
Potentilla impolita	. . . .	.	. . . .	.	1 . . . . + ...	I	. . . .	.	1 . +	2
Cladonia furcata-ml	. . . .	.	. . . .	.	. . . . + ...	I	. . . .	.	. . .	.
Cladonia coniocraea-ml	. . . .	.	. . . .	.	. . . . . + ...	I	. . . .	.	. . .	.
Cladonia gracilis-ml	. . . .	.	. . . .	.	. . . . 2 + ...	I	. . . .	.	. . .	.
Sedum album	. . . .	.	. . . .	.	. . . . 2 .	I	. . . .	.	. . .	.
Cladina species-ml	. . . .	.	. . . .	.	 2	I	. . . .	.	. . +	1
Sedum spurium	. . . .	.	. . . .	.	. . . . +	I	. . . .	.	. . .	.
Cardaminopsis arenosa	. . . . +	I	. . . . + +	I	. . . .	.	. . . .	.	. . .	.
Herniaria glabra	. . . . +	I	. . . .	.	. . . .	.	. . . .	.	. . .	.
Cerastium semidecandrum	. . . + ...	I	. . . .	.	. . . .	.	. . . + ...	I	. . .	.
O. Brometalia, Cl. Festuco-Brometea										
Poa angustifolia	2 : 2 . 2 1 2 3 2	V	. . . + 2 2 2 2 3 − 2 2 2 . 2	IV	1 + . + + 2 + 1 1 2 2 2 2	V	. . 2 + . 2 . .	II	+ 2 1	3
Pimpinella saxifraga	+ + 1 + . 1 1 . .	IV	. . . 1 + . + + + 2 + . 1 . .	III	. . . . + + . . 1 + 2 . +	III	+ . + + . + + +	IV	+ + .	2

Table 2 (continuation)

TWINSPAN group	A									Constancy	B															Constancy	C													Constancy	D								Constancy	E			Constancy
Number of relevé	194	195	196	197	201	202	207	782	784		165	166	167	179	180	181	182	183	184	185	186	208	781	783	785		187	188	189	190	198	199	200	203	204	205	206	209	780		168	169	170	171	172	176	177	178		191	192	193	
Plantago media	+	.	.	.	.	.	.	.	.	I	.	.	.	+	1	1	+	.	1	+	.	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	I	.	.	.	.
Potentilla arenaria	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I	+	+	+	+	.	.	+	+	IV	.	.	.	.
Galium verum	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	2	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	1	1	2	2	2	1	V	.	.	.	.
Carex caryophyllea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	II	1	2	1	2	+	2	2	2	V	.	.	.	.
Helictotrichon pratense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	2	2	1	1	+	1	V	.	.	.	.
Medicago falcata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	I	+	.	.	.	.	.	.	.	.	.	.	.	.	I	+	.	.	.	2	+	.	3	III	.	.	.	.
Erigeron acris	.	.	.	.	+	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	I	.	.	.	.	.	+	.	.	.	.	.	+	.	I	+	+	.	+	.	.	.	.	II	.	.	+	1
Primula veris	.	.	.	.	+	.	.	.	.	I	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pulsatilla patens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1
Anthyllis vulneraria	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	I	.	.	.	.
Trifolium montanum	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	+	.	.	II	.	.	.	.
Campanula glomerata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1
All. Cynosurion																																																					
Agrostis tenuis	2	2	.	1	.	2	+	2	3	IV	4	2	2	.	.	+	2	2	2	2	1	.	2	3	3	V	+	.	.	.	.	+	+	+	+	.	.	.	1	III	.	.	1	1	+	+	1	.	IV	.	.	+	1
Anthoxanthum odoratum	1	+	.	+	.	+	.	+	.	III	.	+	.	.	.	.	+	1	.	.	.	.	+	1	.	II	+	+	.	.	.	.	.	.	.	.	.	.	.	I	1	.	.	.	.	.	+	.	II	.	.	.	.
Briza media	2	.	.	1	.	3	.	.	.	II	.	.	.	.	+	.	2	+	2	2	+	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	+	+	.	III	.	.	.	.
Trifolium repens	.	.	2	2	1	+	2	.	.	III	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	I	.	.	.	.	.	.	.	.	.	.	.	1	.	I	.	.	.	.	.	.	+	.	I	.	.	.	.
Prunella vulgaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
All. Arrhenatherion																																																					
Knautia arvensis	1	2	1	2	+	1	2	+	.	V	.	.	.	1	1	1	.	+	+	+	+	1	+	.	.	IV	.	.	.	.	1	.	2	.	+	+	+	.	.	II	+	+	+	+	+	1	+	+	V	+	1	+	3
Potentilla anserina	.	.	.	.	.	.	+	1	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Arrhenatherum elatius	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	+	1	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	+	.	.	1
Campanula patula	.	.	.	.	+	+	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Festuca pratensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	1	.	+	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table 2 (continuation)

TWINSPAN group	A									Constancy	B															Constancy	C													Constancy	D								Constancy	E			Constancy
Number of relevé	194	195	196	197	201	202	207	782	784		165	166	167	179	180	181	182	183	184	185	186	208	781	783	785		187	188	189	190	198	199	200	203	204	205	206	209	780		168	169	170	171	172	176	177	178		191	192	193	
O.Arrhenatheretalia																																																						
Galium album	2	+	2	2	2	.	2	.	.	IV	2	.	+	2	.	+	+	+	+	.	+	3	.	+	+	V	+	.	1	.	1	1	2	+	1	1	1	1	+	V	+	+	2	.	+	+	.	+	IV	+	+	.	2
Anthriscus sylvestris	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Heracleum sibiricum	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lotus corniculatus	.	.	.	.	.	.	.	+	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	I	.	1	+	.	.	1	.	.	II	.	.	.	.
Leucanthemum vulgare	.	.	.	.	.	.	+	+	.	II	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	I	+	.	.	.	.	.	+	.	.	+	.	+	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.
Alchemilla vulgaris	.	.	.	.	.	+	+	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Helictotrichon pubescens	.	.	.	.	.	.	.	.	.	.	1	+	.	2	.	+	.	1	1	.	2	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Medicago lupulina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Leontodon autumnalis	.	.	+	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cl. Molinio-Arrhenatheretea																																																						
Achillea millefolium	2	2	2	+	+	+	+	+	1	V	+	+	+	+	2	1	1	+	+	+	+	1	1	1	+	V	+	.	.	.	2	+	+	+	2	1	1	2	+	IV	+	.	+	.	.	+	+	.	III	.	.	+	1
Festuca rubra	2	1	+	1	1	1	2	2	1	V	+	2	3	2	2	1	2	+	.	2	2	2	2	2	.	V	2	1	.	1	.	.	1	+	.	1	+	1	1	IV	+	.	1	.	+	.	.	2	III	.	.	.	.
Plantago lanceolata	+	+	.	+	+	1	.	1	.	IV	.	.	.	+	+	.	.	+	+	+	.	+	+	.	.	III	.	.	.	.	.	.	.	+	.	.	.	1	.	I	.	.	.	+	+	1	+	+	IV	.	.	.	.
Dactylis glomerata	.	.	.	.	+	+	1	.	.	II	2	–	.	+	2	3	2	2	1	1	+	+	.	+	+	V	1	+	1	.	.	+	.	.	1	.	.	+	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.
Vicia cracca	+	.	1	+	+	+	1	+	.	V	.	.	1	+	.	+	+	–	+	.	+	3	.	.	+	IV	.	.	.	.	.	.	.	.	.	.	.	.	+	I	.	.	+	.	1	2	.	.	II	.	.	.	.
Veronica chamaedrys	+	+	2	+	+	+	.	+	+	V	.	.	.	+	.	.	+	+	+	.	.	+	.	+	+	III	.	.	.	.	1	+	+	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.
Stellaria graminea	+	.	+	.	.	.	.	.	.	II	.	.	+	.	+	+	+	+	+	.	+	+	+	.	.	IV	+	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	+	.	+	.	.	.	II	.	.	.	.
Phleum pratense	.	.	.	.	+	+	.	+	.	II	.	+	.	1	1	1	+	2	.	+	.	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Taraxacum officinale	.	.	1	+	.	.	.	.	.	II	.	.	.	+	.	.	1	2	2	+	.	+	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Poa pratensis	.	.	.	.	.	.	+	.	.	I	.	+	.	2	1	1	.	+	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	1	.	.	2	II	.	.	.	.
Rumex acetosa	+	+	+	.	.	.	.	.	.	II	.	.	+	.	.	.	+	+	.	+	.	.	.	.	.	II	.	.	.	.	+	.	.	.	.	.	.	.	+	I	.	.	.	.	.	.	.	.	.	.	.	.	.
Holcus lanatus	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Centaurea jacea	.	.	.	.	.	+	+	.	.	II	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	+	I	.	.	.	.	.	.	.	.	.	.	.	.	.

Table 2 (continuation)

TWINSPAN group	A									Constancy	B															Constancy	C													Constancy	D								Constancy	E			Constancy
Number of relevé	194	195	196	197	201	202	207	782	784		165	166	167	179	180	181	182	183	184	185	186	208	781	783	785		187	188	189	190	198	199	200	203	204	205	206	209	780		168	169	170	171	172	176	177	178		191	192	193	
Ranunculus acris	.	+	+	1	+	2	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	I	.	.	.	.	.	.	2	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.
Cerastium holosteoides	.	.	+	+	+	+	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.
Lathyrus pratensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	I	.	.	.	.
Trifolium pratense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Leontodon hispidus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
O.Origanetalia, Cl. Trifolio-Geranietea																																																					
Senecio jacobaea	.	.	+	+	1	+	1	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	.	+	1	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.
Fragaria vesca	2	1	2	1	.	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.
Hypericum perforatum	.	.	.	.	.	.	.	.	.	.	2	+	+	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	+	.	.	.	.	I	+	1	.	+	.	+	+	.	IV	.	.	.	.
Peucedanum oreoselinum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	I	.	.	.	.
Fragaria viridis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	.	.	II	.	.	.	.
Silene nutans	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	1	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	+	.	.	I	+	.	.	1
Seseli libanotis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	2
Melampyrum polonicum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	1	I	.	.	.	.	.	.	.	.	.	.	.	.	.
O.Nardetalia, Cl. Calluno-Ulicetea																																																					
Thymus ovatus	+	.	.	.	.	.	.	+	.	II	.	.	.	+	+	.	2	1	2	1	.	.	3	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	2	I	.	.	.	.	.	.	.	.	.	.	.	.	.
Luzula campestris	+	+	1	+	1	2	.	.	.	IV	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	I	.	.	.	.	.	+	.	.	.	.	.	.	.	I	.	+	+	.	.	.	.	.	II	.	.	.	.
Viola canina	2	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	I	.	.	.	.	1	1	.	.	+	.	.	.	.	II	.	.	.	.	.	+	.	.	I	.	.	.	.
Nardus stricta	.	.	.	.	.	1	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sieglingia decumbens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	I	+	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.
Polygala vulgaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	2	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.
Calluna vulgaris	.	.	.	.	.	.	.	+	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	I	.	.	.	.
Carex pilulifera	.	+	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.
Luzula multiflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table 2 (continuation)

TWINSPAN group	A									Constancy	B															Constancy	C													Constancy	D								Constancy	E			Constancy
Number of relevé	194	195	196	197	201	202	207	782	784		165	166	167	179	180	181	182	183	184	185	186	208	781	783	785		187	188	189	190	198	199	200	203	204	205	206	209	780		168	169	170	171	172	176	177	178		191	192	193	
Other species																																																						
Rumex thyrsiflorus	.	+	+	.	1	+	.	1	+	IV	.	+	.	.	2	1	+	+	+	.	.	+	.	1	+	IV	.	.	.	.	1	+	+	+	.	+	+	+	.	III	.	.	.	.	.	.	.	.	.	1	.	.	1
Pilosella officinarum	.	2	.	3	1	.	+	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	I	2	.	.	.	1	+	.	.	2	2	2	3	2	IV	.	.	.	.	.	.	2	.	I	+	+	1	3
Rhytidiadelphus squarrosus-ml	2	4	4	3	.	2	.	4	2	IV	.	.	.	.	.	.	3	+	+	.	.	.	.	.	2	II	.	.	+	.	.	.	2	+	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.
Geum hispidum	+	+	+	.	+	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Vicia angustifolia	+	+	.	.	+	.	+	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	1	.	+	+	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.
Ranunculus polyanthemos	.	.	.	.	1	+	2	.	.	II	.	.	.	1	1	+	1	+	1	.	.	.	.	.	.	III	.	.	.	.	.	.	+	.	.	.	.	.	.	I	.	.	+	.	+	+	.	.	II	.	.	.	.
Berteroa incana	.	.	.	.	+	.	.	.	.	I	.	.	.	.	.	+	.	.	+	.	.	.	+	.	.	II	.	+	+	+	+	+	.	+	+	+	+	.	.	IV	.	.	.	.	.	.	.	.	.	+	.	.	1
Calamagrostis epigeios	.	1	.	.	.	.	.	.	.	I	+	.	.	.	.	.	.	.	.	.	2	+	.	.	.	II	.	+	1	1	1	1	+	.	2	1	.	.	1	IV	.	+	+	.	.	.	+	+	III	+	+	1	3
Thuidium abietinum-ml	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	2	2	1	.	2	+	1	1	IV	.	.	.	.	.	.	1	.	I	.	.	1	1
Viola arvensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	+	.	+	.	.	.	+	1	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.
Solidago virgaurea	+	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	+	.	.	+	+	.	IV	.	.	.	.
Equisetum hyemale	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	+	+	.	III	.	.	.	.
Equisetum arvense	1	.	.	.	1	.	.	.	.	II	.	+	+	.	.	.	.	.	.	.	.	+	+	.	.	II	.	.	.	.	.	.	.	.	.	.	.	+	.	I	.	.	+	.	.	.	.	+	II	.	.	.	.
Carex hirta	+	.	.	.	.	+	.	.	.	II	.	.	.	2	+	+	.	.	.	.	.	.	+	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	I	+	.	.	1
Plagiomnium cuspidatum-ml	2	+	.	.	.	+	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	I	.	.	.	.	.	+	.	.	.	.	.	1	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.
Pleurozium schreberi-ml	3	+	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	I	.	.	.	.	4	1	.	.	2	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.
Peltigera canina-ml	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	.	.	1	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.
Erigeron canadensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.
Bryum species-ml	.	.	.	.	2	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	I	.	.	.	.	.	2	.	.	.	.	.	1	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.
Galium boreale	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	.	+	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1
Elytrigia repens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	.	.	.	.	.	.	.	.	+	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	I	.	.	.	.

Table 2 (the end)

TWINSPAN group	A									Constancy	B															Constancy	C													Constancy	D								Constancy	E			Constancy
Number of relevé	194	195	196	197	201	202	207	782	784		165	166	167	179	180	181	182	183	184	185	186	208	781	783	785		187	188	189	190	198	199	200	203	204	205	206	209	780		168	169	170	171	172	176	177	178		191	192	193	
Vicia tetrasperma	.	.	.	.	+	.	.	.	.	I	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	I	.	.	.	.
Festuca ovina	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	1	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	I	.	+	+	2
Phleum nodosum	+	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	1	.	2	.	.	.	.	.	.	I	.	.	.	.	.	+	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.
Populus tremula	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	I	+	.	.	1	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	+	1
Melandrium album	.	.	.	.	+	.	+	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.

Sporadic species

Aegopodium podagraria 1 (186), *Alchemilla glaucescens* + (184), 1 (185), *Anchusa officinalis* + (200), *Anthyllis* x *baltica* 1 (177), *Artemisia vulgaris* + (208), *Atrichum undulatum*-ml + (186), *Brachythecium starkei*-ml 2 (180, 184), *Calliergonella cuspidata*-ml 1 (183), *Campanula rotundifolia* + (204), *Climacium dendroides*-ml 1 (199), *Convolvulus arvensis* + (782, 200), *Daucus carota* + (209), *Euphrasia parviflora* + (202), *Hieracium species* + (195), *Hypericum maculatum* + (780), *Hypochoeris radicata* + (197), *Linaria vulgaris* + (198, 204), *Myosotis arvensis* + (199), *Oenothera biennis* + (191, 192), *Ononis arvensis* 2 (170), *Peltigera didactyla*-ml 2 (203, 205), *Plagiomnium affine*-ml 1 (184), + (185), *Plagiomnium undulatum*-ml 1 (184), + (185), *Poa compressa* 1 (192), *Polytrichum juniperinum*-ml + (201), 2 (203), *Potentilla reptans* + (188), 1 (190), *Quercus robur* + (178, 780), *Ranunculus repens* 1 (782), *Rosa species* + (188, 190), *Saponaria officinalis* + (783), *Silene vulgaris* + (179, 181), *Tanacetum vulgare* 1 (165), 2 (167), *Thalictrum flavum* + (183, 185), *Verbascum nigrum* + (198, 205), *Veronica arvensis* + (208), *Veronica officinalis* + (198), *Viola* x *baltica* 1 (195), + (197).

Localities of relevés

165-167 – Ventspils, northwestern part of the airfield next to the ruins of an individual house, dry grassland
168-178 – Saulkalne, next to the railway between Saulkalne and Ikšķile, 2 km from the railway station Ikšķile next to the individual farm Bulstrumi, an old sand pit.
179-185 – Mālupe, flood plain of the right bank of the Pededze River near the bridge, 300 m to SE from the individual farm Lejmalas, dry grassland
186-190 – Daugavpils, 2 km to N from the railway station Mežciems, a railway embankment
191-193 – Daugavpils, 0.5 km to S from the railway station Kūdraine, a railway embankment
194-207 – Dzelzāmurs, the left bank of the Misa River next to the individual farm Krastiņi, dry grassland
208,209 – Vecumnieki, 2.5 km to NE from Vecumnieki next to soldiers'graves, dry grassland
780-782 – Valgunde, 4 km to NE from Valgunde next to the individual farm Ziediņi, dry grassland
783-785 Brankas, the right bank of the Iecava River, 3.5 km to SE from Brankas next to the individual farm Zemdari, dry grassland

Table 3

Site parameters for vegetation relevés in the Table 2 (number of relevé corresponds with the number of relevé in the Table 2)

Relevé number	Relevé area (m^2)	Aspect (degrees)	Slope (degrees)	Cover herb layer (%)	Cover moss layer (%)	Number of species	Date (year/ month/day)
TWINSPAN group A							
194	4.00	–	0	80	80	31	20000802
195	4.00	–	0	75	70	31	20000802
196	4.00	–	0	90	75	22	20000802
197	4.00	–	0	85	50	27	20000802
201	4.00	–	0	85	8	33	20000802
202	4.00	–	0	95	15	30	20000802
207	9.00	–	0	90	1	26	20000802
782	9.00	–	0	75	55	23	20020723
784	9.00	–	0	50	55	14	20020730
TWINSPAN group B							
165	25.00	–	0	70	0	19	19970717
166	25.00	–	0	85	0	19	19970717
167	9.00	–	0	80	0	16	19970717
179	4.00	–	0	90	0	23	20000816
180	4.00	–	0	85	15	23	20000816
181	4.00	–	0	95	0	22	20000816
182	4.00	–	0	95	45	27	20000816
183	4.00	–	0	98	5	30	20000816
184	4.00	–	0	100	35	32	20000816
185	4.00	–	0	100	1	25	20000816
186	4.00	360	65	60	1	24	20000720
208	4.00	–	0	95	3	27	20000802
781	9.00	–	0	85	35	27	20020723
783	6.00	–	0	80	60	16	20020730
785	4.00	180	1	70	30	23	20020730
TWINSPAN group C							
187	4.00	180	60	50	15	30	20000720
188	3.00	180	60	45	5	24	20000720
189	3.00	180	60	55	5	28	20000720
190	6.00	180	60	50	5	20	20000720
198	4.00	–	0	80	70	31	20000802
199	4.00	–	0	70	60	36	20000802

Table 3 (the end)

Relevé number	Relevé area (m²)	Aspect (degrees)	Slope (degrees)	Cover herb layer (%)	Cover moss layer (%)	Number of species	Date (year/month/day)
200	4.00	–	0	80	55	25	20000802
203	4.00	180	4	65	65	24	20000802
204	9.00	–	0	70	20	31	20000802
205	6.00	–	0	75	40	22	20000802
206	9.00	–	0	70	30	21	20000802
209	4.00	–	0	90	20	25	20000802
780	9.00	–	0	60	35	25	20020723
TWINSPAN group D							
168	9.00	180	5	45	0	24	19990715
169	9.00	180	10	50	25	25	19990715
170	4.00	180	15	75	0	27	19990715
171	4.00	225	15	60	15	25	19990715
172	4.00	180	10	85	0	17	19990715
176	4.00	225	5	80	0	28	19990715
177	4.00	135	15	60	15	30	19990715
178	4.00	135	15	65	0	17	19990715
TWINSPAN group E							
191	3.00	135	15	50	18	28	20000720
192	3.00	135	1	35	12	26	20000720
193	3.00	135	1	50	30	27	20000720

In our opinion, these differences are not so significant and group C can be assigned to the Ass. Diantho-Armerietum, but further investigations are needed to create a more detailed classification. It could turn out to be some geographical variant, because also Krausch (1968) emphasizes that moving to the east to more continental climate this association becomes more mesophilous and Pott (1995) mentions several geographical races differing by spectra of floristic elements.

Group D includes relevés from only one locality (Saulkalne). This group is distinguished with several xerothermophilous species of the Cl. Festuco-Brometea (*Helictotrichon pratense*, *Carex caryophyllea*, *Phleum phleoides*, *Medicago falcata*) occuring only in this locality. Dominants are mentioned species, in places also *Poa angustifolia*, *Viscaria vulgaris* and *Calamagrostis epigeios*. Species *Potentilla arenaria* and *Phleum phleoides*, often classified as the character species of the O. Festucetalia valesiacae (Matuszkiewicz 1981; Mucina et al. 1993), indicate the continental character of this plant community.

Syntaxonomically the group represents typical transitional plant community of xerothermophilous calcareous grasslands (Cl. Festuco-Brometea) and xerophilous sandy habitat vegetation (Cl. Koelerio-Corynephoretea). Nevertheless, the group should be assigned to the Cl. Koelerio-Corynephoretea, All. Plantagini-Festucion, because the character species of the alliance *Dianthus deltoides*, *Artemisia campestris*, *Phleum phleoides* and *Viscaria vulgaris* (Dierssen 1996, Pott 1995, Matuszkiewicz 1981), are with high constancy and cover. This group bears some similarities with the communities of the Ass. Armerio-Festucetum veronicetosum spicatae described in Bavaria (Hohenester 1960) which also includes species of the Cl. Festuco-Brometea – *Helictotrichon pratense*, *Phleum phleoides*, *Galium verum* etc.

Group E includes only 3 relevés from the Daugavpils-Kūdraine locality. Both TWINSPAN classification and DECORANA ordination showed that groups D and E are similar by floristic composition and ecology (Fig.3, Table 2). Species with continental distribution like *Koeleria glauca*, *Silene otites*, *Astragalus arenarius*, *Helichrysum arenarium* indicate that this site possesses specific edaphic and microclimatic conditions promoting development of plant communities characteristic for more continental regions to the southeast from Latvia.

Syntaxonomically group E is assigned to the Cl. Koelerio-Corynephoretea, O. Festuco-Sedetalia, All. Koelerion glaucae because relevés encounter the character species of the alliance *Silene otites*, *Astragalus arenarius* and *Koeleria glauca*. Also *Helichrysum arenarium*, *Veronica spicata*, *Carex praecox* and *Pulsatilla patens* are species representing plant communities with continental features. Some of these continental species (*Helichrysum arenarium*, *Silene otites*), are described to occur in the more continental part of the Ass. Armerio-Festucetum helichrysetosum arenarii described by Hohenester (1960) in Bavaria.

Synecology

Relevé groups separated on the floristic background can be easily interpreted ecologically. First axis of DECORANA ordination (explains 36% of variation, $\lambda = 0.65$) can be interpreted as fertility gradient where fertility decreases from the left to the right side of the diagramm (Fig.3.). The vegetation gradient associated with the second axis (explains 28% of variation, $\lambda = 0.51$) reflects a trend from more fresh soils (high scores on the axis) to dry soils. This axis is associated also with stability of substrate. Relevés collected in stable grassland habitats with well developed sod (Dzelzāmurs, Mālupe) have low scores on the axis 2. Relevés collected in highly unstable habitats both in strongly eroded places (Saulkalne, Daugavpils-Mežciems) and in habitats disturbed by natural (Brankas – extreme dryness) and anthropogenic ((Daugavpils-Kūdraine - regular burning) factors have high scores on the axis 2. On the whole relevés within groups are rather heterogeneous.

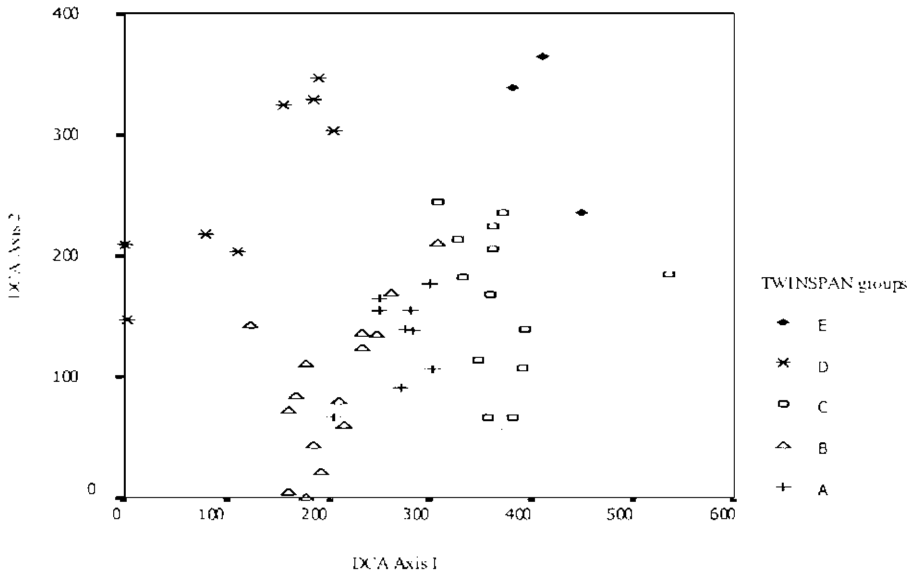

Fig.3. DECORANA ordination of relevés

The relationship between vegetation and soils, suggested by Ellenberg values indicates that communities growing in relatively drier soils (Groups D and E) are less fertile but with higher soil reaction (Table 4) and with more continental character. The last is reflected also by spectrum of species phytogeographical elements (Fig.4., 5., 6.). Groups C, D and E belonging to the Cl. Koelerio-Corynephoretea have slightly higher number of species with subcontinental and continental distribution area. Groups A and B belonging to the Cl. Molinio-Arrhenatheretea encounter more polizonal weakly oceanic species.

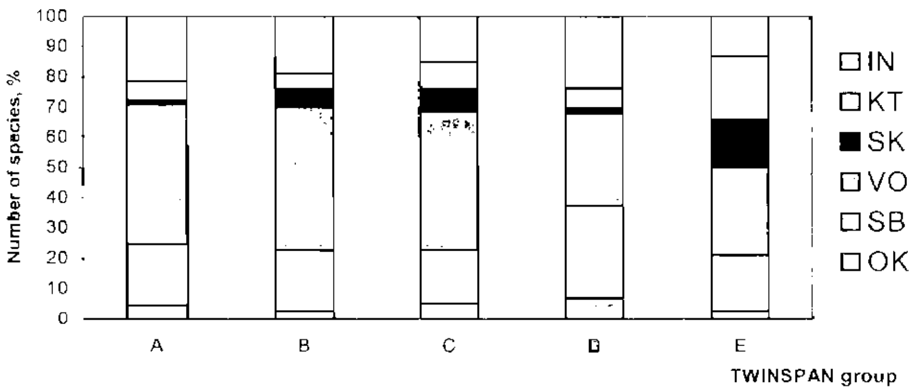

Fig.4. Species continentality group spectra. IN – indifferent, KT – continental, SK – subcontinental, VO – weakly oceanic, SB – suboceanic, OK – oceanic

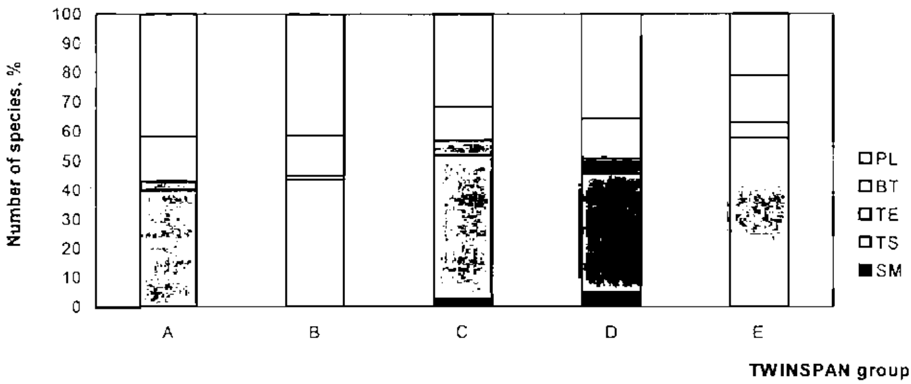

Fig.5. Species zonality group spektra. PL – polizonal, BT – boreo-temperate, TE – temperate, TS – temperate-submeridional, SM – submeridional

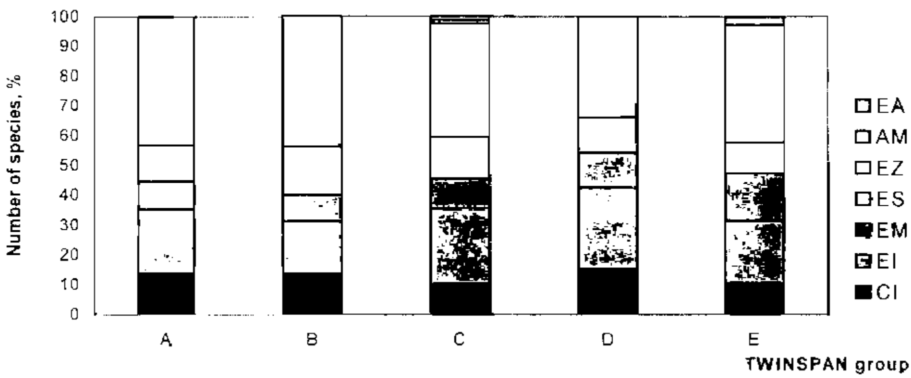

Fig.6. Species sectorality group spektra. AM American, EZ – Eurasian, ES – Eurosiberian, EM – European-Asian Minor, EI – European, CI – Circumpolar

Table 4

Ellenberg indicator values of edaphic and climatic factors for phytosociological groups

Factor	TWINSPAN group				
	A	B	C	D	E
Light	7.2	7.2	7.5	7.3	7.9
Continentality	4.0	4.2	4.2	4.4	5.0
Moisture	4.2	4.1	3.5	3.5	2.9
Reaction	4.4	4.8	4.5	6.0	5.4
Nitrogen	3.5	3.8	2.9	2.8	2.6
Temperature	4.2	4.7	4.8	5.1	5.8

Soils

Soil physical properties were rather similar in both profiles. Dominating soil particle fraction was fine sand constituting 77–95% of all contents in different soil horizons. Saulkalne profile had slightly higher amount of coarse soil particles while Dzelzāmurs profile had higher percentage of fine soil particles (Table 5).

Table 5

Particle size distribution, % (particle fractions after Kachinsky 1958)

Soil horizon	Depth, cm	Soil particle fractions							
		Fine gravel	Sand			Silt			Clay
			Coarse	Medium	Fine	Coarse	Medium	Fine	
		3–1 mm	1–0.5 mm	0.5–0.25 mm	0.25–0.05 mm	0.05–0.01 mm	0.01–0.005 mm	0.005–0.001 mm	<0.001 mm
Profile I Saulkalne									
A_h	0–8	1.53	0.76	4.91	81.15	2.15	2.38	2.76	3.03
A_1B_t	8–27	0.68	0.73	0.75	77.84	8.96	2.45	5.12	2.92
B	27–55	0.00	0.00	0.00	92.04	2.28	0.70	1.71	2.43
BC	55–82	0.00	0.00	0.00	94.39	1.43	0.30	1.45	2.03
C	82–110	0.00	0.00	0.00	92.23	0.67	1.91	0.26	0.78
Profile II Dzelzāmurs									
A_h	0–25	0.00	0.48	3.41	80.53	8.47	0.76	1.40	2.59
B_{thg}	25–42	0.39	0.33	0.52	84.56	8.72	0.78	1.15	1.39
BC_g	42–60	0.00	0.00	0.00	91.98	2.78	2.12	1.72	0.40
C_g	60–90	0.00	0.41	0.38	94.36	0.63	0.02	0.40	3.01

Differences in chemical properties of soils were more pronounced (Table 6). The top soil of the Saulkalne profile representing communities of xerothermophilous Festuco-Brometea and xerophilous Koelerio-Corynephoretea vegetation was less acid than that of the Dzelzāmurs profile representing mesophilous Molinio-Arrhenatheretea communities.

Distinctive feature of the Saulkalne profile is higher amount of Ca and Mg ions and two times higher base saturation. It can be explained by the influence of regular burning on the top soil because these differences are not evident in deeper soil horizons.

Table 6

Chemical properties of soils

Soil horizon	Depth, cm	pH_{H_2O}	pH_{KCl}	Hydrolytic acidity cmol(+) kg^{-1}	Exchangeable bases cmol(+) kg^{-1}	Base saturation, %	Ca, mg kg^{-1}	Mg, mg kg^{-1}	K_2O, mg kg^{-1}	P_2O_5, mg kg^{-1}	Organic C, %	N, %
Profile I Saulkalne												
A_h	0–8	5.9	5.6	2.4	4.2	63.7	384	122	81	21	2.1	0.13
A_1B_h	8-27	5.5	4.9	1.8	0.5	21.6	194	61	22	12	1.0	–
B	27–55	5.3	4.7	1.8	0.5	21.6	93	7	16	79	0.4	–
BC	55–82	5.5	4.9	1.4	0.5	26.8	44	4	19	66	0.3	–
C	82–110	5.6	5.0	0.9	0.5	35.5	42	4	22	51	0.3	–
Profile II Dzelzāmurs												
A_h	0–25	5.2	4.7	4.7	2.0	30.5	275	51	80	137	2.1	0.14
B_{1hg}	25–42	5.4	4.9	2.8	1.0	26.8	126	5	54	68	0.9	–
BC_g	42–60	5.4	5.0	1.8	0.5	21.6	42	6	24	31	0.4	–
C_g	60–90	5.5	5.0	1.4	0.5	26.8	34	11	23	28	0.3	–

DISCUSSION

Plant communities and synecology

Results show that in Latvia, *A.vulgaris* occurs in two anthropogenic strongly influenced habitat types – dry semi-natural grasslands and on railway embankments. The species is present both in the communities of the Cl. Molinio-Arrhenatheretea and in the Cl. Koelerio-Corynephoretea.

Nevertheless, *A.vulgaris* has its ecological optimum in the All. Plantagini-Festucion of the Cl. Koelerio-Corynephoretea. It is proved by the fact that TWINSPAN groups A and B, although belonging to the mesophilous grasslands by overall floristic composition, encounter several species restricted to dry sandy habitats suggesting that these communities are a transition stage between mesophilous and xerophilous grasslands.

These data are consistent with sociological behavior of *A.vulgaris* in the central part of its distribution area. The main distribution area of *A.vulgaris* lies within Central Europe – northern part of Germany and Poland. Primary habitats for the species there are gray dunes and sandy terraces in valleys of large rivers, secondary it grows in antropogenic habitats which support plant communities of the All. Plantagini-Festucion – open sands, fallow-lands, railway embankments and road verges. Young still developing soils which warms up and dry out readily and are medium to weakly acid with high base saturation are common for all these habitats (Pott 1995; Matuszkiewicz 1981; Krausch 1968).

Ass. Sileno-Festucetum Libb. 1933 and Diantho-Armerietum Krausch 1959 are the main associations where *A.vulgaris* is represented. These associations are by some authors merged into the Ass. Armerio-Festucetum trachyphyllae (Libb. 1933) Knapp 1948 ex Hohenester 1960 (Oberdorfer 1978; Pott 1995; Rodi 1974). Another association but occuring more to the south (in Czech Republic) is Erysimo diffusi-Agrostietum capillaris Vicherek 1997 which is floristically very close to the Diantho-Armerietum but with some phytogeographical peculiarities (Chytry et al. 1997).

All the menitioned associations have the same feature – the character species both of the Cl. Festuco-Brometea and the Cl. Koelerio-Corynephoretea participate in plant community with the equal importance (Kovář 1980, Rodi 1974, Pott 1995). This is why the Alliance Plantagini-Festucion is classified into the Cl. Koelerio-Corynephoretea by some authors (Pott 1995; Passarge 1964; Dierssen 1994) but others assign it to the Cl. Festuco-Brometea (Oberdorfer 1978; Ellenberg 1996).

Such a regularity is observed also in the current research in TWINSPAN groups C, D, and E which are classified as the All. Plantagini-Festucion communities. Consequently, this feature of the alliance maintains also in the periphery of its distribution area and this emphasizes that this alliance includes typical contact communities of xerothermophilous calcareous and xerophilous sandy grasslands.

Stability of localities and implications for conservation

Localities of *A.vulgaris* concentrate in two regions in Latvia – in the central part of Central Latvia and in the surroundings of Daugavpils town in southern Latvia. Only two localities are known from other regions – in the surroundings of Ventspils town in the Coastal Lowland and in Alūksne Upland near Mālupe.

Majority of localities are recorded in the period from 1950 to 1999. Up to 1992 only 7 localities were known (Фатаре (ред.) 1978; Baroniņa, Lodziņa 1992) but others were registered in the last ten years. This fact gives indirect proof of the spreading of the species during the last decade. Up to now, no case of extinction of localities is known.

Regarding geographical position of localities, it is worth to mention that almost all localities are located in the surroundings of large towns (Rīga, Ventspils, Daugavpils) and are situated in river valleys – the Daugava and the Lielupe with its tributaries the Iecava and the Misa and one locality in the Pededze River valley. Possibly, these rivers are the migration routes for *A.vulgaris* both because of suitable habitats which are more abundant along the coasts of rivers than outside the valleys and also it can dispers by means of water. The species has no special dispersal mechanism. The fruit can be blown by wind but it can also float buoyantly in water (Woodell, Dale 1993).

Both the history of findings of the species (recent recordings of new localities) and geographical location of the localities (close to urban areas) as well as habitat preferences (only antropogenically strongly affected habitats) suggest that the species can be regarded as meso- to euhemerob element of flora although it is believed to be oligo-mesohemerob in Central Europe (Frank, Klotz 1990). In Finland, *Armeria maritima* subsp. *intermedia* (transition form between species *A.maritima* and *A.vulgaris*) is classified as archaeophyte (Ryttäri, Lahti 1992).

Despite its good ability to survive in extreme conditions and rather good renewal abilities, *A.vulgaris* is endangered species nearly in all the distribution area and it is included into the Red Data Book of several countries (Ingelög et al. 1993; Ryttäri, Lahti 1992). It is connected mainly with reduction of habitat quality and destruction of suitable habitats (Biedermann 1998; Hohenester 1960; Woodell, Dale 1993).

A.vulgaris is a species of open habitats with weak competitive ability. Important factors for successful maintanance of the species in a site are different disturbances keeping the site open. They are mainly man's activities – mowing and grazing of dry semi-natural grasslands, moderate trampling and burning. Important are also natural disturbances – erosion and dryness (Ryttäri, Lahti 1992; Woodell, Dale 1993; Rodi 1974).

In Latvia, *A.vulgaris* is included in the category "vulnerable" (Tabaka 2001). Only 3 of all inventoried sites were still managed (but with uncertain future - one of them (Dzelzāmurs) was abandoned next year after inventory), others were abandoned for several years. Although the results of inventory show that localities are vital, the species can be endangered in the nearest future because of its specific habitat requirements. It is supposed that in anthropogenic habitats such as railway embankments the species will be more stable because management (namely burning and fixing of embankments by gravel and sand) is regular but in semi-natural habitats such as dry grasslands it will be more unstable because of abandonment of such sites. As more than half of all 18 localities are grasslands, for Latvian localities the most important factor for maintaining the species is a goal-directed management of these grasslands.

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REFERENCES

Āboliņa A. 2001. Latvijas sūnu saraksts. (List of bryophytes of Latvia). *Latvijas Veģetācija*, 3:47–87. (in Latvian with English summary).

Anon. 1998. *National report on biological diversity. Latvia.* Ministry of Environmental Protection and Regional Development. United Nations Development Programme, Riga. 48 p.

Baroniņa V., Lodziņa I. 1992. *Populārzinātniskā Latvijas Sarkanā grāmata. Augi.* (Red Data Book of Latvia. Plants.) Zinātne, Rīga, 139 lpp. (in Latvian).

Biedermann H. 1998. *Regeneration von Sandmagerrasen. Untersuchungen zur Vegetationsentwicklung nach Entbuschung, zur Diasporenbank und zur Populationsbiologie von Armeria elongata*. Diplomarbeit, Phillipps-Universität Marburg, 97 S.

Braun-Blanquet J. 1964. *Pflanzensoziologie. Grundzüge der Vegetationskunde.* Springer Verlag, Wien, New York, 865 S.

Bruun H. H., Ejrnaes R. 2000. Classification of dry grassland vegetation in Denmark. *Journal of Vegetation Science* 11 (4): 585-596

Chytry M., Mucina L., Vicherek J., Pokorny-Strudl M., Strudl M., Koó A.J., Maglocky Š. 1997. Die Pflanzengesellschaften der westpannonischen Zwergstrauchheiden und azidophilen Trockenrasen. *Dissertationes Botanicae*. Bd. 277, Berlin, Stuttgart, 167 p.

Dickmann M. 1997. The Differentiation of alliances in South Sweden. *Folia Geobotanica et Phytotaxonomica* 32: 193–205

Dierssn K. 1996. *Vegetation Nordeuropas*. Verlag Eugen Ulmer, Stuttgart, 838 S.

Dierschke H. 1994. *Pflanzensoziologie*. Verlag Eugen Ulmer, Stuttgart, 683 S.

Ejrnaes R. 1998. *Structure and processes in temperate grassland vegetation. Ph.D.-Thesis.* Ministry of Environment and Energy. National Environmental Research Institute. Copenhagen, 126 p.

Ellenberg H. 1996. *Vegetation Mitteleuropas mit den Alpen*. Ulmer, Stuttgart, 1095 S.

Ellenberg H., Weber H.E., Düll R., Wirth V., Werner W., Paulißen D. 1992. *Zeigerwerte von Pflanzen in Mitteleuropa.* Verlag Erich Goltze KG, Göttingen, 258 S.

Frank D., Klotz S. 1990. Biologisch-ökologische Daten zur Flora der DDR. *Wissenschaftliche Beiträge* 1990/32 (P 41), Martin-Luther-Universität Halle-Wittenberg, 167 S.

Gams H. 1975. Plumbaginaceae. – In Hegi G., 1975. *Illustrierte Flora von Mitteleuropa.* Bd. 5, Teil 3. Verlag Paul Parey, Berlin, Hamburg, S. 1877–1901.

Gavrilova Ģ., Šulcs V. 1999. *Latvijas vaskulāro augu flora. Taksonu saraksts*. (Flora of Latvian vascular plants. List of taxa). Latvijas Akadēmiskā bibliotēka, Rīga, 136 lpp. (in Latvian with English summary).

Hill M. O. 1979. *TWINSPAN. A FORTRAN Programm for Arranging Multivariate Data in an Ordered Two Way Table by Classification of the Individuals and Attributes*. Ecology and Systematics Cornell University Ithaca, New York, 47 p.

Hohenester A. 1960. Grasheiden und Forhrenwalder auf Diluvial- und Dolomitsanden im nordlichen Bayern. *Berichte der Bayerischen Botanischen Gesellschaft* 33: 30–85.

Hollmann H. 1972. Verbreitung und Soziologie der Schachblume *Fritillaria meleagris* L. *Abhandlungen und Verhandlungen des Naturwissenschaftlichen Vereins in Hamburg (NF)* 15, Supplement, Verlag Paul Parey, Hamburg, Berlin, 82 S.

Hulten E., Fries M. 1986. *Atlas of North European Vascular Plants. North of the Tropic of Cancer.* Koeltz Scientific Books, Federal Republic of Germany, Konigstein, vol. I, XVI+498pp, vol. II, XI+499–969 pp.

Ingelög T., Andersson R., Tjernberg M. (Eds.) 1993. *Red Data Book of the Baltic Region. Part 1. Lists of threatened vascular plants and vertebrates.* Swedish Threatened Species Unit, Uppsala in co-operation with Institute of Biology, Riga. 95 p.

Jeckel G. 1975. Die Sandtrockenrasen (Sedo-Scleranthetea) der Allerdünen bei Celle-Boye. *Mitteilungen der Floristisch-soziologischen Arbeitsgemeinschaft.* Heft 18: 103–109.

Jēkabsone M., Reinfelde L., Timbare R. 1997. *Augšņu agroķīmisko analīžu metodes. Nozares standarti.* (Methods of soil agrochemical analysis). Latvijas republikas Zemkopības ministrija, Rīga, 69 lpp. (in Latvian).

Jermacāne S. 1999. Smaržzāles-parastās smilgas sabiedrību Anthoxantho-Agrostietum tenuis Sill. 1933 em. Jurko 1969 klasifikācija un ekoloģija Latvijā (Piejūras zemiene, Austrumzemgale, Vidzemes augstiene). (Classification and ecology of Anthoxantho-Agrostietum tenuis Sill. 1933 em. Jurko 1969 in Latvia (Coastal Lowland, Eastern Zemgale, Vidzeme Upland)). *Latvijas Veģetācija* 2: 29–80 (in Latvian with English summary).

Jermacāne S. 2000. Gaujas Nacionālā parka smiltāju pļavu augu sabiedrības. (Sandy grassland plant communities in the Gauja National Park). *Jauns gadsimts – jauna ģeogrāfija. 2. Latvijas Ģeogrāfijas kongress*. Rīga, 50–53. lpp. (in Latvian).

Jermacāne S., Laiviņš M. 2001a. Dry calcareous dolomite outcrop and grassland communities on the Daugava River bank near "Dzelmes". *Latvijas Veģetācija* 4: 51–70.

Jermacāne S., Laiviņš M. 2001b. Latvijā aprakstīto augu sabiedrību sintaksonu saraksts. (List of syntaxa described in Latvia). *Latvijas Veģetācija* 4: 115–132. (in Latvian with English summary).

Kalniņa A. 1995. Klimats. (Climate). – *Latvijas Daba.* Latvijas enciklopēdija, Rīga, vol.2., 247–251.p. (in Latvian).

Kalniņa A. 1998. Sals. (Frost). – *Latvijas Daba.* Preses nams, Rīga, vol.5., 41.p. (in Latvian).

Kent M., Coker P. 1994. *Vegetation Description and Analysis. A Practical Approach.* John Wiley & Sons, England, 363 p.

Kovář P. 1980. Contribution to the syntaxonomy of the Festuca trachyphylla-grasslands. *Preslia,* Praha, 52: 217–226.

Krausch H.D. 1968. Die Sandtrockenrasen (Sedo-Scleranthetea) in Brandenburg. *Mitt. Flor. Soz. Arbeitsgemeinschaft,* N.F. 13: 71–100.

Matuszkiewicz W. 1981. *Przewodnik do oznaczania zbiorowisk roslinnych Polski. Panstwowe* Wydawnictwo Naukowe, Warszawa, 297 p.

Meusel H., Jäger E., Rauschert S., Weinert E. 1978. *Vergleichende Chorologie der Zentraleuropäischen Flora.* Gustav Fischer Verlag, Jena, Bd.II Text 418 S. Karten, 259–421 S.

Meusel H., Jäger E., Weinert E. 1965. *Vergleichende Chorologie der Zentraleuropäischen Flora.* Gustav Fischer Verlag, Jena, Bd.I, Text 583 S, Karten 258 S.

Mucina L., Grabherr G., Ellmauer T. 1993. *Die Pflanzengesellschaften Österreichs.* Teil I. Antropogene Vegetation. Gustav Fischer Verlag, Jena, Stuttgart, New York, 578 S.

Oberdorfer E. 1978. Süddeutsche Pflanzengesellschaften. Teil II. – *Pflanzensoziologie*. VEB Gustav Fischer Verlag, Jena, Bd.10, 355 s.

Passarge H. 1964. Pflanzengesellschaften des nordostdeutschen Flachlandes I. – *Pflanzensoziologie* Bd.13, 324 S.

Piterāns A. 2001. Latvijas ķērpju konspekts. (Checklist of the lichens of Latvia). *Latvijas Veģetācija* 3: 5–46 (in Latvian with English summary).

Pott R. 1995. *Die Pflanzengesellschaften Deutschlands*. Ulmer. Stuttgart. 622 S.

Rodi D. 1974. Trockenrasengesellschaften des nordwestlichen Tertiärhügellandes. *Berichte der Bayerischen Botanischen Gessellschaft.* 45: 151–172.

Ryttäri T., Lahti T. 1992. *Armeria maritima* subsp. *intermedia*, a rare archaeophyte in SE Finland: history, biology and conservation. *Annales Botanici Fennici* 29: 107–117.

Skujāns R., Mežals H. 1964. *Augšņu pētīšana*. (Soil Research). LVI, Rīga, 348 lpp.

Tabaka L. 2001. *Armeria vulgaris* Willd. – parastā armērija. – Gr. *Latvijas Sarkanā grāmata: Vaskulārie augi.* 3.sēj. Rīga, LU Bioloģijas Institūts (in press).

Woodell S.R.J., Dale A. 1993. Biological flora of the British Isles. *Armeria maritima* (Mill.) Willd. (*Statice armeria* L., *S.maritima* Mill.). *Journal of Ecology* 81: 573–588.

Качинский Н. 1958. *Механический и микроагрегатный состав почвы и методы его изучения.* (Physical properties of soils and methods for analysis). Москва, Изд-во АН СССР, 191 стр. (in Russian).

Табака Л., Гаврилова Г., Фатаре И. 1988. *Флора сосудистых растений Латвийской ССР.* (Flora of vascular plants of Latvia). Зинатне, Рига, 193 стр. (in Russian).

Фатаре И. (ред.). 1978. *Хорология флоры Латвийской ССР. Редкие виды растений группы охраны.* (Chorology of flora of Latvia. Rare species.). Рига, Зинатне, 79 стр. (in Russian).

Parastās armērijas Armeria vulgaris Willd. socioloģija Latvijā

Kopsavilkums

Parastā armērija *Armeria vulgaris* Willd. Latvijā aug uz izplatības ziemeļaustrumu robežas. 2000. gadā deviņas no 18 zināmajām *A.vulgaris* atradnēm tika inventarizētas novērtējot atradņu pašreizējo stāvokli un aprakstot sugas socioloģiju.

A.vulgaris cenopopulācijas bija vitālas un bagātīgākas nekā iepriekšējās inventarizācijās (vairumā gadījumu suga bija dominants vai kodominants). Suga Latvijā sastopama tikai sinantropos biotopos – sausos zālājos un uz dzelzceļa uzbērumiem gan klases Koelerio-Corynephoretea (Koelerion glaucae, Plantagini-Festucion), gan klases Molinio-Arrhenatheretea (Cynosurion) sabiedrībās.

Pētījuma rezultāti liecina, ka *A.vulgaris* Latvijā ir stabila suga ar tendenci izplatīties. Sugas izplatīšanos veicina cilvēka darbība – dzelzceļu un ceļu uzbērumi un sausu zālāju apsaimniekošana (ieskaitot arī dedzināšanu) rada šai sugai piemērotus biotopus, kuri dabiskos apstākļos Latvijā būtu sastopami daudz retāk.

Suga tomēr ir apdraudēta, un tai nepieciešams izstrādāt aizsardzības pasākumus, jo tās sastopamību strauji ierobežo piemērotu biotopu izzušana, kas saistīta ar sauso zālāju apsaimniekošanas pārtraukšanu.

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Pine forest plant communities in the Daugava Loki Nature Park

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Abstract

The pine forest vegetation of the Daugava Loki Nature park was described using Braun-Blanquet method in order to clarify vegetation structure and ecology of forests, where rare and protected species of Latvia occur.

Two associations typical for Latvia were described: Cladonio-Pinetum and Vaccinio vitis-idaeo-Pinetum as well as two rare communities *Convallaria majalis-Pinus sylvestris* and *Brachypodium pinnatum-Pinus sylvestris*. Species indicator values according Ellenberg standard scales show, that edaphic conditions like nitrogen content and soil reaction determine the main differences between plant communities.

Keywords: Pine forests, plant communities, Cladonio-Pinetum, Vaccinio vitis-idaeo-Pinetum, *Convallaria majalis -Pinus sylvestris*, *Brachypodium pinnatum-Pinus sylvestris*.

INTRODUCTION

Daugava Loki Nature Park is located in the Daugava River valley area between the western border of Krāslava and stretches up to Naujene in the Augšdaugava Protected Landscape Area. Its area reaches 129.9 km^2. In 1990, the nature park was established there to maintain the unique ancient landscape of the Daugava River middle course, its valuable nature complexes, plant and animal species diversity as well as the cultural and historical monuments. Characteristic natural phenomenon here is 8 large the Daugava River meanders. The length of each meander reaches 4 – 6 km, but the distance between them is only 2 – 3 km. Characteristic local names are given to them, like Adamova (Šķerskāni), Zvejnieki, Tartaka, Daugavsargi, Ververi, Rozališķi, Butišķi and Eleme meander. In the east-west direction the Daugava River valley crosses the hillocky Baltic ridge, separating Augšzeme and the Latgale Upland (Nikodemusa 1994).

The Daugava River here cuts mainly the Quaternary deposits of different thickness that are exposed at the bank fall-off. They are favoured by springs running out from the Devonian clay layers. In some places between Krāslava and Daugavpils yellow Devonian sandstone cliffs are exposed. Two km below Krāslava a large bank fall-off is exposed where a 50 cm thick layer of interglacial peat is revealed that is located between the Devonian rock and glacial debris. At the tops of the meanders, the flow has washed out high, steep basic banks but in the meanders up to 1 km wide terraces have developed whose surface is covered by gravel and pebble sand. On the terraces, humid podsolic soils have developed where large pine forest areas are situated. Forests cover about 38 % of the total area of the nature park. Mainly these are medium age pine stands with the admixture of birch and spruce in some places. The dominant forest type is *lāns* (Myrtillosa), but on richer soils *damaksnis* (Hylocomiosa) occurs. Many rare and peculiar plant species grow there. From the floristic point of view, it is one of the most valuable areas in Latvia (Fatare 1987; Nikodemusa 1994).

The Daugava River valley plays a prominent role in the origin of the Baltic flora. There are 63 phytogeographically remarkable vascular plant species which can be divided into 6 groups: 1) species that occur only in the Daugava River valley; 2) species that occur in the valley and the closest vicinity; 3) species whose main distribution area is East from Latvia and that mainly grow in the Daugava River valley; 4) species that are distributed mainly in the Daugava River valley and in the coastal region; 5) western species that in the Daugava valley reach the north-east border of their distribution or grow in its vicinity; 6) littoral species that migrate along the Daugava River valley towards the central part of the continent. Species whose distribution area is located east from Latvia, like *Lathyrus pisiformis, Neottianthe cucullata, Dracocephalum ruyschiana* often reach here the northern, north-western and western limit of their distribution. The distribution areas of species that are distributed in the Daugava River valley and at the coast of the Baltic Sea are located mainly to the south or south-east from Latvia. Similarly, along the Daugava River valley and the sea coast these species migrate whose distribution areas are west from Latvia, including rare species in pine forests, like *Ajuga pyramidalis*. Therefore, it is possible to say that Daugava valley is a migration way in both the directions (Фатаре 1989). The largest areas covered by pine forests are located on the terraces of the meanders between Krāslava and Daugavpils. The most prominent floristic rarities here in the Daugava Loki Nature Park are *Lathyrus pisiformis* and *Neottianthe cucullata*. For both species it is one of the three localities in Latvia (Fatare 1992). In the frame of the Complex Pine Forest Research Programme in 1997, a project was started to detect the factors that determine the occurrence of the rare plant populations in the pine forests. It was found out that rare species of the pine forests have a higher demand for warmth and light and are less demanding for moisture than vegetation of oligotrophic and oligo-mesotrophic dry pine forests in total . The further task raised in the programme is to study the flora and the vegetation of the pine forests in the valleys of the large rivers. These forests are characterised by high species diversity. It is planned to describe and classify the pine forest communities where the rare and protected plant species occur, to analyse the ecological factors that determine their distribution. The aim of this study is to describe and analyse vegetation of pine forests in Daugava Loki Nature Park.

STUDY SITES AND METHODS

In July – August of 1998 and 1999 the pine forest vegetation of the Daugava Loki Nature Park was studied. For data analysis (classification) 60 relevés were used whose plot size ranged between 400-2500 m^2. Forests were described in 8 meanders: Butišķi, Ververi, Rudņa (Tartaka) and Adamova (Šķerskāni) on the right bank and Elerne, Rozališķi, Daugavsargi and Priedaine (Krāslava) on the left bank of the Daugava River.

For vegetation classification the computer program TWINSPAN (Hill 1979) was applied. Vascular plants, bryophytes and lichens were evaluated in the relevés in the four layers of the forest stands: E3 – trees; E2 – shrubs and undergrowth; E1 – herbs, dwarf shrubs, seedlings of trees and shrubs; E0 – mosses and lichens of the ground layer. For every species of each layer coverage was estimated. The percentage was transformed to the Braun-Blanquet scale and summarised in the tables the following way:

+ –	coverage	up to 1%;
1 –	"	between 1–4%;
2 –	"	5–24%;
3 –	"	25–49%;
4 –	"	50–75%;
5 –	"	>75%.

Species ecological characteristics are estimated using standard scales developed in Central Europe (Ellenberg et al. 1992), values were calculated weighted by coverage.

Species nomenclature: vascular plants – Gavrilova, Šulcs (1999); bryophytes – Āboliņa (2001); lichens – Piterāns (2001).

RESULTS

In total, 183 vascular plant species and 27 bryophyte and lichen species were found in 60 relevés. A number of species varied from 20 to 72, averaging 42 species per relevé.

According to the first level TWINSPAN division, the relevés were divided into 2 groups (Fig.1.). Species richest include *Pimpinella saxifraga* and *Rubus saxatilis* of constant occurrence. The second group has no diagnostic species. On the second level of division, oligotrophic relevés appear that are characterised by the presence of *Diphasiastrum complanatum* and *Cladina rangiferina*, and in the mezotrophic group relevés with *Campanula persicifolia, Hepatica nobilis, Plagiomnium affine* are separated. Further in the text the vegetation peculiarities of the 4 groups of relevés are characterised.

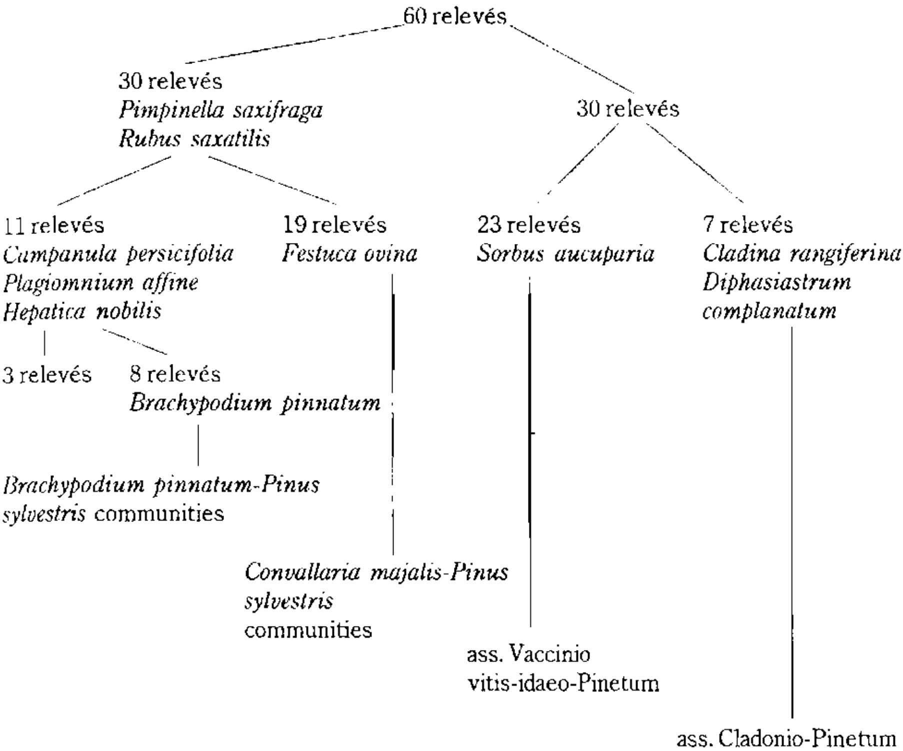

Fig. 1. TWINSPAN dendrogramm

Oligotrophic forests – Cladonio-Pinetum

The community was distinguished in 7 relevés from Rudņa, Adamova and Priedaine meanders on both banks of the Daugava River. The tree layer includes only two species, such as *Pinus sylvestris* with a small admixture of *Picea abies*. In four relevés pine occurs also in the undergrowth, but in six – in the herb layer pine seedlings appear. It testifies that in this species-poor plant community where light conditions are very good, the natural regeneration of pine takes place. It is conquered by spruce undergrowth that is recorded in 6 relevés and pioneer species, like *Betula pendula, Salix caprea, Populus tremula*. In the undergrowth also *Quercus robur* occurs and in underwood *Frangula alnus, Juniperus communis* grow. The total coverage of the shrub layer is small, ranging between 2–20%. As in most of the studied forests thinnings are undertaken, the coverage of the tree layer does not exceed 30%.

In the herb layer the characteristic species of the Class Vaccinio-Piceetea dominate, like *Vaccinium vitis-idaea, V. myrtillus* and *Diphasiastrum complanatum*. Also *Calluna vulgaris, Festuca ovina* and *Melampyrum pratense* are common. The coverage of the herb layer ranges between 15–35%. In total, only 29 herb and dwarf shrub species were determined, 16 of them were found only in one description.

The moss layer covers between 40–75%. *Pleurozium schreberi* and *Dicranum polysetum* dominate. Lichens, especially *Cladina rangiferina* and *C. arbuscula* have a relatively large coverage. In total, 17 moss and lichen species are distinguished.

From rare and protected plant species *Diphasiastrum complanatum, Arctostaphylos uva-ursi, Linnaea borealis, Astragalus arenarius* are to be mentioned.

The studied plant community is assigned to the Cl. Vaccinio-Piceetea, O. Piceetalia abietis, All. Dicrano-Pinion, Ass. Cladonio-Pinetum. The floristic composition of the association is shown in Table 1.

Table 1

Floristic composition of the Ass. Cladonio-Pinetum

Number of relevé	1	2	3	4	5	6	7	Constancy
Number of species per relevé	30	28	25	20	25	23	20	
Cover of tree layer, %	30	20	30	20	10	20	20	
Cover of shrub layer, %	5	10	20	5	10	5	2	
Cover of herb layer, %	25	20	15	15	20	15	35	
Cover of moss layer, %	70	75	75	55	40	75	65	
Characteristic species of the Cl. Vaccinio-Piceetea and Pulsatillo-Pinetea								
Pinus sylvestris E3	3	2	3	2	2	2	2	V
Pinus sylvestris E2	.	.	.	1	+	+	+	III
Pinus sylvestris E1	+	+	.	+	+	+	+	V
Picea abies E3	.	.	+	+	+	+	+	IV
Picea abies E2	+	2	.	1	1	1	+	V
Vaccinium vitis-idaea	2	2	2	2	2	2	3	V
Diphasiastrum complanatum	1	1	.	1	1	1	1	V
Vaccinium myrtillus	+	1	1	+	1	+	+	V
Carex ericetorum	+	+	.	.	–	.	.	III
Arctostaphylos uva-ursi	+	.	.	.	.	1	.	II
Pleurozium schreberi E0	3	4	3	2	2	1	2	V
Cladina arbuscula	2	.	+	2	2	1	1	V
Dicranum polysetum	3	2	1	2	2	2	+	V
Cladina rangiferina	2	+	1	2	2	4	3	V
Hylocomium splendens	+	2	3	2	.	.	+	IV
Cladina stellaris	.	.	+	+	.	+	3	III

Table 1 (continuation)

Number of relevé	1	2	3	4	5	6	7	Constancy
Number of species per relevé	30	28	25	20	25	23	20	
Cover of tree layer, %	30	20	30	20	10	20	20	
Cover of shrub layer, %	5	10	20	5	10	5	2	
Cover of herb layer, %	25	20	15	15	20	15	35	
Cover of moss layer, %	70	75	75	55	40	75	65	
Other species								
Betula pendula E3	.	+	.	.	.	.	.	I
Betula pendula E2	1	+	+	+	2	1	1	V
Salix caprea	+	+	.	.	.	.	+	III
Quercus robur	+	+	+	.	.	.	.	III
Frangula alnus	+	+	.	.	+	.	.	III
Juniperus communis	1	.	.	.	+	.	.	II
Populus tremula	.	.	.	.	+	.	+	II
Calluna vulgaris E1	+	+	1	1	1	2	1	V
Melampyrum pratense	1	2	+	1	2	1	1	V
Festuca ovina	1	+	+	+	1	+	.	V
Calamagrostis epigeios	+	1	.	.	+	.	.	III
Convallaria majalis	+	+	.	.	.	.	.	II
Agrostis tenuis	.	.	+	.	.	+	.	II
Veronica officinalis	.	.	+	.	+	.	.	II
Rumex acetosella	.	+	.	.	+	.	.	II
Polytrichum juniperinum E0	+	+	.	+	1	.	+	IV
Pohlia nutans	.	+	+	.	+	+	+	IV
Dicranum scoparium	.	.	+	+	.	+	.	III
Aulacomnium palustre	.	+	.	.	.	+	+	III
Cetraria islandica	+	.	+	.	.	+	+	III
Cladonia cornuta	+	.	.	+	.	.	.	II
Cladonia gracilis	+	.	.	+	.	.	.	II

Species in 1 relevé: E1: *Monotropa hypopitys* +(1), *Solidago virgaurea* +(1), *Antennaria dioica* +(1), *Scorzonera humilis* +(1), *Astragalus arenarius* +(1), *Calamagrostis arundinacea* +(2), *Luzula multiflora* +(2), *Pyrola chlorantha* +(2), *Rubus idaeus* +(2), *Carex nigra* +(3), *Luzula pilosa* +(3), *Linnaea borealis* +(5), *Trientalis europaea* +(5), *Viola canina* +(5), *Dryopteris carthusiana* +(6).
E0: *Ptilium crista-castrensis* +(3), *Sphagnum capillifolium* +(3), *Cladonia furcata* +(4), *Brachythecium oedipodium* +(6), *Lophocolea heterophylla* +(6).

Oligo-mesotrophic forests – Vaccinio vitis-idaeo-Pinetum

It is the most widespread pine forest community in the Daugava Loki Nature Park. It is represented by 23 relevés. Tree layer is formed by 3 species. *Pinus sylvestris* dominates, in separate places it occurs together with *Picea abies* and *Betula pendula*. The medium coverage of the tree layer is 30%. Twelve species are distinguished in the shrub layer, the most common are *Picea abies* and *Betula pendula*, as well as *Sorbus aucuparia* and *Juniperus communis*. Although in most of the relevés pine is also in the ground layer, its natural regeneration is not satisfactory. In the undergrowth (E2), it has remained only in 35% cases. The coverage of the herb layer ranges between 10–40%. The dominating species are forest dwarf shrubs, such as *Vaccinium vitis-idaea* and *V. myrtillus*, but other species of poor soils, like *Festuca ovina, Melampyrum pratense, Calluna vulgaris* are also often met. In total, 64 species are included in the list. The moss layer covers between 40–90%. Constantly 4 character species of the Class Vaccinio-Piceetea occur, such as *Pleurozium schreberi, Hylocomium splendens, Dicranum polysetum* and *Ptilium crista-castrensis*. In about a half of the relevés scattered lichens characteristic for the ground layer of oligotrophic forest occur like *Cladina arbuscula, C. rangiferina, C. stellaris*. It must be mentioned that *Hylocomium splendens* and *Ptilium crista-castrensis* have a larger coverage as commonly in the oligo-mesotrophic forests. It suggests the eutrophication processes in the ground layer.

Rare and protected plant species are represented by *Lycopodium clavatum, L. annotinum*, as well as *Diphasiastrum complanatum, Platanthera bifolia, Pulsatilla patens* but in separate places also warmth and light demanding species *Trifolium alpestre* and *Geranium sanguineum* grow.

The species composition of the community is revealed in Table 2.

The floristic analysis testifies that the studied plant community belongs to the Cl. Vaccinio-Piceetea, Ass. Vaccinio vitis-idaeo-Pinetum. Relevés were made on the right bank of the Daugava River, in Butišķi, Ververi and Adamova meanders and on the left – Priedaine, Daugavsargi, Rozališķi and Eleme meanders.

Mesotrophic pine forests with species-rich herb layer – *Convallaria majalis-Pinus sylvestris* community

The floristic composition of the tree layer is similar to the Vaccinio vitis-idaeo-Pinetum. *Pinus sylvestris* dominates with an admixture of *Picea abies*. *Betula pendula* is more common and occurs in 40% of the relevés but *Populus tremula* is rare. Pine is mentioned in 50% of the relevés also in the herb layer but in the undergrowth only in 1 relevé. It means that in this community, the natural regeneration of pine is unsatisfactory although the coverage of the tree layer is not high and ranges between 15–40%.

Table 2

Floristic composition of the Ass. **Vaccinio vitis-idaeo-Pinetum**

Number of relevé	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Constancy
Number of species per relevé	33	29	41	29	41	35	32	35	30	43	33	29	39	23	30	35	34	51	27	27	27	30	42	
Cover of tree layer, %	30	30	25	30	30	30	35	30	30	40	20	20	30	20	30	30	31	30	20	30	20	30	30	
Cover of shrub layer, %	5	7	15	3	7	5	10	5	3	6	6	5	13	6	10	1	12	10	1	15	2	10	5	
Cover of herb layer, %	35	20	55	20	26	20	20	20	35	38	20	18	21	30	31	22	10	20	30	10	30	10	12	
Cover of moss layer, %	80	70	60	70	80	70	80	60	70	80	75	75	75	80	85	80	90	70	80	75	40	50	50	
Characteristic species of Cl. Vaccinio-Piceetea and Pulsatillo-Pinetea																								
Pinus sylvestris E3	3	3	2	3	3	3	3	3	3	3	2	2	3	2	3	3	3	3	2	3	2	3	3	V
Pinus sylvestris E2	.	.	.	.	1	1	.	+	.	+	.	.	.	+	+	.	.	+	.	.	.	+	.	II
Pinus sylvestris E1	+	.	+	+	+	+	.	+	+	+	.	+	.	+	.	+	.	+	+	.	+	+	.	IV
Picea abies E3	+	+	2	.	+	.	2	.	.	+	.	.	.	.	.	.	1	.	+	.	.	.	+	II
Picea abies E2	+	2	2	+	1	1	2	+	+	+	1	+	+	1	1	+	2	1	+	2	.	.	1	V
Picea abies E1	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	+	+	.	1	.	.	.	II
Vaccinium vitis-idaea	2	1	1	2	2	2	1	1	3	2	2	2	2	2	2	2	1	2	2	.	1	1	1	V
Vaccinium myrtillus	2	2	2	2	2	2	2	2	+	.	2	1	2	2	2	1	+	+	.	1	.	.	.	IV
Chimaphila umbellata	+	.	+	.	+	.	.	+	.	+	+	.	+	.	+	.	+	.	.	.	1	+	+	III
Goodyera repens	+	+	.	.	+	.	+	.	+	+	+	.	+	.	+	+	.	+	.	.	.	.	+	III
Carex ericetorum	.	.	.	+	+	.	.	+	+	+	+	.	+	.	+	+	+	+	.	.	+	+	.	III
Arctostaphylos uva-ursi	.	.	.	.	+	+	.	.	+	+	.	+	.	.	1	1	.	+	.	.	.	.	+	II
Trientalis europaea	.	+	+	.	+	+	.	.	.	+	+	.	+	.	.	+	.	+	.	.	.	.	.	II
Lycopodium clavatum	.	.	.	+	1	1	.	.	.	.	.	.	.	.	.	.	+	1	.	+	+	.	.	II

Table 2 (continuation)

Number of relevé	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Constancy
Number of species per relevé	33	29	41	29	41	35	32	35	30	43	33	29	39	23	30	35	34	51	27	27	27	30	42	
Cover of tree layer, %	30	30	25	30	30	30	35	30	30	40	20	20	30	20	30	30	31	30	20	30	20	30	30	
Cover of shrub layer, %	5	7	15	3	7	5	10	5	3	6	6	5	13	6	10	1	12	10	1	15	2	10	5	
Cover of herb layer, %	35	20	55	20	26	20	20	20	35	38	20	18	21	30	31	22	10	20	30	10	30	10	12	
Cover of moss layer, %	80	70	60	70	80	70	80	60	70	80	75	75	75	80	85	80	90	70	80	75	40	50	50	
Diphasiastrum complanatum	1	.	1	.	.	.	.	.	.	.	1	.	+	1	.	.	.	2	+	.	.	.	.	II
Pulsatilla patens	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	+	.	+	.	.	.	+	+	II
Monotropa hypopitys	.	.	.	.	.	.	+	.	.	+		.	.	.	.	+	.	.	.	.	.	.	.	I
Lycopodium annotinum	+	.	.	.	.	.	.	.	.	+	1	.	1	.	.	.	.	.	.	.	.	.	.	I
Orthilia secunda	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	I
Pleurozium schreberi E0	1	2	2	2	2	2	1	2	2	2	2	3	3	4	4	4	4	4	4	4	3	2	3	V
Hylocomium splendens	5	4	4	3	4	4	4	4	4	4	4	3	3	2	2	.	1	2	2	1	.	+	2	V
Dicranum polysetum	1	+	+	1	1	2	+	+	+	2	1	2	1	2	2	2	3	2	2	1	2	3	+	V
Ptilium crista-castrensis	1	2	+	2	1	2	2	+	+	2	1	2	1	+	2	2	1	1	.	.	+	+	+	V
Cladina arbuscula	.	.	.	1	1	+	.	+	.	1	.	.	1	.	.	1	2	1	1	+	.	+	.	III
Cladina rangiferina	.	.	.	+	.	.	.	+	.	1	1	.	+	.	.	1	1	1	1	+	.	+	.	II
Cladina stellaris	.	.	.	2	+	1	.	1	.	.	.	.	+	.	.	.	.	+	1	.	.	+	.	II
Other species																								
Betula pendula E3	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	+	.	.	I
Betula pendula E2	+	+	1	.	+	+	2	1	.	+	1	+	+	2	2	1	1	+	+	1	+	.	2	V

Number of relevé	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Constancy
Number of species per relevé	**33**	**29**	**41**	**29**	**41**	**35**	**32**	**35**	**30**	**43**	**33**	**29**	**39**	**23**	**30**	**35**	**34**	**51**	**27**	**27**	**27**	**30**	**42**	
Cover of tree layer, %	30	30	25	30	30	30	35	30	30	40	20	20	30	20	30	30	31	30	20	30	20	30	30	
Cover of shrub layer, %	5	7	15	3	7	5	10	5	3	6	6	5	13	6	10	1	12	10	1	15	2	10	5	
Cover of herb layer, %	35	20	55	20	26	20	20	20	35	38	20	18	21	30	31	22	10	20	30	10	30	10	12	
Cover of moss layer, %	80	70	60	70	80	70	80	60	70	80	75	75	75	80	85	80	90	70	80	75	40	50	50	
Sorbus aucuparia	+	+	1	+	+	.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	.	1	V
Juniperus communis	1	1	+	1	2	1	.	1	1	2	1	2	1	+	1	+	1	2	.	.	.	2	1	V
Frangula alnus	+	+	+	+	+	.	.	+	+	.	+	.	+	.	+	+	+	+	.	+	+	+	.	IV
Quercus robur	1	.	1	.	+	+	.	+	+	1	+	+	+	.	.	.	+	+	+	+	1	1	+	IV
Salix caprea	.	+	.	+	.	+	.	.	+	+	.	+	.	.	.	.	.	.	.	.	.	.	.	II
Populus tremula	+	.	+	.	.	.	.	.	.	+	+	.	.	.	+	.	.	.	.	.	.	.	+	II
Corylus avellana	.	.	2	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	I
Betula pubescens	.	.	.	+	.	.	.	.	.	.	+	.	.	+	.	.	.	.	+	.	.	.	.	I
Sambucus racemosa	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	I
Quercus robur E1	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	+	+	+	II
Frangula alnus	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	I
Populus tremula	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	I
Melampyrum pratense	2	2	3	1	1	1	1	2	1	1	1	1	+	1	1	1	+	2	2	2	2	+	1	V
Festuca ovina	+	+	+	+	1	+	+	+	1	1	+	+	+	+	+	+	+	1	+	+	2	+	1	V
Calluna vulgaris	+	.	+	1	+	+	1	1	1	1	+	+	+	1	+	+	+	+	+	.	1	1	+	V

Table 2 (continuation)

Number of relevé	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Constancy
Number of species per relevé	33	29	41	29	41	35	32	35	30	43	33	29	39	23	30	35	34	51	27	27	27	30	42	
Cover of tree layer, %	30	30	25	30	30	30	35	30	30	40	20	20	30	20	30	30	31	30	20	30	20	30	30	
Cover of shrub layer, %	5	7	15	3	7	5	10	5	3	6	6	5	13	6	10	1	12	10	1	15	2	10	5	
Cover of herb layer, %	35	20	55	20	26	20	20	20	35	38	20	18	21	30	31	22	10	20	30	10	30	10	12	
Cover of moss layer, %	80	70	60	70	80	70	80	60	70	80	75	75	75	80	85	80	90	70	80	75	40	50	50	
Calamagrostis epigeios	1	1	1	1	.	+	+	.	.	1	.	1	1	1	+	1	1	+	2	.	1	+	.	IV
Solidago virgaurea	+	.	+	.	+	+	+	+	.	+	+	.	+	.	+	+	.	+	.	+	+	+	.	IV
Luzula pilosa	+	+	+	+	+	.	1	+	+	+	+	.	+	+	+	+	+	+	.	.	.	.	+	IV
Dryopteris carthusiana	+	.	+	.	.	+	+	+	+	+	+	+	+	.	+	+	.	+	+	+	.	.	+	IV
Convallaria majalis	+	+	2	.	.	.	.	.	+	2	2	+	.	+	1	+	1	.	+	.	1	1	+	IV
Rubus saxatilis	+	+	+	.	.	+	.	.	.	+	.	+	.	.	+	+	.	+	.	.	.	+	.	III
Scorzonera humilis	+	.	.	.	.	.	.	+	.	+	+	.	+	+	+	+	.	+	.	.	+	.	+	III
Calamagrostis arundinacea	1	+	1	.	.	.	1	+	+	1	.	.	.	.	2	+	.	.	+	+	.	1	1	III
Chamaenerion angustifolium	+	.	.	.	.	.	.	+	+	.	+	+	+	.	.	+	+	.	+	.	.	+	.	III
Hieracium umbellatum	+	.	+	.	.	.	.	.	.	+	+	.	+	.	.	.	+	+	.	.	2	+	+	III
Anthoxanthum odoratum	.	.	+	.	+	.	.	+	+	+	.	.	.	.	.	.	+	+	+	1	.	.	+	III
Agrostis tenuis	.	+	+	+	.	+	.	.	.	.	.	+	.	.	.	.	+	+	+	+	.	.	+	III
Pteridium aquilinum	2	2	1	.	2	1	.	.	.	.	.	.	.	1	.	.	.	+	.	.	.	.	.	II
Rubus idaeus	+	+	+	.	+	.	.	+	+	.	.	.	+	.	.	.	.	.	+	+	.	.	.	II
Fragaria vesca	.	.	.	.	+	.	.	.	.	.	.	.	.	+	.	.	+	.	.	+	.	+	.	II

Table 2 (continuation)

Number of relevé	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Constancy
Number of species per relevé	33	29	41	29	41	35	32	35	30	43	33	29	39	23	30	35	34	51	27	27	27	30	42	
Cover of tree layer, %	30	30	25	30	30	30	35	30	30	40	20	20	30	20	30	30	31	30	20	30	20	30	30	
Cover of shrub layer, %	5	7	15	3	7	5	10	5	3	6	6	5	13	6	10	1	12	10	1	15	2	10	5	
Cover of herb layer, %	35	20	55	20	26	20	20	20	35	38	20	18	21	30	31	22	10	20	30	10	30	10	12	
Cover of moss layer, %	80	70	60	70	80	70	80	60	70	80	75	75	75	80	85	80	90	70	80	75	40	50	50	
Rumex acetosella	.	+	+	+	.	.	.	+	.	.	.	.	+	.	.	+	.	+	.	.	+	.	+	II
Polygonatum odoratum	.	.	+	.	+	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	+	+	+	II
Veronica officinalis	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	+	.	.	+	.	+	II
Pilosella officinarum	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	+	.	.	II
Lerchenfeldia flexuosa	.	.	.	1	+	.	.	2	+	+	.	+	+	.	.	.	.	.	.	.	.	.	.	II
Molinia caerulea	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	1	.	.	.	.	.	I
Trommsdorfia maculata		.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	I
Astragalus arenarius	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	+	+	I
Viola canina	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	I
Thymus serphyllum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	I
Knautia arvensis	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	I
Geranium sanguineum		.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	I
Luzula multiflora	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	I
Antennaria dioica	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	+	I
Polytrichum juniperinum EO	.	.	.	+	+	.	+	+	.	.	.	+	+	.	.	+	+	+	+	+	+	.	+	III

Table 2 (the end)

Number of relevé	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Constancy
Number of species per relevé	33	29	41	29	41	35	32	35	30	43	33	29	39	23	30	35	34	51	27	27	27	30	42	
Cover of tree layer, %	30	30	25	30	30	30	35	30	30	40	20	20	30	20	30	30	31	30	20	30	20	30	30	
Cover of shrub layer, %	5	7	15	3	7	5	10	5	3	6	6	5	13	6	10	1	12	10	1	15	2	10	5	
Cover of herb layer, %	35	20	55	20	26	20	20	20	35	38	20	18	21	30	31	22	10	20	30	10	30	10	12	
Cover of moss layer, %	80	70	60	70	80	70	80	60	70	80	75	75	75	80	85	80	90	70	80	75	40	50	50	
Pohlia nutans	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	+	.	+	.	.	+	.	.	II
Aulacomnium palustre	.	.	.	.	1	+	1	.	.	.	1	.	+	.	+	+	.	+	.	.	.	.	.	II
Brachythecium oedipodium	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	I
Dicranum scoparium	.	.	.	.	.	.	.	.	.	+	.	+	.	+	.	.	.	.	.	.	+	.	.	I
Ptilidium ciliare	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	I

Species in 1 relevé: **E2** *Acer platanoides* +(2), *Amelanchier spicata* +(9), *Lonicera xylosteum* +(23).

E1 *Galium album* +(2), *Maianthemum bifolium* +(3), *Epipactis helleborine* +(5), *Moneses uniflora* +(8), *Betula pubescens* +(11), *Lathyrus sylvestris* +(12), *Trifolium alpestre* +(12), *Vicia sylvatica* +(12), *Carex nigra* +(13), *Silene nutans* +(17), *Sieglingia decumbens* +(18), *Calamagrostis canescens* 1(23), *Festuca rubra* +(23), *Lonicera xylosteum* +(23), *Platanthera bifolia* +(23), *Sorbus aucuparia* +(23), *Veronica chamaedrys* +(23).

E0 *Rhytidiadelphus triquetrus* +(2), *Plagiomnium affine* +(5), *Sphagnum capillifolium* +(5), *Polytrichum commune* +(7), *Cetraria islandica* +(8), *Cladonia gracilis* +(18), *Cladonia scabriuscula* +(18).

In the shrub layer, 21 species are determined. Species, like *Berberis vulgaris, Acer negundo, Sambucus racemosa* suggest synantropization processes of the forest flora.

In the herb layer, the largest cover and constant occurrence have the character species of the Vaccinio-Piceetea, like *Vaccinium vitis-idaea* and *V. myrtillus*, as well as *Convallaria majalis* and *Rubus saxatilis.* Grasses, like *Agrostis tenuis* and *Festuca ovina* are also common as well as the other species that are characteristic for dry meadows, such as *Pimpinella saxifraga, Fragaria vesca*. In general, the herb layer is species-rich and diverse. In total, 128 species are distinguished, 59 of them only in one or two relevés. Coverage of the layer ranges between 10–40%.

Mosses cover 40–80% of the area. Only 15 species are mentioned. *Hylocomium splendens* dominates, the other more common species are similar like in Vaccinio vitis-idaeo-Pinetum.

In this community, many rare species occur, such as *Ajuga pyramidalis, Trifolium alpestre, Dracocephalum ruyschiana, Neottianthe cucullata, Seseli libanotis, Pulmonaria angustifolia, Pulsatilla patens*. *Trifolium alpestre* occurs in more than a half of relevés (58 %). The community includes 19 relevés on both the banks of the Daugava River – on the right bank Butišķi and Ververi and on the left – Rozališķi and Eleme meanders.

The floristic composition of the community is shown in Table 3.

Mesotrophic pine forests with abundant grass cover – *Brachypodium pinnatum-Pinus sylvestris* community

In the group of mesotrophic forests, this group represents the species-rich communities with abundant grass cover. It is difficult to identify their syntaxonomical status as the number of character species of the Cl. Vaccinio-Piceetea and Querco-Fagetea is about the same. On the third level of TWINSPAN division, 3 relevés are separated. From the others, they differ due to a well-distinguished shrub layer where *Corylus avellana* and *Lonicera xylosteum* dominate. For the other relevés, a high coverage of herb layer is characteristic – even up to 95%. *Brachypodium pinnatum* dominates. In total, 118 species were determined in herb layer, 42 of them only in 1 relevé. In the moss layer, only 14 species occur, some of them suggesting human influence, such as *Brachythecium oedipodium* and *Plagiomnium affine*. Coverage of moss layer ranges between 20 and 70%.

Coverage of the tree layer ranges between 20 and 50%. *Pinus sylvestris* dominates. It was not found in the shrub layer, but occurred in the herb layer in 3 relevés. It means that the natural regeneration of pine is not satisfactory and species change to spruce, and broad-leaved trees can be expected if the artificial regeneration of pine will not take place. Nevertheless, the current pine forest stand is of natural origin.

The shrub layer in both the variants is different – in the first 3 relevés it reaches 40–70%, but in the variant with *Brachypodium pinnatum* – only 5 to 15%. Therefore, abundant herb layer develops in the latter.

Table 3

Floristic composition of the community ***Rubus saxatilis-Pinus sylvestris***

Number of relevé	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Constancy
Number of species per relevé	61	72	64	41	51	43	50	45	36	43	58	40	53	52	44	60	45	44	50	
Cover of tree layer, %	20	30	20	30	40	30	30	30	40	30	35	35	30	40	35	20	20	20	15	
Cover of shrub layer, %	6	15	10	13	15	7	14	11	4	9	5	5	7	6	15	10	10	5	10	
Cover of herb layer, %	26	15	30	21	41	40	62	35	25	24	26	15	30	25	21	40	23	32	10	
Cover of moss layer, %	80	60	70	75	80	80	40	70	60	70	71	65	80	65	50	65	60	60	80	
Characteristic species of Cl. Vaccinio-Piceetea and Pulsatillo–Pinetea																				
Pinus sylvestris E3	2	3	2	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	V
Pinus sylvestris E2	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	I
Pinus sylvestris E1	.	+	+	.	.	+	.	.	.	+	.	+	+	.	+	+	+	+	.	III
Picea abies E3	.	.	+	.	.	+	.	.	+	+	+	+	+	+	1	+	+	.	+	IV
Picea abies E2	+	+	+	1	1	1	1	1	1	1	1	1	1	+	2	1	+	.	.	V
Picea abies E1	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	I
Vaccinium vitis-idaea	.	.	2	2	2	1	.	2	.	1	1	1	1	1	+	1	1	+	+	IV
Vaccinium myrtillus	.	+	+	2	2	3	2	2	2	2	1	1	1	2	.	1	.	.	.	IV
Goodyera repens	+	+	+	.	+	+	.	+	+	+	+	+	.	.	.	+	+	.	.	IV
Chimaphila umbellata	+	.	+	+	.	+	+	+	.	+	+	+	.	.	.	.	+	.	+	III
Pulsatilla patens	.	.	.	.	+	+	+	.	.	.	+	1	+	.	+	+	+	+	+	III
Arctostaphylos uva-ursi	.	.	.	.	+	.	.	+	.	.	.	+	.	.	.	.	.	+	+	II
Trientalis europaea	+	+	.	.	.	.	+	.	+	+	.	+	.	.	.	.	.	.	.	II

Table 3 (continuation)

Number of relevé	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Constancy
Number of species per relevé	61	72	64	41	51	43	50	45	36	43	58	40	53	52	44	60	45	44	50	
Cover of tree layer, %	20	30	20	30	40	30	30	30	40	30	35	35	30	40	35	20	20	20	15	
Cover of shrub layer, %	6	15	10	13	15	7	14	11	4	9	5	5	7	6	15	10	10	5	10	
Cover of herb layer, %	26	15	30	21	41	40	62	35	25	24	26	15	30	25	21	40	23	32	10	
Cover of moss layer, %	80	60	70	75	80	80	40	70	60	70	71	65	80	65	50	65	60	60	80	
Monotropa hypopitys	.	.	.	.	+	+	.	.	.	.	+	+	.	.	.	+	+	.	.	II
Carex ericetorum	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	+	I
Lycopodium clavatum	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	+	.	.	.	I
Lycopodium annotinum	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	I
Pyrola chlorantha	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	I
Orthilia secunda	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Pyrola rotundifolia	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	I
Pleurozium schreberi E0	4	4	2	1	4	2	2	2	2	2	2	1	3	2	3	4	2	3	4	V
Hylocomium splendens	2	2	4	4	2	3	4	4	2	4	4	4	4	4	2	2	3	3	2	V
Dicranum polysetum	1	+	.	.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	V
Ptilium crista-castrensis	1	2	+	1	2	2	2	+	2	2	1	1	1	2	.	+	+	+	+	V
Cladina arbuscula	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	I
Other species																				
Betula pendula E3	.	.	.	.	.	.	.	.	.	.	1	1	2	2	2	2	2	.	2	III
Betula pendula E2	2	1	.	1	+	+	.	1	1	+	.	1	1	.	.	.	.	+	.	III
Sorbus aucuparia E2	1	2	+	.	1	1	+	+	+	+	+	+	+	+	+	+	.	+	+	V

Table 3 (continuation)

Number of relevé	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Constancy
Number of species per relevé	61	72	64	41	51	43	50	45	36	43	58	40	53	52	44	60	45	44	50	
Cover of tree layer, %	20	30	20	30	40	30	30	30	40	30	35	35	30	40	35	20	20	20	15	
Cover of shrub layer, %	6	15	10	13	15	7	14	11	4	9	5	5	7	6	15	10	10	5	10	
Cover of herb layer, %	26	15	30	21	41	40	62	35	25	24	26	15	30	25	21	40	23	32	10	
Cover of moss layer, %	80	60	70	75	80	80	40	70	60	70	71	65	80	65	50	65	60	60	80	
Juniperus communis	1	+	2	2	2	1	1	2	1	.	1	1	1	2	2	1	2	2	2	V
Frangula alnus	+	1	+	.	+	+	1	1	.	+	+	+	1	1	+	1	.	+	.	IV
Quercus robur	1	1	.	+	1	1	2	1	+	1	1	.	+	+	+	+	+	+	.	V
Salix caprea	+	+	+	+	+	+	+	+	.	.	.	.	.	+	.	+	.	.	.	III
Corylus avellana	+	1	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	II
Populus tremula	.	.	.	.	.	+	+	.	.	.	+	.	+	+	+	+	.	.	.	II
Viburnum opulus	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Salix myrsinifolia	.	.	+	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	I
Malus sylvestris	.	+	.	.	+	.	.	.	.	.	.	.	.	+	+	.	.	.	+	II
Acer platanoides	+	.	.	+	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	II
Padus avium	.	.	+	+	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	II
Melampyrum pratense E1	1	1	1	1	1	1	2	2	2	1	2	1	1	.	2	2	1	2	1	V
Convallaria majalis	+	+	+	1	1	1	2	+	.	+	2	2	+	1	1	+	1	1	1	V
Festuca ovina	+	.	+	+	+	+	+	+	+	+	+	1	1	1	+	+	+	1	1	V
Calluna vulgaris	.	.	+	+	+	+	+	+	+	+	+	.	+	+	+	+	+	+	+	V
Luzula pilosa	+	+	+	.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	V

Table 3 (continuation)

Number of relevé	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Constancy
Number of species per relevé	61	72	64	41	51	43	50	45	36	43	58	40	53	52	44	60	45	44	50	
Cover of tree layer, %	20	30	20	30	40	30	30	30	40	30	35	35	30	40	35	20	20	20	15	
Cover of shrub layer, %	6	15	10	13	15	7	14	11	4	9	5	5	7	6	15	10	10	5	10	
Cover of herb layer, %	26	15	30	21	41	40	62	35	25	24	26	15	30	25	21	40	23	32	10	
Cover of moss layer, %	80	60	70	75	80	80	40	70	60	70	71	65	80	65	50	65	60	60	80	
Rubus saxatilis	+	2	+	1	1	1	2	1	1	1	+	1	2	1	1	2	.	1	+	V
Agrostis tenuis	.	+	+	+	+	+	+	+	+	+	.	+	+	+	+	1	+	+	+	V
Fragaria vesca	.	+	+	+	+	1	2	+	+	+	+	+	1	.	2	2	1	2	+	V
Pimpinella saxifraga	+	+	+	+	+	+	+	+	.	.	+	+	+	+	1	+	1	1	1	V
Viola canina	+	+	+	.	.	+	+	+	+	+	+	+	+	+	+	1	+	+	+	V
Knautia arvensis	+	+	+	+	.	.	+	.	.	.	+	+	1	+	+	+	+	+	+	IV
Pilosella officinarum	+	+	+	+	.	+	+	.	.	.	+	+	.	+	+	+	.	+	.	IV
Anthoxanthum odoratum	+	1	+	+	+	.	1	+	.	+	+	.	1	1	+	.	.	.	.	IV
Solidago virgaurea	.	+	+	+	+	+	.	+	.	+	+	+	+	.	+	+	.	+	+	IV
Veronica officinalis	.	+	+	.	.	+	+	+	+	+	+	+	+	+	+	+	.	+	+	IV
Calamagrostis arundinacea	.	.	1	1	1	1	2	1	1	1	1	.	1	1	.	.	+	.	+	IV
Calamagrostis epigeios	.	.	.	.	1	+	+	+	1	1	.	+	1	.	+	.	1	1	1	IV
Galium album	.	+	+	+	+	.	+	+	.	.	+	.	+	+	+	1	.	.	+	IV
Achillea millefolium	+	+	+	+	.	.	.	.	.	.	+	.	+	+	+	+	.	+	.	III
Thymus serpyllum	+	.	.	.	+	+	.	+	.	.	+	+	.	.	+	.	.	.	+	III
Rubus idaeus	+	.	+	+	+	.	+	+	+	+	.	+	.	.	.	.	.	.	.	III

Table 3 (continuation)

Number of relevé	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Constancy
Number of species per relevé	61	72	64	41	51	43	50	45	36	43	58	40	53	52	44	60	45	44	50	
Cover of tree layer, %	20	30	20	30	40	30	30	30	40	30	35	35	30	40	35	20	20	20	15	
Cover of shrub layer, %	6	15	10	13	15	7	14	11	4	9	5	5	7	6	15	10	10	5	10	
Cover of herb layer, %	26	15	30	21	41	40	62	35	25	24	26	15	30	25	21	40	23	32	10	
Cover of moss layer, %	80	60	70	75	80	80	40	70	60	70	71	65	80	65	50	65	60	60	80	
Festuca rubra	.	+	1	.	.	.	.	+	+	.	.	.	.	1	+	.	+	1	+	III
Polygonatum odoratum	.	.	.	+	+	+	+	+	.	.	+	+	.	+	.	.	+	+	+	III
Trifolium alpestre	.	.	+	+	+	+	+	+	.	.	+	.	+	+	.	+	+	.	.	III
Dryopteris carthusiana	.	−	+	.	+	.	+	.	.	+	.	.	+	.	.	+	.	+	.	III
Veronica spicata	.	.	.	+	+	.	.	.	.	.	+	.	.	+	.	+	+	+	+	III
Melica nutans	+	.	+	+	.	.	.	.	.	.	+	.	+	1	.	+	.	.	.	II
Vicia cracca	+	−	+	.	.	.	.	.	+	.	.	.	.	+	+	+	.	.	.	II
Hieracium umbellatum	+	+	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	II
Poa pratensis	+	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	+	.	+	II
Silene nutans	+	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	+	+	II
Rumex acetosa	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	II
Neottianthe cucullata	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	.	II
Pteridium aquilinum	.	1	1	.	.	.	2	.	2	2	.	.	.	1	.	.	.	.	.	II
Lerchenfeldia flexuosa	.	+	+	+	+	+	.	+	.	.	.	.	.	.	.	+	.	.	.	II
Chamaenerion angustifolium	.	1	.	.	+	+	.	.	.	+	.	.	.	.	.	.	.	.	.	II
Rumex acetosella	.	−	.	.	+	.	.	.	+	.	.	.	.	.	.	+	.	.	.	II

Table 3 (continuation)

Number of relevé	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Constancy
Number of species per relevé	61	72	64	41	51	43	50	45	36	43	58	40	53	52	44	60	45	44	50	
Cover of tree layer, %	20	30	20	30	40	30	30	30	40	30	35	35	30	40	35	20	20	20	15	
Cover of shrub layer, %	6	15	10	13	15	7	14	11	4	9	5	5	7	6	15	10	10	5	10	
Cover of herb layer, %	26	15	30	21	41	40	62	35	25	24	26	15	30	25	21	40	23	32	10	
Cover of moss layer, %	80	60	70	75	80	80	40	70	60	70	71	65	80	65	50	65	60	60	80	
Trifolium montanum	.	.	+	.	+	.	.	.	.	.	.	.	.	+	.	.	+	+	.	II
Seseli libanotis	.	.	1	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	+	II
Leucanthemum vulgare	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	+	+	.	+	II
Galium verum	.	.	+	.	.	.	.	.	.	.	.	.	+	+	+	+	.	+	.	II
Scorzonera humilis	.	.	.	.	+	.	+	.	+	+	.	.	+	.	.	.	.	.	.	II
Veronica chamaedrys	.	+	.	+	.	.	.	.	.	.	.	.	+	.	.	+	.	+	.	II
Trifolium medium	.	.	+	.	.	.	.	.	.	.	+	.	+	.	+	.	.	.	.	II
Succisa pratensis	.	.	.	.	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	II
Hypericum perforatum	.	.	+	.	.	.	.	.	.	.	.	+	.	+	.	+	+	.	.	II
Geranium sanguineum	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	+	+	.	II
Molinia caerulea	.	.	.	.	.	.	+	+	+	.	+	.	.	.	.	.	.	.	.	II
Platanthera bifolia	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	+	+	+	+	II
Melampyrum polonicum	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	.	2	.	+	II
Taraxacum officinale	+	+	.	.	.	.	.	.	+	+	.	.	.	.	.	+	.	.	.	II
Moehringia trinervia	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	I
Viscaria vulgaris	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	I

Table 3 (continuation)

Number of relevé	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Constancy
Number of species per relevé	61	72	64	41	51	43	50	45	36	43	58	40	53	52	44	60	45	44	50	
Cover of tree layer, %	20	30	20	30	40	30	30	30	40	30	35	35	30	40	35	20	20	20	15	
Cover of shrub layer, %	6	15	10	13	15	7	14	11	4	9	5	5	7	6	15	10	10	5	10	
Cover of herb layer, %	26	15	30	21	41	40	62	35	25	24	26	15	30	25	21	40	23	32	10	
Cover of moss layer, %	80	60	70	75	80	80	40	70	60	70	71	65	80	65	50	65	60	60	80	
Stellaria graminea	.	+	.	+	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	I
Brachythecium oedipodium E0	+	+	+	.	.	.	.	.	.	.	.	.	.	+	+	+	+	.	+	III
Polytrichum juniperinum	.	+	.	.	+	.	.	+	.	.	.	+	+	+	.	.	.	.	+	II
Aulacomnium palustre	.	+	+	.	+	+	.	.	.	+	+	.	+	.	.	.	.	.	.	II
Rhytidiadelphus triquetrus	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	+	II
Pohlia nutans	.	.	.	.	.	.	.	.	+	.	.	.	+	+	.	.	.	.	.	I
Dicranum scoparium	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	+	I

Species in 1 or 2 relevés: E0 *Rhytidiadelphus squarrosus* 1(1), +(2), *Plagiomnium affine* +(2), *Cirriphyllum piliferum* +(15), *Ceratodon purpureus* +(16).

E3 *Populus tremula* +(11).

E2 *Sambucus racemosa* +(2), *Acer negundo* +(3), *Berberis vulgaris* +(3), *Rhamnus cathartica* +(3), *Betula pubescens* +(14, 16).

E1 *Agrimonia eupatoria* +(1,3), *Carex praecox* 2(1), *Carex hirta* +(1,2), *Carlina vulgaris* +(1,13), *Clinopodium vulgare* +(1,7), *Epipactis atrorubens* +(1), *Epipactis helleborine* +(1), *Equisetum hiemale* 2(1), +(6), *Lathyrus sylvestris* +(1), *Leontodon hispidus* +(1,3), *Lonicera xylosteum* +(1), *Medicago falcata* 1(1), *Moneses uniflora* +(1), *Oenothera biennis* +(1), *Plantago lanceolata* +(1), *Plantago media* +(1), *Senecio jacobaea* +(1,18), *Valeriana officinalis* +(1), *Anthryscus sylvestris* +(2), *Betula pubescens* +(2), *Centaurea scabiosa* +(2), *Elymus caninus* +(2), *Elytrigia repens* +(2,3), *Galium boreale* +(2), *Lychnis flos-cucidi* +(2), *Mycelis muralis* +(2), *Polygonatum multiflorum* +(2), *Ranunculus acris* +(2), *Thymus ovatus* +(2), *Trommsdorfia maculata* +(2,4), *Brachypodium pinnatum* 1(3), *Campanula persicifolia* +(3), *Helianthemum nummularium* +(3), *Ranunculus polyanthemos* +(3,7), *Silene vulgaris* +(3), *Astragalus arenarius* +(5), *Carex nigra* +(4), *Geranium sylvaticum* +(4,7), *Lathyrus vernus* +(4), *Plantago major* 1(5), *Ajuga pyramidalis* +(7,11), *Potentilla erecta* +(7), *Carex caryophyllea* +(8), *Diphasiastrum complanatum* +(8), *Sieglingia decumbens* +(8), *Holcus lanatus* +(9,17), *Koeleria pyramidata* +(9,11), *Luzula multiflora* +(10,18), *Hepatica nobilis* 1(11), *Juniperus communis* +(11), *Linaria vulgaris* +(11,12), *Maianthemum bifolium* +(11), *Pulmonaria angustifolia* +(11), *Vicia cassubica* +(11,13), *Sorbus aucuparia* +(14), *Aegopodium podagraria* +(16), *Dracocephalum ruyschiana* +(17,18), *Viola rupestris* +(17), *Fraxinus excelsior* +(19), *Padus avium* +(19).

In this community, several rare and protected species, like *Ajuga pyramidalis* and *Trifolium alpestre* occur. Only in such a grass-rich pine forest on the Daugava River left bank in Daugavsargi meander *Lathyrus pisiformis* grows. There are known only 3 localities of this species in Latvia (Табака, Гаврилова, Фатаре 1988).

On the left bank of the Daugava River, the community is described in Daugavsargi, Rozališķi and Elerne meanders and on the right bank in Ververi and Butišķi meanders.

In one of the relevés also rare species appear that occur mainly in poor habitats, like *Epipactis atrorubens, Pulsatilla patens, Chimaphila umbellata, Lycopodium annotinum, Seseli libanotis* as well as *Digitalis grandiflora* that is more characteristic for open places and broad-leaved forests.

The floristic composition of the community is shown in Table 4.

Table 4

Floristic composition of the community
Brachypodium pinnatum-Pinus sylvestris
(Relevés 4-11)

Number of relevé	1	2	3	Constancy	4	5	6	7	8	9	10	11	Constancy
Number of species per relevé	60	58	45		49	48	66	60	47	70	69	66	
Cover of tree layer, %	50	35	20		30	30	20	40	30	30	20	20	
Cover of shrub layer, %	70	40	70		5	6	5	10	15	15	10	15	
Cover of herb layer, %	20	15	15		90	75	95	80	40	75	90	35	
Cover of moss layer, %	65	65	45		70	65	60	55	60	20	30	65	
Characteristic species of Cl. Vaccinio-Piceetea and Pulsatillo-Pinetea													
Pinus sylvestris E3	2	2	2	**3**	3	3	2	3	3	3	2	2	**V**
Pinus sylvestris E1	.		.		.	.	.	.	.	+	+	+	**II**
Picea abies E3	2	2	+	**3**	+	+	+	1	+	+	+	+	**V**
Picea abies E2	3	1	+	**3**	1	1	1	2	1	.	.	1	**IV**
Vaccinium myrtillus	+	1	+	**3**	1	1	1	1	1	2	1	1	**V**
Vaccinium vitis-idaea	+	+	.	**2**	+	+	+	+	.	+	+	1	**V**
Goodyera repens	+	+	+	**3**	.	+	.	+	+	+	+	.	**IV**
Trientalis europaea	.	+	.	**1**	+	+	+	+	+	+	.	.	**IV**
Orthilia secunda	+	+	.	**2**	+	.	.	.	.	+	.	.	**II**
Pleurozium schreberi E0	1	+	1	**3**	1	2	2	+	2	1	2	2	**V**
Hylocomium splendens	4	3	2	**3**	4	4	3	4	4	2	2	3	**V**
Ptilium crista-castrensis	.	2	+	**2**	2	1	3	2	2	2	1	2	**V**
Dicranum polysetum	+	+	.	**2**	.	.	+	.	+	.	.	.	**II**
Characteristic species of Cl. Querco-Fagetea													
Corylus avellana E2	+	2	4	**3**	.	.	.	.	.	.	+	.	**I**

Table 4 (continuation)

Number of relevé	1	2	3	Constancy	4	5	6	7	8	9	10	11	Constancy
Number of species per relevé	60	58	45		49	48	66	60	47	70	69	66	
Cover of tree layer, %	50	35	20		30	30	20	40	30	30	20	20	
Cover of shrub layer, %	70	40	70		5	6	5	10	15	15	10	15	
Cover of herb layer, %	20	15	15		90	75	95	80	40	75	90	35	
Cover of moss layer, %	65	65	45		70	65	60	55	60	20	30	65	
Lonicera xylosteum	2	2	1	**3**	.	.	+	.	.	.	+	.	**II**
Daphne mezereum	+	+	.	**2**	.	.	.	.	.	.	.	.	**II**
Viburnum opulus	.	+	.	**1**	+	.	.	.	.	+	.	+	**II**
Acer platanoides	.	+	.	**1**	.	.	+	.	.	+	.	.	**II**
Malus sylvestris	+	.	.	**1**	.	.	.	.	.	+	+	.	**II**
Calamagrostis arundinacea E1	1	+	+	**3**	2	2	2	1	1	2	2	1	**V**
Melica nutans	1	+	1	**3**	+	+	1	+	1	2	.	2	**V**
Hepatica nobilis	1	2	2	**3**	1	1	2	1	.	.	+	1	**IV**
Carex digitata	+	+	.	**2**	+	.	.	.	.	.	.	.	**I**
Maianthemum bifolium	.	+	.	**1**	+	.	.	.	.	+	.	+	**II**
Aegopodium podagraria	.	.	+	**1**	.	.	+	+	.	.	.	+	**II**
Lathyrus vernus	.	+	.	**1**	+	+	1	1	.	.	.	+	**IV**
Hieracium umbellatum	.	.	.		+	.	.	.	.	+	+	.	**II**
Other species													
Betula pendula E2	+	2	.	**2**	1	1	1	2	.	+	1	.	**IV**
Sorbus aucuparia	+	.	+	**2**	+	+	+	.	.	.	.	1	**III**
Frangula alnus	+	+	.	**2**	.	1	+	.	.	1	+	1	**IV**
Quercus robur	+	.	+	**2**	.	1	.	+	1	1	2	.	**IV**
Quercus robur E1	.	.	.		.	.	.	.	+	.	+	.	**II**
Juniperus communis	.	.	.		.	+	+	+	2	2	1	2	**V**
Salix caprea	.	.	.		+	.	+	+	+	.	+	1	**IV**
Populus tremula	.	+	.	**1**	.	.	.	+	+	+	.	.	**II**
Padus avium	.	.	+	**1**	.	+	.	.	.	+	.	.	**II**
Rubus saxatilis E1	1	2	1	**3**	2	1	2	3	1	2	2	2	**V**
Veronica chamaedrys	+	+	+	**3**	+	+	+	+	+	+	+	+	**V**
Pimpinella saxifraga	+	1	1	**3**	.	+	+	+	.	+	2	1	**IV**
Galium album	+	+	+	**3**	+	+	.	.	+	+	1	+	**IV**
Viola canina	+	+	+	**3**	+	+	.	+	.	+	+	+	**IV**
Convallaria majalis	+	+	1	**3**	+	+	1	1	.	.	.	.	**III**
Solidago virgaurea	+	1	+	**3**	.	.	.	.	+	.	.	+	**II**
Fragaria vesca	.	+	+	**2**	+	1	2	+	+	+	+	+	**V**
Pteridium aquilinum	.	1	+	**2**	3	2	2	1	2	3	3	.	**V**

Table 4 (continuation)

Number of relevé	1	2	3	Constancy	4	5	6	7	8	9	10	11	Constancy
Number of species per relevé	60	58	45		49	48	66	60	47	70	69	66	
Cover of tree layer, %	50	35	20		30	30	20	40	30	30	20	20	
Cover of shrub layer, %	70	40	70		5	6	5	10	15	15	10	15	
Cover of herb layer, %	20	15	15		90	75	95	80	40	75	90	35	
Cover of moss layer, %	65	65	45		70	65	60	55	60	20	30	65	
Geranium sylvaticum	+	.	+	2	+	1	1	1	.	+	1	+	V
Campanula persicifolia	+	.	+	2	+	+	+	+	+	+	+	+	V
Melampyrum pratense	+	+	.	2	.	1	+	2	.	1	.	2	IV
Luzula pilosa	+	.	+	2	.	.	+	+	.	+	+	+	IV
Veronica officinalis	+	+	.	2	.	.	+	+	+	+	.	+	IV
Trifolium alpestre	+	+	.	2	+	.	+	.	+	+	+	1	IV
Dryopteris carthusiana	+	+	.	2	+	+	+	+	.	+	.	+	IV
Rubus idaeus	+	.	+	2	.	+	+	+	.	+	.	+	IV
Polygonatum odoratum	+	.	+	2	+	+	.	.	+	+	+	.	IV
Taraxacum officinale	.	+	+	2	+	.	+	.	+	+	+	+	IV
Trifolium medium	+	+	.	2	.	.	+	+	.	+	+	.	III
Primula veris	+	.	+	2	.	.	.	.	.	.	.	+	I
Angelica sylvestris	+	.	+	2	.	.	.	.	.	.	.	.	
Agrostis tenuis	.	+	.	1	+	.	+	+	+	+	+	+	V
Knautia arvensis	.	+	.	1	.	.	+	+	+	+	+	+	IV
Galium boreale	.	.	+	1	+	+	+	+	1	.	+	.	IV
Potentilla erecta	+	.	.	1	+	+	+	.	.	+	+	+	IV
Mycelis muralis	.	.	+	1	.	.	.	.	.	+	+	.	II
Succisa pratensis	+	.	.	1	+	.	1	.	.	+	.	.	II
Clinopodium vulgare	+	.	.	1	.	.	.	.	.	+	1	+	II
Stachys officinalis	+	.	.	1	.	.	.	.	.	.	1	1	II
Aquilegia vulgaris	+	.	.	1	.	.	.	.	.	+	+	.	II
Anthryscus sylvestris	+	.	.	1	.	+	+	+	.	.	.	.	II
Lathyrus sylvestris	1	.	.	1	.	.	+	.	.	.	1	.	II
Ajuga pyramidalis	.	+	.	1	.	.	.	+	.	+	.	.	II
Cerastium holosteoides	.	+	.	1	.	.	.	.	.	.	+	+	II
Moehringia trinervia	+	.	.	1	.	.	.	+	.	.	.	.	I
Hypericum maculatum	+	.	.	1	.	.	.	.	.	+	.	.	I
Silene vulgaris	.	+	.	1	.	.	.	.	.	.	+	.	I
Brachypodium pinnatum	.	.	.		3	4	4	3	2	2	2	2	V
Festuca rubra	.	.	.		.	+	+	+	+	+	1	+	V

Table 4 (the end)

Number of relevé	1	2	3	Constancy	4	5	6	7	8	9	10	11	Constancy
Number of species per relevé	60	58	45		49	48	66	60	47	70	69	66	
Cover of tree layer, %	50	35	20		30	30	20	40	30	30	20	20	
Cover of shrub layer, %	70	40	70		5	6	5	10	15	15	10	15	
Cover of herb layer, %	20	15	15		90	75	95	80	40	75	90	35	
Cover of moss layer, %	65	65	45		70	65	60	55	60	20	30	65	
Calluna vulgaris	.	.	.		+	.	+	.	+	.	+	+	IV
Anthoxanthum odoratum	.	.	.		.	.	.	+	+	+	+	+	IV
Stellaria graminea	.	.	.		.	.	+	.	+	+	1	+	IV
Lathyrus pisiformis	.	.	.		+	1	1	1	.	.	.	.	III
Molinia caerulea	.	.	.		+	1	+	.	.	.	.	+	III
Achillea millefolium	.	.	.		.	+	+	+	.	.	.	+	III
Viola riviniana	.	.	.		.	.	+	+	.	+	+	.	III
Chamaenerion angustifolium	.	.	.		.	.	+	+	.	+	+	.	III
Scorzonera humilis	.	.	.		.	.	+	+	.	+	+	.	III
Ranunculus polyanthemos	.	.	.		.	.	+	.	.	+	+	.	II
Lathyrus pratensis	.	.	.		+	.	+	.	+	.	.	.	II
Agrimonia eupatoria	.	.	.		.	.	.	.	+	.	+	+	II
Vicia cracca	.	.	.		.	.	.	.	+	.	+	.	II
Silene nutans	.	.	.		.	.	.	.	+	+	.	.	II
Festuca ovina	.	.	.		.	.	.	+	.	.	.	+	II
Hypericum perforatum	.	.	.		.	.	.	.	+	.	.	+	II
Platanthera bifolia	.	.	.		.	.	.	+	.	+	.	.	II
Trommsdorfia maculata	.	.	.		+	.	.	+	.	.	.	.	II
Plagiomnium affine E0	2	2	2	3	+	.	+	2	+	+	1	+	V
Brachythecium oedipodium	+	2	2	3	1	+	+	2	+	+	+	+	V
Rhytidiadelphus triquetrus	+	+	.	2	.	.	.	.	.	.	+	+	II
Rhodobryum roseum	+	.	+	2	.	.	+	.	.	.	.	.	I
Cirriphyllum piliferum	2	.	.	1	.	.	+	.	.	.	.	.	I
Aulacomnium palustre	.	.	.		.	.	+	+	+	.	+	+	IV
Polytrichum juniperinum	.	.	.		.	.	+	.	.	.	+	.	II

Species in 1 relevé: E2 *Swida alba* +(4), *Euonymus verrucosa* +(5), *Rhamnus cathartica* +(5), *Salix myrsinifolia* +(6), *Betula pubescens* +(7), *Berberis vulgaris* +(10).

E1 *Festuca gigantea* +(1), *Oxalis acetosella* +(1), *Chimaphila umbellata* +(2), *Epilobium montanum* +(2), *Leucanthemum vulgare* +(2), *Lycopodium annotinum* +(2), *Pilosella officinarum* +(2), *Vicia sepium* +(2), *Thalictrum flavum* +(4), *Glechoma hederacea* +(5), *Holcus lanatus* +(5), *Poa nemoralis* +(5), *Stellaria holostea* +(5), *Viola mirabilis* +(5), *Linnaea borealis* +(6), *Polygonatum multiflorum* +(6), *Veronica longifolia* +(6), *Luzula multiflora* +(8), *Carex pallescens* +(9), *Seseli libanotis* +(9), *Veronica spicata* +(9), *Vicia cassubica* +(9), *Calamagrostis epigeios* 1(10), *Centaurea jacea* +(10), *Digitalis grandiflora* 1(10), *Epipactis atrorubens* +(10), *Leontodon hispidus* +(10), *Origanum vulgare* +(10), *Prunella vulgaris* +(10), *Briza media* +(11), *Carex caryophyllea* +(11), *Cirsium vulgare* +(11), *Phleum pratense* +(11), *Pulsatilla patens* +(11), *Selinum carvifolia* +(11).

E0 *Polytrichum commune* +(1), *Dicranum scoparium* +(5), *Plagiothecium ruthei* +(7).

Comparison of plant communities

In Table 5, 59 species are separated, which have constancy higher than 50% (V and IV constancy class) in at least one community. In all communities, characteristic species of Vaccinio-Piceetea and Pulsatillo-Pinetea are widespread except *Diphasiastrum complanatum* and lichens *Cladina arbuscula*, *C. rangiferina*. They are constantly present in Cladonio-Pinetum, but rare or absent in other communities.

Ass. Vaccinio vitis-idaeo-Pinetum is characterized by larger cover of forest dwarf shrubs *Vaccinium vitis-idaea*, *V. myrtillus*.

Community *Convallaria majalis-Pinus sylvestris* has some features of Cl. Querco-Fagetea characterized by high constancy of *Convallaria majalis* in herb layer and *Quercus robur* in underwood.

The most peculiar is community *Brachypodium pinnatum-Pinus sylvestris*, for which almost three times higher cover of herb layer is characteristic as in other communities, as well as constant species *Brachypodium pinnatum*, *Campanula persicifolia*, *Geranium sylvaticum* rare or absent in other pine forests.

Table 5

Constancy of the most distributed species

Index/species	Cladonio-Pinetum	Vaccinio vitis-idaeo-Pinetum	*Convallaria majalis Pinus sylvestris community*	*Brachypodium pinnatum-Pinus sylvestris community*
Total number of species	54	96	164	140
Average number of species per relevé	24	34	50	59
Average cover of tree layer %	21	28	29	28
Average cover of shrub layer %	8	7	9	10
Average cover of herb layer %	21	24	28	73
Average cover of moss layer %	65	72	67	53
Characteristic species of the Cl. Vaccinio-Piceetea and Pulsatillo-Pinetea				
Pinus sylvestris E3	V	V	V	V
Pinus sylvestris E1	V	IV	III	II
Picea abies E3	IV	.	IV	V
Picea abies E2	V	V	V	IV
Vaccinium vitis-idaea E1	V	V	IV	V
Vaccinium myrtillus	V	IV	IV	V
Diphasiastrum complanatum	V	.	I	.
Goodyera repens	.	III	IV	IV
Trientalis europaea	I	II	II	IV
Pleurozium schreberi E0	V	V	V	V

Table 5 (continuation)

Index/species	Cladonio-Pinetum	Vaccinio vitis-idaeo-Pinetum	*Convallaria majalis Pinus sylvestris community*	*Brachypodium pinnatum-Pinus sylvestris community*
Hylocomium splendens	IV	V	V	V
Ptilium crista-castrensis	I	V	V	V
Dicranum polysetum	V	V	V	II
Cladina arbuscula	V	III	I	.
Cladina rangiferina	V	II	.	.
Other species				
Betula pendula E2	V	V	III	IV
Calluna vulgaris E1	V	V	V	IV
Melampyrum pratense	V	V	V	IV
Festuca ovina	V	V	V	II
Polytrichum juniperinum E0	IV	III	II	II
Aulacomnium palustre	III	II	II	IV
Brachythecium oedipodium	I	I	III	V
Pohlia nutans	IV	II	I	.
Sorbus aucuparia E2	.	V	V	III
Juniperus communis	II	V	V	V
Frangula alnus	III	IV	IV	IV
Quercus robur	III	IV	V	IV
Salix caprea	III	II	III	IV
Calamagrostis epigeios E1	III	IV	IV	.
Veronica officinalis	II	II	IV	IV
Convallaria majalis	II	IV	V	III
Agrostis tenuis	II	III	V	V
Solidago virgaurea	I	IV	IV	II
Luzula pilosa	I	IV	V	IV
Rubus saxatilis	I	III	V	V
Dryopteris carthusiana	I	IV	III	IV
Rubus idaeus	I	II	III	IV
Viola canina	I	I	V	IV
Calamagrostis arundinacea	I	III	IV	V
Anthoxanthum odoratum	.	III	IV	IV
Fragaria vesca	.	II	V	V
Pilosella officinarum	.	II	V	.
Pteridium aquilinum	.	II	II	V

Table 5 (the end)

Index/species	Cladonio-Pinetum	Vaccinio vitis-idaeo-Pinetum	*Convallaria majalis Pinus sylvestris community*	*Brachypodium pinnatum-Pinus sylvestris community*
Polygonatum odoratum	.	II	III	IV
Knautia arvensis	.	I	IV	IV
Galium album	.	I	IV	IV
Festuca rubra	.	I	III	V
Veronica chamaedrys	.	I	II	V
Trifolium alpestre	.	I	III	IV
Pimpinella saxifraga	.	.	V	IV
Melica nutans	.	.	II	V
Taraxacum officinale	.	.	II	IV
Brachypodium pinnatum	.	.	I	V
Geranium sylvaticum	.	.	I	V
Campanula persicifolia	.	.	I	V
Hepatica nobilis	.	.	I	IV
Lathyrus vernus	.	.	I	IV
Galium boreale	.	.	I	IV
Stellaria graminea	.	.	I	IV
Potentilla erecta	.	.	.	IV
Plagiomnium affine E0	.	I	.	V

Species indicator values

Ecological factors like light, temperature, moisture, continentality, soil reaction and nitrogen content are analysed according to standard scales applied in Europe (Ellenberg, et al. 1992). Their values are summarised in Table 6.

In all the 4 plant communities the light factor is almost the same. Semi-shade species dominate. Most of light-demanding species occur in Cladonio-Pinetum.

Temperature factor is characterised by species adapted to cool climate. Most of the species of medium warm climate are in *Brachypodium pinnatum-Pinus sylvestris* community where most of the submeridional species occur.

Moisture factors for the studied communities differ little. Xeromesophytic species dominate.

Continentality factors are similar for the studied communities and testify that mainly suboceanic species occur.

Table 6

Mean values of species ecological factors

Factors	Cladonio-Pinetum	Vaccinio vitis-idaeo-Pinetum	*Convallaria majalis Pinus sylvestris* community	*Brachypodium pinnatum-Pinus sylvestris* community
Light	6.3	6.1	6.1	5.9
Temperature	3.4	3.6	3.1	4.3
Moisture	4.5	4.5	4.4	4.7
Continentality	5.4	5.1	4.8	4.7
Soil reaction	2.8	3.3	4.0	4.7
Nitrogen	2.2	3.0	3.4	3.8

Other soil indicators, like nitrogen content and soil reaction form an ecological series. Soil reaction varies from 2.8 (acidic soils) in Cladonio-Pinetum to 4.7 (medium acidic soils) in *Brachypodium pinnatum-Pinus sylvestris* community. Nitrogen content in the soils is small and ranges between 2.2 (poor soils) in Cladonio-Pinetum community up to 3.8 (medium rich soils) in *Brachypodium pinnatum-Pinus sylvestris* community.

Conclusion can be derived that for the studied communities the indicators that characterise climate (temperature, moisture, continentality and tree growth influencing light) differ very little. Different by 1–2 classes are soil indicators, such as nitrogen content and soil reaction. Therefore, the edaphic factors determine the differences between the plant communities. Similar results were obtained studying pine forests on hills and hill changes (Bambe 1999). The community *Brachypodium pinnatum-Pinus sylvestris* is ecologically similar to ass. Melico nutantis-Pinetum on the southern slopes of Grebļakalns, however, there is a higher soil reaction – 5.5.

Structure of geographical elements

Zonality

In the studied communities species of three zonality groups dominate – boreo-temperate (characteristic for cool climate), temperate to submeridional (characteristic for medium warm climate) and polizonal (distribution does not depend on air temperature). Species division according to zonality groups is given in Table 7.

Two community groups are relatively well separated. In the communities Cladonio-Pinetum and Vaccinio vitis-idaeo-Pinetum about 45% boreo-temperate species occur but in both the species-rich communities *Brachypodium pinnatum-Pinus sylvestris* and *Convallaria majalis-Pinus sylvestris* their occurrence is much smaller – about 30%. In these communities species characteristic for moderately warm climate (temperate to submeridional) dominate (>42%), but in Cladonio-Pinetum they are represented by less than 20%. Polizonal species dominate here – about 30%.

Table 7

Species division according to zonality groups in percentages

Zonality groups	Cladonio-Pinetum	Vaccinio vitis-idaeo-Pinetum	*Convallaria majalis Pinus sylvestris* community	*Brachypodium pinnatum-Pinus sylvestris* community
Boreo-temperate	45.9	43.2	30.1	28.9
Temperate	5.4	2.7	2.7	0.9
Temperate-submeridional	18.9	28.4	42.5	42.1
Submeridional	0	1.4	2.1	2.6
Polizonal	29.7	24.3	22.6	25.4

Sectorality

Sectorality characterizes the main types of species distribution areas. Structure of sectorality is revealed in Table 8. Most common are 4 types of species distribution areas: circumpolar, European, Eurosiberian and Eurasian.

Circumpolar species are connected with cool climate regions and number of these species gradually decreases in the direction from Cladonio-Pinetum to *Brachypodium pinnatum-Pinus sylvestris*. European-Asia-Minor species occur only in the species-rich communities *Brachypodium pinnatum-Pinus sylvestris* and *Convallaria majalis-Pinus sylvestris*. This group includes several species characteristic for dry meadows in the eastern part of Latvia, such as *Agrimonia eupatoria, Centaurea scabiosa, Pimpinella saxifraga, Senecio jacobea* and *Veronica spicata.*

Table 8

Species division according to the sectorality groups in percentages

Sectorality groups	Cladonio-Pinetum	Vaccinio vitis-idaeo-Pinetum	*Convallaria majalis Pinus sylvestris* community	*Brachypodium pinnatum-Pinus sylvestris* community
Circumpolar	29.7	25.7	18.5	14.9
Circumpolar- North American	2.7	1.4	0.7	0.9
Euroamerican	0	1.4	0	0
European	16.2	18.9	19.2	17.5
European-North American	2.7	2.7	2.1	1.8
European- Asia Minor	0	0	6.8	7.9
Eurosibirian	18.9	21.6	16.4	21.9
Eurosibirian- North American	0	1.4	3.4	3.5
Eurasian	16.2	17.6	20.5	21.9
Eurasian - North American	13.5	8.1	10.3	8.8
Cosmopolites	0	1.4	0.7	0.9

Oceanity

Species distribution according to oceanity groups is shown in Table 9. Most of all there are slightly oceanic, suboceanic, as well as continental and indifferent species. In the species richest communities, like *Brachypodium pinnatum-Pinus sylvestris* and *Convallaria maajlis-Pinus sylvestris* there is a larger number of slightly oceanic species but in Cladonio-Pinetum and Vaccinio vitis-idaeo-Pinetum there are comparatively more continental and indifferent species.

Table 9

Species division according to oceanity groups in percentages

Oceanity groups	Cladonio-Pinetum	Vaccinio vitis-idaeo-Pinetum	*Convallaria majalis Pinus sylvestris* community	*Brachypodium pinnatum-Pinus sylvestris* community
Oceanic	0	1.4	2.7	1.8
Slightly oceanic	32.4	32.4	38.4	42.1
Suboceanic	16.2	20.3	20.5	19.3
Subcontinental	13.5	12.2	11.0	7.9
Continental	16.2	16.2	13.0	14.0
Indifferent	21.6	17.6	14.4	14.9

DISCUSSION

Scots pine in Latvia is the most widespread tree species. It dominates on more than 676 300 ha of forest land area (State Forest Service data of 2002). It is ecologically most adapted species as it occurs on the soils of all forest type groups, like dry, wet, swamp, drained forests on peat and mineral soil. For most of pine forests, rather simple ground layer structure is characteristic where dwarf shrubs *Vaccinium vitis-idaea, V. myrtillus* dominate but in the vicinity of large cities, the vegetation has changed due to human influence and many synatrophic species occur there (Laiviņš, Laiviņa 1991; Laiviņš 1998).

In the Daugava Loki Nature Park pine forest communities both with natural, for oligotrophic to oligo-mesotrophic vegetation (Ass. Cladonio-Pinetum, Vaccinio vitis-idaeo-Pinetum) and species-rich communities were described which are difficult to compare to other forests elsewhere. They differ from species-rich pine forests in other parts of Latvia (Bambe 1999; Kreile 2002), also in the neighbouring countries (Каразия 1988; Миркин 1986) and elsewhere in Europe (Krausch 1962; Matuszkiewicz 1962; Passarge, Hofmann 1968; Kielland-Lund 1981; Oberdorfer 1992; Dierßen 1996).

In the pine forest vegetation, several species with European-Asia Minor distribution area occur that are characteristic for dry grasslands in eastern Latvia, such as *Agrimonia eupatoria, Centaurea scabiosa, Pimpinella saxifraga, Senecio jacobaea* and *Veronica spicata*. Commonly there is no one dominating species but together with *Vaccinium vitis-idaea, V. myrtillus* a considerable coverage has also *Rubus saxatilis, Fragaria vesca*. Rich in grass species field layer has developed in separate pine forest areas of the Daugava River meanders where *Brachypodium pinnatum* dominates which is a character species of the Cl. Festuco-Brometea (subcontinental dry grasslands) (Laiviņš 1998). In Latvia, it can also be distinguished as a diagnostic species of subcontinental pine and oak communities (Laiviņš 2001).

In the *Brachypodium pinnatum-Pinus sylvestris* community, also a very rare species occurs, like *Lathyrus pisiformis* with only 3 localities known in Latvia where it reaches the western border of its distribution (Табака et al. 1988; Fatare 1992). Pine and mixed forest communities in which the species occurs are mentioned from Western Siberia and Altai (Ermakov et al. 2000) but most of the eastern species occurring there does not grow in Latvia.

Species-rich pine forest communities occur also elsewhere in Europe. In Germany, Ass. Pyrolo-Pinetum of the Cl. Pulsatillo-Pinetea was described. It is an endangered plant community. The occurrence of *Chimaphila umbellata* – character species of Pyrolo-Pinetum decreases in Germany. It can be caused by air pollution that makes soil more acidic and eutrophic. Climate changes could be a less probable reason (Oberdorfer 1992).

There is a question under discussion – can we assign the pine forest communities described in the Daugava Loki Nature Park to the subcontinental dry pine forest Cl. Pulsatillo-Pinetea or still Vaccinio-Piceetea communities. Characteristic species of Cl. Pulsatillo-Pinetea, O. Pulsatillo-Pinetalia, All. Cytiso-Pinion are *Pyrola chlorantha, Diphasiastrum complanatum, Pulsatilla patens, P. pratensis* (?), *Cytisus nigricans, Chimaphila umbellata, Carex ericetorum, Viola rupestris* (Laiviņš 1998). In our relevés, *Cytisus nigricans* and *Pulsatilla pratensis* do not occur. The latter species is characteristic for the western part of Latvia where the forest communities similar to the Cl. Pulsatillo-Pinetea were described in Ovīši Nature Reserve (Ofkante 2001). Other species in the Daugava Loki Nature Park are of small coverage, the constancy class is not higher than III (*Chimaphila umbellata, Carex ericetorum* in Ass. Vaccinio vitis-idaeo-Pinetum; *Chimaphila umbellata, Pulsatilla patens* in *Convallaria majalis-Pinus sylvestris* community). *Chimaphila umbellata* in Daugava Loki Nature Park is richer in flowers and has a higher vitality than commonly in pine forests of Latvia. In the descriptions of *Brachypodium pinnatum-Pinus sylvestris* community these species have an accidental character. Therefore it is possible to assert that more similar to the Cl. Pulsatillo-Pinetea are *Convallaria majalis-Pinus sylvestris* communities, but the features of this class have also the forests of Ass. Vaccinio vitis-idaeo-Pinetum.

In author's opinion, in the development of species-rich pine forests in the Daugava Loki Nature Park interaction of various factors are observed: 1) species migration along the Daugava River; 2) warmer climate than in the rest of Latvia; 3) diverse, in places lime-rich soils; 4) human impact – part of the forests grow on earlier agricultural land and in most of the forests animals were pastured 50 and more years ago.

Floristically rich pine forests have several features in common: 1) low tree layer density that favours the growth of rather light-demanding species; 2) admixture of birch to pine which is a dominant species; 3) alongside with forest herb layer species species of grasslands and forest edges occur.

Conclusions

1. Communities described in the pine forests of the Daugava Loki Nature Park using the Braun-Blanquet system are assigned to the syntaxonomic structure as follows:

    Cl. Vaccinio-Piceetea Br.-Bl. in Br.-Bl. et al. 1939
    O. Piceetalia abietis Pawl. et al. 1928
    All. Dicrano-Pinion Matusz. 1962 emend. Oberd. 1979
    Associations
    1. Cladonio-Pinetum (Cajander 1921) Kielland-Lund 1967
    2. Vaccinio vitis-idaeo-Pinetum Cajander 1921
    1. *Convallaria majalis-Pinus sylvestris* communities
    2. *Brachypodium pinnatum-Pinus sylvestris* communities

2. For the studied communities ecological indicators characterising climate (moisture, continentality) and the tree growth influence on vegetation (light) differ slightly. Soil indicators differ by 1–2 classes, like nitrogen content and soil reaction. Therefore, the edaphic conditions determine the main differences between plant communities. These indicators form an increasing ecological series starting from Cladonio-Pinetum leading to *Brachypodium pinnatum-Pinus sylvestris* community.

3. In the Cladonio-Pinetum and Vaccinio vitis-idaeo-Pinetum the species characteristic for cool and temperate climate dominate but in *Convallaria majalis-Pinus sylvestris* and *Brachypodium pinnatum-Pinus sylvestris* community species of moderately warm climate are prevailing.

4. In the pine forests of the Daugava Loki Nature Park 14 rare and protected plant species were found. Habitats of high importance are those with *Neottianthe cucullata, Dracocephalum ruyschiana, Pulmonaria angustifolia* in the *Convallaria majalis-Pinus sylvestris* community and *Lathyrus pisiformis* in the *Brachypodium pinnatum-Pinus sylvestris* community. In both the above mentioned communities *Ajuga pyramidalis* and *Trifolium alpestre* occur.

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REFERENCES

Āboliņa A. 2001. Latvijas sūnu saraksts (List of bryophytes of Latvia). – *Latvijas Veģetācija*, 3:47–87.

Bambe B. 1999. Sausieņu priežu mežu augu sabiedrības pauguraines un uz pauguru grēdām (Plant communities of dry pine forests on hills and hill changes). – *Mežzinātne*, 8(41):3–42.

Dierßen K. 1996. *Vegetation Nordeuropas*. Verlag Eugen Ulmer, Stuttgart, 838 S.

Ellenberg H., Weber H. E., Düll R., Wirth W., Werner W., Paulißen D. 1992. Zeigerwerte von Pflanzen in Mitteleuropa. *Scripta Geobotanica*, Vol.18, Verlag Erich Goltze, 258 S.

Ermakov N., Dring J., Rodwell J., 2000. Classification of continental hemiboreal forests of North Asia. – *Braun-Blanquetia*, 28, 132 p.

Fatare I. 1987. *Daugavas ielejas flora* (Flora of the Daugava River valley). – Rīga, Zinātne, 80 lpp.

Fatare I. 1992. Latvijas floras komponentu izplatības analīze un tās nozīme augu sugu aizsardzības koncepcijas izstrādāšanā (The analysis of distribution of Latvian autochthonous floral components and its importance in developing a conception on plant species protection). – *Vides aizsardzība Latvijā* 3. Rīga, 258 lpp.

Gavrilova Ģ., Šulcs V. 1999. *Latvijas vaskulāro augu flora*. Taksonu saraksts (Flora of Latvian vascular plants). Rīga, 136 lpp.

Hill M. O. 1979. *TWINSPAN. A FORTRAN Program for Arranging Multivariate Data in an Ordered Two Way Table by Classification of the Individuals and Attributes. Ecology and Systematics.* Cornell University Ithaca, New York, 47 p.

Karazija S. 1988. *Lietuvos miškų tipai* (Types of forests in Lithuania). *Vilnius*, Mokslas, 212 pp.

Kielland-Lund A. 1981. Die Waldgesellschaften SO-Norvegens. – *Phytocoenologia* 2, 1/2:53–250.

Krausch H. 1962. Der Sandnelken-Kiefernwald an seiner Westgrenze in Brandenburg. – *Mitteilung der floristisch-soziologischen Arbeitsgemeinschaft* Stolzenau/Weser. NF., 9:141–144.

Kreile V. 2002. Priežu meži ar asinssārto gandreni *Geranium sanguineum* L. Madonas-Trepes valnī (Pine forests with *Geranium sanguineum* L. on Madona-Trepe hill change). – Ģeogrāfija. Ģeoloģija. Vides zinātne. LU 60. Zinātniskā konference. Referātu tēzes, 74.–78. lpp.

Laiviņš M., Laiviņa S. 1991. Jūrmalas mežu sinantropizācija (Forest synanthropization in Jūrmala). – *Jaunākais Mežsaimniecībā*, 33:67–83.

Laiviņš M. 1998. a. Latvijas boreālo priežu mežu sinantropizācija un eitrofikācija (Synanthrophization and eutrophication of the boreal pine forests of Latvia). – *Latvijas Veģetācija*, 1. 137 lpp.

Laiviņš M. 1998. b. Latvijas ziedaugu un paparžaugu sabiedribu augstākie sintaksoni (Highest syntaxonomic units of plant communities of Latvia). – *Latvijas purvu veģetācijas klasifikācija un dinamika. LU Zinātniskie raksti*, 613:7–22.

Laiviņš M. 2001. Subkontinentālie priežu un ozolu meži Latvijā (Subcontinental pine and oak forests in Latvia). – Book of Abstracts. International Conference Research and conservation of biological diversity in the Baltic Region. – Daugavpils, Latvia, April 26–28, 2001., 55. lpp.

Matuszkiewicz W. 1962. Zur Systematik der natürlichen Kiefernwälder des mittel- und osteuropäischen Flachlandes. – *Mitteilung der floristisch-soziologischen Arbeitsgemeinschaft* Stolzenau/Weser. NF., 9:145–186.

Nikodemusa A. 1994. "Daugavas loki". – *Latvijas Daba*. Enciklopēdija. 1, 218.–219. lpp.

Oberdorfer E. (Hrsg.) 1992. *Süddeutsche Pflanzengesellschaften. Wälder und Gebüsche*. A Textband. 2. Aufl. Teil 4. Gustav Fischer Verlag, Jena, Stuttgart, New York, 282 S.

Ofkante D. 2001. Sauso priežu mežu augu sabiedrības Baltijas jūras piekrastē "Ovīšu" dabas liegumā (Plant communities of dry pine forests on coast of the Baltic Sea in the Ovisi Nature Reserve). – Book of Abstracts. International Conference Research and conservation of biological diversity in the Baltic Region. – Daugavpils, Latvia, April 26–28, 2001., 67.–68. lpp.

Passarge H., Hofmann G. 1968. Pflanzengesellschaften des nordostdeutschen Flachlandes. – *Pflanzensoziologie*, Gustav Fischer Verlag, Jena, Bd. 16, Teil II, 298 ss.

Piterāns A. 2001. Latvijas ķērpju konspekts (Checklist of the lichens of Latvia). – *Latvijas Veģetācija*, 3:5–46.

Миркин Б. М. 1986. *Классификация растительности СССР с использыванием флористических критериев* (Vegetation classification of USSR using floristical criteria). Изд. МГУ, 200 с.

Табака Л., Гаврилова Г., Фатаре И. 1988. *Флора сосудистых растений Латвийской ССР* (Flora of vascular plants of the Latvian SSR). – Рига, Зинатне, 195 с.

Фатаре И. 1989. *Флора долины реки Даугавы* (Flora of the Daugava River valley). – Рига. Зинатне, 168 с.

Priežu mežu augu sabiedrības dabas parkā "Daugavas loki"

Kopsavilkums

Priežu meži dabas parkā "Daugavas loki" tika aprakstīti, izmantojot Brauna-Blankē metodi, lai skaidrotu augu sabiedrību struktūru un ekoloģiju vietās, kur sastopamas Latvijā retas un aizsargājamas augu sugas.

Aprakstītas divas Latvijas priežu mežiem tipiskas asociācijas Cladonio-Pinetum un Vaccinio vitis-idaeo-Pinetum un divas retas sabiedrības *Convallaria majalis-Pinus sylvestris* un *Brachypodium pinnatum-Pinus sylvestris*. Analizējot sugu ekoloģiskos rādītājus ar Ellenberga standartskalām, noskaidrots, ka augu sabiedrību atšķirības nosaka galvenokārt edafiskie faktori – slāpekļa saturs un augsnes reakcija.

Nozīmīgākie vārdi: Priežu meži, augu sabiedrības, Cladonio-Pinetum, Vaccinio vitis-idaeo-Pinetum, *Convallaria majalis-Pinus sylvestris, Brachypodium pinnatum-Pinus sylvestris.*

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Vegetation of dry subcontinental pine forests in central and eastern Latvia

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Abstract

The dry subcontinental pine forest vegetation was described in the central and eastern part of Latvia. 88 relevés were divided into 5 clusters by classification program TWINSPAN. According to species composition 5 plant communities were described: *Thymus serpyllum-Pinus sylvestris* community, *Carex ericetorum-Pinus sylvestris* community, *Convallaria majalis-Pinus sylvestris* community, Ass. Cladonio-Pinetum var. *Polygonatum odoratum*, Ass. Cladonio-Pinetum. There is a slight difference between ecological values in investigated forest plant communities. Character species of classes Vaccinio-Piceetea, Pulsatillo-Pinetea, Koelerio-Corynephoretea occur in all plant communities.

Key words: pine, forest plant communities.

INTRODUCTION

The majority of Latvian forests belong to boreal coniferous Cl. Vaccinio-Piceetea. Subcontinental forests of Cl. Pulsatillo-Pinetea with light demanding plant species occur in valleys of rivers and on hill slopes with specific temperature regime and calcareous substrate. Character species of Cl. Koelerio-Corynephoretea are common on dry slopes close to the sun-exposed clearings.

The natural and anthropogenic successions increase cover of shrubs and herbs. The light demanding plant species are decreasing and disappearing. On the other hand, forest cutting and roads stimulate the preservation of the light demanding plant species. Information regarding influence of forest management, tourism and recreation activities on plant species populations is scarce. There is also little information about distribution of dry subcontinental pine forests in Latvia.

The aim of the present work is to clarify the distribution and structure of dry subcontinental forests in Latvia.

Investigated localities

The investigations were carried out in pine forests on hills and slopes, in dry forests around the bogs and lakes in 4 geobotanical regions: the Middle Latvia, the Central Vidzeme, the East Latvia and the South-East Latvia. There are 88 relevés on 21 localities described: Baldone, Djatlovka, Driksna forest, Dviete, Gaigalava, Kalnis forest, Krišjāņi, Krustkalni Nature Reserve, Laukezers, Melnais hilly forest, Mežole, Numerne, Ozolsala, Pērlis forest, Posulnīca, Silene, Steķi forest, Taurkalne, Teiči Nature Reserve, Timsmales, Vecumnicki. The field work was carried out during the summer of 2001.

Methods

The method of Braun-Blanquet was applied for vegetation description (Braun-Blanquet 1964, Dierschke 1994, Pakalne, Znotiņa 1992). The area of relevés was 25 – 400 m^2.

The cover of 4 vegetation layers has been estimated: E3 – trees, E2 – shrubs and undergrowth, E1 – herbs and dwarf shrubs, seedlings of trees and shrubs, E0 – mosses and lichens on soil. Wherever possible, the age of pine stands according to forest data was estimated.

The data base was created in TURBO(VEG) (Hennekens 1995). The data has been grouped according to TWINSPAN (Hill 1979). Cover percentage was transformed to 6 grade scale: + (<1%), 1(1–5%), 2(6–25%), 3(26–50%), 4(51–75%), 5(76–100%) . The constancy (I – 1–20%, II – 21–40%, III – 41–60%, IV – 61–80%, V – 81–100%) of all species in each group was estimated.

The syntaxonomy was characterized according to character species (Kielland-Lund 1981, Oberdorfer 1992, Mucina a.o.1993, Pott 1995, Dierßen 1996, Laiviņš 1998).

The satellite maps scale 1:50000, forest use maps 1:20000, orienteering maps scale 1:10000 and 1:15000 have been used. The nomenclature of species: Gavrilova, Šulcs, 1999 (vascular plants); Āboliņa 2001 (mosses); Piterāns 2001 (macrolichens).

The Ellenberg's indicator values (Ellenberg et al. 1992) were used for determination of ecological factors. The geographical structure was analysed according to H.Meusel area diagnosis (Meusel 1965, Rothmaler 1976, Fatare 1992).

RESULTS

Classification of plant communities

The TWINSPAN divided the relevés into 5 clusters (Fig.1.). On the first level of TWINSPAN division, the light demanding vegetation (37 relevés with *Thymus serpyllum, Antennaria dioica, Hieracium umbellatum, Pulsatilla patens)* have been separated from other 51 relevés with differential species *Hylocomium splendens* and *Vaccinium vitis-idaea*.

On the second level of division, in each cluster species-rich relevés (with *Melampyrum pratense, Convallaria majalis, Calamagrostis arundinacea*) have been distinguished from relevés with lichens (*Cladina arbuscula*).

On the third level of division of the largest cluster, 10 relevés with *Polygonatum odoratum* and *Solidago virgaurea* have been separated from typical oligotrophic community with *Hylocomium splendens*.

The plant communities encounter species of very different syntaxa (several vegetation classes). Consequently, it is difficult to classify the communities in the phytosociological hierarchy of the Braun-Blanquet system. Therefore, 3 clusters are named

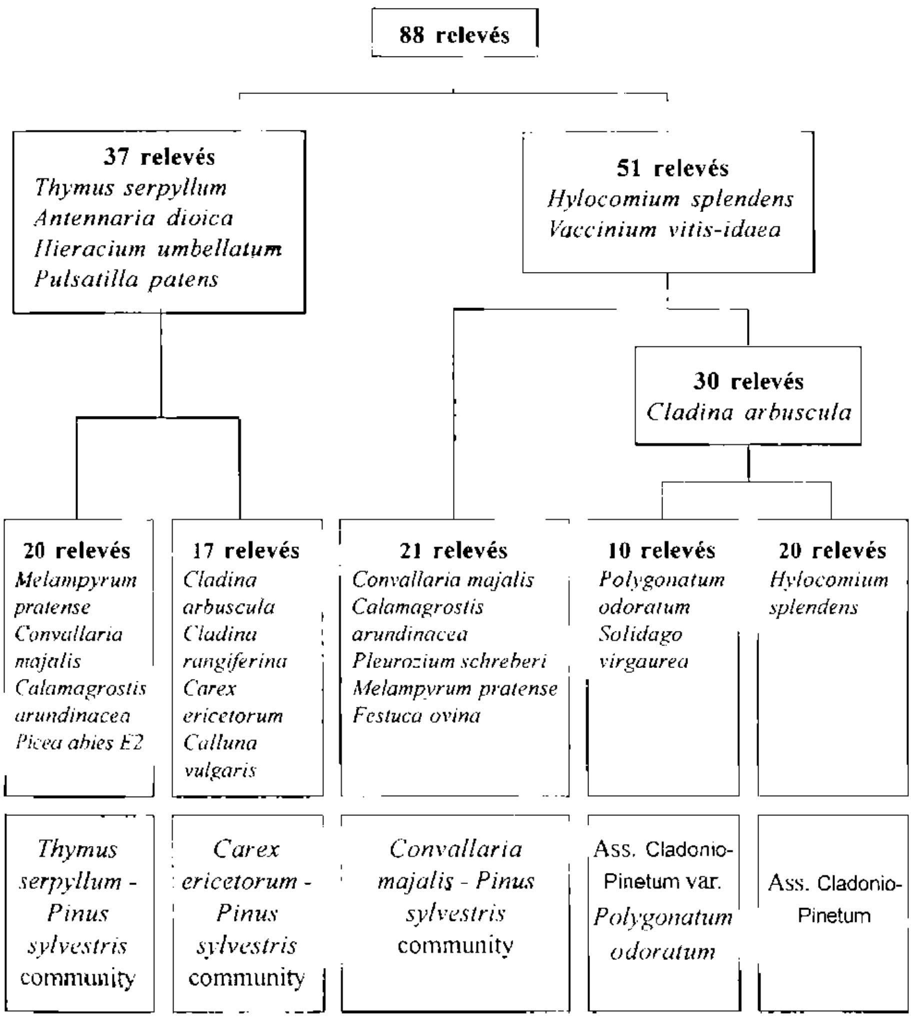

Fig.1. TWINSPAN division of relevés

according to differential species: *Thymus serpyllum* – *Pinus sylvestris* community, *Carex ericetorum* – *Pinus sylvestris* community, *Convallaria majalis* – *Pinus sylvestris* community. Other 2 clusters belong to the Ass. Cladonio-Pinetum – with *Polygonatum odoratum* and typical variant.

The synoptic table (Table 1) shows some differencial species complexes and similarity of divided communities as well. Both communities *Thymus serpyllum - Pinus sylvestris* and *Carex ericetorum - Pinus sylvestris* contain species with high constancy: *Hieracium umbellatum, Antennaria dioica, Pilosella officinarum, Thymus serpyllum*. There is a similarity between communities *Thymus serpyllum - Pinus sylvestris* and *Convallaria majalis - Pinus sylvestris* (constancy of *Melampyrum pratense, Calamagrostis arundinacea, Convallaria majalis, Luzula pilosa*) and between *Carex ericetorum - Pinus sylvestris* community and Ass. Cladonio-Pinetum var. *Polygonatum odoratum* (constancy of *Gypsophila fastigiata*). The constancy of lichens *Cladina* spp. increases from *Thymus serpyllum - Pinus sylvestris* community to Ass. Cladonio-Pinetum.

***Thymus serpyllum - Pinus sylvestris* community** (Appendix 1). These communities occupy sun-exposed southern and south-western slopes. The herb layer is species-rich, the average number of species per relevé is 24. The age of pine stands is 40-100 years. These communities have been found in Numerne, Driksna forest, near Laukezers, Posulnīca, Djatlovka, Vecumnieki, Gaigalava. The old fire signs can be discerned on 3 relevés of Driksna forest.

Pinus sylvestris forms the tree layer, somewhere with *Betula pendula*. The tree layer cover is 10–60%, on average – 39%. 10 species are registered on shrub layer, most common are *Picea abies, Quercus robur, Juniperus communis, Betula pendula*. The shrub layer cover is 1–15%, on average – 5%. The herb layer is formed by character species of Cl. Pulsatillo-Pinetea (*Carex ericetorum, Pulsatilla patens)* and Cl. Koelerio-Corynephoretea, Festuco-Brometea and Calluno-Ulicetea (*Thymus serpyllum, Hieracium umbellatum, Festuca ovina, Calluna vulgaris, Antennaria dioica, Pilosella officinarum)*. The other species with high constancy are *Solidago virgaurea, Melampyrum pratense, Polygonatum odoratum, Calamagrostis arundinacea*. In total, 64 species are registered in herb layer. The average herb layer cover is 45%. The moss layer is formed by *Pleurozium schreberi* and *Dicranum polysetum*, small patches with macrolichens are a rarity. The average cover of moss layer is 90%. Total number of moss species is 4, of macrolichens – 9.

***Carex ericetorum - Pinus sylvestris* community** (Appendix 2). The average number of species is 23. The majority of relevés is located on flat sites. Some relevés occur on the southern and the eastern slopes. The age of pine stands is 30–100 years. These communities have been found in Kalnis forest, Gaigalava, Steķi forest, Vecumnieki, Baldone, near Laukezers, Taurkalne.

The tree layer is formed by *Pinus sylvestris*. The average tree layer cover is 44%. The shrub layer is poorly developed, only 8 species are registered. The most common among them are *Picea abies, Juniperus communis*. The average shrub layer cover is 2%. Widely spread but with low cover are character species of Cl. Pulsatillo-Pinetea

Table 1

Synoptic table of dry subcontinental pine forest communities (without sporadic species)

Layer	Communities	*Thymus serpyllum – Pinus sylvestris* community	*Carex ericetorum – Pinus sylvestris* community	*Convallaria majalis - Pinus sylvestris* community	Ass. Cladonio-Pinetum var. *Polygonatum odoratum*	Ass. Cladonio-Pinetum
	Number of relevés	20	17	21	10	20
Character species of Cl. Vaccinio-Piceetea						
E3	*Pinus sylvestris*	V	V	V	V	V
E2	*Pinus sylvestris*	I	I	II	II	I
E1	*Pinus sylvestris*	I	I	II	II	II
E3	*Picea abies*	.	.	I	.	I
E2	*Picea abies*	V	III	V	II	V
E1	*Picea abies*	I	I	I	.	II
E2	*Juniperus communis*	III	III	IV	III	II
E1	*Juniperus communis*	.	I	.	I	I
E1	*Vaccinium vitis-idaea*	IV	III	IV	V	V
E1	*Vaccinium myrtillus*	II	III	III	II	IV
E1	*Arctostaphylos uva-ursi*	II	III	II	I	II
E1	*Trientalis europaea*	I	I	I	.	I
E1	*Monotropa hypopitys*	I	.	I	.	I
E1	*Orthilia secunda*	I	.	.	.	I
E0	*Dicranum polysetum*	V	V	V	V	V
E0	*Pleurozium schreberi*	V	V	V	V	V
E0	*Cladina rangiferina*	II	V	IV	V	IV
E0	*Cladina arbuscula*	II	V	III	V	IV
E0	*Hylocomium splendens*	I	II	V	I	V
E0	*Cladonia gracilis*	I	II	.	.	I
E0	*Ptilium crista-castrensis*	.	.	I	.	II
E0	*Cladonia crispata*	.	I	.	I	I
Character species of Cl. Pulsatillo-Pinetea, O. Pulsatillo-Pinetalia, All. Cytiso-Pinion						
E1	*Carex ericetorum*	IV	V	III	III	I
E1	*Pulsatilla patens*	IV	III	III	II	I
E1	*Chimaphila umbellata*	II	I	II	.	.
E1	*Diphasiastrum complanatum*	I	.	I	II	I
E1	*Pulsatilla pratensis*	I	I	I	I	.
E1	*Viola rupestris*	I	I	.	.	.
E1	*Epipactis atrorubens*	I	.	I	.	.
E1	*Pyrola chlorantha*	.	I	I	.	.

Table 1 (continuation)

Layer	Communities / Number of relevés	*Thymus serpyllum – Pinus sylvestris* community	*Carex ericetorum – Pinus sylvestris* community	*Convallaria majalis - Pinus sylvestris* community	Ass. Cladonio-Pinetum var. *Polygonatum odoratum*	Ass. Cladonio-Pinetum
	Number of relevés	20	17	21	10	20
Character species of Cl. Calluno-Ulicetea, Koelerio-Corynephoretea, Festuco-Brometea						
E1	*Calluna vulgaris* (C.-U.)	V	V	V	V	V
E1	*Festuca ovina* (C.-U.)	IV	V	IV	III	III
E1	*Hieracium umbellatum* (C.-U.)	IV	IV	II	I	I
E1	*Thymus serpyllum* (K.-C.)	V	IV	II	I	.
E1	*Pilosella officinarum* (K.-C.)	III	III	I	I	I
E1	*Antennaria dioica* (C.-U.)	III	III	I	.	.
E1	*Veronica spicata* (F.-B.)	I	II	I	.	.
E1	*Astragalus arenarius* (K.-C.)	I	II	I		I
E1	*Dianthus arenarius* (K.-C.)	I	II	I	I	.
E1	*Gypsophila fastigiata* (K.-C.)	.	II	I	III	.
E1	*Koeleria glauca* (K.-C.)	.	II	.	I	.
E1	*Empetrum nigrum* (C.-U.)	.	I	I	I	I
E1	*Lycopodium clavatum* (C.-U.)	I	I	.	.	I
E1	*Sieglingia decumbens* (C.-U.)	I	.	I	I	I
E1	*Pimpinella saxifraga* (F.-B.)	I	I	.	.	.
Other species						
E3	*Betula pendula*	II	I	II	.	I
E2	*Betula pendula*	III	II	II	I	III
E1	*Betula pendula*	I	I	.	.	I
E2	*Quercus robur*	III	II	III	II	I
E1	*Quercus robur*	II	II	II	I	II
E2	*Frangula alnus*	II	II	II	I	I
E1	*Frangula alnus*	I	I	I	.	I
E2	*Sorbus aucuparia*	II	I	II	.	.
E1	*Sorbus aucuparia*	I	.	I	.	.
E2	*Populus tremula*	II	I	I	.	.
E1	*Solidago virgaurea*	V	V	IV	IV	I
E1	*Melampyrum pratense*	V	I	V	I	III
E1	*Calamagrostis epigeios*	II	IV	III	IV	III
E1	*Polygonatum odoratum*	IV	III	II	IV	.
E1	*Calamagrostis arundinacea*	IV	I	III	.	I
E1	*Convallaria majalis*	III	I	IV	.	I

Table 1 (the end)

Layer	Communities	*Thymus serpyllum – Pinus sylvestris* community	*Carex ericetorum – Pinus sylvestris* community	*Convallaria majalis - Pinus sylvestris* community	Ass. Cladonio-Pinetum var. *Polygonatum odoratum*	Ass. Cladonio-Pinetum
	Number of relevés	20	17	21	10	20
E1	*Luzula pilosa*	II	I	II	I	I
E1	*Trommsdorfia maculata*	II	II	I	I	.
E1	*Campanula rotundifolia*	II	II	.	.	I
E1	*Koeleria grandis*	I	II	I	I	I
E1	*Knautia arvensis*	II	I	.	.	.
E1	*Geranium sanguineum*	II	.	.	.	.
E1	*Scorzonera humilis*	I	I	I	.	II
E0	*Cladina stellaris*	I	I	I	III	III
E0	*Cladonia cornuta*	I	I	I	II	I
E0	*Cladonia furcata*	I	II	I	I	I
E0	*Cladonia fimbriata*	I	I	I	I	I
E0	*Polytrichum juniperinum*	I	.	II	.	II
E0	*Cetraria islandica*	.	II	I	.	I

(*Carex ericetorum* and *Pulsatilla patens*). The species of Cl. Koelerio-Corynephoretea (*Thymus serpyllum, Pilosella officinarum, Koeleria glauca, Astragalus arenarius, Dianthus arenarius, Gypsophila fastigiata)* have constancy II–III. Total number of species in herb layer is 63, the average cover – 44%. In all, 6 moss species and 10 lichens are recorded. *Pleurozium schreberi* and *Dicranum polysetum* are dominating species. *Cladina arbuscula, Cladina rangiferina* have scarce cover, however they are widely spread. The mean moss layer cover is 75%.

***Convallaria majalis - Pinus sylvestris* community** (Appendix 3). The average number of species per relevé is 21. These communities have been found in Driksna forest, Melnais hilly forest, Krišjāņi, Silene, Posulnīca, near Laukezers, Vecumnieki, Timsmales, Pērlis forest, Gaigalava. The age of pine stands is 40–90 years. The relevés are both on flat areas and southern and eastern slopes.

The cover of tree layer is 10–50%, on average 37%. The tree layer is formed by *Pinus sylvestris*, somewhere with *Betula pendula*. In all, 55 species are registered in herb layer. It is formed by *Calluna vulgaris, Festuca ovina, Vaccinium vitis-idaea, Convallaria majalis.* Character species of Cl. Pulsatillo-Pinetea (*Carex ericetorum* and *Pulsatilla patens*) and of Cl. Koelerio-Corynephoretea are rare and with sparse cover. In all, 5 moss species and 9 lichen species were registered in moss layer. The dominant moss species is *Pleurozium schreberi. Dicranum polysetum* and *Hylocomium splendens. Cladina rangiferina* are common in this community. Other moss species are rare.

Ass. **Cladonio-Pinetum** var. ***Polygonatum odoratum*** (Appendix 4). The community is poor in species. Total 45 species are registered, the average number of species per relevé is 17. The relevés are described on flat areas and on slopes in Steķi forest, Kalnis forest, Pērlis forest, Timsmales. The age of pine stands is 30–80 years.

Pinus sylvestris forms the tree layer. The cover of tree layer is 20–60%, on average 37%. The shrub layer is poorly developed, mostly with *Juniperus communis*. The average shrub layer cover is 4%. The average herb layer cover is 35%. It forms *Calluna vulgaris* and *Vaccinium vitis-idaea*. The most common accompanying species with low cover are *Calamagrostis epigeios, Polygonatum odoratum* and *Solidago virgaurea*. In all 29 species are registered on herb layer. In 3 registers, *Diphasiastrum complanatum* has been qualified as having an outstanding cover. The dominant moss species are *Pleurozium schreberi* and *Dicranum polysetum*. The lichens *Cladina arbuscula, C.rangiferina, C.stellaris* form patches, on soil outcrops – lichenes *Cladonia* spp.

Ass. **Cladonio-Pinetum** (Appendix 5). The typic variant of Ass. has been described on flat areas and gentle slopes in Ozolsala, Steķi forest, Driksna forest, Vecumnieki, Timsmales, Pērlis forest, Kalnis forest, Gaigalava, Dviete, Krustkalni, Mežole. The age of pine stands is 30–90 years.

The tree layer forms *Pinus sylvestris*, somewhere with *Betula pendula*. The tree layer cover is 20–55%, average 38%. In all, 7 species have been registered in shrub layer. The most common being *Picea abies* and *Betula pendula*. The herb layer forms *Calluna vulgaris, Vaccinium myrtillus, Vaccinium vitis-idaea*. The average number of species per relevé is 17. The species composition are varied. The character species of Cl. Pulsatillo-Pinetea can be found in some descriptions.

Ecology of plant communities

The ecological values of plant species of all 5 communities are similar (Table 2). The light value is 6.1–6.5, temperature value – 3.4–4.1, continentality value 5.1–5.6, moisture value 4.0–4.4, soil pH value 3.0–3.7, nitrogen value 2.1–2.8. The forest communities are characterised by light demanding species, growing in low nitrogen and acid soils.

Table 2

Ecological indicators (Ellenberg's values)

Indicators	*Thymus serpyllum - Pinus sylvestris* community	*Carex ericetorum - Pinus sylvestris* community	*Convallaria majalis - Pinus sylvestris* community	Ass. Cladonio-Pinetum var. *Polygonatum odoratum*	Ass. Cladonio-Pinetum
Light	6.3	6.5	6.1	6.5	6.3
Temperature	4.1	4.1	3.7	3.8	3.4
Continentality	5.1	5.4	5.2	5.6	5.6
Moisture	4	4	4.1	4.2	4.4
Reaction	3.7	3.6	3.3	3.3	3
Nitrogen	2.8	2.3	2.8	2.1	2.1

The ordination in accordance with edaphic factors (Fig.2) shows a similarity, but *Carex ericetorum - Pinus sylvestris* community, Ass. Cladonio-Pinetum var. *Polygonatum odoratum* and Ass. Cladonio-Pinetum are characterised by somewhat poor soils, *Thymus serpyllum - Pinus sylvestris* community and *Convallaria majalis - Pinus sylvestris* community – are richer in nitrogen. The most acid soil is characterised by Ass. Cladonio-Pinetum var. *Hylocomium splendens*, the least – by *Thymus serpyllum - Pinus sylvestris* community and *Carex ericetorum - Pinus sylvestris* community.

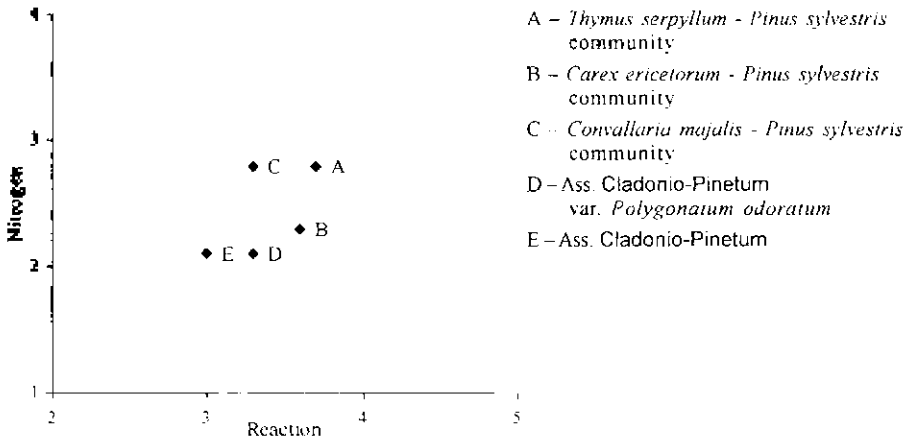

Fig.2. Ordination of subcontinental pine forest communities after edaphic factors (Ellenberg's values)

In order to estimate the difference of communities DECORANA analysis was used (Fig.3.). The DCA axis 1 explains the decrease of acidity, the axis 2 – the increase of soil fertility. However, this difference is not so pronounced, but shows the continuum of investigated communities.

Analysis of species distribution areas

There are many species growing on borders of their distribution area and near area bordershare in Latvia. According to area diagnosis, the most different is the zonality of species in all groups (Fig.4.).

The majority of species is boreotemperate, especially of communities Ass. Cladonio-Pinetum var. *Polygonatum odoratum* and Ass. Cladonio-Pinetum var. *Hylocomium splendens* – the number of boreotemperate species is more than 40% (*Picea abies, Pinus sylvestris, Betula pendula, Calluna vulgaris, Carex ericetorum, Festuca ovina, Vaccinium vitis-idaea, Vaccinium myrtillus, Pulsatilla patens, Pyrola chlorantha, Sorbus aucuparia* a.o.). Boreotemperate species of Latvia's flora comprises only 8.2% (Fatare 1992). Temperate species *Astragalus arenarius, Dianthus arenarius, Jovibarba sobolifera, Koeleria grandis, Gypsophila fastigiata, Trientalis europaea* are common in all investigated communities. The number of temperate-submeridional species decrease from *Thymus serpyllum - Pinus sylvestris* community to Ass. Cladonio-Pinetum.

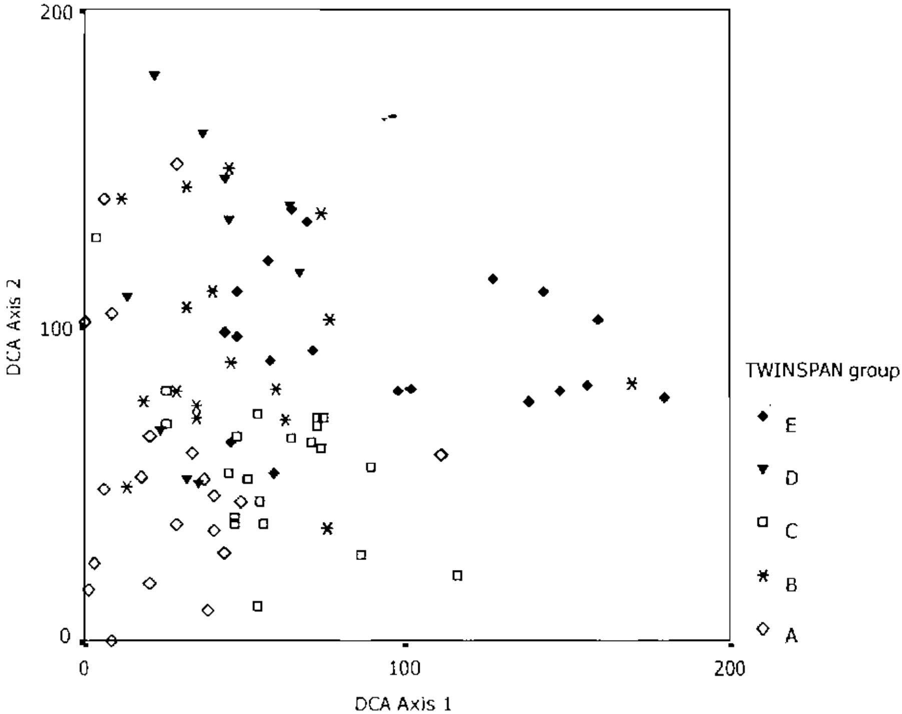

Fig.3. DCA ordination of relevés

A – *Thymus serpyllum - Pinus sylvestris* community

B – *Carex ericetorum - Pinus sylvestris* community

C – *Convallaria majalis - Pinus sylvestris* community

D – Ass. Cladonio-Pinetum var. *Polygonatum odoratum*

E – Ass. Cladonio-Pinetum

These species are *Amelanchier spicata, Calamagrostis arundinacea, Chimaphila umbellata, Convallaria majalis, Polygonatum odoratum, Frangula alnus, Pulsatilla pratensis* a.o. Polizonal species are common in all the communities – *Antennaria dioica, Calamagrostis epigeios, Hieracium umbellatum, Juniperus communis, Melampyrum pratense, Pteridium aquilinum, Solidago virgaurea, Thymus serpyllum* a.o.

The sectoriality and oceanity of species are not closely connected with distribution of divided plant communities.

DISCUSSION

Thymus serpyllum - Pinus sylvestris community is rather like in Poland on light localities described Ass. Festuco-Thymetum serpylli (Łuczycka-Popiel 1984). This association forms in forest clearings without tree layer but in our investigated forests tree layer cover is 39% on average.

Similar vegetation of divided *Carex ericetorum - Pinus sylvestris* community has been described near Irtysh river. Ass. Carici supinae – Pinetum sylvestris Ermakov 1999 belongs to Cl. Pulsatillo-Pinetea Oberd. 1992, O. Koelerio glaucae-Pinetalia Ermakov

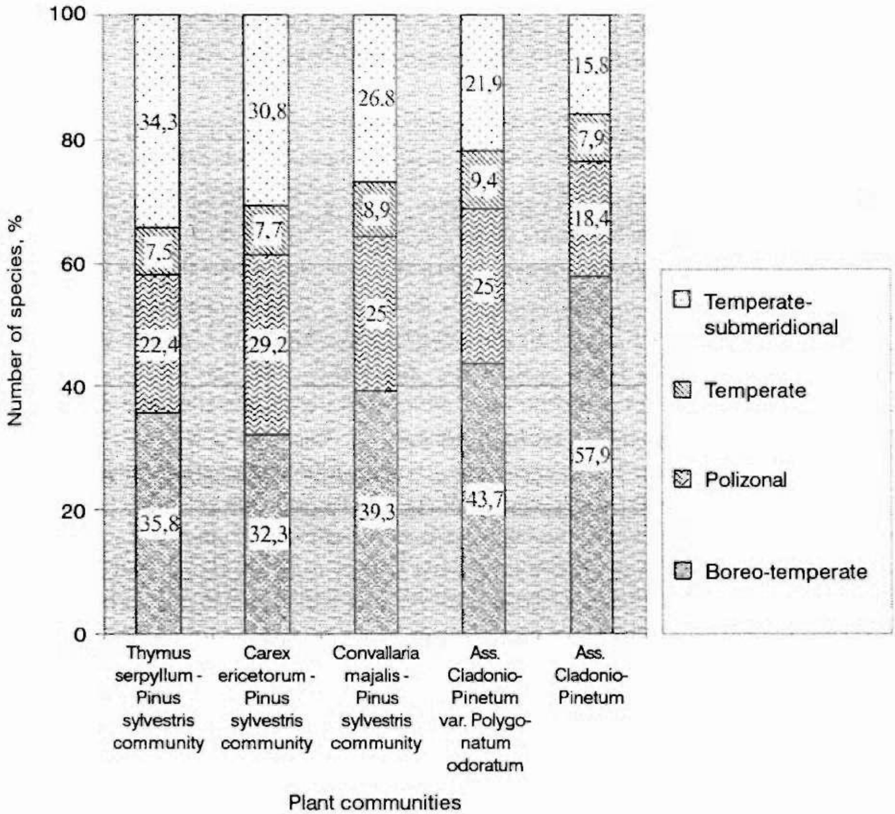

Fig.4. Species zonality group spectra of dry subcontinental pine forests

1999, All. Koelerio glaucae-Pinion sylvestris Ermakov 1999. These forests form in the higher terraces on poor sandy soils and have signs of Cl. Koelerio-Corynephoretea and Festuco-Brometea. These communities are replaced by mesophilous forests of the Cladonio-Pinetum (Caj.1921) K.Lund 1967 and Carici ericetorum-pinetum Kustova 1988 in the shallow mesic depressions on slopes (Ermakov 2000). The Ass. Pinetum xeroherboso-cladinosum (with mesoxerophitic species *Koeleria glauca, Dianthus arenarius, Pulsatilla patens, Gypsophila fastigiata, Festuca ovina, Carex ericetorum*) has been described in vicinity of Pskov on sun-exposed slopes of hills (Sambuk 1986).

The herb-rich variant of pine forests Ass. Convallario - Pinetum has been described in SE Norway (Bjørndalen 1980). These forests belong to Cl. Trifolio-Geranietea and contains character species of Cl. Querco-Fageteav throughout. The divided *Convallaria majalis - Pinus sylvestris* community is not so basiphilous and rich in species of Cl. Querco-Fagetea.

In Poland, the divided variants of Ass. Cladonio-Pinetum are similar to described communities of Ass. Cladonio-Pinetum with poorly developed herb layer and with *Vaccinium* spp. (Matuszkiewicz 1984) but *Polygonatum odoratum, Solidago virgaurea* and *Hylocomium splendens* are rare in these communities.

The 5 classified communities differ as to proportion of species. The low difference shows the continuum of investigated communities.

Conclusions

1. All groups of investigated dry oligotrophic pine forest communities are characterised by light demanding species, forming rather stable groupings in thinnings of pine crowns.

2. Dry pine forest communities occur in acid to medium acid soils poor in nitrogen.

3. Described plant communities are characterized by syntaxonomical continuum. The character species of boreal and hemiboreal pine forests (Cl. Vaccinio-Piceetea and Pulsatillo-Pinetea) and that of dry grasslands and heaths (Cl. Koelerio-Corynephoretea, Festuco-Brometea, Calluno-Ulicetea) have the same importance in forming herb layer in these communities.

4. Although the described dry pine forest communities cover small areas and occur fragmentary, they contribute to maintain diverse and mosaic forest landscape in Latvia.

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REFERENCES

Āboliņa A. 2001. Latvijas sūnu saraksts. (List of bryophytes of Latvia). *Latvijas Veģetācija*, 3: 47–87.

Bjørndalen J.E. Phytosociological studies of basiphilous pine forests in Grenland, Telemark, SE Norway. *Norwegian Journal of Botany*. Vol 27, pp.139–161.

Braun-Blanquet J. 1964. *Pflanzensoziologie. Grundzüge der Vegetationskunde.* Springer Verlag, Wien, New York, 865 S.

Dierschke H. 1994. *Pflanzensoziologie.* Ulmer, Stuttgart, 683 S.

Dierßen K. 1996. Vegetation Nordeuropas. Ulmer. 838 S.

Ellenberg H., Weber H.E., Düll R., Wirth V., Werner W., Paulißen D. 1992. *Zeigerwerte von Pflanzen in Mitteleuropa.* Verlag Erich Goltze KG, Göttingen, 258 S.

Ermakov N., Dring J., Rodwell J. 2000. Classification of continental hemiboreal forests of North Asia. Braun-Blanquetia, Camerino. 131 p.

Fatare I. 1992. Latvijas floras komponentu izplatības analīze un tās nozīme augu sugu aizsardzības koncepcijas izstrādāšanā. (The study of distribution of Latvian autochtonous floral components and its importance in developing a conception on plant species protection). Rīga, 259 lpp.

Gavrilova Ģ., Šulcs V. 1999. *Latvijas vaskulāro augu flora: Taksonu saraksts.* (Flora of Latvian vascular plants. List of taxa). Rīga, 136 lpp.

Hennekens S.M. 1995. TURBO(VEG) Software package for input, processing, and presentation of phytosociological data. IBN-DLO University of Lancaster. 54 p.

Hill M.O. 1979. *TWINSPAN. A FORTRAN Program for Arranging Multivariate Data in an Ordered Two Way Table by Classification of the Individuals and Attributes.* Cornell University Ithaca, New York, 47 p.

Hill M.O. 1979. *DECORANA. A FORTRAN Program for Detrended Correspondence Analysis and Reciprocal Averaging.* Cornell University Ithaca, New York, 52 p.

Kielland-Lund A. 1981. Die Waldgesellschaften SO-Norwegens. *Phytocoenologia* 2, 1/2:53–250.

Laiviņš M. 1998. Latvijas ziedaugu un paparžaugu sabiedrību augstākie sintaksoni. (Highest syntaxonomic units of plant communities of Latvia). *Latvijas purvu veģetācijas klasifikācija un dinamika. Latvijas Universitātes Zinātniskie Raksti.* Rīga, 613: 7–22.

Laiviņš M., Laiviņa S. 1991. Jūrmalas mežu sinantropizācija. (Synanthrophication of forests in Jūrmala Town). *Jaunākais Mežsaimniecībā* 33: 67–83.

Łuczycka-Popiel A. 1984. Bory sosnowe i torfowiska wysokie kompleksu lesnego Kozlowka kolo Lublina. (Pine Forests and Hihh Peatbogs of the Kozlowka Forest Association near Lublin). Annales Universitatis Mariae Curie-Sklodowska Lublin Polonia, Sectio C, vol.XXXIX, 8, p. 63–81.

Matuszkiewicz W. 1984. Die Karte der potentiellen natürlichen Vegetation von Polen. *Braun-Blanquetia* 1, Camerino, 99 S.

Mucina L., Grabherr G., Wallnofer S. 1993. *Die Pflanzengesellschaften Österreichs.* Teil III. *Wälder und Gebüsche.* Gustav Fischer Verlag, Jena, Stuttgart, New York, 353 S.

Oberdorfer E. (Hrsg.) 1992. *Süddeutsche Pflanzengesellschaften.* Teil IV, *Wälder und Gebüsche.* A. Textband. 2-te Aufl., Gustav Fischer Verlag, Jena, Stuttgart, New York, 282 S.

Ofkante D. 2001. Sauso priežu mežu augu sabiedrības Baltijas jūras piekrastē "Ovīšu" dabas liegumā. (Plant communities of dry pine forests in Baltic sea coast in Oviši Nature Reserve). *Book of Abstracts. International conference Research and conservation of biological diversity in Baltic Region.* Daugavpils, p.67–68.

Pakalne M., Znotiņa V. 1992. Veģetācijas klasifikācija: Brauna-Blankē metode. (Classification of vegetation: Braun-Blanquet method). Rīga, 34 lpp.

Piterāns A. 2001. Latvijas ķērpju konspekts. (Checklist of the lichens of Latvia). *Latvijas Veģetācija*, 3. 5–46.

Pott R. 1995. *Die Pflanzengesellschaften Deutschlands.* Ulmer Verlag, Stuttgart 622 S.

Rothmaler W. 1976. *Exkursionsflora. Kritischer band.* Berlin, 811S.

Самбук С. Г. 1986 b. Классификация лишайников и зеленомошных сосновых лесов северо-запада европейской части СССР. (The classification of the lichen and greenmoss pine forests of the North-West of the European part of the USSR). *Ботаницеский журнал,* Том 71, 11, с. 1468–1479.

Sauso subkontinentālo priežu mežu veģetācija Centrālajā un Austrumlatvijā

Kopsavilkums

Sauso subkontinentālo priežu mežu veģetācija pētīta Latvijas centrālajā un austrumu daļā. Izmantojot klasifikācijas programmu TWINSPAN, 88 veģetācijas apraksti sadalīti 5 grupās. Pēc sugu sastāva aprakstītas 5 augu sabiedrības: *Thymus serpyllum-Pinus sylvestris* sabiedrība, *Carex ericetorum-Pinus sylvestris* sabiedrība, *Convallaria majalis-Pinus sylvestris* sabiedrība, asociācijas Cladonio-Pinetum variants ar *Polygonatum odoratum*, asociācijas Cladonio-Pinetum tipiskais variants. Atšķirības pētīto augu sabiedrību ekoloģijā ir nelielas, visu grupu sugu sastāvu veido klašu Vaccinio-Piceetea, Pulsatillo-Pinetea, Koelerio-Corynephoretea rakstursugas.

Atslēgas vārdi: priede, meža augu sabiedrības.

The floristic composition of *Thymus serpyllum* – *Pinus sylvestris* community

Layer																						Constancy
	Number of relevé	105	151	163	165	22	18	20	21	25	55	86	150	197	54	174	175	192	107	187	262	
	Size of relevé m²	25	100	50	100	50	50	100	50	100	100	100	100	100	100	25	25	100	100	25	50	
	Cover of tree layer (E3) %	10	30	50	55	40	40	45	30	25	35	60	25	30	30	40	20	50	45	40	40	
	Cover of shrub layer (E2) %	5	1	1	5	15	5	7	3	1	10	1	1	1	1	10	4	1	5	6	6	
	Cover of herb layer (E1) %	75	30	50	70	35	20	20	50	20	50	55	35	75	10	20	30	45	70	35	35	
	Cover of moss layer (E0) %	87	85	87	63	95	95	90	90	90	65	90	95	80	95	90	85	90	85	90	85	
	Number of species per relevé	28	27	31	43	18	26	24	25	17	25	23	22	25	24	24	22	15	18	22	21	
Character species of Cl. Vaccinio-Piceetea																						
E3	*Pinus sylvestris*	1	3	2	3	3	3	3	3	2	3	4	2	3	3	3	2	3	3	3	3	V
E2	*Pinus sylvestris*	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Pinus sylvestris*	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	I
E2	*Picea abies*	1	1	.	1	1	+	1	+	.	2	1	1	1	+	1	+	.	1	1	1	V
E1	*Picea abies*	.	.	+	.	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	I
E2	*Juniperus communis*	.	.	.	1	2	+	1	1	+	+	.	.	+	1	1	1	+	.	.	.	III
E2	*Amelanchier spicata*	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Vaccinium vitis-idaea*	1	1	1	1	1	1	1	1	1	.	2	1	1	.	+	.	1	.	+	.	IV
E1	*Arctostaphylos uva-ursi*	.	+	.	+	.	.	.	.	.	.	.	1	.	.	.	+	.	.	1	.	II
E1	*Vaccinium myrtillus*	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	2	+	2	II
E1	*Trientalis europaea*	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Orthilia secunda*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	I

Appendix 1 (continuation)

Layer	Number of relevé	105	151	163	165	22	18	20	21	25	55	86	150	197	54	174	175	192	107	187	262	Constancy
	Size of relevé m^2	25	100	50	100	50	50	100	50	100	100	100	100	100	100	25	25	100	100	25	50	
	Cover of tree layer (E3) %	10	30	50	55	40	40	45	30	25	35	60	25	30	30	40	20	50	45	40	40	
	Cover of shrub layer (E2) %	5	1	1	5	15	5	7	3	1	10	1	1	1	1	10	4	1	5	6	6	
	Cover of herb layer (E1) %	75	30	50	70	35	20	20	50	20	50	55	35	75	10	20	30	45	70	35	35	
	Cover of moss layer (E0) %	87	85	87	63	95	95	90	90	90	65	90	95	80	95	90	85	90	85	90	85	
	Number of species per relevé	28	27	31	43	18	26	24	25	17	25	23	22	25	24	24	22	15	18	22	21	
E1	*Monotropa hypopitys*	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E0	*Pleurozium schreberi*	4	2	5	3	2	3	4	5	5	4	3	3	3	5	5	5	5	4	5	5	V
E0	*Dicranum polysetum*	2	3	1	2	4	3	2	2	2	1	2	3	2	2	1	1	2	2	.	1	V
E0	*Cladina rangiferina*	1	2	1	1	.	.	.	.	.	.	+	+	.	.	.	.	.	.	+	+	II
E0	*Cladina arbuscula*	1	2	1	1	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	II
E0	*Cladonia gracilis*	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E0	*Hylocomium splendens*	1	.	.	.	.	.	.	.	.	.	3	.	.	.	+	.	.	.	+	.	I
Character species of Cl. Pulsatillo-Pinetea, O. Pulsatillo-Pinetalia, All. Cytiso-Pinion																						
E1	*Carex ericetorum*	.	+	+	1	1	+	1	+	+	.	.	.	+	+	+	+	+	.	.	.	IV
E1	*Pulsatilla patens*	.	1	.	1	1	1	1	1	1	1	+	+	.	+	.	+	.	1	.	.	IV
E1	*Chimaphila umbellata*	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	+	1	II
E1	*Viola rupestris*	.	1	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	I
E1	*Epipactis atrorubens*	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Pulsatilla pratensis*	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I

Layer		105	151	163	165	22	18	20	21	25	55	86	150	197	54	174	175	192	107	187	262	Constancy
	Number of relevé	105	151	163	165	22	18	20	21	25	55	86	150	197	54	174	175	192	107	187	262	
	Size of relevé m²	25	100	50	100	50	50	100	50	100	100	100	100	100	100	25	25	100	100	25	50	
	Cover of tree layer (E3) %	10	30	50	55	40	40	45	30	25	35	60	25	30	30	40	20	50	45	40	40	
	Cover of shrub layer (E2) %	5	1	1	5	15	5	7	3	1	10	1	1	1	1	10	4	1	5	6	6	
	Cover of herb layer (E1) %	75	30	50	70	35	20	20	50	20	50	55	35	75	10	20	30	45	70	35	35	
	Cover of moss layer (E0) %	87	85	87	63	95	95	90	90	90	65	90	95	80	95	90	85	90	85	90	85	
	Number of species per relevé	28	27	31	43	18	26	24	25	17	25	23	22	25	24	24	22	15	18	22	21	
E1	*Diphasiastrum complanatum*	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	I
Character species of Cl. Calluno-Ulicetea, Koelerio-Corynephoretea, Festuco-Brometea																						
E1	*Calluna vulgaris* (C.-U.)	1	1	+	+	.	1	1	1	+	1	1	1	+	+	+	2	2	1	1	1	V
E1	*Thymus serpyllum* (K.-C.)	+	1	.	2	.	+	+	+	+	2	1	1	2	1	1	1	.	1	1	1	V
E1	*Hieracium umbellatum* (C.-U.)	+	1	+	1	+	+	.	+	+	.	+	+	.	+	+	.	.	1	+	.	IV
E1	*Festuca ovina* (C.-U.)	1	.	1	1	+	+	1	1	.	1	1	.	2	1	1	2	2	1	2	2	IV
E1	*Antennaria dioica* (C.-U.)	+	.	1	2	.	.	+	+	.	1	1	1	.	+	.	+	+	.	.	.	III
E1	*Pilosella officinarum* (K.-C.)	.	1	.	1	.	1	+	.	.	2	.	.	+	.	.	.	+	.	1	+	III
E1	*Viola canina* (C.-U.)	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I
E1	*Lycopodium clavatum* (C.-U.)	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Sieglingia decumbens* (C.-U.)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	I
E1	*Pimpinella saxifraga* (F.-B.)	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Veronica spicata* (F.-B.)	+	.	+	1	.	.	+	.	.	.	.	.	.	.	.	+	.	.	.	.	I
E1	*Jovibarba globifera* (K.-C.)	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	I

Appendix 1 (continuation)

Layer	Number of relevé	105	151	163	165	22	18	20	21	25	55	86	150	197	54	174	175	192	107	187	262	Constancy
	Size of relevé m^2	25	100	50	100	50	50	100	50	100	100	100	100	100	100	25	25	100	100	25	50	
	Cover of tree layer (E3) %	10	30	50	55	40	40	45	30	25	35	60	25	30	30	40	20	50	45	40	40	
	Cover of shrub layer (E2) %	5	1	1	5	15	5	7	3	1	10	1	1	1	1	10	4	1	5	6	6	
	Cover of herb layer (E1) %	75	30	50	70	35	20	20	50	20	50	55	35	75	10	20	30	45	70	35	35	
	Cover of moss layer (E0) %	87	85	87	63	95	95	90	90	90	65	90	95	80	95	90	85	90	85	90	85	
	Number of species per relevé	28	27	31	43	18	26	24	25	17	25	23	22	25	24	24	22	15	18	22	21	
E1	*Astragalus arenarius* (K.-C.)	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	I
E1	*Dianthus arenarius* (K.-C.)	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	1	.	1	.	.	I
	Other species																					
E3	*Betula pendula*	1	.	3	2	.	.	.	.	.	.	+	.	+	.	+	.	.	.	.	.	II
E2	*Betula pendula*	1	.	+	.	.	1	+	1	+	.	.	.	.	+	+	.	.	.	1	.	III
E1	*Betula pendula*	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E2	*Quercus robur*	.	.	.	+	.	.	.	.	.	+	+	+	.	+	+	1	.	1	.	+	III
E1	*Quercus robur*	+	.	+	+	.	.	.	.	.	.	.	.	+	+	.	+	.	.	.	.	II
E2	*Populus tremula*	+	.	.	.	.	+	1	1	.	.	.	.	.	.	.	.	.	.	.	+	II
E1	*Populus tremula*	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E2	*Sorbus aucuparia*	1	.	.	+	.	+	.	+	+	.	+	.	.	.	.	.	.	+	.	+	II
E1	*Sorbus aucuparia*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	I
E2	*Frangula alnus*	.	.	1	+	.	.	.	.	.	+	.	.	.	.	+	.	+	1	1	.	II
E1	*Frangula alnus*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	I

Layer	Number of relevé	105	151	163	165	22	18	20	21	25	55	86	150	197	54	174	175	192	107	187	262	Constancy
	Size of relevé m[2]	25	100	50	100	50	50	100	50	100	100	100	100	100	100	25	25	100	100	25	50	
	Cover of tree layer (E3) %	10	30	50	55	40	40	45	30	25	35	60	25	30	30	40	20	50	45	40	40	
	Cover of shrub layer (E2) %	5	1	1	5	15	5	7	3	1	10	1	1	1	1	10	4	1	5	6	6	
	Cover of herb layer (E1) %	75	30	50	70	35	20	20	50	20	50	55	35	75	10	20	30	45	70	35	35	
	Cover of moss layer (E0) %	87	85	87	63	95	95	90	90	90	65	90	95	80	95	90	85	90	85	90	85	
	Number of species per relevé	28	27	31	43	18	26	24	25	17	25	23	22	25	24	24	22	15	18	22	21	
E2	*Rubus idaeus*	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I
E1	*Acer platanoides*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	I
E1	*Solidago virgaurea*	1	+	1	1	+	+	+	.	+	1	1	+	+	+	+	1	+	1	1	.	V
E1	*Melampyrum pratense*	1	1	2	1	.	+	+	1	.	1	2	1	+	+	+	+	.	2	1	1	V
E1	*Polygonatum odoratum*	.	.	.	1	1	+	1	1	1	+	.	+	+	+	+	.	+	+	.	.	IV
E1	*Calamagrostis arundinacea*	2	2	2	.	1	+	1	2	2	1	1	2	+	1	.	.	.	.	.	.	IV
E1	*Convallaria majalis*	3	1	+	.	.	+	1	2	.	+	.	1	3	1	.	.	2	3	.	.	III
E1	*Calamagrostis epigeios*	.	+	1	.	.	.	.	1	.	1	.	.	.	.	+	+	.	.	.	1	II
E1	*Campanula rotundifolia*	.	.	.	.	1	.	+	+	.	+	.	.	.	+	.	.	.	.	.	+	II
E1	*Geranium sanguineum*	1	.	1	1	2	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	II
E1	*Knautia arvensis*	.	.	+	1	+	1	+	.	.	1	.	.	.	.	.	+	.	.	.	.	II
E1	*Luzula pilosa*	.	.	+	1	.	+	.	.	.	.	.	.	.	.	+	+	.	.	+	.	II
E1	*Trommsdorfia maculata*	.	.	.	1	.	+	.	+	+	.	.	+	.	.	.	.	.	.	.	.	II
E1	*Fragaria vesca*	1	.	.	1	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	I

Layer	Number of relevé	105	151	163	165	22	18	20	21	25	55	86	150	197	54	174	175	192	107	187	262	Constancy
	Size of relevé m²	25	100	50	100	50	50	100	50	100	100	100	100	100	100	25	25	100	100	25	50	
	Cover of tree layer (E3) %	10	30	50	55	40	40	45	30	25	35	60	25	30	30	40	20	50	45	40	40	
	Cover of shrub layer (E2) %	5	1	1	5	15	5	7	3	1	10	1	1	1	1	10	4	1	5	6	6	
	Cover of herb layer (E1) %	75	30	50	70	35	20	20	50	20	50	55	35	75	10	20	30	45	70	35	35	
	Cover of moss layer (E0) %	87	85	87	63	95	95	90	90	90	65	90	95	80	95	90	85	90	85	90	85	
	Number of species per relevé	28	27	31	43	18	26	24	25	17	25	23	22	25	24	24	22	15	18	22	21	
E1	*Scorzonera humilis*	+	+	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Silene nutans*	.	+	.	+	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	I
E1	*Rubus saxatilis*	1	.	+	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Chamerion angustifolium*	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	I
E1	*Melampyrum polonicum*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	I
E1	*Veronica officinalis*	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	I
E1	*Anthyllis arenaria*	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Koeleria grandis*	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	I
E1	*Agrostis tenuis*	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	I
E1	*Campanula persicifolia*	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Succisa pratensis*	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Dracocephalum ruyschiana*	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Lotus corniculatus*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	I
E1	*Maianthemum bifolium*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	I

Appendix 1 (the end)

Layer	Number of relevé	105	151	163	165	22	18	20	21	25	55	86	150	197	54	174	175	192	107	187	262	Constancy
	Size of relevé m^2	25	100	50	100	50	50	100	50	100	100	100	100	100	100	25	25	100	100	25	50	
	Cover of tree layer (E3) %	10	30	50	55	40	40	45	30	25	35	60	25	30	30	40	20	50	45	40	40	
	Cover of shrub layer (E2) %	5	1	1	5	15	5	7	3	1	10	1	1	1	1	10	4	1	5	6	6	
	Cover of herb layer (E1) %	75	30	50	70	35	20	20	50	20	50	55	35	75	10	20	30	45	70	35	35	
	Cover of moss layer (E0) %	87	85	87	63	95	95	90	90	90	65	90	95	80	95	90	85	90	85	90	85	
	Number of species per relevé	28	27	31	43	18	26	24	25	17	25	23	22	25	24	24	22	15	18	22	21	
E1	*Melica nutans*	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	I
E1	*Galium album*	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I
E1	*Pteridium aquilinum*	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E0	*Cladonia furcata*	+	.	.	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	I
E0	*Polytrichum juniperinum*	.	+	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	I
E0	*Peltigera canina*	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E0	*Peltigera aphtosa*	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	I
E0	*Cladonia cornuta*	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	I
E0	*Cladonia fimbriata*	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	I
E0	*Cladina stellaris*	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	I

Localities of relevés: 18, 20, 21, 22, 25 – Numerne; 54, 55 – Djatlovka; 86 – Teiči Nature Reserve; 105, 107, 163, 165 - Driksna forest; 150, 151 – Posulnīca; 174, 175, 187 – Laukezers; 262 – Gaigalava.

The floristic composition of *Carex ericetorum - Pinus sylvestris* community

Layer	Number of relevé	200	211	255	263	176	254	78	191	193	258	232	233	241	234	240	235	244	Constancy
	Size of relevé m^2	100	50	100	100	25	100	25	100	25	50	100	50	50	100	25	100	50	
	Cover of tree layer (E3) %	50	60	60	60	45	30	40	50	40	35	50	20	40	45	25	45	50	
	Cover of shrub layer (E2) %	5	5	15	1	5	3	0	1	1	1	0	10	0	1	1	0	1	
	Cover of herb layer (E1) %	80	77	55	32	80	50	35	45	60	30	17	12	30	62	35	25	22	
	Cover of moss layer (E0) %	45	85	60	80	60	77	96	55	75	70	80	90	96	50	80	98	85	
	Number of species per relevé	32	31	34	31	22	31	15	19	22	24	15	16	18	21	24	20	21	
Character species of Cl. Vaccinio-Piceetea																			
E3	*Pinus sylvestris*	3	4	4	4	3	3	3	3	3	3	3	3	3	2	2	3	3	V
E2	*Pinus sylvestris*	.	.	.	.	.	1	.	.	.	.	.	.	.	+	.	.	.	I
E1	*Pinus sylvestris*	.	.	.	.	.	.	.	.	.	+	.	.	.	+	+	.	.	I
E2	*Picea abies*	1	1	2	+	.	1	.	.	.	+	.	.	.	+	+	.	.	III
E1	*Picea abies*	.	.	.	.	+	.	.	.	.	+	.	.	.	.	+	.	.	I
E2	*Juniperus communis*	+	1	1	+	1	+	.	+	.	+	.	.	.	.	.	.	1	III
E1	*Juniperus communis*	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Vaccinium vitis-idaea*	1	2	.	.	.	2	.	.	.	.	+	1	2	2	2	.	2	III
E1	*Arctostaphylos uva-ursi*	.	2	1	1	+	1	.	.	.	.	.	.	.	1	1	.	.	III
E1	*Vaccinium myrtillus*	.	.	1	+	2	1	+	+	+	.	.	.	.	.	.	.	.	III
E1	*Trientalis europaea*	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I
E0	*Pleurozium schreberi*	3	1	3	3	4	3	5	2	2	4	2	4	5	2	3	5	3	V
E0	*Dicranum polysetum*	1	.	1	2	1	2	2	3	4	2	3	2	2	.	2	1	3	V

Appendix 2 (continuation)

Layer	Number of relevé	200	211	255	263	176	254	78	191	193	258	232	233	241	234	240	235	244	Constancy
	Size of relevé m²	100	50	100	100	25	100	25	100	25	50	100	50	50	100	25	100	50	
	Cover of tree layer (E3) %	50	60	60	60	45	30	40	50	40	35	50	20	40	45	25	45	50	
	Cover of shrub layer (E2) %	5	5	15	1	5	3	0	1	1	1	0	10	0	1	1	0	1	
	Cover of herb layer (E1) %	80	77	55	32	80	50	35	45	60	30	17	12	30	62	35	25	22	
	Cover of moss layer (E0) %	45	85	60	80	60	77	96	55	75	70	80	90	96	50	80	98	85	
	Number of species per relevé	32	31	34	31	22	31	15	19	22	24	15	16	18	21	24	20	21	
E0	*Cladina rangiferina*	1	.	1	+	+	2	1	1	1	.	1	1	1	2	2	2	1	V
E0	*Cladina arbuscula*	1	.	1	+	.	2	+	1	1	+	1	+	+	1	1	1	1	V
E0	*Cladonia gracilis*	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	+	II
E0	*Hylocomium splendens*	+	5	+	2	.	.	.	.	.	.	.	.	.	.	.	.	.	II
E0	*Cladonia crispata*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	I
Character species of Cl. Pulsatillo-Pinetea, O. Pulsatillo-Pinetalia, All. Cytiso-Pinion																			
E1	*Carex ericetorum*	1	+	1	+	+	1	.	1	+	1	1	1	1	1	1	+	1	V
E1	*Pulsatilla patens*	.	1	.	.	1	.	.	.	.	+	1	1	1	1	1	+	.	III
E1	*Viola rupestris*	.	.	+	.	.	+	.	.	.	+	.	.	.	.	.	.	.	I
E1	*Chimaphila umbellata*	.	.	.	1	.	.	.	.	.	+	.	.	.	.	.	.	.	I
E1	*Pyrola chlorantha*	.	.	.	+	.	.	.	.	.	1	.	.	.	.	.	.	.	I
E1	*Pulsatilla pratensis*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	I
Character species of Cl. Calluno-Ulicetea, Koelerio-Corynephoretea, Festuco-Brometea																			
E1	*Festuca ovina* (C.-U.)	2	1	1	1	1	1	1	2	2	2	.	1	.	1	.	+	+	V
E1	*Calluna vulgaris* (C.-U.)	2	2	2	1	4	.	+	3	3	2	1	1	1	2	1	1	1	V

Layer	Number of relevé	200	211	255	263	176	254	78	191	193	258	232	233	241	234	240	235	244	Constancy
	Size of relevé m²	100	50	100	100	25	100	25	100	25	50	100	50	50	100	25	100	50	
	Cover of tree layer (E3) %	50	60	60	60	45	30	40	50	40	35	50	20	40	45	25	45	50	
	Cover of shrub layer (E2) %	5	5	15	1	5	3	0	1	1	1	0	10	0	1	1	0	1	
	Cover of herb layer (E1) %	80	77	55	32	80	50	35	45	60	30	17	12	30	62	35	25	22	
	Cover of moss layer (E0) %	45	85	60	80	60	77	96	55	75	70	80	90	96	50	80	98	85	
	Number of species per relevé	32	31	34	31	22	31	15	19	22	24	15	16	18	21	24	20	21	
E1	*Hieracium umbellatum* (C.-U.)	.	.	1	1	.	1	1	.	.	1	+	+	1	+	+	1	+	IV
E1	*Thymus serpyllum* (K.-C.)	2	2	1	.	1	2	.	+	+	+	.	+	+	+	+	.	.	IV
E1	*Antennaria dioica* (C.-U.)	.	+	.	.	.	1	2	.	.	+	+	.	1	1	1	+	.	III
E1	*Pilosella officinarum* (K.-C.)	+	.	2	+	.	1	1	+	1	+	.	.	.	.	.	.	.	III
E1	*Viola canina* (C.-U.)	+	.	+	+	.	+	.	.	+	.	.	.	.	.	.	.	.	II
E1	*Veronica spicata* (F.-B.)	.	+	.	.	.	1	.	.	.	+	+	.	.	.	+	.	.	II
E1	*Koeleria glauca* (K.-C.)	.	.	.	.	.	.	.	.	+	.	+	.	.	+	+	+	+	II
E1	*Astragalus arenarius* (K.-C.)	1	1	1	.	+	1	.	.	.	.	.	.	.	.	.	.	.	II
E1	*Dianthus arenarius* (K.-C.)	.	+	.	.	1	+	.	.	.	.	.	.	.	.	+	+	1	II
E1	*Gypsophila fastigiata* (K.-C.)	.	.	+	.	.	1	.	.	.	+	.	.	.	+	.	+	+	II
E1	*Lycopodium clavatum* (C.-U.)	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Empetrum nigrum* (C.-U.)	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	I
E1	*Plantago media* (F.-B.)	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I

Appendix 2 (continuation)

Layer	Number of relevé	200	211	255	263	176	254	78	191	193	258	232	233	241	234	240	235	244	Constancy
	Size of relevé m²	100	50	100	100	25	100	25	100	25	50	100	50	50	100	25	100	50	
	Cover of tree layer (E3) %	50	60	60	60	45	30	40	50	40	35	50	20	40	45	25	45	50	
	Cover of shrub layer (E2) %	5	5	15	1	5	3	0	1	1	1	0	10	0	1	1	0	1	
	Cover of herb layer (E1) %	80	77	55	32	80	50	35	45	60	30	17	12	30	62	35	25	22	
	Cover of moss layer (E0) %	45	85	60	80	60	77	96	55	75	70	80	90	96	50	80	98	85	
	Number of species per relevé	32	31	34	31	22	31	15	19	22	24	15	16	18	21	24	20	21	
E1	*Pimpinella saxifraga* (F.-B.)	.	+	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E0	*Thuidium abietinum* (F.-B.)	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Jasione montana* (K.-C.)	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Artemisia campestris* (K.-C.)	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E0	*Tortula ruralis* (K.-C.)	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Other species																			
E3	*Betula pendula*	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E2	*Betula pendula*	+	.	1	.	1	.	.	+	.	+	.	.	.	.	.	.	.	II
E1	*Betula pendula*	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	I
E2	*Frangula alnus*	.	.	+	+	.	+	.	.	+	.	.	.	.	.	.	.	.	II
E1	*Frangula alnus*	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	I
E2	*Quercus robur*	.	+	1	+	1	.	.	+	.	.	.	.	.	.	+	.	.	II
E1	*Quercus robur*	.	.	.	+	+	.	.	.	.	.	.	.	+	+	+	.	.	II
E2	*Populus tremula*	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I

Layer	Number of relevé	200	211	255	263	176	254	78	191	193	258	232	233	241	234	240	235	244	Constancy
	Size of relevé m²	100	50	100	100	25	100	25	100	25	50	100	50	50	100	25	100	50	
	Cover of tree layer (E3) %	50	60	60	60	45	30	40	50	40	35	50	20	40	45	25	45	50	
	Cover of shrub layer (E2) %	5	5	15	1	5	3	0	1	1	1	0	10	0	1	1	0	1	
	Cover of herb layer (E1) %	80	77	55	32	80	50	35	45	60	30	17	12	30	62	35	25	22	
	Cover of moss layer (E0) %	45	85	60	80	60	77	96	55	75	70	80	90	96	50	80	98	85	
	Number of species per relevé	32	31	34	31	22	31	15	19	22	24	15	16	18	21	24	20	21	
E2	*Sorbus aucuparia*	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Solidago virgaurea*	+	.	+	+	+	1	2	+	1	+	+	+	1	1	1	+	.	V
E1	*Calamagrostis epigeios*	+	1	1	2	+	1	+	1	.	2	.	.	1	.	1	1	1	IV
E1	*Polygonatum odoratum*	.	.	.	.	.	.	.	.	1	.	1	.	+	+	+	2	1	III
E1	*Campanula rotundifolia*	.	.	+	1	.	.	.	.	+	+	.	.	.	.	.	.	.	II
E1	*Trommsdorfia maculata*	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	+	.	II
E1	*Koeleria grandis*	.	.	1	.	.	1	.	1	.	1	.	.	.	.	.	.	.	II
E1	*Hypericum perforatum*	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Festuca rubra*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	I
E1	*Carex pilulifera*	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	I
E1	*Deschampsia cespitosa*	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Briza media*	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Vicia cracca*	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I

Appendix 2 (continuation)

Layer	Number of relevé	200	211	255	263	176	254	78	191	193	258	232	233	241	234	240	235	244	Constancy
	Size of relevé m²	100	50	100	100	25	100	25	100	25	50	100	50	50	100	25	100	50	
	Cover of tree layer (E3) %	50	60	60	60	45	30	40	50	40	35	50	20	40	45	25	45	50	
	Cover of shrub layer (E2) %	5	5	15	1	5	3	0	1	1	1	0	10	0	1	1	0	1	
	Cover of herb layer (E1) %	80	77	55	32	80	50	35	45	60	30	17	12	30	62	35	25	22	
	Cover of moss layer (E0) %	45	85	60	80	60	77	96	55	75	70	80	90	96	50	80	98	85	
	Number of species per relevé	32	31	34	31	22	31	15	19	22	24	15	16	18	21	24	20	21	
E1	*Trifolium arvense*	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Lathyrus pratensis*	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Achillea millefolium*	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Linaria vulgaris*	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Hypochoeris radicata*	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Knautia arvensis*	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Rumex acetosa*	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	I
E1	*Chamerion angustifolium*	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Fragaria vesca*	.	1	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Calamagrostis arundinacea*	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Agrostis tenuis*	.	.	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Convallaria majalis*	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	I
E1	*Luzula pilosa*	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	I

Appendix 2 (the end)

Layer	Number of relevé	200	211	255	263	176	254	78	191	193	258	232	233	241	234	240	235	244	Constancy
	Size of relevé m^2	100	50	100	100	25	100	25	100	25	50	100	50	50	100	25	100	50	
	Cover of tree layer (E3) %	50	60	60	60	45	30	40	50	40	35	50	20	40	45	25	45	50	
	Cover of shrub layer (E2) %	5	5	15	1	5	3	0	1	1	1	0	10	0	1	1	0	1	
	Cover of herb layer (E1) %	80	77	55	32	80	50	35	45	60	30	17	12	30	62	35	25	22	
	Cover of moss layer (E0) %	45	85	60	80	60	77	96	55	75	70	80	90	96	50	80	98	85	
	Number of species per relevé	32	31	34	31	22	31	15	19	22	24	15	16	18	21	24	20	21	
E1	*Melampyrum pratense*	1	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	I
E1	*Anthoxanthum odoratum*	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Scorzonera humilis*	.	+	.	.	+	.	.	.	.	.	.	.	1	.	.	.	.	I
E1	*Deschampsia flexuosa*	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	I
E0	*Cetraria islandica*	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	II
E0	*Cladonia furcata*	+	.	+	.	.	+	.	.	+	.	.	.	.	.	.	.	.	II
E0	*Brachythecium campestre*	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E0	*Peltigera canina*	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	I
E0	*Cladonia cornuta*	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	I
E0	*Cladonia fimbriata*	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	I
E0	*Cladina stellaris*	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	I

Localities of relevés: 78 – Steķi forest, 176 – Laukezers, 191, 193 – Vecumnieki, 200 – Baldone, 211 – Taurkalne, 232-235, 240, 241, 244 – Kalnis forest, 254, 258, 258, 263 – Gaigalava.

Appendix 3

The floristic composition of *Convallaria majalis-Pinus sylvestris* community

Layer	Number of relevé	126	265	152	153	71	72	14	39	69	70	177	103	196	198	221	227	13	99	102	131	247	Constancy
	Size of relevé m²	25	100	100	25	100	100	100	100	100	100	25	25	100	100	100	100	100	100	100	100	100	
	Cover of tree layer (E3) %	45	35	40	45	35	50	35	50	45	35	30	40	20	40	10	25	40	45	50	20	40	
	Cover of shrub layer (E2) %	1	1	2	1	5	10	3	1	1	1	5	15	10	3	5	2	1	3	20	5	2	
	Cover of herb layer (E1) %	48	50	60	75	45	55	75	40	30	55	30	75	20	42	40	45	40	45	40	45	80	
	Cover of moss layer (E0) %	90	85	96	95	95	90	70	95	95	85	80	75	95	91	90	90	90	92	90	90	80	
	Number of species per relevé	14	20	20	17	25	28	19	19	22	25	15	21	19	21	27	15	24	25	25	21	22	
Character species of Cl. Vaccinio-Piceetea																							
E3	*Pinus sylvestris*	3	3	3	3	2	3	3	3	3	3	3	3	2	3	1	2	3	3	3	2	3	V
E2	*Pinus sylvestris*	.	.	1	.	+	.	.	.	.	+	.	.	.	.	+	.	.	.	.	+	.	II
E1	*Pinus sylvestris*	.	+	.	.	+	.	.	.	.	.	+	.	+	.	.	.	.	+	.	.	+	II
E3	*Picea abies*	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	1	.	.	.	.	I
E2	*Picea abies*	.	+	1	1	1	2	1	+	+	+	1	2	2	1	1	1	+	1	1	1	+	V
E1	*Picea abies*	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	+	.	+	.	.	.	I
E2	*Juniperus communis*	.	.	.	.	1	1	+	.	1	+	1	+	1	1	1	1	+	.	+	.	.	IV
E1	*Vaccinium vitis-idaea*	.	.	2	2	2	2	3	2	2	2	1	2	+	.	2	2	2	.	1	.	2	IV
E1	*Vaccinium myrtillus*	1	1	.	.	+	1	2	2	1	1	.	.	.	.	1	.	1	2	1	.	.	III
E1	*Arctostaphylos uva-ursi*	.	.	.	3	1	1	1	1	.	+	.	.	.	.	.	.	+	.	1	.	.	II
E1	*Lycopodium annotinum*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	I
E1	*Monotropa hypopitys*	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	+	.	.	I
E1	*Trientalis europaea*	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	+	.	.	.	.	I
E0	*Dicranum polysetum*	2	1	5	3	2	2	+	2	2	1	2	1	2	2	2	1	1	.	.	1	+	V
E0	*Hylocomium splendens*	.	2	1	.	1	1	.	2	1	2	.	1	2	2	2	2	2	3	2	3	3	V
E0	*Pleurozium schreberi*	4	4	2	4	5	4	4	4	5	4	4	4	4	4	4	4	4	4	4	3	3	V
E0	*Cladina rangiferina*	.	+	1	.	.	1	.	.	1	1	.	+	1	.	+	1	1	1	1	1	+	IV

Appendix 3 (continuation)

Layer	Number of relevé	126	265	152	153	71	72	14	39	69	70	177	103	196	198	221	227	13	99	102	131	247	Constancy
	Size of relevé m²	25	100	100	25	100	100	100	100	100	100	25	25	100	100	100	100	100	100	100	100	100	
	Cover of tree layer (E3) %	45	35	40	45	35	50	35	50	45	35	30	40	20	40	10	25	40	45	50	20	40	
	Cover of shrub layer (E2) %	1	1	2	1	5	10	3	1	1	1	5	15	10	3	5	2	1	3	20	5	2	
	Cover of herb layer (E1) %	48	50	60	75	45	55	75	40	30	55	30	75	20	42	40	45	40	45	40	45	80	
	Cover of moss layer (E0) %	90	85	96	95	95	90	70	95	95	85	80	75	95	91	90	90	90	92	90	90	80	
	Number of species per relevé	14	20	20	17	25	28	19	19	22	25	15	21	19	21	27	15	24	25	25	21	22	
E0	*Cladina arbuscula*	.	.	+	.	.	.	.	.	+	.	.	+	1	+	.	1	1	+	1	.	.	III
E0	*Ptilium crista-castrensis*	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	I
Character species of Cl. Pulsatillo-Pinetea, O. Pulsatillo-Pinetalia, All. Cytiso-Pinion																							
E1	*Carex ericetorum*	.	+	.	+	.	+	.	.	+	+	1	.	.	+	+	.	.	+	1	+	+	III
E1	*Pulsatilla patens*	.	+	+	+	+	.	+	+	.	.	.	.	.	.	+	+	.	.	.	+	+	III
E1	*Chimaphila umbellata*	+	1	.	.	.	1	.	.	.	.	.	.	.	+	+	.	.	.	1	.	.	II
E1	*Diphasiastrum complanatum*	.	.	.	1	.	.	1	.	.	2	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Epipactis atrorubens*	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Pulsatilla pratensis*	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Pyrola chlorantha*	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Character species of Cl. Calluno-Ulicetea, Koelerio-Corynephoretea, Festuco-Brometea																							
E1	*Calluna vulgaris* (C.-U.)	.	2	1	1	+	.	2	1	+	+	1	1	1	1	2	1	2	1	1	1	2	V
E1	*Festuca ovina* (C.-U.)	1	2	.	.	2	+	1	.	+	.	.	2	2	2	1	2	.	1	1	2	2	IV
E1	*Hieracium umbellatum* (C.-U.)	.	.	.	.	+	.	.	+	+	.	+	.	.	+	.	.	.	.	+	.	+	II
E1	*Thymus serpyllum (K.-C.)*	.	.	+	1	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	II
E1	*Antennaria dioica* (C.-U.)	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Sieglingia decumbens* (C.-U.)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	I

Appendix 3 (continuation)

Layer	Number of relevé	126	265	152	153	71	72	14	39	69	70	177	103	196	198	221	227	13	99	102	131	247	Constancy
	Size of relevé m²	25	100	100	25	100	100	100	100	100	100	25	25	100	100	100	100	100	100	100	100	100	
	Cover of tree layer (E3) %	45	35	40	45	35	50	35	50	45	35	30	40	20	40	10	25	40	45	50	20	40	
	Cover of shrub layer (E2) %	1	1	2	1	5	10	3	1	1	1	5	15	10	3	5	2	1	3	20	5	2	
	Cover of herb layer (E1) %	48	50	60	75	45	55	75	40	30	55	30	75	20	42	40	45	40	45	40	45	80	
	Cover of moss layer (E0) %	90	85	96	95	95	90	70	95	95	85	80	75	95	91	90	90	90	92	90	90	80	
	Number of species per relevé	14	20	20	17	25	28	19	19	22	25	15	21	19	21	27	15	24	25	25	21	22	
E1	*Veronica spicata* (F.-B.)	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Astragalus arenarius* (K.-C.)	1	+	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Dianthus arenarius* (K.-C.)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	I
E1	*Gypsophila fastigiata* (K.-C.)	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	+	I
E1	*Pilosella officinarum* (K.-C.)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	I
Other species																							
E3	*Betula pendula*	.	.	.	.	2	2	.	.	.	.	.	1	.	.	1	.	1	1	+	2	.	II
E2	*Betula pendula*	.	.	.	.	+	.	.	+	.	.	.	1	.	.	.	.	+	+	+	.	+	II
E2	*Quercus robur*	1	+	.	.	.	.	1	1	.	.	.	+	.	.	1	.	+	+	2	+	.	III
E1	*Quercus robur*	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1	+	.	II
E2	*Frangula alnus*	+	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	+	.	.	+	+	II
E1	*Frangula alnus*	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	I
E2	*Sorbus aucuparia*	.	.	.	.	.	.	+	.	.	+	.	+	.	.	.	.	.	+	+	+	1	II
E1	*Sorbus aucuparia*	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	I
E2	*Populus tremula*	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	I
E1	*Populus tremula*	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	I
E2	*Rubus idaeus*	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	I

Appendix 3 (continuation)

Layer	Number of relevé	126	265	152	153	71	72	14	39	69	70	177	103	196	198	221	227	13	99	102	131	247	Constancy
	Size of relevé m^2	25	100	100	25	100	100	100	100	100	100	25	25	100	100	100	100	100	100	100	100	100	
	Cover of tree layer (E3) %	45	35	40	45	35	50	35	50	45	35	30	40	20	40	10	25	40	45	50	20	40	
	Cover of shrub layer (E2) %	1	1	2	1	5	10	3	1	1	1	5	15	10	3	5	2	1	3	20	5	2	
	Cover of herb layer (E1) %	48	50	60	75	45	55	75	40	30	55	30	75	20	42	40	45	40	45	40	45	80	
	Cover of moss layer (E0) %	90	85	96	95	95	90	70	95	95	85	80	75	95	91	90	90	90	92	90	90	80	
	Number of species per relevé	14	20	20	17	25	28	19	19	22	25	15	21	19	21	27	15	24	25	25	21	22	
E1	*Rubus idaeus*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	I
E1	*Acer platanoides*	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Melampyrum pratense*	2	.	1	1	1	1	1	1	1	1	1	2	+	1	.	1	1	2	2	2	.	V
E1	*Convallaria majalis*	.	.	2	2	+	2	1	1	1	1	1	2	1	2	.	.	.	2	1	2	2	IV
E1	*Solidago virgaurea*	.	.	.	+	.	+	.	+	+	+	.	1	+	+	+	.	+	+	+	1	1	IV
E1	*Calamagrostis arundinacea*	.	.	2	1	1	+	.	.	+	2	.	1	1	1	.	.	+	+	2	.	.	III
E1	*Calamagrostis epigeios*	.	2	.	1	2	1	.	.	+	1	2	.	.	.	+	1	.	1	.	.	.	III
E1	*Luzula pilosa*	1	+	.	.	+	+	+	.	.	.	.	.	.	.	+	+	.	.	.	.	.	II
E1	*Polygonatum odoratum*	.	+	.	.	.	+	.	+	1	.	.	+	.	.	+	.	.	.	.	+	.	II
E1	*Agrostis gigantea*	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Agrostis tenuis*	1	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	2	I
E1	*Anthoxanthum odoratum*	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	I
E1	*Arenaria procera*	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Deschampsia flexuosa*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	I
E1	*Dryopteris carthusiana*	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	I
E1	*Fragaria vesca*	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Koeleria grandis*	.	1	.	.	.	.	.	.	.	1	.	.	1	1	.	.	.	.	.	.	.	I

Appendix 3 (the end)

Layer	Number of relevé	126	265	152	153	71	72	14	39	69	70	177	103	196	198	221	227	13	99	102	131	247	Constancy
	Size of relevé m²	25	100	100	25	100	100	100	100	100	100	25	25	100	100	100	100	100	100	100	100	100	
	Cover of tree layer (E3) %	45	35	40	45	35	50	35	50	45	35	30	40	20	40	10	25	40	45	50	20	40	
	Cover of shrub layer (E2) %	1	1	2	1	5	10	3	1	1	1	5	15	10	3	5	2	1	3	20	5	2	
	Cover of herb layer (E1) %	48	50	60	75	45	55	75	40	30	55	30	75	20	42	40	45	40	45	40	45	80	
	Cover of moss layer (E0) %	90	85	96	95	95	90	70	95	95	85	80	75	95	91	90	90	90	92	90	90	80	
	Number of species per relevé	14	20	20	17	25	28	19	19	22	25	15	21	19	21	27	15	24	25	25	21	22	
E1	*Melampyrum polonicum*	.	.	.	.	.	.	+	.	.	.	1	.	.	.	.	.	.	.	.	.	.	I
E1	*Pteridium aquilinum*	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Rubus saxatilis*	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Rumex acetosa*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	I
E1	*Scorzonera humilis*	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Trommsdorfia maculata*	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Veronica officinalis*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	I
E0	*Polytrichum juniperinum*	.	.	.	.	.	.	.	.	.	.	.	.	+	1	+	.	.	+	.	.	+	II
E0	*Cetraria islandica*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	I
E0	*Cladina stellaris*	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	I
E0	*Cladonia cenotea*	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	I
E0	*Cladonia cornuta*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	I
E0	*Cladonia fimbriata*	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	I
E0	*Cladonia furcata*	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	1	.	.	.	.	I
E0	*Cladonia squamosa*	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	I

Localities of relevés: 13, 14 – Melnais hilly forest, 39 – Krišjāņi, 69-72, 99, 102, 103 – Driksna forest, 123, 131 – Silene, 152, 153 – Posulnica, 177 – Laukezers, 196, 198 - Vecumnieki, 221 – Timsmales, 227 Perlis forest, 247, 265 – Gaigalava.

Appendix 4

The floristic composition of Ass. Cladonio-Pinetum var. *Polygonatum odoratum*

Layer												Constancy
	Number of relevé	81	230	228	236	237	238	220	225	239	242	
	Size of relevé m²	25	100	100	100	100	25	100	100	50	100	
	Cover of tree layer (E3) %	35	60	40	45	30	40	35	20	30	30	
	Cover of shrub layer (E2) %	1	1	2	0	1	10	5	20	1	1	
	Cover of herb layer (E1) %	47	30	32	10	25	30	20	50	60	45	
	Cover of moss layer (E0) %	80	96	90	95	95	95	92	90	76	90	
	Number of species per relevé	10	14	15	16	12	13	22	24	21	23	
Character species of Cl. Vaccinio-Piceetea												
E3	*Pinus sylvestris*	3	4	3	3	3	3	3	2	3	3	V
E2	*Pinus sylvestris*	.	1	.	.	.	.	.	1	+	+	II
E1	*Pinus sylvestris*	.	.	.	.	.	.	.	+	+	+	II
E2	*Juniperus communis*	.	+	1	.	1	.	1	1	.	.	III
E1	*Juniperus communis*	.	.	.	.	.	.	+	.	.	.	I
E2	*Picea abies*	.	.	1	.	.	.	.	2	+	+	II
E1	*Vaccinium vitis-idaea*	2	1	2	.	1	1	1	2	2	1	V
E1	*Vaccinium myrtillus*	.	.	1	.	.	.	1	.	.	+	II
E1	*Arctostaphylos uva-ursi*	.	.	.	.	.	.	.	.	.	2	I
E0	*Cladina arbuscula*	1	1	1	+	2	2	1	1	1	2	V
E0	*Cladina rangiferina*	1	1	1	1	2	3	1	2	2	2	V
E0	*Dicranum polysetum*	4	1	1	2	2	2	3	2	3	2	V
E0	*Pleurozium schreberi*	1	5	5	5	3	3	3	3	2	3	V
E0	*Cladonia crispata*	.	.	.	.	.	.	.	.	.	+	I
E0	*Hylocomium splendens*	.	.	.	.	.	.	.	.	2	.	I
Character species of Cl. Pulsatillo-Pinetea, O. Pulsatillo-Pinetalia, All. Cytiso-Pinion												
E1	*Carex ericetorum*	.	.	+	+	.	.	1	+	1	1	III
E1	*Diphasiastrum complanatum*	2	2	.	.	.	2	.	.	.	.	II
E1	*Pulsatilla patens*	.	.	.	+	.	.	+	+	+	.	II
E1	*Pulsatilla pratensis*	.	.	.	+	.	.	.	.	.	.	I
Character species of clasis Calluno-Ulicetea, Koelerio-Corynephoretea, Festuco-Brometea												
E1	*Calluna vulgaris* (C.-U.)	1	.	1	1	2	1	1	2	2	2	V
E1	*Empetrum nigrum* (C.-U.)	.	.	.	.	.	.	.	.	.	1	I
E1	*Festuca ovina* (C.-U.)	.	.	.	+	.	.	1	1	2	+	III

Appendix 4 (the end)

Layer												Constancy
	Number of relevé	81	230	228	236	237	238	220	225	239	242	
	Size of relevé m²	25	100	100	100	100	25	100	100	50	100	
	Cover of tree layer (E3) %	35	60	40	45	30	40	35	20	30	30	
	Cover of shrub layer (E2) %	1	1	2	0	1	10	5	20	1	1	
	Cover of herb layer (E1) %	47	30	32	10	25	30	20	50	60	45	
	Cover of moss layer (E0) %	80	96	90	95	95	95	92	90	76	90	
	Number of species per relevé	10	14	15	16	12	13	22	24	21	23	
E1	*Hieracium umbellatum* (C.-U.)	1	.	.	.	.	.	.	.	+	.	I
E1	*Sieglingia decumbens* (C.-U.)	.	.	.	.	.	.	1	.	.	.	I
E1	*Dianthus arenarius* (K.-C.)	.	+	.	.	.	.	.	.	.	.	I
E1	*Gypsophila fastigiata* (K.-C.)	.	.	.	+	+	+	+	.	.	+	III
E1	*Koeleria glauca* (K.-C.)	.	.	.	.	.	.	.	.	+	.	I
E1	*Pilosella officinarum* (K.-C.)	.	.	.	.	.	.	.	.	+	.	I
E1	*Thymus serpyllum* (K.-C.)	.	.	.	.	.	.	.	.	+	+	I
Other species												
E2	*Quercus robur*	+	.	.	.	.	.	+	+	.	.	II
E1	*Quercus robur*	.	.	.	.	.	.	+	.	.	+	I
E2	*Betula pendula*	.	.	.	.	.	.	1	1	.	.	I
E2	*Frangula alnus*	.	+	.	.	.	.	.	+	.	.	I
E1	*Calamagrostis epigeios*	.	.	+	1	1	1	.	1	1	1	IV
E1	*Polygonatum odoratum*	.	.	+	1	1	1	+	.	+	+	IV
E1	*Solidago virgaurea*	.	+	.	+	+	+	1	+	+	1	IV
E1	*Convallaria majalis*	.	2	2	+	.	.	.	.	.	1	II
E1	*Chamerion angustifolium*	.	+	.	.	.	.	.	.	.	.	I
E1	*Koeleria grandis*	.	.	.	.	.	.	.	1	.	.	I
E1	*Luzula pilosa*	.	.	.	.	.	.	+	+	.	.	I
E1	*Melampyrum pratense*	.	.	.	.	.	.	.	1	.	.	I
E1	*Trommsdorfia maculata*	.	.	.	.	.	.	.	.	+	.	I
E0	*Cladina stellaris*	.	+	+	+	.	+	.	1	+	.	III
E0	*Cladonia cornuta*	.	.	.	.	.	.	+	+	.	+	II
E0	*Cladonia deformis*	.	.	.	.	.	.	.	+	.	.	I
E0	*Cladonia fimbriata*	.	.	.	.	.	.	.	+	.	.	I
E0	*Cladonia furcata*	.	.	.	.	.	.	+	.	.	.	I
E0	*Cladonia phyllophora*	.	.	.	.	.	.	.	.	.	+	I
E0	*Cladonia uncialis*	.	.	.	.	.	.	+	.	.	.	I

Localities of relevés: 81 – Steķi forest, 220 – Timsmales, 225 – Pērlis forest, 228, 230, 236–239, 242 – Kalnis forest.

The floristic composition of Ass. Cladonio-Pinetum

Layer	Number of relevé	169	243	219	223	229	231	96	168	8	80	190	267	309	325	194	199	308	224	286	260	Constancy
	Size of relevé, m²	25	100	100	100	100	100	100	25	400	25	100	100	400	400	100	100	400	50	400	100	
	Cover of tree layer (E3) %	30	45	40	40	35	50	50	20	45	30	40	30	30	50	40	40	35	30	30	55	
	Cover of shrub layer (E2) %	1	1	5	1	1	3	1	1	5	0	2	1	10	5	1	5	1	15	20	1	
	Cover of herb layer (E1) %	20	40	30	40	20	30	35	30	30	60	21	32	55	50	30	27	23	55	25	45	
	Cover of moss layer (E0) %	80	95	85	92	95	90	85	56	95	85	95	55	99	70	95	97	91	80	90	61	
	Number of species per relevé	16	10	20	18	12	13	17	16	24	11	18	19	16	12	14	18	15	20	22	25	
Character species of Cl. Vaccinio-Piceetea																						
E3	*Pinus sylvestris*	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3	2	4	V
E2	*Pinus sylvestris*	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	I
E1	*Pinus sylvestris*	+	.	.	+	.	+	.	+	.	.	.	+	.	.	.	.	.	.	+	+	II
E3	*Picea abies*	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	1	.	I
E2	*Picea abies*	+	.	1	1	+	1	+	+	1	.	1	1	1	1	1	1	1	2	2	.	V
E1	*Picea abies*	+	+	.	.	.	+	.	.	+	.	+	+	.	.	.	+	.	.	.	.	II
E2	*Juniperus communis*	.	+	.	.	.	.	.	.	.	.	+	.	1	.	.	+	.	1	.	.	II
E1	*Juniperus communis*	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Vaccinium vitis-idaea*	2	3	2	3	2	2	2	1	2	2	1	2	2	2	2	2	1	2	2	2	V
E1	*Vaccinium myrtillus*	+	.	1	1	+	.	1	1	2	+	2	1	1	2	.	.	.	2	2	2	IV
E1	*Arctostaphylos uva-ursi*	.	.	1	+	1	1	1	.	+	.	+	.	2	.	.	.	.	.	.	.	II
E1	*Trientalis europaea*	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Orthilia secunda*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	I
E1	*Monotropa hypopitys*	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Diphasiastrum tristachyum*	1	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Goodyera repens*	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	I
E0	*Pleurozium schreberi*	4	4	3	4	5	4	3	2	5	3	3	2	2	3	2	3	2	1	2	3	V

Layer	Number of relevé	169	243	219	223	229	231	96	168	8	80	190	267	309	325	194	199	308	224	286	260	Constancy
	Size of relevé, m^2	25	100	100	100	100	100	100	25	400	25	100	100	400	400	100	100	400	50	400	100	
	Cover of tree layer (E3) %	30	45	40	40	35	50	50	20	45	30	40	30	30	50	40	40	35	30	30	55	
	Cover of shrub layer (E2) %	1	1	5	1	1	3	1	1	5	0	2	1	10	5	1	5	1	15	20	1	
	Cover of herb layer (E1) %	20	40	30	40	20	30	35	30	30	60	21	32	55	50	30	27	23	55	25	45	
	Cover of moss layer (E0) %	80	95	85	92	95	90	85	56	95	85	95	55	99	70	95	97	91	80	90	61	
	Number of species per relevé	16	10	20	18	12	13	17	16	24	11	18	19	16	12	14	18	15	20	22	25	
E0	*Dicranum polysetum*	1	2	3	1	1	3	3	2	1	3	3	1	1	2	2	1	2	+	2	2	V
E0	*Hylocomium splendens*	1	1	.	2	.	1	1	1	1	2	2	2	4	2	4	4	3	4	3	.	V
E0	*Cladina rangiferina*	1	.	1	1	1	.	2	2	+	+	1	1	1	.	1	1	2	1	.	1	IV
E0	*Cladina arbuscula*	.	.	1	1	1	.	1	1	+	+	1	2	+	+	1	1	.	1	2	1	IV
E0	*Ptilium crista-castrensis*	.	.	1	.	.	.	.	.	+	.	.	.	.	.	.	.	.	1	+	1	II
E0	*Cladonia gracilis*	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	I
E0	*Cladonia crispata*	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	I
	Character species of Cl. Pulsatillo-Pinetea, O. Pulsatillo-Pinetalia, All. Cytiso-Pinion																					
E1	*Carex ericetorum*	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	I
E1	*Pulsatilla patens*	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Diphasiastrum complanatum*	.	.	.	.	.	.	.	.	.	2	.	2	.	.	.	.	.	.	.	.	I
E1	*Pyrola chlorantha*	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	I
	Character species of Cl. Calluno-Ulicetea, Koelerio-Corynephoretea, Festuco-Brometea																					
E1	*Calluna vulgaris* (C.-U.)	.	1	1	1	1	1	2	2	1	3	2	1	1	1	2	1	1	1	+	1	V
E1	*Festuca ovina* (C.-U.)	.	.	1	+	.	+	+	.	.	.	+	.	.	.	.	1	.	1	+	1	III
E1	*Lycopodium clavatum* (C.-U.)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	I
E1	*Hieracium umbellatum* (C.-U.)	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	I
E1	*Sieglingia decumbens* (C.-U.)	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	I
E1	*Empetrum nigrum* (C.-U.)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	2	.	.	.	I

Appendix 5 (continuation)

Layer	Number of relevé	169	243	219	223	229	231	96	168	8	80	190	267	309	325	194	199	308	224	286	260	Constancy
	Size of relevé, m²	25	100	100	100	100	100	100	25	400	25	100	100	400	400	100	100	400	50	400	100	
	Cover of tree layer (E3) %	30	45	40	40	35	50	50	20	45	30	40	30	30	50	40	40	35	30	30	55	
	Cover of shrub layer (E2) %	1	1	5	1	1	3	1	1	5	0	2	1	10	5	1	5	1	15	20	1	
	Cover of herb layer (E1) %	20	40	30	40	20	30	35	30	30	60	21	32	55	50	30	27	23	55	25	45	
	Cover of moss layer (E0) %	80	95	85	92	95	90	85	56	95	85	95	55	99	70	95	97	91	80	90	61	
	Number of species per relevé	16	10	20	18	12	13	17	16	24	11	18	19	16	12	14	18	15	20	22	25	
E1	*Nardus stricta* (C.-U.)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	I
E1	*Astragalus arenarius* (K.-C.)	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Dianthus arenarius* (K.-C.)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Pilosella officinarum* (K.-C.)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	I
Other species																						
E3	*Betula pendula*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	1	.	I
E2	*Betula pendula*	.	.	+	+	.	.	+	1	1	.	.	+	+	1	.	.	.	.	.	+	III
E1	*Betula pendula*	.	.	.	.	+	+	.	+	.	.	.	+	.	.	.	.	.	.	.	.	I
E2	*Frangula alnus*	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	I
E1	*Frangula alnus*	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	I
E2	*Quercus robur*	.	.	.	.	.	.	1	+	+	.	+	.	.	.	.	.	.	.	.	.	I
E1	*Quercus robur*	+	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	+	II
E2	*Salix caprea*	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	I
E1	*Melampyrum pratense*	+	.	.	.	.	.	+	.	1	1	1	1	2	1	.	.	+	1	+	1	III
E1	*Calamagrostis epigeios*	1	.	+	.	.	+	+	.	.	.	.	+	.	.	+	+	.	+	.	+	III
E1	*Scorzonera humilis*	.	+	1	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	.	II
E1	*Campanula rotundifolia*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	I
E1	*Trommsdorfia maculata*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Calamagrostis arundinacea*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	+	.	I

Appendix 5 (the end)

Layer	Number of relevé	169	243	219	223	229	231	96	168	8	80	190	267	309	325	194	199	308	224	286	260	Constancy
	Size of relevé, m²	25	100	100	100	100	100	100	25	400	25	100	100	400	400	100	100	400	50	400	100	
	Cover of tree layer (E3) %	30	45	40	40	35	50	50	20	45	30	40	30	30	50	40	40	35	30	30	55	
	Cover of shrub layer (E2) %	1	1	5	1	1	3	1	1	5	0	2	1	10	5	1	5	1	15	20	1	
	Cover of herb layer (E1) %	20	40	30	40	20	30	35	30	30	60	21	32	55	50	30	27	23	55	25	45	
	Cover of moss layer (E0) %	80	95	85	92	95	90	85	56	95	85	95	55	99	70	95	97	91	80	90	61	
	Number of species per relevé	16	10	20	18	12	13	17	16	24	11	18	19	16	12	14	18	15	20	22	25	
E1	*Solidago virgaurea*	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	I
E1	*Convallaria majalis*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	I
E1	*Luzula pilosa*	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	I
E1	*Anthoxanthum odoratum*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	I
E1	*Koeleria grandis*	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	I
E1	*Deschampsia flexuosa*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	I
E0	*Cladina stellaris*	+	.	.	1	+	.	.	1	+	.	.	.	1	.	+	.	1	.	.	1	III
E0	*Polytrichum juniperinum*	.	.	.	.	.	.	.	.	+	.	.	+	.	.	+	.	1	+	+	.	II
E0	*Cetraria islandica*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	I
E0	*Cladonia furcata*	.	.	.	.	.	.	.	.	+	.	+	.	+	.	.	.	.	.	.	.	I
E0	*Cladonia cornuta*	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	I
E0	*Cladonia fimbriata*	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	1	.	.	.	I
E0	*Pohlia nutans*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	I
E0	*Cladonia macilenta*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	I
E0	*Cladonia coniocraea*	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	I
E0	*Aulacomnium palustre*	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	.	.	I
E0	*Cladonia chlorophaea*	.	.	.	+	.	.	.	.	+	.	.	+	.	.	.	.	.	.	+	.	I
E0	*Cladonia cenotea*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	I

Localities of relevés: 8 – Ozolsala, 80 – Steķi forest, 96, 168, 169 – Driksna forest, 190, 194, 199 – Vecumnieki, 219 – Timsmales, 223, 224 – Pērlis forest, 229, 231, 243 – Kalnis forest, 260 – Gaigalava, 267 – Dviete, 286, 325 – Krustkalni Nature Reserve, 308, 309 – Mežole.

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Invasive knotweeds *Reynoutria japonica* and *R. sachalinensis* in Latvia

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Abstract

In Latvia, tall-herb communities are formed frequently by two species of Eastern Asia floral region – *Reynoutria japonica* and *R. sachalinensis*. These species were recorded in Latvia in the 80–90ies of the 19[th] c. for the first time. *R. japonica* is more common than *R. sachalinensis*. Both species have higher number of localities in Western Latvia with milder climate than in Eastern Latvia where climate is more continental. Plant communities with knotweeds are species poor. They belong to the class Galio-Urticetea (nitrophilous tall-herb vegetation) and are classified as derivate communities. Knotweed communities develop in neutral and weakly acid soils rich in nitrogen.

Keywords: tall-herb communities, alien species, distribution, *Reynoutria japonica, Reynoutria sachalinensis*, Latvia.

INTRODUCTION

During the last decades the vegetation of Latvia has been characterised by the formation and distribution of tall-herb communities. Usually these communities are monodominant, with simplified layering, and a single edificatory species. They are characterised by high biomass (length of the main vegetative stem is 1–3 m) and decorative outlook. Formation of tall-herb communities is facilitated by extensive land management and growth of ruderal areas, eutrophication of the environment, and climate warming (Laiviņš 2001).

Tall-herb communities in Latvia are formed of both local species – *Pteridium aquilinum, Epiobion angustifolium, Chaerophyllum aromaticum, Laserpitium latifolium, Calamagrostis epigeios, Phragmites australis, Rubus idaeus*, and alien ones – *Solidago canadensis, S.gigantea, Helianthus tuberosus, Petasites hybridum, Heracleum sosnowskyi, Echinocystis lobata, Reynoutria sachalinensis, R. japonica, Impatiens glandulifera, I. parviflora, Rudbeckia laciniata, Symphytum asperum*, etc.

Among alien species frequently forming tall-herb communities in Latvia, there are two species from the East Asian flora region – *Reynoutria japonica* and *R. sachalinensis*. In Latvia, both species are anthropophytes, and mainly spread from gardens or greeneries (Laiviņš 1989; Gavrilova, Šulcs 1999).

Usually knotweeds form small plant communities (from several tens to several hundreds of m^2), which are common at anthropogenic site habitats in inhabited localities. The largest stands are quite often formed on roadsides and ruderal site habitats; they can be frequently met in old rural parks.

Currently there is an increased distribution of knotweeds in Latvia due to intensive synanthropisation of biota, therefore research has been carried out along the following lines:

1) mapping of knotweed localities and clarification of the distribution peculiarities of species;

2) analysis of the composition and ecological conditions of the species of knotweed plant communities.

MATERIAL AND METHODS

A grid net in the size of 7.7 x 9.3 km has been used for the mapping of knotweed localities (locality area is 71.6 km^2). Herbarium materials, literature sources, and data from flora inventory have been used in drawing up distribution maps. Locality has been characterised by the conventional coordinates in the mapping net of flora, geographical name of the place, data source, author, and disclosure year of the locality. The following abbreviations have been used for the data sources: H – herbarium materials; LATV – herbarium of the Institute of Biology at the University of Latvia; RIG I – Herbarium Balticum (herbarium of K. Kupffer, Faculty of Biology, University of Latvia); RIG II – Herbarium Latvicum (herbarium of the Faculty of Biology, University of Latvia); BI KF – inventory materials of particular floras of the Institute of Biology, University of Latvia; NBD DI – inventory data of garden flora of the National Botanical Garden; LU FK – flora mapping materials of the Laboratory of Biogeography, Faculty of Geography and Earth Sciences, University of Latvia; L – literature data.

According to the time of disclosure, localities have been divided into 4 groups indicated in the distribution maps.

The author has described knotweed communities (10 *Reynoutria japonica* and 11 *R. sachaliensis*) in 1987 in various places of Latvia, mainly in towns, nearby homesteads, and on roadsides. Area covered by knotweed communities is usually rather small, thus the area of relevé usually coincided with that of coenosis. In the relevé, the cover (in per cent) of each species has been estimated by eye. In the course of data processing the percentage values have been equated with the 7-point Braun-Blanquet scale, and have been summarised in tables (Mueller-Dombois, Ellenberg 1974; Dierschke 1994).

Ellenberg indicator values (Ellenberg et al. 1992) for the detection of environmental factors were calculated, weighted by coverage. Furthermore, topsoil samples (in 2–5 cm depth) of the communities described in 1987 were taken for the detection of the chemical properties of the soil. Soil pH was determined 1 *M* KCl solutions, exchangeable acidity (extractant 1 *M* CH_3COONa, Kappen method), sum of exchangeable basic cations – extraction by 0,1 *M* HCl (method of Kappen-Gilkovich), soil organic carbon after method of Tjurin (oxidation by $K_2Cr_2O_7 + H_2SO_4$), and total nitrogen by Kjeldahl. Particle size analysis was made by sedimentation and pipette method after N. Kachinsky (Skujāns, Mežals 1964).

Nomenclature: Gavrilova, Šulcs 1999.

RESULTS

Distribution in Latvia

Data on 207 *Reynoutria japonica* and 96 *R. sachalinensis* localities in Latvia in the 19th and 20th century have been compiled in this work.

In Latvia, according to the herbarium data, these two species had been first found in Riga at the end of the 19th century – *Reynoutria sachalinensis* in 1887, and *Reynoutria japonica* in 1888. Apparently, these species had been bred as decorative plants in Riga, since herbarium samples of *R. sachalinensis* have been taken in one of the oldest parks of the city – Vermandarzs. Presumably, in the beginning of the 20th century, propagation of these species in the Baltics took place also in semi-natural site habitats. In 1904, pharmacist Brahmanis had herborised *R. japonica* in the town of Pavilosta, and had been observing the semi-natural site habitat of this species at the Kurzeme seaside for several years (Kupffer 1907). Collections of *R. sachaliensis* gathered in 1909 in Pernava region in the western Estonia are kept in the herbarium of K. Kupffer (Faculty of Biology, University of Latvia). In the course of 30 years knotweeds had been registered already in several places in Latvia: *R.japonica* – in the towns of Rīga, Ogre, Bauņi, Gulbene, and Nīca, while *R. sachalinensis* – in the towns of Sloka, Gulbene, Džūkste, Kalēti, and Malnava (Starcs 1934).

In the period of time from 1951 to 1970 only some new knotweed localities in Latvia had been mentioned in the literature, while there are no herbarium collections. Majority of knotweed localities have been registered after 1970 (Appendix 1). Distribution maps of Japanese and Sakhalinian knotweeds have been drawn up based on materials of herbariums, archives, and literature (Fig. 1, 2.).

Species composition, syntaxonomy and ecology

Knotweed plant communities are monodominant tall-herb communities, with a single edificatory knotweed species. Knotweeds form a dense stand of 2–3 metres in height. They are strong competitors, since there is a considerable shade under the thick foliage, thus determining the small number of species of the plant communities. On average, 9 species have been encountered in the described plant communities, however, even those are met mainly on the edge of knotweed stands with better lighting.

Altogether there are 31 species registered in the communities of *R. japonica* (Table 1). With the exception of the Japanese knotweed, there are only 2 species – *Aegopodium podagraria* and *Dactylis glomerata* that are frequently encountered (constancy class V), one species – *Urtica dioica* – is medium frequent (constancy class III), while others are rare ones.

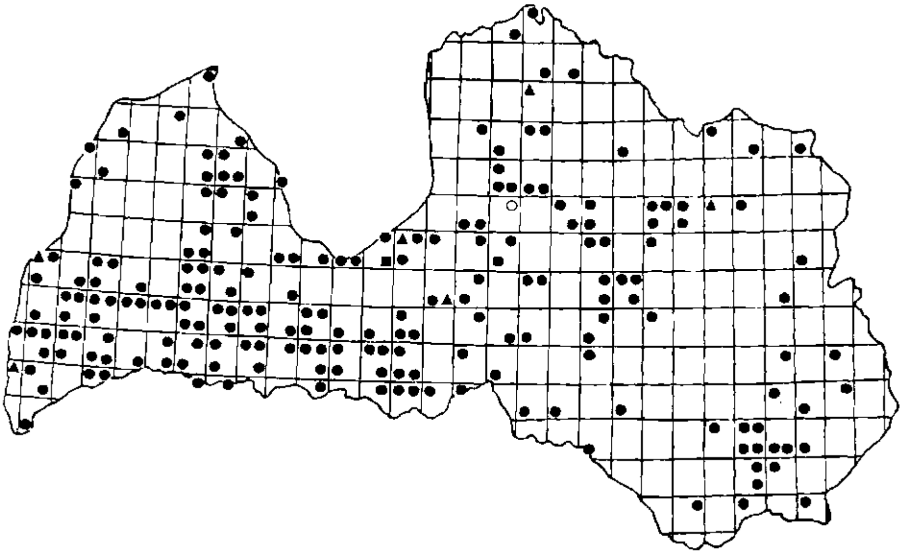


Fig. 1. Distribution of *Reynoutria japonica* in Latvia. Locality is recorded: ■ – before 1900, ▲ – 1901–1950, ○ – 1951–1970, ● – 1971–2002

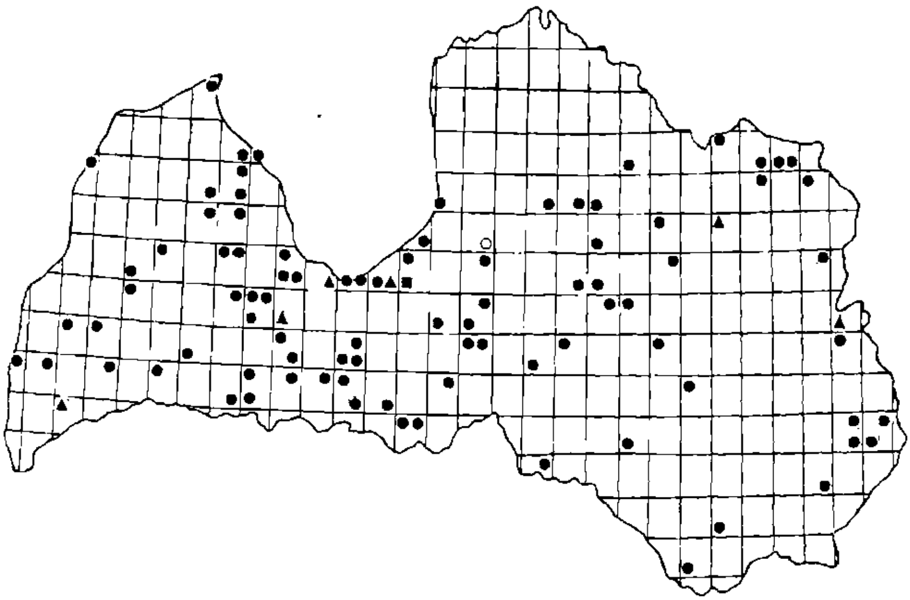


Fig. 2. Distribution of *Reynoutria sachalinensis* in Latvia. Locality is recorded: ■ – before 1900, ▲ – 1901–1950, ○ – 1951–1970, ● – 1971–2002

Table 1

The floristic composition of *Reynoutria japonica* communities

Nr. of relevé	1	2	3	4	5	6	7	8	9	10	Constancy
Size of relevé, m^2	50	60	12	48	10	6	6	36	10	50	
Cover of *Reynoutria japonica*,%	100	95	95	100	100	100	95	100	100	100	
Number of species per relevé	14	13	14	10	4	8	6	4	7	9	
Ch. Cl. Galio-Urticetea, O. Lamio albi-Chenopodietalia boni-chenrici, All. Aegopodion											
Aegopodium podagraria (All)	1	.	+	1	1	+	2	+	2	2	V
Urtica dioica (Cl)	+	+	+	+	.	+	.	.	+	+	III
Rumex obtusifolius (Cl)	+	+	.	+	.	.	.	.	.	.	II
Chelidonium majus (O)	+	+	.	.	.	.	.	.	.	+	II
Impatiens parviflora (Cl)	.	.	+	+	.	.	.	.	.	1	I
Anthriscus sylvestris (O)	.	.	+	.	.	+	.	.	.	+	I
Lapsana communis (O)	+	+	.	.	.	.	.	.	.	.	I
Geum urbanum ((O)	+	.	.	+	.	.	.	.	.	.	I
Glechoma hederacea (O)	+	.	.	.	.	.	.	.	.	+	I
Vicia sepium (O)	.	+	.	.	.	.	.	.	.	.	I
Heracleum sibiricum (O)	.	.	.	.	.	+	.	.	.	.	I
Aster salignus (Cl)	.	.	.	.	.	.	.	.	+	.	I
Reynoutria japonica	5	5	5	5	5	5	5	5	5	5	V
Other species											
Dactylis glomerata	+	.	+	+	+	+	+	+	+	+	V
Taraxacum officinale	+	.	.	.	.	+	+	.	+	.	II
Artemisia vulgaris	.	+	+	.	.	.	.	.	.	+	II
Elytrigia repens	.	.	+	+	.	.	+	.	.	.	II
Poa pratensis	.	+	+	.	.	.	.	.	.	.	I
Chaerophyllum aromaticum	+	1	.	.	.	.	.	.	.	.	I
Ranunculus repens	+	+	.	.	.	.	.	.	.	.	I
Athyrium filix-femina	+	+	.	.	.	.	.	.	.	.	I
Tripleurospermum perforatum	.	+	+	.	.	.	.	.	.	.	I
Acer platanoides	.	.	.	+	+	.	.	.	.	.	I

Rare species: E1 *Myosotis palustris* +(1), *Equisetum pratense* +(2), *Chenopodium album* +(3), *Capsella bursa-pastoris* +(3), *Festuca pratensis* +(6), *Potentilla anserina* +(7), *Fraxinus excelsior* +(8). *Betula pendula* +(9).

Localities of relevés
1,2 – Park Zasas, 04.07.1987.
3 – Gaiļezers, Rīga, next to cottage, 22.08.1987.
4 – Ogre, slope of hill range Zilie kalni, forest fringe, 22.08.1987.
5 – Purvciems. Rīga, Gailes street, 23.08.1987.
6 – Railway station Aizkraukle, roadside, 25.08.1987.
7 – Alūksne, Komjaunatnes street 25, yard, 10.09.1987.
8 – Sigulda, Vidzemes highway 7, roadside, 17.09.1987.
9 – Jaunogre, Lāčplēša street 13, roadside, 26.09.1987.
10 – Dzintari, Jurmala, Krišjāņa Barona street 18, ruderal habitat, 28.09.1987.

Richer in species are *R. sachalinensis* communities with the total number of 41 species (Table 2). Three frequently met species are – *Aegopodium podograria, Artemisia vulgaris,* and *Dactylis glomerata* (class IV–V).

Table 2

The floristic composition of *Reynoutria sachalinensis* communities

Nr. of relevé	1	2	3	4	5	6	7	8	9	10	11	Constancy
Size of relevé, m^2	3	10	16	50	8	10	10	28	15	8	20	
Cover of *Reynoutria sachalinensis*, %	90	95	95	100	90	100	95	100	100	95	100	
Number of species per relevé	5	11	7	6	6	10	8	14	8	9	8	
Ch. Cl. Galio-Urticetea, O. Lamio albi-Chenopodietalia boni-chenrici, All. Aegopodion												
Aegopodium podagraria (All)	1	2	1	2	2	2	1	1	1	2	2	V
Urtica dioica (Cl)	.	.	1	.	+	.	+	2	.	.	.	II
Heracleum sibiricum (O)	+	.	+	.	.	.	+	+	.	.	.	II
Impatiens parviflora (Cl)	.	.	.	.	.	+	.	.	.	1	.	I
Anthriscus sylvestris (O)	.	.	.	.	.	.	+	.	+	.	.	I
Impatiens glandulifera (Cl)	.	+	.	.	.	.	.	.	.	.	.	I
Rudbeckia laciniata (Cl)	.	+	.	.	.	.	.	.	.	.	.	I
Chelidonium majus (O)	.	.	.	.	.	+	.	.	.	.	.	I
Rumex obtusifolius (Cl)	.	.	.	.	.	.	.	+	.	.	.	I
Arctium tomentosum (Cl)	.	.	.	.	.	.	.	+	.	.	.	I
Reynoutria sachalinensis	5	5	5	5	5	5	5	5	5	5	5	V
Other species												
Dactylis glomerata	+	.	+	.	+	+	+	+	+	+	+	V
Artemisia vulgaris	.	+	+	+	+	+	+	+	.	+	.	IV
Equisetum arvense	+	.	.	.	.	.	+	+	.	.	.	*II*
Taraxacum officinale	.	.	.	.	+	.	.	.	.	+	+	II
Chaerophyllum aromaticum	.	.	.	.	.	.	+	.	+	.	+	II
Melilotus albus	.	+	.	.	+	.	.	.	.	.	.	I
Galinsoga parviflora	.	.	+	.	.	.	.	.	+	.	.	I
Trifolium medium	.	.	.	.	.	.	.	+	.	1	.	I

Rare species: E1 *Sambucus nigra* +(1), *Elytrigia repens* +(2), *Chenopodium album* +(2), *Bidens tripartita* +(2), *Bromopsis inermis* +(2), *Silene vulgaris* +(3), *Solidago canadensis* +(4), *Salix caprea* +(4), *Ranunculus repens* +(6), *Rosa spinosissima* +(6), *Plantago major* +(6), *Alnus incana* +(8), *Stellaria media* +(8), *Vicia cracca* +(8), *Rubus idaeus* +(8), *Acer platanoides* +(9), *Equisetum pratense* +(10), *Cirsium arvensis* +(10), *Polygonum aviculare* +(11), *Poa annua* +(11), *Sorbaria sorbifolia* +(11).

Localities of relevés
1 – Ogre, Brīvības street next to Lutheran church, 22.08.1987.
2 – Lielvārde, E.Kauliņa street 8, roadside, 23.08.1987.
3 – Lielvārde, Lāčplēša street 5, yard, 23.08.1987.
4 – Ķegums, railway embankment, 24.08.1987.
5 – Railway station Ķegums, highway edge, 24.08.1987.
6 – Ķegums, edge of pathway near the railway station, 24.08.1987.
7,8 – Gaiziņkalns, roadside near the forestry house, 25.08.1987.
9 – Vestiena, ruderal area next to the dairy, 25.08.1987.
10 – Karitāni, the edge of Alūksnes-Liepnas highway near the Veisteru Lake, 25.08.1987.
11 – Alūksnes cemetery, 10.09.1987.

Most widely represented species in the knotweed community are those of the nitrophilous tall-herb communities – Cl. Galio-Urticetea, O. Lamio albi-Chenopodietalia boni-chenrici, All. Aegopodion (in *R. japonica* communities, species of this class make up 38% of the total number of species, and up to 24% in *R. sachalinensis* communities). The next most widely distributed ones are the characteristic species of grassland communities Molinio-Arrhenatheretea, and ruderal communities Artemisietea vulgaris. Furthermore, there is a large share of characteristic species of forest fringe communities of the Cl. Trifolio-Geranietea in *R. sachaliensis* communities. The described communities of knotweeds are derivate plant communities which have formed in site habitats, rich in nutrients, and belong to the class of nitrophilous tall-herb communities:

Dc. *Reynoutria japonica* communities [Galio-Urticetea];

Dc. *Reynoutria sachaliensis* communities [Galio-Urticetea].

Knotweed communities usually form in weakly acid and neutral site habitats (Table 3, Fig. 3). Site habitats of Japanese knotweed communities are slightly more acid than those of Sakhalinian knotweed communities. It is typical that site habitats of both

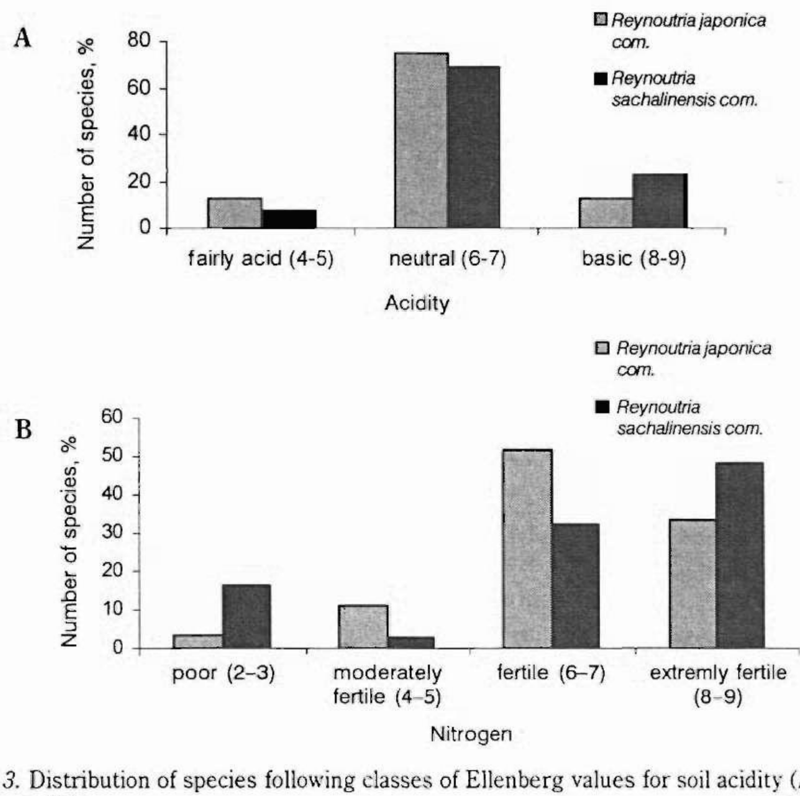


Fig. 3. Distribution of species following classes of Ellenberg values for soil acidity (A) and nitrogen (B)

Table 3

Ellenberg indicator values of Knotweed communities

Factor	Plant community	
	Reynoutria japonica	*Reynoutria sachalinensis*
Light	6.8	6.4
Temperature	6.5	5.6
Continentality	2.9	3.8
Moisture	6.6	5.5
Reaction R	5.6	6.9
Nitrogen N	6.7	6.9
R + S	12.5	13.6

knotweeds are rich or even extremely rich in nitrogen. A large mass of organic substances is annually accumulated in the site habitat; active microbiological activity promotes their decomposition, mineralisation, and accumulation of nitrogen. Topsoil is rich in nutrients and saturated with exchangeable bases (Tables 4, 5). On the whole, topsoil is more homogeneous in Sakhalinian knotweed communities, and there is a lower variation of chemical properties than in Japanese knotweed communities.

Table 4

Chemical properties of soils of *Reynoutria japonica* communities

Parameter	Number of relevé									
	1	2	3	4	5	6	7	8	9	10
pH_{KCl}	6.6	6.8	4.4	6.7	6.1	6.3	6.8	6.6	6.1	6.1
Hydrolytic acidity, cmol(+) kg^{-1}	1.4	0.9	32.5	1.3	1.3	1.3	1.8	2.6	1.3	1.8
Exchangeable bases, cmol(+) kg^{-1}	48.8	41.9	34.4	29.8	45.6	47.4	40.9	15.1	42.1	37.5
Base saturation,%	97	98	51	95	97	97	96	85	97	95
Organic C, %	10.4	4.1	40.7	6.0	3.5	10,9	5.4	2.5	7.8	5.9
N, %	0.93	0.53	0.93	0.37	0.35	1.16	0.58	0.31	0.49	0.44
C/N	7	5	19	11	7	6	5	5	11	9
Silt <0,01 mm	17.6	11.8	2.3	4.5	3.2	8.3	10.6	20.4	5.8	3.9

Table 5

Chemical properties of soils of *Reynoutria sachalinensis* communities

Parameter	Number of relevé										
	1	2	3	4	5	6	7	8	9	10	11
pH_{KCl}	7.0	6.2	6.7	6.8	7.3	6.7	6.7	6.7	6.7	6.9	7.0
Hydrolytic acidity, cmol(+) kg^{-1}	0.9	1.8	2.7	1.8	0.9	0.9	1.8	1.8	1.7	0.9	1.0
Exchangeable bases, cmol(+) kg^{-1}	46.1	45.2	43.9	46.5	48.4	45.9	44.2	47.1	48.3	49.2	34.9
Base saturation, %	98	96	94	97	98	98	96	96	97	98	97
Organic C, %	6.6	6.5	11.5	6.6	2.2	2.5	3.1	2.0	4.8	7.7	1.8
N, %	0.48	0.59	0.81	0.63	0.11	0.38	0.5	0.64	0.63	0.73	0.25
C/N	9	8	10	7	14	5	5	4	5	7	5
Silt <0,01 mm	4.7	7.9	7.2	6.4	4.3	6.4	8.2	5.8	3.5	12.3	2.5

DISCUSSION

In the Baltics, *Reynoutria japonica* and *R. sachalinensis* had been bred as decorative plants, and their naturalisation had apparently started about 100 years ago. In the first half of the 20th century, the distribution of knotweeds in semi-natural and natural biotopes had been slow; an increased intensity of naturalisation being observed only during the last decades (Table 6). A recent, expansive distribution of knotweeds, and *Reynoutria japonica* in particular, has been observed also in Great Britain and Belgium (Conolly 1977; Godefroid 1996), and it is related to increased density of knotweed community and environmental change. The radical increase in the number of knotweed localities in Latvia at the end of the 20th century is related mainly to

Table 6

Dynamics of registered localities of *Reynoutria japonica* and *R. sachalinensis*

Years	*Reynoutria japonica*		*Reynoutria sachalinensis*	
	number	%	number	%
before 1900	1	0.5	1	1
1901–1950	6	3	6	7
1951–1970	1	0.5	1	1
1971–2002	199	96	88	91
Total	207	100	96	100

eutrophication of the environment and climate warming during the last 50 years, thus apparently exercising a positive effect on the distribution of knotweeds. At the same time, one cannot ignore an increased inventory activities of invasive species during the last 30 years.

Just as in Europe, there is a wider distribution of *Reynoutria japonica* than *R. sachalinensis* in Latvia (Wagenitz 1981; Connoly 1997; Danneberg 1995). Japanese knotweed is typically widely distributed in old rural and urban parks in the Baltics (Bumbure 1955; Kuusk 1971), where it had been planted as a decorative plant. This species is also characteristic of old parks in the neighbourhood of Moscow (Полякова 1989). In its turn, Sakhalinian knotweed is more widely distributed around inhabited localities and on roadsides.

Higher density of *Reynoutria japonica* localities is found in the western part of Latvia, with a gradual decrease in the number of localities in the direction towards inland (Fig. 4). Apparently, it is influenced by climate conditions, particularly by air temperature and humidity. The western part of Latvia is characterised by milder climate, while climate continentality is increasing in the inland regions of the country. Therefore *Reynoutria japonica* communities have a high share of oceanic species of milder climate (Table 3, Fig. 5).

First naturalised localities of *Reynoutria japonica* in Latvia and Lithuania had been found on the coast of the Baltic Sea (Kupffer 1907; Gudžinskas 1999). Presumably, this species has begun its naturalisation in the Baltics right in the Coastal Lowland – a region with similar climate conditions to those of the species' basic area (East Asia). This is also the case for the time being, with the highest density of localities situated in the Coastal Lowland and Kurzeme.

Density of *Reynoutria sachaliensis* localities is higher in the western part of Latvia, though rather high levels of density are present also in some parts of Eastern Latvia. *Reynoutria sachalinensis* communities are dominated by suboceanic species and species of cooler climate if compared with *R.japonica* communities (Table 3, Fig. 5).

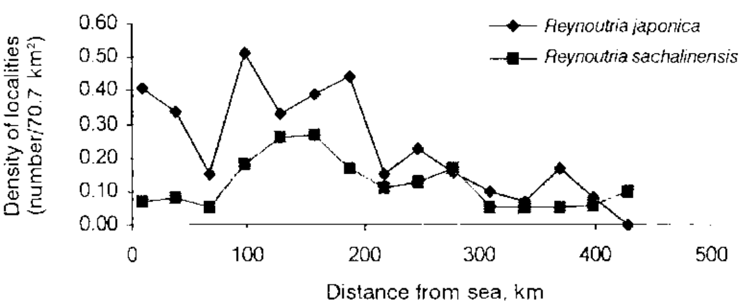
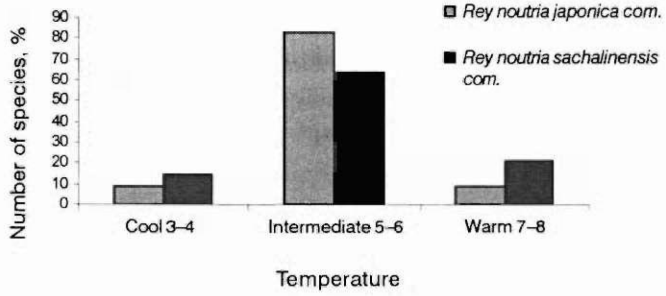


Fig. 4. Relationship between density of localities of knotweeds and distance from the sea

A



B

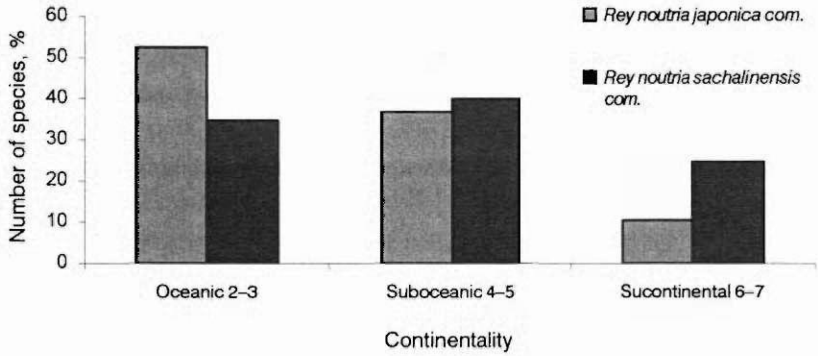


Fig. 5. Distribution of species following classes of Ellenberg values for temperature (A) and continentality (B)

Density of knotweed localities depends on the anthropogenic load of the location. More intensively managed and urbanised localities (Eastern Kursa Upland, Zemgale, Riga region) have higher density of localities, while distribution of knotweeds is more limited in wooded and less cultivated regions (the Venta-Usma Valley, the Eastern Latvia Plain).

Just as in other European regions, knotweed communities in Latvia are derivate communities of nitrophilous tall-herb vegetation of the Cl. Galio-Urticetea (Višnak 1986, 1996; Sobotkova 1995) poor in species (Fijalkowski 1978; Danneberg 1995).

It is characteristic that more than half of species in *R. sachalinensis* communities (26 species, 63% of the total number) and one third in *R. japonica* communities (12 species, 39% of the total number) can be found only in a single relevé. Consequently, there is a large number of occasional species in knotweed communities, and only some species are constant to these communities, which are characteristic to nitrophilous soils, rich in nutrients. Knotweeds enrich the site habitat and facilitate accumulation of organic substances. This is particularly important in the present-day changing environment, when the resources of organic substances are decreasing due to activities undertaken by man.

Several shrub *(Sorbaria sorbifolia, Sambucus nigra, Salix caprea, Rosa spinosissima)*, as well as young tree *(Fraxinus excelsior, Acer platanoides, Alnus incana)* species can be found in knotweed communities. In a while, provided an increasing influence of these species, they could probably transform into brushwood and wood communities. Thus, knotweed communities in Latvia can be considered a prior stage of brushwood and wood communities.

REFERENCES

Adler C. 1993. Zur Strategie und Vergesellschaftung des Neophyten *Polygonatum cuspidatum* unter besonderer Berücksichtigung der Mahd. *Tuexenia*, 13:373–397.

Bumbure M. 1955. Sūreņu dzimta – *Polygonaceae*. (Knotweed family – *Polygonaceae*). *Latvijas PSR flora*. LVI, Rīga, II: 96–127. (in Latvian).

Conolly A.P. 1977. The distribution and history in the British Isles of some alien species of *Polygonum* and *Reynoutria*. *Watsonia*, 11:291–311.

Danneberg A. 1995. Die Ruderalvegetation der Klasse Artemisietea vulgaris in Schleswig-Holstein. *Mitteilungen der Arbeitsgemeinschaft Geobotanik in Schleswig-Holstein un Hamburg*, 49, 143 S.

Dierschke H. 1994. *Pflanzensoziologie*. Verlag Eugen Ulmer, Stuttgart, 683 s.

Ellenberg H., Weber H.E., Dull R., Wirth V., Werner W., Paulissen D. 1992. *Zeigerwerte von Pflanzen in Mitteleuropa*. Verlag Erich Goltze KG, Gottingen, 258 S.

Fijalkowski D. 1978. *Synantropy rošline Lubelszczyzny*. Panstwowe Wydawnictwo Naukowe. Warszawa-Lodž, 260 c.

Gavrilova Ģ., Šulcs V. 1999. *Latvijas vaskulāro augu flora. Taksonu saraksts*. (Flora of Latvian vascular plants. List of taxa.) Rīga, 133 lpp.

Godefroid S. 1996. A propos de l'extension spectaculaire de *Fallopia japonica, F. sachalinensis, Buddleja davidii* et *Senecio inaequidens* en Region bruxelloise. *Dumortiera*, 63: 9–16.

Gudžinskas Z. 1999. Conspectus of alien plant species of Lithuania. 12. *Amaranthaceae* and *Polygonaceae*. *Botanica Lithuanica*, 5: 313–326.

Kupffer K. 1907. Beitrage zur Kenntnis der ostbaltischen Flora IV. Kleine Notizen. *Korrespondenzblatt des Naturforscher-Vereins zu Riga*. Bd. 50: 180–210.

Kuusk V. 1971. *Polygonaceae. Eesti NSV Flora*. Valgus, Tallinn, VIII: 390–472.

Laiviņš M. 1989. *Latvijas ziedaugu un paparžaugu datu katalogs. I Sinantropie elementi*. (Data catalogue of flowering plants and spore plants in Latvia. I Synanthropic elements). Salaspils, 40 lpp. (in Latvian).

Laiviņš M. 2001. Augstzāļu un krūmāju sabiedrības – jauni dinamiski veidojumi Latvijas augājā. (Tall-herb and brushwood communities – new dynamic formations in the vegetation of Latvia). *II Pasaules latviešu zinātnieku kongress. Tēžu krājums*. Rīga, 358. lpp. (in Latvian).

Mueller-Dombois D., Ellenberg H. 1974. *Aims and methods of vegetation ecology*. John Wiley&Sons, New York, London, Sydney, Toronto, 547 p.

Pētersone A., Birkmane K. 1980. *Latvijas PSR augu noteicējs* (Plant guide of the Latvian SSR). Zvaigzne, Rīga, 590 lpp. (in Latvian).

Skujāns R., Mežals II. 1964. *Augšņu pētīšana* (Soil research). LVI, Rīga, 348 lpp. (in Latvian).

Sobotkova V. 1995. Sinantropni flora a vegetace na ūzemi mesta Ostravy. *Scripta Facultatis Rerum Naturalium Universitatis Ostraviensis*, 87, 74 s.

Starcs K. 1934. Ziņojumi par Latvijas divdīgļapaino augu izplatību un formām. I *Salicaceae – Papaveraceae*. (Reports on the distribution and forms of dicotyledonous plants in Latvia). *Latvijas Universitātes Botāniskā Dārza Raksti*, 9:101–142 (in Latvian).

Višnak R. 1986. Prispevek k poznani antropogenni vegetace v severnich Čechach, zvlašt v miste Liberci. *Preslia*, 58,4: 353–368.

Višnak R. 1996. Synantropni vegetace na uzemi mesta Ostravy. 1. čast. *Preslia*, 67: 261–299.

Полякова Т.А. 1989. Адвентивная флора старых парков Подмосковя. (Adventive flora of old parks on the outskirts of Moscow). В кн. *Проблемы изучения синантропной флоры СССР*. Москва, с. 51-52 (in Russian).

Invazīvās dižsūrenes Reynoutria japonica un R. sachalinensis Latvijā

Kopsavilkums

Augstzāļu sabiedrības Latvijā nereti veido divas Austrumāzijas floras apgabala sugas – *Reynoutria japonica* un *R. sachalinensis*. Pirmo reizi šīs sugas Latvijā konstatētas 19. gs 80-os gados. *R.japonica* ir biežāk sastopama nekā *R. sachalinensis*, lielāks atradņu blīvums abām sugām ir Latvijas rietumu daļā ar maigāku klimatu, attālinoties no jūras un palielinoties klimata kontinentalitātei, atradņu skaits samazinās. Dižšūreņu sabiedrības ir sugām nabadzīgas, tās ir nitrofilo augstzāļu sabiedrību klases Galio-Urticetea derivātās sabiedrības. Tās veidojas vāji skābās un neitrālās ar slāpekli bagātās augtenēs.

Appendix 1

List of *Reynoutria japonica* localities

01-35 NBD DI Ipiķi 1983
02-34 NBD DI Mežmuiža (Rencēnu p.) 1983
04-36 NBD DI Ārgaļi (Jeru p.) 1983
04-38 NBD DI Jaunāmuiža (Rencēnu p.) 1983
05-14 LU FK Kolka M.Laiviņš 1985
05-35 L Bauņi (Matīšu p.) K.Starcs 1934
07-12 NBD DI Āži (Dundagas p.) 1977
07-32 H LATV Umurga G.Gavrilova 1991
07-35 NBD DI Pāpenmuiža (Kocēnu p.) 1983
07-36 NBD DI Silupīte (Kocēnu p.) 1983
07-47 LU FK Ape M.Laiviņš 1985
08-08 NBD DI Vēde (Popes p.) 1977
08-16 BI KF Roja I.Lodziņa 1988
08-33 NBD DI Tampas (Stalbes p.) 1981
08-41 LU FK Smiltene M.Laiviņš 1985
08-50 NBD DI Alūksne 1975

08-53 NBD DI Jaunā muiža 1979
09-06 BI KF Ventspils G.Gavrilova 1992
09-14 NBD DI Ambraki (Valdemārpils p.) 1977
09-15 NBD DI Laukmuiža (Valdemārpils p.) 1977
09-33 NBD DI Ezergaiļi (Stalbes p.) 1981
10-07 NBD DI Ūdrande (Piltenes p.) 1977
10-14 NBD DI Valdgale 1977
10-15 NBD DI Šķēde (Laucienas p.) 1977
10-16 NBD DI Iģene (Vandzenes p.) 1977
10-19 BI KF Bērzciems G.Gavrilova 1991
10-33 NBD DI Baukalni (Straupes p.) 1981
10-34 NBD DI Kalnakuķēni (Straupes p.) 1981
10-35 NBD DI Cēsis 1981
10-36 NBD DI Cēsis 1981
11-05 BI KF Užava I.Lodziņa 1990
11-14 NBD DI Dižstende (Lībagu p.) 1993
11-15 NBD DI Stūrīši (Laidzes p.) 1977
11-17 NBD DI Fidriķmuiža (Laucienas p.) 1977
11-28 LU FK Lilaste M.Laiviņš 1987
11-34 L Līgatne A.Pētersone, K.Birkmane 1958
11-37 NBD DI Skrastiņi (Vaives p.) 1981
11-39 LU FK Dzērbene M.Laiviņš 1997
11-43 NBD DI Andrakalni (Rankas p.) 1983
11-44 NBD DI Lizums 1983
11-45 NBD DI Velēna 1983
11-47 L Gulbene K.Starcs 1934
11-49 NBD DI Lāčplēši 1983
12-17 NBD DI Cēre (Zentenes p.) 1977
12-31 LU FK Murjāņi M.Laiviņš 1992
12-32 LU FK Sigulda M.Laiviņš 1985
12-38 NBD DI Gruntāļi (Skujenes p.) 1981
12-38 LU FK Apši (Taurenes p.) 1992
12-43 NBD DI Kapine (Druvienas p.) 1983
12-45 NBD DI Āži (Tirzas p.) 1983
13-14 NBD DI Pedvāle (Abavas p.) 1977
13-15 NBD DI Kalnamuiža (Kandavas p.) 1977
13-26 BI KF Vecdaugava I.Lodziņa 1989
13-27 L Rīga K.Starcs 1934
13-28 NBD DI Langstiņi 1979
13-29 LU FK Garkalne M.Laiviņš 1985
13-32 NBD DI Skrunte (Allažu p.) 1979
13-34 NBD DI Mūrmuiža (Mores p.) 1981
13-39 LU FK Zobols (Vecpiebalgas p.) M.Laiviņš 1998
13-40 LU FK Vecpiebalga M.Laiviņš 1992
13-43 NBD DI Dzeņumuiža (Liezeres p.) 1981
14-13 NBD DI Kabile 1978
14-14 NBD DI Aizupe 1975
14-19 NBD DI Lauksargi (Tumes p.) 1972
14-20 NBD DI Aizpure (Smārdes p.) 1977
14-22 LU FK Sloka M.Laiviņš 1990
14-23 LU FK Melluži M.Laiviņš 1986
14-24 LU FK Lielupe M.Laiviņš 1986
14-26 H RIG I Rīga Vestbergs 1888
14-27 H LATV Rīga G.Gavrilova 1997
14-33 NBD DI Pūlaka (Sidgundas p.) 1979
14-53 LU FK Lutenānu kapi M.Laiviņš 2001
15-03 H RIG I Pāvilosta Brahmans 1904
15-04 NBD DI Šarlate (Sakas p.) 1977
15-07 NBD DI Birži 1978
15-08 NBD DI Apšenieki (Kurmales p.) 1983
15-13 NBD DI Zutēni (Viesturu p.) 1978
15-14 NBD DI Jaunvarieba (Vānes p.) 1977
15-15 NBD DI Plāņi (Zantes p.) 1977
15-17 NBD DI Mežvidi (Zemītes p.) 1977
15-32 NBD DI Annasmuiža (Suntažu p.) 1979
15-35 NBD DI Silamuiža (Madlienas p.) 1979
15-36 NBD DI Vecreimuiža (Taurupes p.) 1979
15-40 NBD DI Stuļģi 1979
15-41 NBD DI Demene 1973
15-42 LU FK Zalgauska M.Laiviņš 2002
16-03 NBD DI Valki (Sakas p.) 1977
16-06 NBD DI Apriķi 1977
16-07 NBD DI Klostere (Lažas p.) 1977
16-10 NBD DI Savenieki (Raņķu p.) 1978
16-13 NBD DI Kalni (Jaunlutriņu p.) 1978
16-14 NBD DI Lielsatiķi (Gaiķu p.) 1978
16-16 NBD DI Viņšeņķi (Viesātes p.) 1977
16-20 NBD DI Grauzīte (Džūkstes p.) 1977
16-29 LU FK Ikšķile M.Laiviņš 1987
16-30 L Ogre L K.Starcs 1934
16-31 LU FK Pārogre M.Laiviņš 1986
16-40 NBD DI Vidsmuiža (Filiptāle) 1979
16-42 NBD DI Pilskalns (Mārcienas p.) 1978

16-52 NBD DI Krišjāņi 1979
17-05 NBD DI Cīrava 1978
17-06 NBD DI Aizpute 1978
17-07 NBD DI Kazdanga 1977
17-08 NBD DI Kapši (Kazdangas p.) 1977
17-09 NBD DI Krūmiņi (Laidu p.) 1978
17-10 NBD DI Skrunda 1983
17-11 NBD DI Niedre (Skrundas p.) 1979
17-12 NBD DI Lašupe (Lutriņu p.) 1978
17-13 NBD DI Saldus 1978
17-15 NBD DI Jaunāmuiža (Remtes p.) 1978
17-16 BI KF Smukas I.Kabucis 1992
17-17 NBD DI Biksti 1977
17-18 NBD DI Jaunpils 1977
17-21 NBD DI Bērzaine (Bērzu p.) 1977
17-22 NBD DI Līvbērze 1977
17-27 NBD DI Dzērumi (Ķekavas p.) 1980
17-32 LU FK Lielvārde M.Laiviņš 1987
17-40 NBD DI Jaunāmuiža (Vietalvas p.) 1979
17-43 NBD DI Ezerieši (Ļaudonas p.) 1981
18-03 NBD DI Kapsēde (Medzes p.) 1977
18-05 NBD DI Raibāmuiža (Durbes p.) 1978
18-07 NBD DI Kalvene 1978
18-13 NBD DI Sātiņi 1975
18-14 NBD DI Mazciecere (Brocēnu p.) 1978
18-16 NBD DI Blīdene 1978
18-18 LU FK Kaķenieki M.Laiviņš 1993
18-20 LU FK Dobele M.Laiviņš 1993
18-21 NBD DI Krišjāņi (Bērzes p.) 1977
18-23 H LATV Jelgava V.Šulcs 1979
18-25 NBD DI Lībieši (Sidrabenes p.) 1985
18-27 NBD DI Cēsinieki (Iecavas p.) 1981
18-28 NBD DI Dzelzāmurs (Iecavas p.) 1977
18-34 LU FK Skrīveri M.Laiviņš 2001
18-35 LU FK Aizkraukle M.Laiviņš 1987
18-39 NBD DI Pleči (Klintaines p.) 1979
19-02 H LATV Liepāja I.Lodziņa 1985
19-03 NBD DI Grobiņa 1977
19-04 NBD DI Mazvārve (Tadaiķu p.) 1978
19-05 NBD DI Vārve (Tadaiķu p.) 1978
19-06 NBD DI Bunka (Bunkas p.) 1978
19-08 NBD DI Embūte 1978
19-12 NBD DI Pauri (Novadnieku p.) 1978
19-14 H LATV Odzēnu ez. I.Kabucis 1994
19-15 NBD DI Zvārde (Novadnieku p.) 1978
19-17 NBD DI Lielauces mežkungmuiža 1981
19-18 NBD DI Īle 1977
19-20 NBD DI Lielapgulde 1977
19-21 H LATV Zaļenieki I.Kabucis 1990
19-22 NBD DI Daktermuiža (Zaļenieku p.) 1981
19-23 BI KF Svēte V.Šulcs 1985
19-25 NBD DI Emburga 1977
19-26 NBD DI Garoza (Mežotnes p.) 1977
19-27 NBD DI Podi (Iecavas p.) 1977
19-31 NBD DI Kalnamuiža (Birzgales p.) 1981
19-39 LU FK Sēlpils 1987
19-52 NBD DI Sutrava (Vērēmu p.) 1981
19-55 NBD DI Ludza 1979
20-04 NBD DI Vidusmuiža (Gaviezes p.) 1977
20-05 NBD DI Virga 1993
20-07 NBD DI Asīte (Priekules p.) 1978
20-08 LU FK Vaiņode M.Laiviņš 2002
20-10 NBD DI Dziras (Nīgrandes p.) 1978
20-12 NBD DI Griezes (Ezeres p.) 1978
20-13 NBD DI Bruzilas (Kursīšu p.) 1978
20-15 NBD DI Jaunauce 1978
20-18 NBD DI Piukšķi (Bēnes p.) 1981
20-22 H LATV Ūziņi I.Kabucis 1990
20-23 NBD DI Jaunplatone 1977
20-26 LU FK Jumpravmuiža M.Laiviņš 2001
20-27 NBD DI Bauskas kokaudzētava Bērzos 1977
20-28 NBD DI Vecsaule 1977
20-33 NBD DI Salasmuiža (Mazzalves p.) 1980
21-01 NBD DI Bernāti 1977
21-02 L Nīca K.Starcs 1934
21-07 NBD DI Mazgramzda (Priekules p.) 1978
21-08 NBD DI Rauži (Vaiņodes p.) 1978
21-14 NBD DI Reņģe 1978
21-16 NBD DI Mežbenkava (Vadakstes p.) 1978
21-22 NBD DI Bārzdiņmuiža (Vilces p.) 1981
21-26 NBD DI Ziedoņi (Borsminde) 1977
21-27 NBD DI Īslīce 1977
21-28 NBD DI Ceraukste 1977
21-29 NBD DI Jaunsaule 1977

21-31 NBD DI Skaistkalne 1977
21-51 NBD DI Vertukšne (Špēļu p.) 1981
21-56 NBD DI Lapinka (Pildas p.) 1980
22-04 NBD DI Dunika 1978
22-35 NBD DI Kalnamuiža (Zalves p.) 1980
22-37 LU FK Sauka M.Laiviņš 1999
22-41 LU FK Zasa 1987
22-53 NBD DI Dvarči (Mākoņkalna p.) 1981
23-47 NBD DI Leonpole (Vārkavas p.) 1981
23-50 NBD DI Kategrade (Rušonu p.) 1981
23-49 NBD DI Rušona 1974
24-03 LU FK Rucava M.Laiviņš 1986
24-39 NBD DI Akniīkste 1974
24-49 NBD DI Rutuļi (Rušona p.) 1981
24-50 NBD DI Starodvorje (Aglonas p.) 1981
24-51 NBD DI Foļvaroka (Kostuļinas p.) 1981
24-52 NBD DI Jaunokra (Andrupenes p.) 1981
24-53 H LATV Dagda Z. Šlangena 1979
25-52 NBD DI Teneismuiža (Skaistas p.) 1981
25-53 NBD DI Ludvigova (Skaistas p.) 1981
26-52 NBD DI Ezermuiža (Skaistas p.) 1981
27-46 LU FK Grīva M.Laiviņš 2000
27-49 H LATV Šalpotkas upes ieleja G.Gavrilova 1975
27-53 NBD DI Vaivodi (Indras p.) 1981

List of *Reynoutria sachaliense* localities

05-14 LU FK Kolka M.Laiviņš 1985
07-47 LU FKApe M.Laiviņš 1987
08-16 LU FK Kaltene M.Laiviņš 2002
08-17 LU FK Valgalciems M.Laiviņš 2002
08-41 LU FK Smiltene M.Laiviņš 1987
08-50 LU FK Alūksne M.Laiviņš 1985
08-51 LU FK Beja M.Laiviņš 1985
08-52 LU FK Visikums M.Laiviņš 1985
09-06 LU FK Ventspils M.Laiviņš 1994
09-16 NBD DI Dārte (Vandzenes p.) 1977
09-50 H LATV Veistera ez. (Jaunalūksnes p.) G.Gavrilova 1984
09-53 LU FK Liepna M.Laiviņš 1987
10-14 NBD DI Vīgrieze (Laidzes p.) 1977
10-16 NBD DI Iģene (Vandzenes p.) 1977
10-29 BI KF Saulkrasti I.Lodziņa 1986
10-36 NBD DI Annasmuiža (Priekuļu p.) 1981
10-38 LU FK Bērzkrogs M.Laiviņš 1985
10-39 LU FK Drustu pagrieziens M.Laiviņš 2002
11-14 NBD DI Talsi 1977
11-16 NBD DI Lauciena 1983
11-43 NBD DI Vecmuiža (Rankas p.) 1983
11-47 L Gulbene K.Starcs 1934
12-28 LU FK Gauja M.Laiviņš 1987
12-32 L Sigulda M.Bumbure 1955
12-39 LU FK Apši (Taurenes p.) M.Laiviņš1992
13-11 NBD DI Ozolmuiža (Kurmales p.) 1978
13-15 NBD DI Kalnamuiža (Kandavas p.) 1977
13-16 NBD DI Kandava 1977
13-19 NBD DI Rauda 1977
13-27 H LATV Rīga Brasa Z.Eglīte 1976
13-32 NBD DI Mežmuiža (Allažu p.) 1979
13-54 LU FK Rekava M.Laiviņš 2002
14-09 LU FK Kuldīga M.Laiviņš 2002
14-19 LU FK Tukums M.Laiviņš 1986
14-20 NBD DI Salas (Smārdes p.) 1977
14-22 L Sloka K.Starcs 1934
14-23 LU FK Melluži M.Laiviņš 1985
14-24 LU FK Lielupe M.Laiviņš 1986
14-25 LU FK Buļļuciems M.Laiviņš 2002
14-26 H RIG IV Rīga, Latvijas Universitātes botāniskais dārzs 1941
14-27 H RIG II Rīga Vērmaņdārzs (bez autora) 1887
14-38 NBD DI Kulmes (Jumurdas p.) 1979
14-39 NBD DI Valola (Jumurdas p.) 1979
15-09 NBD DI Mazsālija (Snēpeles p.) 1978
15-16 NBD DI Valmaņi (Zemītes p.) 1977
15-17 NBD DI Līdakas (Irlavas p.) 1977
15-18 NBD DI Degole 1977

15-32 LU FK Lielie Kangari M.Laiviņš 1999
15-40 LU FK Vestiena M.Laiviņš 1986
15-41 NBD DI Devena 1973
15-44 LU FK Sarkaņi M.Laiviņš 2002
16-17 NBD DI Strutele (Jaunpils p.) 1977
16-19 L Džūkste K.Starcs 1934
16-29 LU FK Ikšķile M.Laiviņš 1986
16-31 LU FK Ciemupe M.Laiviņš 1985
16-55 L Malnava K.Starcs 1934
17-05 NBD DI Cīrava 1978
17-07 LU FK Laidi M.Laiviņš 1999
17-19 NBD DI Krūmiņi (Laidu p.) 1978
17-24 LU FK Ozolnieki M.Laiviņš 1986
17-31 LU FK Ķegums M.Laiviņš 1985
17-32 LU FK Lielvārde M.Laiviņš 1985
17-37 NBD DI Vecbebri 1979
17-43 LU FK Ļaudona M.Laiviņš 1999
17-55 LU FK Mērdzene M.Laiviņš 2001
18-13 LU FK Saldus M.Laiviņš 1985
18-20 NBD DI Dobele 1977
18-23 H LATV Jelgava V.Šulcs 1979
18-24 NBD DI Mežciems (Jaunsvirlaukas p.) 1984
18-35 NBD DI Skrīveri 1987
19-02 H LATV Liepāja I.Lodziņa 1985
19-04 H LATV Gavieze G.Gavrilova1986
19-08 LU FK Embūte M.Laiviņš 2001
19-11 NBD DI Pampāļi 1975
19-17 NBD DI Stirnas (Īles p.) 1976
19-20 H LATV Kroņauce G.Gavrilova 1990
19-22 NBD DI Dimzēni (Zaļenieku p.) 1977
19-23 NBD DI Platone 1977
19-30 NBD DI Stelpe 1977
19-45 H LATV Atašiene Z.Šlangena 1979
20-16 H LATV Auce G.Gavrilova 1990
20-17 BI KF V.Baroniņa 1990
20-24 NBD DI Vircava (Sesavas p.) 1977
20-26 NBD DI Mežotne 1977
21-05 L Kalēti K.Starcs 1934
21-27 NBD DI Derpele (Codes p.) 1977
21-28 NBD DI Kļavas (Cераukstes p.) 1977
21-56 NBD DI Zaharmuiža (Pildas p.) 1979
21-58 LU FK Ploski M.Laiviņš 1988
22-41 LU FK Zasa M.Laiviņš 1987
22-56 NBD DI Pakalne (Rundēnu p.) 1981
22-57 LU FK Ļauderi M.Laiviņš 1988
23-36 NBD DI Lielunkēni (Neretas p.) 1985
24-54 H LATV Dagda Z.Šlangena 1979
26-47 NBD DI Jezufova (Naujenes p.) 1975
28-45 NBD DI Pokropiški (Laucesas p.) 1981