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THE BOTANICAL COMPOSITION OF GRASSLANDS IN THE TERVETE NATURE PARK AS A BASIS OF MANAGEMENT RECOMMENDATIONS

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The Tervete Nature Park is a geographically original object relating to the history of civilization and being of great biological diversity value. The phytocenological investigation of grasslands was carried out in the Tervete Nature Park in the area of 88.7 ha. Types of soil were described, phytocenological characteristics with ecological and biological estimation criteria and recommendations for use in the future were given for each meadow massif. The grasslands' hay average harvest was 1.87 to 3.63 t ha^{-1}. Spridisi and Auzinas grasslands are typical dry meadows. Silalibiesi, Illeni and Plavnieki grasslands are moderate moisture grass fields. Meadows of the Tervete river are flooded meadows. The grassland flora of the Tervete Nature Park is formed by two vegetation classes: *Molinio-Arrhenatheretea* and *Festuco-Brometea*. The grasslands of Silalibiesi, Auzinas and Spridisi (33.4 ha) are of great biological importance and are in need of extensive management.

Key words: Tervete Nature Park, meadows, flora, diversity of grassland flora

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Introduction

Biological diversity in the territory of Latvia was formed in the post – glacial period before 12 thousand years. Man joined in this process only a couple of thousand years ago. Initially man used accessible natural resources and later introduced domesticated animals and cultivated plants. Clearing of woodland, grazing animals in forest pastures and the cutting of grass resulted in the gradual development free from forest areas covered only or mainly with herbs. People maintained these areas through animals grazing or cutting grass. Therefore Latvia's landscape was developed like mosaic.

When Latvia's territory was uninhabited, herbivorous animals maintained small meadow areas: wild horses, elks and deer. They grazed in forests nibbling off not only herbs but also shrubs and young trees which caused the development of small forest meadows – glades.

According to the historical situation the number of inhabitants, density of populated areas, influence on nature and landscape, cultivated and non-cultivated land areas were changed.

Before World War II, Latvia had reached a high level of agricultural production for that time. Forests occupied only 25 % of the territory of Latvia, but the grassland areas covered 24 % of the territory or 42 % of the utilized agricultural area in 1940 (VARAM 2000 b).

During the recent 45 years vast areas of agricul-

tural land – 2 million hectares – have been afforested or overgrown with shrubs and deciduous trees thus forming a mosaic–shape landscape. Nowadays forests occupy already 45% of the territory of Latvia. In 1991, meadows and pastures (including cultivated grasslands and abandoned land) occupied only 13 % of the territory of Latvia (33% of agricultural area) (VARAM 2000 b).

Currently natural meadows cover 1 % of the territory of Latvia, and they are found in small areas in mosaic shapes. Natural meadows are found mainly in floodlands. Definite activities of man have resulted in the development of semi–natural meadows, which are of great importance in the protection of rarely found plant and animal species. The area of these meadows is rapidly decreasing due to the current economic situation - uncut and ungrazed grasslands have resulted in overgrowing with shrubs.

Decreased intensity of agricultural production has resulted in more grasslands than necessary for use and management. Grasslands of the lowest value by the opinion of farmers are abandoned first. Unfortunately, these are botanically valuable meadows, which are rich in plant species. Now most of the cultivated high–yielding grasslands have been set aside. In the near future household farmers will not be interested in resuming the management of grasslands with a high diversity.

In farms with more intensive agriculture sown and fertilized grasslands are used. In such a way, meadows as habitats that have been managed for centuries disappear.

The meadow is a unique complex of nature and an object of protection. The meadow's ecosystems are formed by perennial plant communities, which are connected with a whole complex of microorganisms and animal species. The meadows are habitats rich in plant species having 40 – 50 species per m^2, which have been provided by man's activities such as cutting and grazing animals.

The most valuable meadows for biological diversity are those which permanently lack fertilization and improvement.

One fourth of the 1650 vascular plant species in Latvia grow in meadows. About 100 plant species registered in Latvia's Red Data Book are found in meadows (Fatare 1992).

The significance of meadows has been stressed in both contexts – internationally in EU Directive "On the conservation of natural habitats and of wild fauna and flora" (European Council Directive, 21 May 1992) and nationally (Kabucis 2000; VARAM 2000b).

The Tervete Nature Park (area 1350 ha, included 88.7 ha of grasslands, in state protection since 1957, located in the Dobele district) is including in the group of Viduslatvija's geobotanical districts. The soil is rich in carbonates, being in the range of 20 – 30 %. It could explain the predominance of sod–carbonatic soils. In the course of time these soils have – quality, cultivated sod–carbonatic and sod–gley silt loam and clay soils (Tabaka 2001). The valleys of the Tervete and the Skujaine rivers together make a linked relief. The diversity of landscape depends on the meadows in valleys. The banks of the rivers explain the development of narrow flooded meadows (Вимба 1985).

The first information about Tervete and its surroundings flora was found in the middle of the 19th century in a herbarium collected by Pabo (Vimba 1984). The materials collected by Latvian botanists are from 1940 - 1980. 594 taxons have been identified in the Park flora (Table 2) referring to 335 genera and 94 families. 19 taxons represent introducents, 7 taxons are hybrids, 6 taxons – subspecies. The 560 species belong to the local flora (Table 1).

The greatest number of plant species are found in the following families: *Compositae* (59), *Gramineae* (51), *Cyperaceae* (32), *Rosaceae* (33), *Caryophyllaceae* (28), *Leguminosae* (25), *Labiatae* (21), *Umbelliferae* (20), *Scrophylariaceae* (16), *Cruciferae* (13), *Orhidaceae* (11), *Liliaceae* (10), *Salicaceae* (12),

Table 1. Distribution of vascular plants groups of the Tervete Nature Park

Group	Number of species
Seedless vascular plants,	22
Club mosses	4
Horsetails	7
Ferns	11
Gymnosperms	3
Angiosperms,	535
Monocots	130
Dicots	405

Polygonaceae (11). The other 79 families are represented by less than 10 plant species, but 35 families - by only 1 genus and 1 species.

Phytogeographically the Tervete Nature Park abounds in plant species with Eurasian area (35.9 %), followed by species with European (22.1 %), circumpolar (19.5 %), Eurosiberian (14.2 %), and Eurasian – American (32 %) areas.

32 plant species of western origin have been identified in the Tervete Nature Park. It is rich in rare and protected plant species - significant 21 species have been found (Вимба 1985).

The vegetation of the Tervete Nature Park is of high biodiversity. Most of territory is covered by forests. The deciduous – pine forests occupy the main part of the Park. Similar forests in Latvia have been found only in small areas in the valleys of the rivers. Such forest types have developed as secondary forests in the area of former agricultural lands (Вимба 1985).

The aim of the research was to clarify the syntaxonomic status of the Tervete Nature Park grasslands, to analyze the diversity of flora, to estimate grasslands productivity and to predict the optimum management complex.

Materials and Methods

The description of plant communities found in the Tervete Nature Park was carried out according to Braun – Blanquet method (Braun – Blanquet 1964, Dierschke 1994; Pakalne, Znotina 1992) in the summers of 2000 – 2002. The research was carried out in 6 grasslands (Silalibiesi, Auzinas, Illeni, Plavnieki, Spridisi, the Tervete river flooded meadows) different by plant community complex and management. The vegetation was analysed in 10 sample plots (1 m^2 in size) in each grassland to cover the diversity of all the represented plant communities. The percentage of projective covering for each plant species was visually estimated in sample plots. The area (%) occupied by plant groups (grasses, herbs, legumes, sedges and horsetails) was estimated in the sample plots for grassland floral composition analysis cutting a 1.0 - 1.5 kg sample. The hay was harvested from a plot 1 m^2 in size in ten replications to estimate grassland's productivity.

Descriptions of plant communities were grouped according to plant species composition by a multi–dimension method TWINSPAN (Hill 1979), but the nomenclature of vascular plants was determined according to Gavrilova and Sulcs (Gavrilova, Sulcs 1999).

The soil samples of grasslands were analyzed in the Department of Soil and Agrochemistry of the Latvia University of Agriculture. The ecological and biological estimation criteria and recommendations for use in the future are given on the basis of the obtained experimental database and phytocenological characteristic.

Results and discussion

In the Tervete Nature Park is established following grassland soils: 1. medium loam (sM_2) sod – gleysolic soil (GLg); 2. medium loam (sM_2) sod – gleysolic soil (GLg) loam sand (mS); 3. Brown base

unsaturated soil (BRn) light loam (sM_3); 4 Brown base unsaturated soil (BRn) light loam (sM_3) Brown base unsaturated soil (BRn).

Results of the investigation show that grasslands in the Tervete Nature Park were comparatively productive and dynamic and their botanical composition has a high diversity (Table 2). Fluctuations in productivity between years could be explained mainly by significant differences in rainfall – dry conditions prevailed during the growth period in 1999, and excessive rainfall that was observed in 2001.

Silalibiesi meadow's soil is medium loam (sM_2) Sod gleysolic (GLg) soil: pH_{KCl} 7.0, P_2O_5 - 48 mg kg $^{-1}$ of soil (low sufficiency level), and K_2O – 106 mg kg $^{-1}$ of soil (medium high sufficiency level).

Silalibiesi meadows (21.1 ha, hay harvest 2.37 t ha $^{-1}$) are medium moist meadows with plant communities formed by grasses (32 %), legumes (17 %), herbs (40 %), horsetails (6 %) in two years average, but sedges (12 %) appear in more wet years. In these meadows seven species of indicator plants were found: *Dianthus deltoides* L., *Filipendula vulgaris* Moench, *Galium verum* L., *Fragaria viridis* Duch., *Phleum phleoides* (L.) H. Karst., *Plantago media* L., *Trifolium montanum* L.

Auzini meadow's soil is medium loam (sM_2) Sod gleysolic soil (GLg): pH_{KCl} 8.1, P_2O_5 - 25 mg kg $^{-1}$ of soil (very low sufficiency level), and K_2O – 83 mg kg $^{-1}$ of soil (medium high sufficiency level). Auzini meadows (4.6 ha, hay harvest 3.36 t ha^{-1}) are dry meadows with plant communities formed by grasses (48 %), legumes (14 %), herbs (38 %), including cow parsley – *Anthriscus sylvestris* (L.) Hoffm. (5 %). Five species of indicator plants were found: *Dianthus deltoides, Fragaria viridis* Duch., *Plantago media, Pimpinella saxifraga* L., *Trifolium montanum.* A high percentage of medicinal plants occurrence was identified in these meadows.

Silalibiesi and Auzini meadows (25.7 ha) are used as objects of protected biological diversity in the Tervete Nature Park. The sward's botanical composition indicates that meadows have developed from woodland; they are not fertilized. Silalibiesi and Auzini meadows haven't been cut for several years. Therefore these meadows are in need of extensive management – cutting could be done once every two years, preferably in July, to favour the spreading of flowering plant seeds or these grasslands should be grazed. The cutting of shrubs and trees would benefit to better maintaining of these meadows. The "flowering meadows" should be maintained as an integral part of the Tervete Nature Park though grassland productivity was low.

Illeni (3.7 ha, hay harvest 3.63 t ha^{-1}) are medium moist meadows with plant communities composed of grasses (61 %), legumes (1 %), herbs (44 %) average in two years. The botanical composition indicates that meadows were improved by the additional sowing of grasses resulting in lack of indicator plants, except *Plantago media*. The meadow was free from legumes. This grassland was regularly cut and fertilized. The cutting should

Table 2. Productivity and botanical composition of grasslands of the Tervete Nature Park, %

Grasslands' area	Hay yield, t ha^{-1}		Botanical composition of grasslands, %									
			grasses		legumes		herbs		horsetails		sedges	
	1999	2001	1999	2001	1999	2001	1999	2001	1999	2001	1999	2001
Silalibiesi	1.92	2.82	35	28	20	14	40	40	5	6	-	12
Auzinas	1.91	4.81	40	56	10	18	50	26	-	-	-	-
Illeni	2.10	5.16	70	51	1	-	29	58	-	-	-	1
Plavnieki	2.23	3.50	50	60	25	15	25	25	-	-	-	-
Spridisi	2.41	1.33	50	30	10	2	40	68	-	-	-	-
Tervete river's meadows	2.92	3.14	50	63	-	5	30	27	-	1	20	4

be desirable in the future and additional sowing of legumes would improve the agronomic value of the meadow.

Spridisi meadows have developed on light loam (sM_3) Brown base unsaturated soil (BRn): pH_{KCl} 7.1, P_2O_5- 60 mg kg $^{-1}$ of soil (low sufficiency level), and K_2O – 88 mg kg $^{-1}$ of soil (medium high sufficiency level). Spridisi meadows are dry. Spridisi meadows (7.7 ha, hay harvest 1.87 t ha^{-1}) were improved by sowing legumes. The botanical composition of plants indicates the natural origin of the meadows. The indicator plants: *Dianthus deltoides, Filipendula vulgaris, Fragaria viridis, Galium verum, Geranium palustre* L., *Geranium sanguineum. Plantago media, Pimpinella saxifraga* were found there. The sward was composed of 40 % grasses, 6 % legumes and 54 % herbs. Deciduous trees appeared there. The meadows (7.7. ha) are located in the central part of the Tervete Nature Park. For that reason they should be necessary keep to the historical traditions – flowering meadows up to solstice, hayracks thus maintaining the landscape and the aesthetic value. These meadows should be used extensively.

Plavnieki meadows occur on loamy sand (mS) Brown base unsaturated soil (BRn) with pH_{KCl} 5.8, containing P_2O_5- 70 mg kg $^{-1}$ of soil (low sufficiency level), and K_2O – 89 mg kg $^{-1}$ of soil (medium high sufficiency level). They are medium moist meadows (39 ha, hay harvest 2.86 t ha^{-1}), a part of them has been improved and are high quality grasslands. The indicator plant species were found in the remote corners of the grasslands: *Dianthus deltoides; Galium verum, Trifolium montanum.*

The grasslands' sward were composed of 55 % grasses, 20 % legumes (out of which 15 % *Medicago sativa* L.) and 25 % herbs. The central plain part of the relief was partly improved by *Medicago sativa* L. Plavnieki grasslands are under management – they are regularly cut and grazed. The future use should include both - cutting and grazing. A rough relief could burden cutting.

The flood meadows of the Tervete river are on light loam (sM_3) Alluvial granular soil (ALT): pH_{KCl} 6.6, P_2O_5- 13 mg kg $^{-1}$ of soil (very low sufficiency level), and K_2O – 31 mg kg $^{-1}$ of soil (low sufficiency level). The Tervete river's flood meadows (2.6 ha, hay harvest 3.03 t ha $^{-1}$) are overflow meadows seasonally enriched with organic and inorganic substances brought by floodwaters. A peculiar microrelief and typical hygrophytic vegetation characterize these soils. The indicator plant species found growing in the meadows was *Plantago media*. The communities of plants are composed of grasses (57 %), herbs (29 %), included *Anthriscus sylvestris* (15 %), *Heracleum sibiricum* L. (5 %), sedges (12 %) with *Scirpus sylvaticus* L. as a dominant plant. Sedges are the main plants of these habitats. In dry summers the meadows of the Tervete river are used for cutting. The meadows should be cut in late May – early June when sedges are rich in plant nutrients. Under wet weather conditions sedges could be used for bedding as they are low in plant nutrients when cut in July. In flooded meadows the cutting height of grass should be at least 10 cm to maintain its biological diversity. This practice avoids the injury of many animal species. During utilizing 1 to 2 metres wide belts or plots 1 – 2 m ^{2} in size should be left uncut changing their sequence each year.

The method of Braun–Blanquet used in the classification of vegetation is based on botanical composition. The following syntaxonomy was distinguished:

1.**Class**: *Molinio – Arrhenatheretea* R. Tx. 1937 em R.Tx. 1970.

Order: *Arrhenatherretalia* R. Tx. 1931

Alliance: *Arrhenatherion elatioris* Koch 1926

Association: *Arrhenatherion elatioris* Br. – Bl. 1915 1926 (Obersdorfer, 1983; Laivins, 1998)

2. **Class**: *Festuco – Brometea* Br. – Bl.et R.Tx. 1943 in Br. – Bl. 1949

Order: *Brometalia erecti* Br. – Bl. 1936 (Obersdorfer 1983; Laivins, 1998)

Helictotrichon pubescens – Fragaria viridis community (Obersdorfer, 1983; Laivins, 1998)

The class *Molinio – Arrhenathereta* includes mesophyte Eurosiberian grasslands: meadows and pastures of moderate moisture on eutrophic and mesotrophic mineral and organogenic soils. The characteristic species of the class include a wide ecological range of species: *Achillea millefolium* L., *Centaurea jacea* L., *Dactylis glomerata* L., *Festuca pratensis* Huds., *Lathyrus pratensis* L., *Phleum pratense* L., *Poa pratensis* L., *Poa trivialis* L., *Ranunculus acris* L., *Taraxacum officinale* F.H. Wigg.s.l., *Stellaria graminea* L., *Trifolium pratense* L., *Trifolim repens* L., *Vicia cracca* L. (Jermacane 1999; Dierschke 1994). The botanical composition was developed under the influence of man's activities – cutting, fertilization and grazing (Obserdorfer 1983).

The order *Arrhenatheretalia* Koch 1926 (Laivins 1998) includes high – productive medium moist meadows on clay, loam or loamy sand soils with a thin humus layer in topsoil in former or potential forest areas (Jermacane 1999; Obersdorfer 1983). The meadows of this order show the great anthropogenic influence. The kind of management of the order *Arrenatheretalia* meadows significantly influence the botanical composition of plant communities. The cutting once a year or extensive grazing could provide the diversity of plant species and develop seasonally changeable aspects. The intensive cutting or grazing favours uniformity in quantitative and seasonal aspect (Obersdorfer 1983).

The association of *Arrhenatherum elatioris*, idenfied in the Tervete Nature Park, was mainly represented in Silalibiesi meadows. The association *Arrhenatherion elatioris* most widely occurred in the valleys of the rivers in the south and west parts of Latvia in sites of flat and gently sloping topography and on river terraces (Mateeba 1967).

Silalibiesi meadows are situated on the slope of the bank of Gulbju (Tervete) Lake, which was the Tervete river flood plain before flooding in 1983. These are moderate moisture meadows on fertile, warm soils near the forest. The tall oat - Arrenatherum *elatius* (L.) J.et C. Presl. was dominating, which, as it was thought, was sometimes sown in habitats of anthropogenic origin - former arable land and in the course of time had developed natural plant communities. The high and medium high grasses: *Helictotrichon pubescens* (Huds.) Pilg., *Festuca pratensis, Poa pratensis, Poa trivialis* are characteristic. A high diversity of dicots was found. Historically such meadows are used mainly for harvesting hay (Obserdorfer 1983; Kabucis 2001).

Class *Festuco – Brometea* Br. – Bl. Et R.Tx 1943 in Br. – Bl. 1949 unite rich in species steppe–and basophilic sunny site plant communities. In Latvia they are found mainly in the valleys of the rivers and elsewhere in the places of south exposition (Jermacane, Laivins 2001 a). Light and drought loving plant communities prevent tree and shrub invasion into these meadows (Obserdorfer, 1978). The investigations indicate that anthropogenic activities (burning, clearing of woodland, grazing) have resulted in the increase of meadow area of this vegetation class. The source of species for class *Festuco–Brometea* Br. – Bl. Et R. Tx. 1943 in Br. – Bl. 1949 are stands of pine trees growing nearby. In the Tervete Nature Park the order *Brometalia erecti* (W. Koch, 1926) is most widely represented in Auzini and Spridisi meadows forming *Helictotrichon pubescens – Fragaria viridis* community.

The order *Brometalia erecti* (W.Koch, 1926) unite dry to moderate moist meadows on warm, calcium– rich soils. In Latvia such meadows occur on banks of rivers on terrace slopes and on terraces. Frequently separate shrubs were found there (Obersdorfer, 1983; Laivins, 1998). The different management of these meadows advances the obtaining different results. The cutting, for example, contributed to development of various orchids and *Bromus erectus* Huds, but grazing ensured the presence of more resistant plant species (*Brachypodium pinnatium* (L.) P.Beauv.). Historically these dry meadows in Latvia have been used for sheep grazing.

The existence of meadows as semi–natural vegetation and the maintenance of their biological diversity depends on management. At the same time changes in management (cutting, grazing,

burning) resulted in inconsistent vegetation and the formation of unstable combinations of plant species; frequently the plant boarder- communities are formed between various meadow types or replacement of plant communities occur (Jermacane 1999). Such plant communities are difficult to classify as it is not shown by uniform description obtained by clusters' analysis of the Tervete Nature Park. The fertilization, for example, contributes to the mesophytization of dry meadows (order: *Brometalia erecti*, class: *Festuco – Brometea*) and the development of plant communities characteristic to class *Molinio – Arrhenetheretea* (Jermacane 1999).

The vegetation classes identified in the Tervete Nature Park correspond to Habitats Directive (Kabucis 2000: dry meadows on limy soils (habitat code 6210, Latvia's habitats classification code E 1.4., syntaxonomic appurtenance: *Festuco – Brometea* class) and moderately moist meadows (habitat code 6510, Latvia's habitats classification code E 2.3., e 3.1., syntaxonomic appurtenance: Alliance: *Arrhenatherion*).

The dry meadows on limy soils (Auzini and Spridisi meadows) are characteristic of the great diversity of calcareous dicots. These meadows could be significant orchid deposits. Up to now there haven't been identified orchid species in the dry meadows of the Tervete Nature Park. However, more detailed research is needed. The grazing is traditional and recommended management practice of these meadows.

The moderately moist meadows (Silalibiesi meadows) with a great diversity of dicots, high and medium high species of grasses are hay meadows which are cut more or less regularly. Sometimes they are grazed, traditionally it is done in the aftermath.

The cutting and grazing create particular conditions for growth of herbs, which enables the growing together of a great number of plant species. However extensive management is the main factor, which ensures a great biological diversity. The discontinued cutting and grazing in natural grassland resulted in the accumulation of the last year's plants. The accumulation was rapid, reaching 70 % of the total above – ground mass of live and dead plants already after 7 years (Wells 1974).

The layer of last year's grass reduced the diversity of environmental conditions (reduced difference in microclimate, light intensity and moisture regime). Last year's grass reduced evaporation, hindered seed germination and thus renovation of plant species. The accumulation of last year's grass ensured fertilization effect. The competitive grasses, such as *Calamagrostis epigeios* (L.) Roth, *Brachypodium pinnatium, Dactylis glomerata, Elytrigia repens* (L.) Nevski suppressed other plant species. The result is a rapidly diminishing diversity of species. The rate of diminishing plant species is different for various meadows. The calculations indicated 70 % decrease of plant species in dry calcareous meadows over the period of 10 years (Willems 1990).

The overgrowing with shrubs and trees lowers the value of the landscape. Besides, year by year renovation of such unmanaged meadows are more complicated and expensive because the removal of shrub vegetation is a labour–intensive process and the seed reserves in the soil are rapidly reduced.

The initiation of grasslands' management is particularly significant in protected nature areas based on research results. The monitoring as an integral part of grassland management and renovation measures is necessary and should be started in such places (Jermacane 2002). The obtained information will allow the finding of most suitable management projects for protected territories and secure protection of meadows throughout Latvia. We should be aware of that maintenance of meadows is not possible without agricultural activities. Considering definite principles and using well–grounded methods it is possible to keep the balance between traditional management of meadows with intensive economic activities.

The nature parks must become a model of managed territories which enables maintaining of biodiversity, organizing recreation in and provid-

ing normal conditions for the development of agriculture and forestry.

The management of biologically most significant meadows – Auzini, Spridisi and Silalibiesi meadows (33.4 ha) is problematic- to maintain the biological values and to balance economic interests of private owners of the Tervete Nature Park.

Conclusions

The Tervete Nature Park is a geographically peculiar object of great biological diversity value relating to the history of civilization. The grasslands represent 2 vegetation classes: class: *Molinio – Arrhenatheretea*, order: *Arrenatheretalia*, alliance: *Arrhenatherion elatioris*, association *Arrenatherion elatioris* and class: *Festuco – Brometea*, Order: *Brometalia erecti*, *Helictotrichon pubescens – Fragaria viridis* community. The vegetation classes identified in the Tervete Nature Park are corresponding to Habitat Directive: dry meadows on limy soils (syntaxonomic appurtenance: *Festuco – Brometea* class), and moderately moist meadows (syntaxonomic appurtenance: alliance *Arrhenatherion*). The maintenance of biological diversity of meadows (33.4 ha) – Auzini, Spridisi and Silalibiesi – needs an extensive management excluding measures of improvement.

In the Tervete Nature Park the functions of nature protection and maintenance of biological diversity must be coordinated with the corresponding methods of management.

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WILLOWS (*SALIX* L.) OF *VIMEN* DUMORT. SECTION IN LATVIA

Pēteris Evarts-Bunders

Evarts-Bunders P. 2004. Willows (*Salix* L.) of *Vimen* Dumort. section in Latvia. *Acta Biol. Univ. Daugavp., 4 (1): 11 – 18.*

Section *Vimen* is well-defined, compact group of Latvia's *Salix* genus. There are three taxa: two species and one variety – *S. viminalis* L. *S. burjatica* Nasarov and S. *viminalis* var. *rossica* (Nasarov) Evarts comb. nov. In some cases *S. rossica* have been mentioned as unaffiliated species in Eastern Europe, especially in Russia. Determination of these species is quite difficult due to morphological polymorphism and widespread hybridization of species in this section. These plants are wild-growing in Latvia, especially along rivers and lakes in alluvial biotopes. It is possible that in isolated cases taxa of this section can go over to wild from nurseries, where they are cultivated at least from 19. century as wattle material, therefore autochtonity of species in segregated territories is disputable. *S. burjatica* is quite rare species in Latvia, grow beyond the borders of their continuous areal and may be one of potentially protected species in future.

Key words: Willow, *Salix*, Latvia, dendrology, areal.

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Introduction

Section *Vimen* is quite small, compact group of Palearctic willows. To the section belongs small trees or tall shrubs with long and straight young shoots, densely ashy pubescent at first. Species of section are easy to differentiate for several other signs, too. They have bigger generative buds than vegetative, long linear or linear-lanceolate leaves with revolute margins and thinly puberulous hairs above.

These species have characteristic well-developed petioles, remaining all vegetation season on the shoots. Determination of morphological borders of the species are quite difficult in this section. The complexity of this procedure is increased by the fact that we may possible deal with not strictly indigenous taxa.

The data about distribution of this section species in Latvia are quite contradictory. *S. viminalis* is very common in all territory of Latvia and adjacent territories, mainly along rivers and lakes. This is wild-growing species in Latvia, however, the distribution is not homogenous. It had been cultivated in several places as wattle material, and during Soviet time in several collective farms too. It is quite believable that cultivated clones go over to wildness in these places. *Salix viminalis* var. *rossica* is distributed mainly in Eastern Latvia, as well as separated localities in central and Western Latvia. Further investigations are necessary for clarification of species distribution in Latvia. The most widespread viewpoint about *S. burjatica* (in previous works mentioned as *S. dasyclados*) is that *species* grows autochtonically quite rare in all territory of Latvia (Starcs 1925; Galenieks 1965). According to the investigations of west European dendrologists S. *dasyclados* is

hybridogenous species among *S. caprea*, *S. cinerea* and *S. viminalis*. (Rechinger 1949, 1981; Meikle 1984, Chmelar, Meusel 1979, 1986) It is hard to agree to such opinion in Baltic region, because similar taxa growing here is non-hybridogenous *S. burjatica* (Gavrilova, Dulcs 1999; Evarts-Bunders 2001). This species has firm morphological features in all territory of continuous areal. It proliferates by seeds, and the specifical splitting in the next generations is not observed as it is typicaly for hybrids. Nevertheless the most of salicologists from western Europe consider *S. dasyclados* as hybrid (such is herbarium of lectotype!), but believe that *S. calodendron* Wimm., and *S. stipularis* Smith as unaffiliated species, which rather are hybrids between species of *Vimen* and *Vetrix* sections.

Materials and methods

The investigations on the spreading of willow genus species in Latvia were initiated in 1993. Researches were made during scientific expeditions in different locations of Latvia, especially in the regions, which lack herbarium materials and thereby it was not possible to judge equitably about the distribution of the specific species, particularly in eastern Latvia. Herbarium materials were analysed in the all largest available herbariums: University of Latvia (LU), Institute of Biology, laboratory of Botany (LATV), herbarium of A. Rasiņš (RAS), National Botanical garden, Department of Dendrology (HBN), LU faculty of Biology (RIG), Natural History Museum of Latvia (LDM), University of Daugavpils (DAU), Teiči Nature reserve (TVR). Materials about largest herbariums of other Baltic countries were summarised too: in Lithuania – Institute of botany (BILAS), in Estonia – University of Tartu (TU) and Tartu Institute of Zoology and Botany (TAA). All the available data from literature about distribution of section *Vimen* species in Latvia were summarised.

Results and discussion

Salix viminalis L.

Salix viminalis L. 1753, Sp. Pl.: 1021; Fischer, 1778, Vers Naturg. Livl.: 302, sine auct; 1791, Vers. Natrurg. Livl., 2. Aufl.: 635, sine auct; Ledeb. 1850, Fl. Ross. 3, 2: 605, s. str; Wimmer, 1866, Salices Europaeae: 36; Schneider, 1906, Laubholzk. 1: 45; Starcs, 1925, Koku un krūmu noteic: 73; Расиньш, 1959, Ивы Латв. ССР, in Раст. Латв. ССР, 2: 112; Krall, Viljasoo, 1965, Eest. kasv. Pajud: 69, s. str; Скворцов, 1968, Ивы СССР: 192; Krüssmann, 1978, Laubgeh. 3: 315; Скворцов, 1981, Фл. Европ. части СССР, 5: 31; Cinovskis et al., 1993, Fl. of Balt. Countr, 1: 169.

Large shrub up to 6 (8) m high. Young shoots olive-green or brown, densely pubescent at first, then glabrous or subglabrous. Underlying wood smooth, without striae. Buds about 4 mm long, ovoid, yellow or reddish-brown with short, grey hairs. Leaves linear or linear lanceolate up to 15 cm long and 0.5 - 2 cm wide. Upper surface dull green, glabrous or subglabrous, below with a dense silky hairs. Leaflet near smooth, margins conspicuously revolute, slightly undulate. Central nerve well developed. Petioles often shorter than 1 cm. Stipules narrow, acute, margins glandulous-serrate, usually only in first months of vegetation season. Catkins appearing before the leaves in march or early April, 2 - 3 cm long and 0,5 – 1 cm wide. Catkin-scales light brown with dark margin. Male flowers with 2 free glabrous, yellow stamens, later turn dark-yellow or brown. Ovary nearly sessile, ovoid, densely tomentose. Capsule narrowly flask-shaped, densely tomentose, 4 - 5 mm long, ripening in may or in first days of June.

S. viminalis (Osier) has a very wide continuous areal – all the territory of central Europe, species is not represented only in Southern and Northern extremity. From Atlantic coast of Europe areal reach as far as Mongolia and North China (Большаков 1992). It is believable, that species is not wild-growing in Scandinavia (Floderus 1931, Hulten 1950), British isles (Meikle 1984), Denmark, Pyr-

enees and Appenines, too (Jalas, Suominen 1987).

Opinion that species is growing mostly along the rivers in association with *S. triandra*, is not completely correct. Osier is not growing only along the rivers and lakes, where doubtless is dominanting of this species along with *S. triandra* and forming typical riverbanks association, but also in many different biotopes. Sometimes it is forming dense brushwood even in dry roadsides, ditches and forest margins.

In accordance with our investigations and literature data the following hybrids of this species are known in Latvia: *S. aurita, S. burjatica, S. caprea, S. cinerea, S. daphnoides*. (*S.* × *digenea* Kerner), *S. lapponum, S. myrsinifolia, S. rosmarinifolia, S. phylicifolia, S. purpurea*. (*S.* × *rubra* Huds.), *S. triandra* (Расиньш, 1959, Cinovskis et al. 1993). Hybrids with *S. acutifolia* and *S. starkeana* are not found but are mentioned in literature (Galenieks 1955). More or less common is only *S.* × *rubra*, other hybrids have been found very rare, known only in one or several localities.

Very wide variability of morphological signs is typical for this taxa, it is possible that species is isolated incorrectly. It is more believable, that *S. viminalis* contain several unaffiliated species or interspecies taxa at all. Still in P. Pallas work 'Flora Rossica' such species as *S. gmelini* Pall. and *S. serotina* Pall. (Pallas 1776, 1788) are mentioned. Really, according the description it is impossible to determinate this species in natural conditions and to specify their areals. Much seriously description of *Vimen* section species we can find in the M. Nasarov's work 'Флора СССР', volume 5. (Назаров 1936). *S. rossica* defined by Nasarov is described with specific complex of indications and some salicologists from Russia (I. Belyaeva a. oth.) and Estonia (H. Krall) have considered it as fixed species growing in Estonia, too (Krall, Viljasoo 1965). In his turn A. Skvortsov has accented that the indications of *Viminalis* complex are too indefinite for the recognition of this taxa. (Скворцов 1968). Analyzing herbarium materials from North Latvia and Estonia we come to conclusion, that it is well founded to separate two different varieties of *S. viminalis:*

Salix viminalis* L. var. *viminalis

S. verviminalis Nasarov, 1936, Фл. СССР. 5: 134.
Salix viminalis L. subsp.*verviminalis* (Nasarov) Hylander, 1945, Stud. über nord. Gefässpl.: 122.

Shrub, up to 6 m high. Young shoots olive-green, flexible and tough, densely pubescent in all vegetation season (completely glabrous only 2 years old shoots). Underlying wood smooth, without striae. Buds 4 mm long, ovoid, yellow or reddish-yellow, with short ashy hairs. Leaves up to 15 (20) cm long and 1,5 (2) cm wide, widest point of leaf – lower third. Leaves glabrous or subglabrous above, with dense silky hairs below (see fig. 1). Petioles short. Catkins bloom before foliage, in second part of march or April, reach 4 cm long. Catkin scales light rusty-brown, apex dark blackish-brown. Capsules silky tomentose, 4 - 5 mm long, with appr. 2 mm. long pedicle, ripening in may or in first days of June.

West-Europe species, wild growing and going over to wildness in all territory of Latvia. Eastern border of the distribution in territory of Russia is not sufficiently investigated for this variety

Table 1. Morphological signs essential for determination of interspecies taxa of *S. viminalis* (Krall 1962), with recension

Morphological signs	*S. viminalis* L. var. *viminalis*	*S. viminalis* L. var. *rossica* (Nasarov) Evarts
Length of leaf	8 – 15 (20) cm	5 – 10 (15) cm
Width of leaf	0,5 – 1,5 (2,0) cm	0,5 – 1 (1,5) cm
Proportion length : width	1 : 10 - 18	1 : 7 - 14
Blooming time	Before foliage	At the some time
Widest point of leaf	Lower third	Medium or upper third
Pedicle of capsule (length)	1,3 – 2,0 mm	Nearly sessile (0,3 – 0,8 mm)

***Salix viminalis* L. var. *rossica* (Nasarov) Evarts** comb. nov.

Salix rossica Nasarov, 1936, Фл. СССР. 5: 135; Rechinger, fil, 1964, Fl. Europ. 1: 52.
Salix viminalis L. subsp. *rossica* (Nasarov) Hylander, 1945, Stud. über nord. Gefässpl.: 122. Расиньш, 1959, Ивы Латв. ССР, in Раст. Латв. ССР, 2: 112.
Salix serotina Pall. 1776, Reise 3: 759, p.p; 1788, Fl. Ross. 1, 2: 77, p.p.
Salix gmelinii Pall.1788, Fl. Ross. 1, 2: 77 p.p; Ledeb. 1850, Fl. Ross. 3, 2: 606, p. max. p; Krall, Viljasoo, 1965, Eest. kasv. pajud: 72.

Usually 6 – 8 m high shrub. In central part of continuous areal - Western Siberia, grow as tree and can reach up to 20 m high. Young shoots olive green or greyish-brown, more slender than twigs of typical variety, at first shortly pubescent, soon glabrous or subglabrous. Underlying wood smooth, without striae. Buds up to 5 mm long, ovoid, yellow or reddish-brown, at first pubescent, then glabrous. Leaves up to 10 cm long and 0.5 – 1,5 cm wide, widest point - medium or upper third. Leaves usually glabrous above, silky tomentose below. Leaflet near smooth, margins conspicuously revolute, slightly undulate (see fig. 2, 3). Petioles often shorter than 1 cm. Stipules narrow, acute, margins glandulous-serrate, usually developed only on the vigorous shoots. Catkins appear at the some time with leaves, 5 - 7 cm long. Ovary nearly sessile, elliptic at base. Capsule silky pubescent, 4 - 5 mm long, nearly sessile, ripening in May or first part of June.

Fig 1. Leaf of *S. viminalis* (mark = 1cm)

Fig 2. Leaf of *S. viminalis* var. *rossica* (mark = 1cm)

Variety from Siberia and East Europe. Indigenous for Latvia reaching here western border of continuous distribution. Areals of these two varieties are coming out in territory of Latvia and Estonia, forming a lot of extremely hardly determined transition forms. In A. Rasiņš opinion the more frequently observed are *rossica* – type specimens (Расиньш 1959). Kupfers and Lakðevics have determined great part of *S. viminalis* as *S. gmelinii* Pall. in their herbariums.

The distribution areal of *S. rossica* in Latvia possibly is decreasing in last ten years in connection with taking up the more suitable biotopes by ecologically more aggressive typical variety or transition forms. In the beginning of 20-th century Seemen after analysis of Latvia's herbariums had put down that the border of taxa distribution reaches Daugava-valley (Seemen 1908-1910). According to our investigations the well-defined specimens of var. *rossica* have found in North-eastern Vidzeme, Latgale and South-eastern Estonia during last ten years. In the rest territory of Latvia the different transition forms had observed in the connection of wide hybridisation.

Illusory percept can made specimens who grow in dry, sandy biotopes. They have a narrower,

Fig. 3. Shoot of *S. viminalis* var. *rossica* (mark = 1cm)

shorter and densely tomentous leaves below than it is for the shrubs growing along rivers. In this cases the generative indications must be observed complexly.

It is necessary to remark *S. viminalis* 'Gigantea' (Cinovskis 1979) – one of commonest forms cultivated as wattle material. There are no data about expansivity of this clone in Latvia.

***Salix burjatica* Nasarov**

Salix burjatica Nasarov, 1936, Фл. CCCP 5: 137, sensu Atlas Fl. Europ. 3: 43.

Salix dasyclados Wimm. 1849, in Regensb. flora, 32: 35; Schneider, 1906, Laubholzk. 1: 45; Starcs, 1925, Koku un krūmu noteic: 74; Назаров, 1936, Фл. CCCP, 5: 147; Galenieks, 1955. Latv. PSR fl., 2: 43; Расиньш, 1959, Ивы Латв. CCP, In: Раст. Латв. CCP, 2: 116; Rechinger, fil, 1964, Fl. Europ. 1: 53; Скворцов, 1968, Ивы CCCP: 196; Krüssmann, 1978, Laubgeh. 3: 299; Скворцов, 1981, Фл. Европ. части CCCP, 5: 31; Cinovskis et al.,1993, Fl. of Balt. Countr, 1: 170.
Salix serotina Pall. 1776, Reise 3: 759, p.p; 1788, Fl. Ross. 1, 2: 77, p.p.
Salix gmelinii Pall.1788, Fl. Ross. 1, 2: 77 p.p; Ledeb. 1850, Fl. Ross. 3, 2: 606, p. min. p.
Salix stipularis auct, non Smith: Trautv. 1832, Salic. Livon.: 374; Ledeb. 1850, Fl. Ross. 3, 2: 605; Fleischer, Lindemann, 1839, Fl. Esth., Liv. u. Curl: 344.
Salix acuminata auct., non Smith: Wiedemann, Weber, 1852, Beschr. phan. Gew. Esth., Liv. u. Curl: 599.
Salix longifolia auct., non Host; Wimmer, 1866, Salices Europaeae: 42.
S. cinerea x viminalis: Klinge, Fl. Est., Liv. u. Curl: 429.

Second species of *Vimen* section in Latvia's flora. Shrub, usually 3 - 5 m high or seldom tree up to 10 m high. Young shoots gray, tomentose, then glabrous, smooth, green or olive-green. Leaves 8 - 12 cm long or still longer and 2 - 3.5 cm wide, widest point of leaf is more or less in center. Leaves often an asymmetric, apex and base even elongate, without a long, slender acumen. Leaves pale green or dark lustrous green, glabrous above, thinly pubescent with a gray silky hairs below. Margins of leaf is not conspicuously revolute, entire (se fig 5). Petioles tomentous, extended at base. Stipules well-developed, lanceolate ovoid or cuneate, denticulate. Catkins appear early before the leaves in April, up to 4 cm long and 1 - 2 cm wide. Male catkins sessile, widest than female racemes, female catkins petiolate, petioles with a tiny scale-form leaves, ripened in May, at this time up to 12 cm long. Catkin scales ovoid, grayish tomentous, dark brown, nearly black at the top. Stamens 2, anthers brown filaments glabrous. Ovary ovoid at base, densely grayish tomentous.

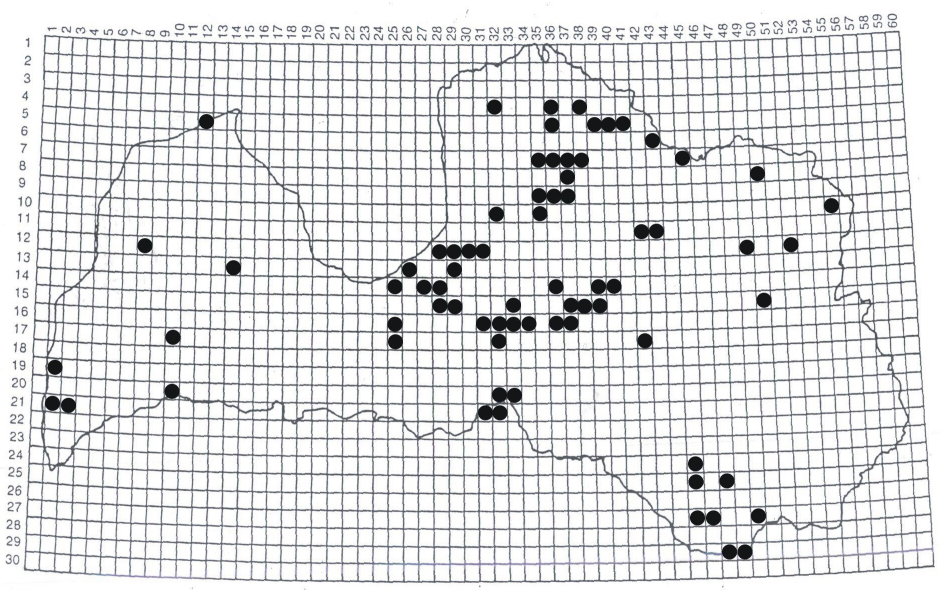

Fig 4. Distribution of *S. burjatica* in Latvia

Style long, tomentous at base, stigma bilobed. Capsule ovoid, tomentous.

Areal is similar with *S. viminalis* areal, only significant difference – species is not representing in Western Europe. Western border of species areal reaches up to Kaliningrad region (Jalas, Suominen 1987) although some localities can be find in Northern Poland or still in Germany.

It is very similar species to osier, especially var. *rossica*, therefore it is often mistaked with it in literature already in Pallas' publications (Pallas 1776, 1788). In this work we can find such species as *S. serotina*, *S. gmelinii*, which can be recognized as *S. burjatica* or *S. rossica.*

The main indications for this species: leaves of *S. burjatica* are up to 3,5 cm wide with widest point in leave's center (not in lower third as *S. viminalis* var. *viminalis*), margin of leaf is not revolute, and leaf usually is dark lustrous green above (in compare to *S. viminalis* var. *rossica*). Important in determination is style - stigma length proportion too. *S. viminalis* - longer stigma than style, but *S. burjatica* - style is longer than stigma (Скворцов 1968).

Distribution of species is irregular in Latvia in connection with the fact that the North-eastern border of this distribution is not far. This species is rather common in the South-eastern, South-west and central parts of Latvia, but in North-Vidzeme it is rarely observed. In Estonia it grows only in South-west regions - in the valleys of the rivers Emajogi, Vaike –Emajogi and Gauja (Koiva) (see fig.4).

A. Rasiņš had isolated two new forms (Rasiņš 1959)

f. *argentata* Rasiņš. Leaves with dense silvery hairs below.

f. *glabrifolia* Rasiņš. Leaves completely glabrous below.

It is mentioned as commonest form in publication:f. *denudata* Nasarov. Leaves subglabrous below.

Fig 5. *S. burjatica.* Shoot with leaves (mark = 1cm)

Howewer, P. Lakðevics isolated var. *baltica* Lacksch. with glabrous shoots and leaves long time ago before Rasiņš worked. All the forms described by Rasiņš have not scientifical importance in connection with the fact that after planting of vegetatively propagated specimens in dendrarium of National Botanical garden (Salaspils) in the identical conditions, the abovementioned differences are not observed. Densely pubescent specimens (collected along Bārta-river) are not different from f. *denudata* specimens growing naturally in Salaspils.

In accordance with our investigations and literature data the following hybrids with these species are known in Latvia: *S. acutifolia, S. caprea, S. cinerea, S. myrsinifolia, S. phylicifolia, S. purpurea, S. triandra* and *S. viminalis* (Расиньш, 1959, Cinovskis et al. 1993).

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THE WILD *SORBUS* L. SPECIES IN EAST BALTIC REGION

Edvīns Roziņš

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There are 5 wild *Sorbus* species in the East Baltic region. It is estimated status and distributiion of the Baltic countries wild *Sorbus* species. This paper included kea to the wild *Sorbus* species of this region, maps with *Sorbus* species distrubution area and pictures of the each Sorbus species.There are just 1 diploid *Sorbus* species – *Sorbus aucuparia*, what occurs widespread in all types of forests of the Baltic region. Other polyploid and hybrid *Sorbus* species distrubution connected near by the Baltic sea shore line and with presence of pine woods. We reasearched plant societies where occur Baltic region wild *Sorbus* species. It is estimated, that all polyploid *Sorbus species Sorbys rupicola, Sorbus intermedia, Sorbus hybrida, Sorbus meinichii*, considered to be as the native flora elements of Baltic region with narrow distribution area. All polyploid *Sorbus* species, show bygone connection with Scandinavian and Central Europe mountain flora.

Key words: *Sorbus*, flora, East Baltic region, distribution, hybrids

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Introduction

Sorbus are the shrubs or small trees that are distributed in all kind of forests as underwood species.

Majority of inhabitants of Baltic States recognised only one species - mountain ash tree - *Sorbus aucuparia* L., inhabitants of the Western part of Estonia recognised also Swedish whitebeam - *Sorbus intermedia* (L.) Pers. However Latvia has the largest number of *Sorbus* species, inhabitants recognised only mountain ash, and distinguished *Sorbus* species mark with one word - "sea mountain ashes". Mountain ash occurs only in Lithuania and Kaliningrad district.

Mountain ash is important in mythology of the Baltic nations. Mountain ash is considered to be the tree presence of which fears off evil spirits and protects domestic animals against deceases and evil spirits. Still in nowadays, during the different celebrations houses, rooms and farms are decorated with branches of mountain ash tree. Mountain ash tree is similarly important for many Slavian and German nations.

Because of wide adaptation ability to different kind of growth condition *Sorbus* has important role in forest ecosystems. Fallen leaves enrich soil structure and berries are important source of food for birds in autumn and winter period.

Sorbus is often planted near the houses as an ornamental tree that in the same time protect from evil spirits. Fruits of *Sorbus* are used in medicine and food. Fruits of mountain ash tree are of bitter and ooze taste, but after frost they become more sweet and juicy. In nature, there are selected forms of mountain ash trees, with fine and taste qualities, and they are cultivated as fruit trees. *Sorbus* interspecies and intergenus hybrids usually are

of better taste quality as their parent species and in such a way many *Sorbus* sorts have been made. *Sorbus* fruits include antiseptic features, they are easy to preserve and store.

Sorbus are favourite ornamental trees, they are very decorative during blooming time. In autumn *Sorbus* leaves become yellow, purple and red, but clusters of berries decorate tree after the fall of leaves. As the *Sorbus* species belong to these few woody plants which have high salt resistance of soil, then *Sorbus* species made especially welcome for conditions of cities.

There are 5 species of *Sorbus* occur in East Baltic region. One specie occur in Kaliningrad district and Lithuania, 3 species in Estonia and 5 species in Latvia.

Material and method

Place of resaerch - East shoreline of the Baltic Sea. This territory included Monzund archipelago, West shoreline of the Baltic Sea in Estonia, shoreline of the open Baltic Sea in Latvia, shoreline of the Lithuania, Kuršu peninsula and shoreline of the Kaliningrad district.

Material from these places has been collected within 1997 - 2002. Ways of the expedition were chosen by the principle to check the most possible places where interesting for me *Sorbus* species can be found.

We checked herbarium of the Latvian University, herbarium of the Latvian Nature museum, herbarium of Botany laboratory of Biology Institute of the Latvian University, herbarium of the Tartu University, herbarium of the Tartu Zoology and Botany Institute and Kaliningrad State University herbarium.

Maps of the *Sorbus* species distribution area were made according to "Cronologie der Zentraleiropänichen Flora" (Mousel etc. 1965) data and own acquired data.

Special acknowledgement to Toomas Kukk, the staff of the Tartu Zoology and Botany Institute, who gave me information about the Sorbus species distribution areas in Estonia.

Key to the Baltic *Sorbus* species

1	Leaves are simple	4
-	Leaves are odd	2
2	Leaves are odd with (1) 2 -3 pairs of lateral leaflet	*Sorbus hybrida*
-	number of lateral leaflets more than 3	3
3	Leaves with 4 -6 lateral leaflets	*Sorbus meinichii*
-	Leaves with 6 - 8 lateral leaflets	*Sorbus aucuparia*
4	Beneath of leaves are grey pubescent	*Sorbus intermedia*
-	Beneath of leaves are dense whitish pubescen	*Sorbus rupicola*

***Sorbus hybrida* L. 1762, Sp. plant. ed 2, p. 684 (Fig. 1 - 2)**

Crataegus fennica Kalwii (ut Cr. ?) L. 1755, Fl. Suec. ed 2, p. 167
Cr. hybridus L. 1761, Fauna suec. ed.2, (Florae novitae) p.557
Cr. fennica Kalm 1765, Fl. Fenn. pars I, Aboae p.6
Pyrus pinnatifida Ehrhart 1791, Beitr.z. Naturk. VI p. 93
Sorbus fennica Fries 1846, Summa veg. Scand. p.42.

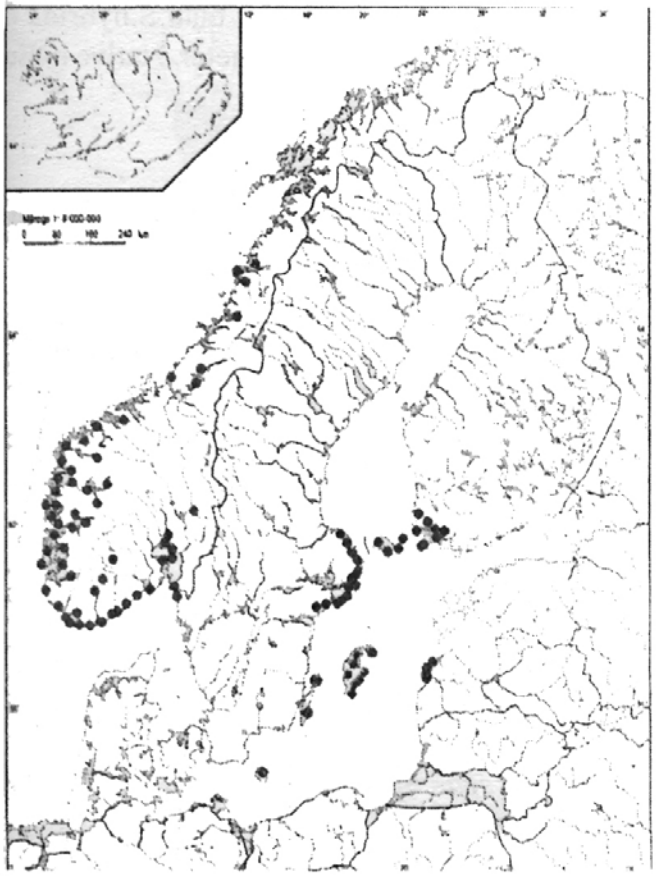

Fig. 1. Distribution area of *Sorbus hybrida* L.

Big shrub that in good growth condition can reach medium tree size. Hybrid between S.aucuparia and *S.intermedia*. Top of simple segment of leaf resembling to top of *S.intermedia*. Lateral leaflets pairs often cover each other. Leaf before raceme often simple. Leaves above glamorous, leaves beneath with short grey pubescence. Buds dark grey with, covered with sparse grey pubescence. Shoots with elongated lenticels. Young shoots are pubescent, what later disappeared. Fruits round matured dark pink, 1,1 - 1,3 cm diameter. Native in Latvia, Sweden, Finland, Denmark (Bronhlom island), Norway (map 1).

***Sorbus meinichii* Hedl. 1901, Mon. der. Gat. Sorbus (Fig. 3 - 4)**

Sorbus hybrido-aucuparia Bergstrand 1852, Naturalh. Anteckn.om Åland in Bot. Not. Stockh.

*S.aucuparia *Meinichii* 1879, Lindeberg in Hartman, Handb. I Skand. fl. ed 11, p.271

S. teodori Lijef. 1953, Studies on propagation.

Fig. 2. Twig of *Sorbus hybrida* L. with leaves and flovers

embriology and pollination in Sorbus. Band 16, No 10 Acta Hortii Berg. p.283

Big shrub or small tree. Hybrid between the *S.hybrida* and *S.aucuparia*. Leaves above glabrous, leaves beneath with short grey pubescence. Top of the leaf of different trees variable, features response to top of *S.intermedia* or top of *S.aucuparia*.

Shoots with elongated lenticels. Young shoots are pubescent, what later disappeared.

Fruits round, matured dark pink. Native in Latvia, Norway, Finland and Sweden (Fig. 3).

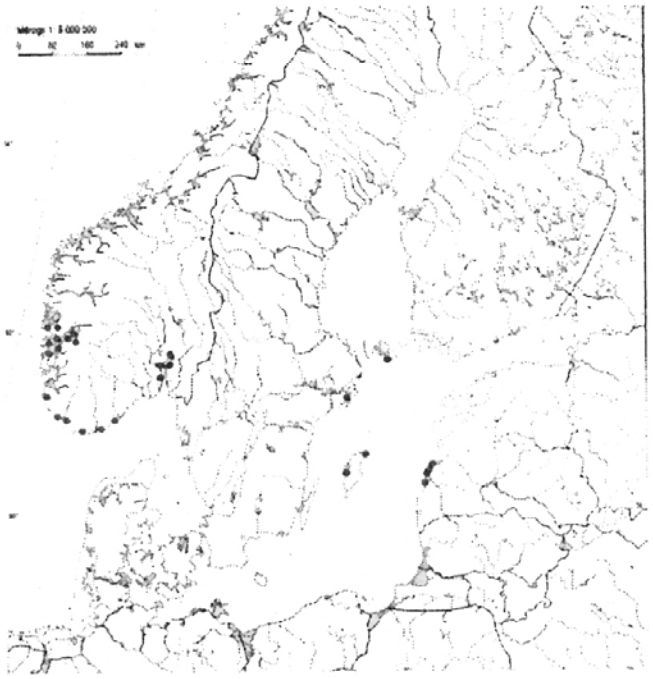

Fig. 3. Distribution area of *Sorbus meinichii* Hedl.

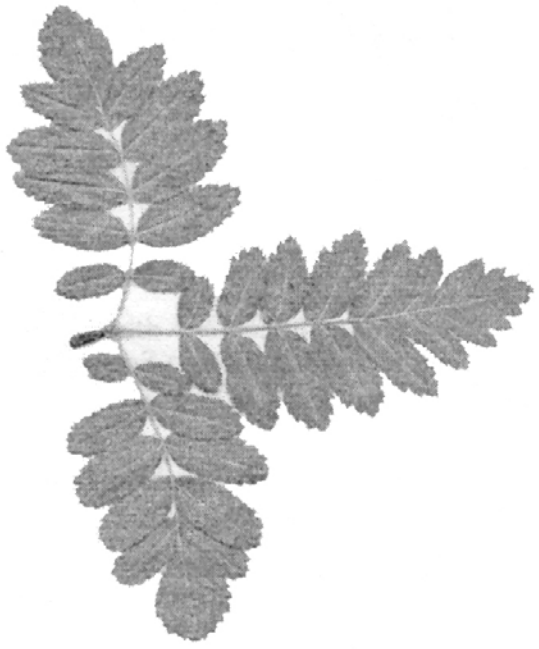

Fig. 4. Twig of *Sorbus meinichii* Hedl. with leaves

***Sorbus aucuparia* L. 1753, Spec. plant. I p 477.**

Pirus aucuparia Gaertner 1791, De fruct et sem II p.45

Aucuparia silvestris Medicus 1793, Gesh. D. Bot. p. 86

Big shrub or small tree. It can reach in good growth condition 20 m height. Leaves above glabrous, lower side whitish pubescent. Leaves margins are double serrate. Buds are light grey, bigger and more pubescent than S.hybrida or S.meinichii. Shoots without lenticels. Matured fruits are orange. Size of fruits is smaller than S.hybrida or *S.meinichii*,. 0,9 - 1,1 cm diameter. Native in Europe, Siberia, Island.

***Sorbus intermedia* (Ehrh.)Pers.1807, Syn. Plant. p. 38 (Fig. 5 - 7)**

Crataegus scandica L. 1751, Amoen. acad. (Gemme arborum.) ed. Holm. p.211

Crataegus aria ß suecica L. 1753, Spec. plant. I p. 476

Pyrus intermedia Ehrhart 1789, Beitr.z. Naturk. IV p.20

Sorbus scandica 1818, Fries Fl. Hallandiae p. 83

Crataegus scandica Wahlenberg 1820, Fl. Upsal. p.165

Pirus suecica Gracke 1820, Fl. Nord.- u. Mitt. Deutschl. Ed.9 p.140

Aria scandica Decaisne 1874, Pom. in Nouv. Arch. du mus d, hist. nat. X. Paris p.163

Sorbyus suecica Krok 1879, in Hartman , Skand. fl. ed 11 p. 270

Aria suecica Koehne 1893, Dendrol. p. 250

Hanhia suecica Dippel 1893, Laubholzk. III p. 377

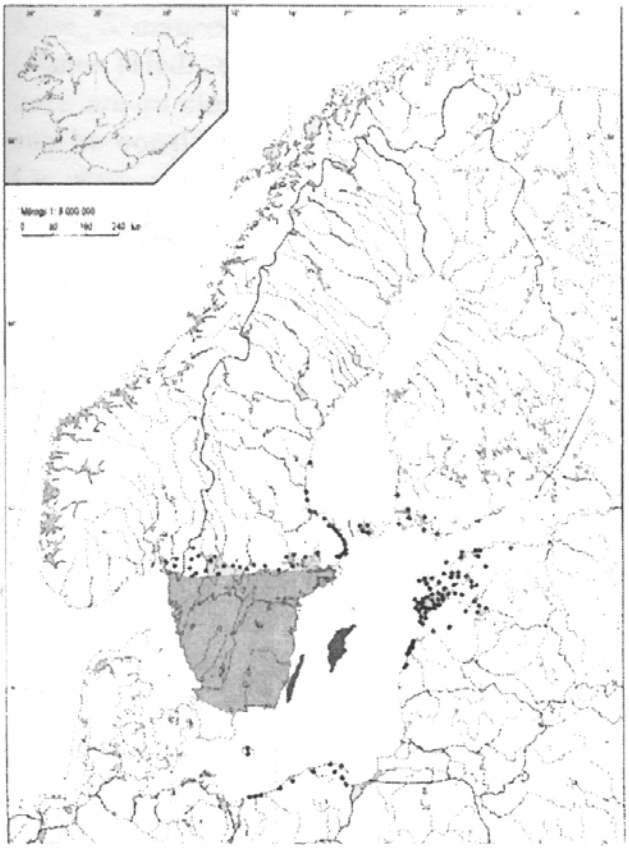

Fig. 5. Distribution area of *Sorbus intermedia* (Ehrh.)Pers.

Fig. 6. Twig of *Sorbus intermedia* (Ehrh.)Pers. with leaves and flovers

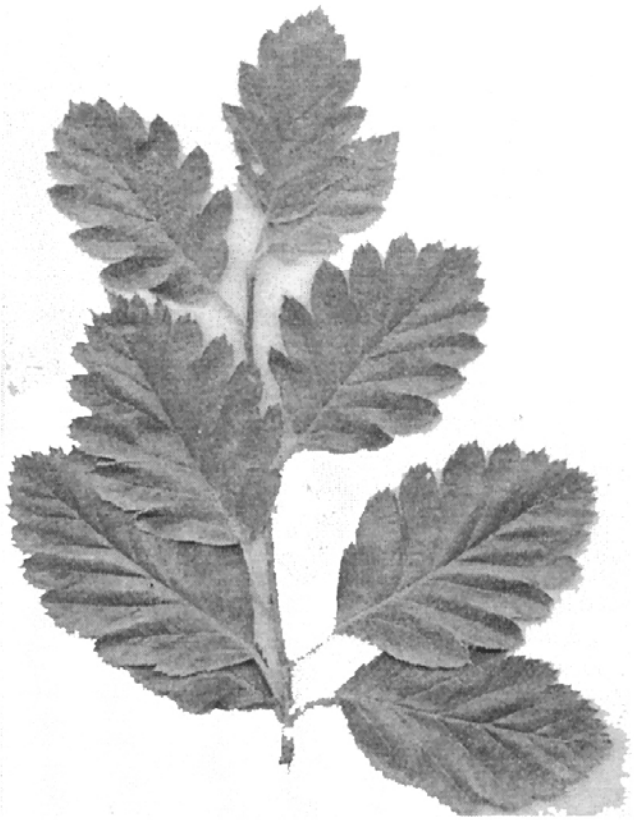

Fig. 7. Twig of *Sorbus intermedia* (Ehrh.)Pers. with leaves

Big shrub or medium size tree. Leaves have till 4 lobes with acute top. Leaves above leathery, beneath covered with tight grey pubescence, leaves margins serrate. Top of leaf is acute. Buds with glabrous, light yellow cover scale. Fruits oblong, matured orange-red, 1,1 - 1,3 cm diameter. Native in Estonia, Denmark (Bornholm island), Sweden, Norway, Finland, N-Poland (Fig. 5).

***Sorbus rupicola* (Syme) Hedl. 1914, in Nyt. Mag Naturvid. (Christiana) 52; 256. (Fig. 8 - 9)**

Pyrus rupicola Syme 1864, Sowerby, s Engl. Bot. Ed. 3 III, p.244

Sorbus salicifolia Hedl. 1901, Mon. der Gat. Sorbus S.78

Big shrub or a small tree. Leaves egg-shaped with noged base. Leaves above glabrous, beneath

species to *S. aucuparia* occur in Siberia and Far East, these are *S.sibirica* Hedl., *S. kamchatica* Kom., *S. amurensis* Koehne, *S. pohuashanensis* (Hance.) Hedl., these species morphological features are so close to *S.aucuparia* L., that they can be considered as taxons of *S.aucuparia* (www.ngdc.noaa.gov/paleo/gpdsynonymy.html.,www.dijon.inra.fr/malherbo/fdf/so-sq.htm)

Other native *Sorbus* species of Baltic countries occurs only in the Latvia and Estonia in special growth conditions. All these species are connected with pine forests or at least with presence of pine and closeness of the Blatic sea. Still nowadays it is considered to be, that all other *Sorbus* species aren't the native species, and these species were introduced in hundreds years ago. (Cinovskis 1979, 1984, Cinovskis etc 1996, Gavrilova, Šulcs 1999). We cant agree with this opinion, because the rarest and historically eldest Sorbus species of East Baltic - rocky whitebeam occur in absolutely natural plants society, together with other very rare native litoral species - *Cotonoaster scandinacius* B.Hylmö. And if the *S.rupicola* is native species, then all other East Baltic *Sorbus* species are native too. Other *Sorbus* species occurring in places with Atlantic climate - soft and warm winters and cool summers with high atmospheric moisture. Limited factor for these species is low winter temperatures. Places with continental climate, where they are planted, these species more or less frozen and almost don't maturing.

The second most distributed *Sorbus* species is Swedish whitebeam - *S.intermedia*. The chromosome number 4n = 68. The first who noticed this species was D. H. Grindel (Grindel 1803) in 1803 in Saaremaa , Estonia. In Mozund archipelago *S.intermedia* is very common, as important alvar species. In Mozund archipelago, there are many old and big size trees of *S.inetrmedia*. Many points of *S.intermedia* are in the West continental part of Estonia. *S.intermedia* makes expansion in its basic distribution area in Estonia, because in Soviet time alvars and meadows overgrew with shrubs and trees and Swedish whitebeam is one of the pioneer-species. In Latvia *S.intermedia* is distributed only near the open Baltic Sea, it occurs less than *S.hybrida*, but have larger distribution area than *S.hybrida*. In Latvia *S.intermedia* have different growth conditions as in Estonia and it don't reach big size. In Latvia it occurs in underwood of pine forest. *S.intermedia* is considered to be ancient hybrid between *S.aria* Crantz. and *S.torminalis* Crantz. (Hedlund 1901, Liljefors 1955).

Sorbus rupicola - rocky whitebeam is the rarest native species in the Baltic countries. There are few points of *S.rupicola* in Saaremaa, one point in Hiijumaa in Estonia, and one point In Latvia, to N from Ventspils. The first who found *S.rupicola* in East Baltic, Saaremaa was K. R. Kuppfer in 1901. At first this species was described as *S.aria* Crantz (Kupffer 1903), but it is considered to be *S.aria* tetraploid form - *S.rupicola*. The chromosome number 4n = 68. In Latvia first who didcovered *S.rupicola* was R. Cinovskis (Cinovskis 1986), but he supposed that *S.rupicola* is planted as fruit tree, and nobody after then didn't inspected this point and because it is hard to say what providence is here *S.rupicola*. In 1998 year we found the new point of *S.rupicola* in Latvia. There are few features what show that *S.rupicola* is origin species. Firstly it occurs as underwood species with 250 -300 year old pine forest, secondly, it grows together with *Cotonoaster scandinavicus*, thirdly, the closest house from this place is 5 km far. *S.rupicola* is fast growing but short time species, because there are no old and big trees of *S.rupicola*. Rocky whitebeam have on the young twigs and leaves dense white pubescence, what show that this species was historically connected with the arid and rocky conditions. *S.rupicola* doesn't make expansion, however at points of *S.rupicola* young exemplars occur.

S. hybrida and *S.meinichii* occurs only in NW Latvia, near the open Baltic Sea.

S. hybrida chromosome number is 4n = 68. *S.hybrida* is the hybrid between *S.aucuparia* and *S.intermedia* (Rehder 1956, Eiselt, etc.1977, Lange, etc.1978), because the top of leaf resemble *S.intermedia*. Many authors supposed that instead of *S.intermedia* parent species is *S.aria*

(Hedlund1901, Liljefors 1953, 1955, Mauriņš, Morkons 1953). R. Cinovskis supposed that simple leaved parent species is *S.rupicola* (Cinovskis1979). Problem is quite complicate, because *S.intermedia* is also hybrid between *S.aria* Crantz. and *S. torminalis* Crantz., and no doubts that S.hybrida get something from *S.aria* genome too. Distribution are of *S.hybrida* is ~25 km to North and South from Ventspils. There is opinion that *S.hybrida* was introduced by seamen from Gotland (Cinovskis1986), other Latvian authors (Расиньш 1978) suppose that *S.hybrida* bring birds from Saaremaa island. It is true that the biggest and oldest *S. hybrida* occur in the seamen gardens, and seamen planted *S.hybrida* and *S.intermedia* in their gardens because these are almost only fruit species what can grow in their garden, cause the sandy and unfertile soil. But seamen got these species from nature. Because *S.hybrida* and *S.intermedia* have better taste quality as the *S.aucuparia*, birds prefer better these species, and around the maturing trees near forest, there are many young trees of these species. Second opinion isn't serious because *S.hybrida* don't occur in Saaremaa; therefore birds can't bring to NW Latvia from this island. We found some isolated points of *S.hybrida* where the closest other point is at 3 km distance and closest houses 7 km. Because we consider that *S.hybrida* is originated in Latvia.

The chromosome number of *S.meinichii* is 3n = 51. It was supposed, that before in Latvia grew *S.teodori*, which is the same *S.meinichii* (Bolstad, Salvesen 1999). All authors are united about this *S.meinichii* parents species. It is the hybrid between *S.hybrida* and *S.aucuparia*. A.Liljefors, who made cytological reasearches with all Baltic wild *Sorbus* species,estimated, that *S.meinichii* is tetraploid, but *S.teodori* is triploiod (Liljefors 1953, 1955). He marked also other specific features how to distinguish *S.meinichii* from *S.teodorii*. But as observed A.Liljefors (Liljefors 1955). morphological features of *S.meinichii* and *S.teodorii* are so close, that in some cases even he cant distinguish exact status of species.

Revision of cytological status and morphological features about these species showed that *S.meinichii* and *S.teodorii* are the same species with triploid 3n = 51 chromosome number (Bolstad, Salvesen 1999). According to systematic nomenclature preference is to S.meinichii name of species. Traditionally in Latvia these species (Cinovskis 1986, Gavrilova, Šulcs 1999) are called under *S.teodori* name. Under the *S.teodori* name this species figure in Europe union protected plants schedule (http://europa.eu.int/comm/environment/hab-an2en.htm). *S.meinichii* appeared in Latvia just short time ago as the spontaneous hybrid between *S.hybrida* and *S.aucuparia*, because young trees rarely appear ~40 km near sea shoreline without presence of maturing *S.meinichii* exemplars.

Ecological, genetic and geographical features of *Sorbus* species

Genus *Sorbus* belongs to Rosaceae L. family, Maloidae L. subfamily. Simply chromosome number to *Sorbus* species as the all other subfamilies of Maloidae is 17. This number as marked V. Gladkova (Гладкова 1970) is to determine advantage to hybridisation between the *Sorbus* species and the other Maloidae subfamily genus as well. There are many intergenetic hybrids occur in nature, for example *xSorbaronia* Schneid, *xCrataegosorbus* Makino, x*Malosorbus* Browitcz, *xSorbocotonoaster* Pojark., *xAmelosorbus* Schneid.. There are many artificial hybrids between *Sorbus* and *Pyrus* L., *Mespilus* L, *Crataegus* L, and other Maloidae subfamily genus (Аверченко, Горбунов, Стенина 2000). I. Mitchurin made many *Sorbus* intergenetic hybrids as the fruit trees (Аверченко, Горбунов, Стенина 2000).

T. Hedlund discovered features how to distinguish "clear" and bastard *Sorbus* species. He noticed that there are just 5 species with the well-developed pollens - *S.aucuparia, S.aria, S.torminalis., S.chaemespilus* (L.) Crantz. and *S.domestica* L.

All bastard species have high percent of sterile pollens. Exceptions are the bastard species with diploid chromosome number - *S. latifolia* (Lam.)

Pers., *S. confusa* Gremlin. These species are hybrids between *S.aria x S. torminalis* (Venema 1970).

T. Hedlund discovered, that there are two ways of reproduction in genus *Sorbus* - sexual and apomixis. In the first case reproduce species with the well-developed pollens, but apomixis dominated for bastard species. Apomixis is the reproduction way, when seeds developed without ovulation, but presence of pollens is necessary for seed primordial development (Hedlund 1948).

With apomixis reproduced polyploid *Sorbus* species. In this reproduction morphological features are identical to parent tree, and *Sorbus* species multiply as clone (Liljefors 1955). Polyploid species have disadvantage in meiosis process, especially species with the triploid chromosome number (Мацкевич 1959).

A. Liljefors gave attention to low percent of seed germination of triploid *Sorbus* species. Optimal ploidity level for many species is tetraploid chromosome number, and for *Sorbus* genus it is 4n = 68 (Lijefors 1955). It is rare occur species with the trploid chromosome number 3n = 51. We can note *xSorbocotonoaster* pozdnjakovii (Гладкова 1967), *Sorbus meinichii.* (Bolstad, Salvesen 1999), *Sorbus arranensis* Hedl. (Liljefors 1953, 1955).

Almost everyone researcher, while investigating genus *Sorbus*, faced a problem of hybridisation in this genus. *Sorbus* genus has plenty of hybrid species and it is most abundant genus of species of hybrid providence. These hybrids were made between mutually close species and also between species, which belong to distant sections. Often these hybrids are fertile, and as result of split morphological features appeared many new morphological variants, which later fixated by apomixis (Габриэлян 1978).

During the investigations we paid attention to grow conditions of *Sorbus* species. *S.aucuparia* appear in all forest types, but this species rare appears in deciduous trees forests and often find in coniferous forests, especially in light places. *S.aucuparia* can rate as the boreal forest species, which is distributed in all zones of boreal woods. In south direction this species appear only in mountain (Crimea Mountains, Balkan Mountains, Caucasus) coniferous forests and alpine vegetation belt. In these mountains *S.aucuparia* is the witness of icing period, when boreal species distributed far away to south (Вульф 1960). *S.aucuparia* is most shade resistant *Sorbus* species, but anyway for maturing it demands light. All *Sorbus* species with simple leaves are light demanded species, that are distributed in mountain growth habitats, and occurs in high belt of the forests line, where is enough light. After the end of the ice period in Europe *Sorbus* species with simple leaves was one of the pioneer species what occupied ice free territories. When later followed Atlantic and subboreal period, with dominance of *Quercus robur* L., *Acer platanoides* L., *Tilia cordata* Mill. *Fraxinus exelsior* L., *Fagus sylvatica* L., *Picea abies* (L.) H.Karst., simple leafed *Sorbus* species disappeared under the shadow forests conditions. *Sorbus* species with simple leaves survive in pine forests near the sea, because in this places are dynamic environmental changes. It is take process of coastal line abrasion and sand accumulation. Under these dynamic environmental conditions *S. intermedia, S. rupicola, S.hybrida* survive in Latvia and Estonia. *S.intermedia, S.rupicola* and *S.hybrida* are the tetraploid species, and species with elevated ploidity are better adapted to severe climatic conditions. Therefore these species with high elevated ploidity are the distributed farthest to north than basic diploid species - *S.aria* and *S.torminalis.* Latvia and Estonia is the North East border of distribution of *S.intermedia* and *S.rupicola.* Latvia is the extreme East border of *S.hybrida* and *S.meinichii* distribution.

Compare Caucasian *Sorbus* species descriptions (Гроссгейм 1952, Габриэлян 1978, Колосовский 1985), we noted that some very similar species appear in Caucasus mountains and our native *Sorbus* species. Caucasus was the place where many plants during the last ice-period survived. Because in these mountains there is the plenty of *Sorbus* species. Caucasian *Sorbus* species are very variable with their morphological features and transition between the species is so fioat.

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BRYOPHYTES IN GRASSLANDS OF LATGALE UPLAND

Baiba Bambe

Bambe B. 2004. Bryophytes in grasslands of Latgale. *Acta Biol. Univ. Daugavp., 4 (1): 31- 37.*

Aim of the study was to investigate floristic composition of bryophytes in different grassland habitats. Inventory of grasslands was carried out in summers of 2001-2002. Bryoflora of 100 grassland sites was investigated in the western part of Latgale Upland. In total, 73 species were recorded including 68 mosses and 5 liverworts, the most widespread of them are *Rhytidiadelphus squarrosus* - 55 %, *Climacium dendroides* - 48 %, *Thuidium abietinum* - 43 %, *Brachythecium albicans* - 41 %, *Calliergonella cuspidata* - 38 % and *Ceratodon purpureus* - 34 % of studied sites. Ecological features of grasslands are represented by typical species groups of bryophytes. *Brachythecium albicans, Campylium chrysophyllum, Racomitrium canescens, R. ericoides, Thuidium abietinum, Tortula ruralis* are characteristic for dry grasslands, *Rhytidiadelphus squarrosus, Plagiomnium affine, P. cuspidatum, P. undulatum*, other species of genus *Brachythecium* represent mesophytic ones, but *Calliergonella cuspidata, Plagiomnium elatum, P. ellipticum*, genus *Calliergon* and *Drepanocladus* predominate in moist and wet grasslands. Colonist species *Barbula unguiculata, Didymodon fallax, Bryum caespiticium, B. argenteum, Pohlia nutans* a.o. indicate disturbance in vegetation cover of grasslands. The most widespread species in this group is C*eratodon purpureus*. The greatest part of recorded species are distributed in different habitats. Only one of them - *Hypnum pratense* - is included in the Red List of Latvia. In the dry summer of 2002 bryophytes suffered from a drought, especially after burning in spring. The total cover of moss layer in grasslands is very different and varies from 0 to 80 %.

Key words: bryoflora, grassland habitats, Latgale Upland

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Introduction

Grasslands include plant communities, formed mainly from perennial herbs and grasses. They have developed due to human impact – mowing and pasturing. Semi-natural grasslands occupy about 1 % of the whole area of Latvia (Kabucis, 1997). They occur among other ecosystems mainly in river valleys, slopes of hills and in relief depressions. Greatest part of grasslands in Latvia need management, but without it they overgrow with shrubs and subsequently, afforestation occurs. More endangered are mesophile grasslands, but dry grasslands on steep southern slopes as well as eutrophic humid grasslands can remain for a longer period.

Bryophytes are common in the flora of grasslands. Altogether 113 species of mosses are recorded in grasslands of Latvia (Аболинь, 1968). There are

several species, that occur in forests as well (*Pleurozium schreberi, Rhytidiadelphus triquetrus, Climacium dendroides*), others are typical for wetlands (*Calliergonella cuspidata, Calliergon giganteum, Campylium stellatum*).

The aim of the study is to investigate floristic composition of bryophytes in grasslands of the Latgale Upland, frequency of species and distribution of species of different ecology.

Study area

Latgale Upland is a nature region, situated in the eastern part of Latvia. The total area of the region reaches 6510 km^2. The study area is located in the western part of it and includes a territory about 1250 km^2 between 55^{0}55'-56^{0}21' N and 26^{0}48'-27^{0}11' E. Typical for the area is hilly relief with absolute height above a see level about 120-250 m. Soils are soddy-podsolic and eroded, sandy-clay, including gravel; in depressions soddy-podsolic gleyed and even boggy. Climate is the most continental in Latvia with cold winter (average temperature of January –7^0 C, minimal –43^0 C) and rather warm summer (average temperature of July 16^0-17^0 C, maximal 35^0 C). Medium duration of vegetation period lasts 145 days. Annual sum of precipitations reaches 550-650 mm (Āboltiņš, 1995).

Latgale Upland is the richest in lakes region in Latvia. There are many large lakes with an area more than 100 ha in the study area: Ruðons, Cirīšu, Jazinkas, Feimaņu, Višķu, Pušas, Zolvas, Svātavas, Aksenovas, Bicānu, Kategrades, Cārmans, Salmejs, Geraņimovas Ildzs, but only few rivers: Dubna, Malta and Tartaka.

The greatest part of studied sites represent complexes of biotopes because of fragmentation and diversity of habitats.

Material and methods

Inventory of grassland biotopes in Latgale Upland was carried out in summers of 2001 and 2002 according to methods of National inventory of grasslands in Latvia. Altogether 182 grassland sites were mapped and described including full list of vascular plants and evaluation of grassland biotopes and management. The most distributed grassland biotopes in the studied area are mesophile long fallow grasslands, what correspond to alliance Cynosurion. Dry, moist and wet grasslands are less represented. In the moist grassland group rare are communities from alliance Molinion, but in dry grassland group a new plant community Centaurea scabiosa-Fragaria vesca were described, that includes features of three vegetation classes: Festuco-Brometea, Koelerio-Corynephoretea and Trifolio-Geranietea (Bambe, 2002; Jermacāne, Bambe, 2003).

Bryoflora was investigated simultaneously with inventory of habitats in 100 grassland sites at 2001. In the summer of 2002 the inventory continued and bryophyte genera difficult for determination as Brachythecium, Campylium a. o. were studied in addition.

Nomenclature for bryophytes follows Āboliņa, 2001; ecological values: Düll, 1991.

Results and discussion

In total, 73 species were recorded including 68 mosses and 5 liverworts. The most represented genera are *Brachythecium* – 8, *Plagiomnium* – 5, *Campylium* and *Thuidium* – 4 species in each genus. Largest families are *Brachytheciaceae* – 12, *Amblystegiaceae* – 11 and *Hypnaceae* – 11 species. The most widespread species are *Rhytidiadelphus squarrosus* - 55 %, *Climacium dendroides* - 48 %, *Thuidium abietinum* - 43 %, *Brachythecium albicans* - 41 %, *Calliergonella cuspidata* - 38 % and *Ceratodon purpureus* - 34 % of studied sites. All these species as well as *Calliergon giganteum, Plagiomnium ellipticum* and *Tortula ruralis* are marked as vegetation dominants in bryophyte layer (Table 1.).

Rhytidiadelphus squarrosus is the most common species in grasslands in the bryophyte layer. Similar result is reported from the Netherlands, where

Table 1. List of bryophyte species

I – species
II – frequency in % (number of sites where the species is recorded)
III – ecological values of species (Düll, 1991):

L – light number: 1- deep shade plants , 2 – between 1 and 3, i. e. only on shady sites, 3 – shade plants, 4 – between 3 and 5, 5 – semi-shade plants, 6 – between 5 and 7, 7 – semi-light plants, 8 – light plants, 9 – full light plants.

T – temperature number: 1 – cold indicators, 2 – between 1 and 3, 3 – cool indicators, 4 – between 3 and 5, 5 – moderate warmth indicators, 6 – between 5 and 7, 7 – warmth indicators , 8 – between 7 and 9, 9 – extreme warmth indicators.

C – continentality number: 1 – euoceanic, 2 – oceanic, 3 – between 2 and 4, 4 – suboceanic, 5 – intermediate, 6 – subcontinental, 7 – between 6 and 8, 8 – continental, 9 – eucontinental.

M – moisture number: 1 – great dryness indicators, 2 – between 1 and 3, i. e. mainly on dry sites, 3 – dryness indicators, 4 – between 3 and 5, 5 – freshness indicators, 6 – between 5 and 7, 7 – moisture indicators, 8 – between 7 and 9, 9 – near waters, regularly flooded, waterlogged or floating.

R – reaction number: 1 – strong acid indicators, 2 – between 1 and 3, 3 – acid indicators, 4 – between 3 and 5, 5 – moderate acid indicators, 6 – between 5 and 7, 7 – weakly acid to weakly basic indicators, 8 – between 7 and 9, 9 – base and lime indicators.

Species recorded as dominants are marked with bold.
H before the species name indicates liverwort; all the others are mosses.

I	II	III				
		L	T	C	M	R
Amblystegium serpens (Hedw,)B.,S.et G.	1	5	x*	5	4	6
Atrichum undulatum (Hedw.)P.Beauv.	9	6	x	5	6	4
Aulacomnium palustre (Hedw.)Schwaegr.	3	7	2	6	7	3
Barbula convoluta Hedw.	1	8	x	5	3	6
Barbula unguiculata Hedw.	15	7	x	5	2	7
***Brachythecium albicans* (Hedw.)B.,S. et G.**	41	9	3	5	2	? *
Brachythecium campestre (C.Müll.)B.,S. et G.	4	6	4	7	3	5
Brachythecium glareosum (Spruce)B.,S. et G.	2	4	3	5	5	8
Brachythecium oedipodium (Mitt.)Jaeg.	6	?	?	?	?	?
Brachythecium rutabulum (Hedw.)B.,S. et G.	2	5	x	5	4	?
Brachythecium salebrosum (Web. et Mohr)B.,S. et G.	16	6	4	5	4	5
Brachythecium starkei (Brid.)B.,S. et G.	1	6	1	6	6	2
Brachythecium velutinum (Hedw.)B.,S. et G.	1	5	3	5	4	6
Bryum argenteum Hedw.	2	7	x	?	?	6
Bryum caespiticium Hedw.	6	8	x	5	5	6
Bryum capillare Hedw.	1	5	x	5	5	6
Bryum pseudotriquetrum (Hedw.)Gaertn., Meyer et Scherb.	6	7	x	5	7	7
Calliergon cordifolium (Hedw.)Kindb.	2	7	4	6	8	4
***Calliergon giganteum* (Schimp.)Kindb.**	7	8	3	5	8	8

***Calliergonella cuspidata* (Hedw.)Loeske**	38	8	3	5	7	7
Campylium chrysophyllum (Brid.)J.Lange	12	9	2	6	2	8
Campylium elodes (Lindb.)Kindb.	1	8	4	5	7	9
Campylium polygamum (B.,S. et G.)J.Lange et C.Jens.	2	8	2	6	8	4
Cephalozia lunulifolia (Dum.)Dum.	1	5	3	6	6	2
***Ceratodon purpureus* (Hedw.)Brid.**	34	8	x	?	2	?
Cirriphyllum piliferum (Hedw.)Grout	11	7	3	6	5	6
***Climacium dendroides* (Hedw.)Web. et Mohr**	48	7	3	5	6	5
Cratoneuron filicinum (Hedw.)Spruce	1	7	x	5	7	7
Dicranum bonjeanii De Not.	2	8	3	6	7	7
Dicranum polysetum Sw.	1	6	3	6	4	5
Dicranum scoparium Hedw.	1	5	x	5	4	4
Didymodon fallax (Hedw.)Zander	7	8	x	6	2	7
Drepanocladus aduncus (Hedw.)Warnst.	9	8	x	5	8	7
Drepanocladus revolvens (Sw.)Warnst.	3	9	x	6	7	8
Encalypta streptocarpa Hedw.	1	5	x	5	5	8
Encalypta vulgaris Hedw.	1	9	5	5	4	8
Eurhynchium hians (Hedw.)Sande Lac	6	7	4	5	5	7
Eurhynchium pulchellum (Hedw.)Jenn.	2	6	4	6	4	6
Fissidens taxifolius Hedw.	4	5	4	5	6	7
Funaria hygrometrica Hedw.	2	8	x	5	6	6
Hylocomium splendens (Hedw.)B.,S. et G.	7	6	3	6	4	5
Hypnum lindbergii Mitt.	8	8	3	6	7	6
Hypnum pratense (Rabenh.)W.Koch ex Hartm.	1	8	2	7	7	8
Leptobryum pyriforme (Hedw.)Wils.	1	?	x	5	6	7
H *Lophocolea bidentata* (L.)Dum.	1	7	3	5	6	5
H *Lophocolea heterophylla* (Schrad.)Dum.	1	4	3	5	4	3
H *Marchantia polymorpha* L. emend. Burgeff	2	8	x	5	6	5
H *Pellia endiviifolia* (Dicks.)Dum.	1	?	4	5	8	9
Plagiomnium affine (Bland.)T.Kop.	11	5	4	5	5	5
Plagiomnium cuspidatum (Hedw.)T.Kop.	16	4	3	4	5	7
Plagiomnium elatum (B. et S.)T.Kop.	13	?	2	4	7	6
***Plagiomnium ellipticum* (Brid.)T.Kop.**	17	3	2	4	7	3
Plagiomnium undulatum (Hedw.)T.Kop.	4	4	3	5	6	6
Pleuridium subulatum (Hedw.)Rabenh.	1	6	3	4	7	4
Pleurozium schreberi (Brid.)Mitt.	16	6	3	6	4	2
Pohlia nutans (Hedw.)Lindb.	1	5	x	6	4	2
Polytrichum commune Hedw.	3	6	2	6	7	2
Polytrichum juniperinum Hedw.	3	8	2	?	4	3
Ptilium crista-castrensis (Hedw.)De Not.	1	4	2	6	6	3
Racomitrium canescens (Hedw.)Brid.	1	9	3	6	1	6
Racomitrium ericoides (Brid.)Brid.	6	8	2	3	6	4
***Rhytidiadelphus squarrosus* (Hedw.)Warnst.**	55	7	3	6	6	5
Rhytidiadelphus triquetrus (Hedw.)Warnst.	2	7	3	6	4	5
Sphagnum squarrosum Crome	1	5	x	5	7	3
Sphagnum teres (Schimp.)Åongstr.	2	9	x	6	7	3
Sphagnum warnstorfii Russ.	1	7	2	6	8	3

***Thuidium abietinum* (Hedw.)B.,S. et G.**	43	8	x	6	2	7
Thuidium delicatulum (Hedw.)Mitt.	8	7	4	5	4	7
Thuidium philibertii Limpr.	32	6	3	4	4	7
Thuidium recognitum (Hedw.)Lindb.	4	5	3	4	6	6
Tomentypnum nitens (Hedw.)Loeske	1	7	2	6	8	8
***Tortula ruralis* (Hedw.)Gaertn., Meyer et Scherb.**	13	9	x	5	2	6

* x – indeterminate number
? – unknown number

Rhytidiadelphus squarrosus was expanded on several soil types and in various grassland communities over the period 1980-2000. Atmospheric deposition of nutrients may be an important factor in the increase of this species (Londo, 2002).

Ecological features of grasslands are represented by some typical species groups of bryophytes. *Brachythecium albicans, Campylium chrysophyllum, Racomitrium canescens, R. ericoides, Thuidium abietinum, Tortula ruralis* are characteristic for dry grasslands, *Rhytidiadelphus squarrosus, Plagiomnium affine, P. cuspidatum, P. undulatum*, other species of genus *Brachythecium* represent mesophytic ones, but *Calliergonella cuspidata, Plagiomnium elatum, P. ellipticum,* genus *Calliergon* and *Drepanocladus* predominate in moist and wet grasslands.

Some species as *Pleurozium schreberi, Rhytidiadelphus triquetrus, Hylocomium splendens, Polytrichum juniperinum, P. commune* are widely distributed in different types of forests as well. Species of raised bogs were not recorded, but moist and wet grasslands support bryophytes, characteristic for fens and transitional mires: *Calliergonella cuspidata,* species of genera *Calliergon* and *Drepanocladus*. Rare for Latgale Upland are purple moorgrass *Molinia caerulea* communities, that are characterised by *Sphagnum teres, S. warnstorfii, Tomentypnum nitens* in bryophyte layer. Only in dry calcareous grasslands *Encalypta streptocarpa, E. vulgaris* were stated, but wet grassland communities with calcareous springs include such species as *Cratoneuron filicinum, Drepanocladus revolvens*.

In grasslands, bryophytes are continuously suppressed by herb layer, and therefore depend partly on the structure of herb layer and partly on temporally favourable microsites created by small-scale disturbances (Gilbert, 1993, Ųkland, Eilertsen, 1994). Therefore the bryophyte cover differs significantly in various grassland sites. The total cover of moss layer varies from 0 to 80 %. In the dry summer of 2002 bryophytes suffered from a drought, especially after burning in spring.

Special group of grassland bryophytes represent colonist species, that occupy soil patches with disturbed vegetation cover: roadsides, ruts, balks, gravel-pits, where in the first stage of colonisation a competition by vascular plants is reduced. Most widespread species in this group is *Ceratodon purpureus*, that is recorded in 34 % of studied sites, but *Barbula unguiculata, Didymodon fallax, Bryum caespiticium* are common as well.

According to ecological values of bryophytes (Düll, 1991) the following ecological groups are more represented: semi-light and light plants - 25 species, cool indicators -23, intermediate species - 33, hygrophytes - 36 and weakly acid soil indicators - 30 species (Table 1.).

The greatest part of recorded species is widely distributed in different habitats. Only one of them – *Hypnum pratense* - is included in the Red List of Latvia.

Similar results are obtained in Lithuania, Estonia and the Central Europe. In the grasslands of Lithuania, 63 species of mosses were stated, 3 of them are rare (Jukoniene, 1993, 1996). Bryophytes

form a significant part in the plant cover of grasslands in Lithuania, 55 species are mentioned in vegetation descriptions of meadows (Balevičienė et al, 1998).

Bryophyte vegetation was investigated in the Laelatu wooded meadow in Estonia. Ninety-six bryophyte species were found, including epilithic, epiphytic and epixylic ones; the majority of bryophytes are epigeic species common to meadows and forests. In response to fertilising disappear *Hylocomium splendens* and *Pleurozium schreberi*, but the most tolerant species is *Rhytidiadelphus squarrosus* (Ingerpuu, Kull, Vellak, 1998).

Trends in the bryophyte and lichen flora of semi-natural grasslands over the last 50 years were investigated in Denmark. Two generalist bryophytes *Brachythecium rutabulum* and *Ceratodon purpureus,* are more frequent in the recent data set whereas two specialist bryophytes, *Thuidium abietinum* and *Rhytidiadelphus triquetrus*, were more frequent in the old data set. Altogether 63 species of mosses and 5 species of liverworts were found recently (Ejrnęs & Poulsen, 2001, a, b).

Mowing and grazing is necessary to preserve the community structure of grasslands. The study in wooded meadow in Sweden demonstrates, that mowing is to be preferred in cases where maintaining of species richness is of primary concern (Hansson, Fogelfors, 2000).

Conclusions

In total, 73 bryophyte species, including 68 mosses and 5 liverworts, were recorded in semi-natural grasslands of Latgale Upland.

The most widespread species are *Rhytidiadelphus squarrosus* and *Climacium dendroides* in different types of grasslands, *Thuidium abietinum* and *Brachythecium albicans* in dry ones, *Calliergonella cuspidata* in moist and wet ones, and *Ceratodon purpureus* in disturbed sites of grasslands.

Only one species of recorded bryophytes – *Hypnum pratense* – is included in the Red List of Latvia.

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ALDROVANDA VESICULOSA L. (DROSERACEAE) IN LITHUANIA (JULY 17, 2001 - AUGUST 15, 2003)

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Vilkonis K. K., 2003. *Aldrovanda vesiculosa* L. (Droseraceae) in Lithuania (July 17, 2001 - August 15, 2003). *Acta Biol. Univ. Daugavpil, 4 (1): 39 - 41.*

Up till this century it was supposed that Vesicular aldrovanda was found only once in a big lake as it was carried by a bird by accident.

In Lithuania Vesicular aldrovanda (*Aldrovanda vesiculosa* L.) was once found in the Lake of Dysnai (Ignalina district, North-East Lithuania) in 1955. Later all the attempts to find this species were unsuccessful and it was ascribed to the group of extinct ones. In 2001 a new locality of *Aldrovanda vesiculosa* was found in the Lake of Rūžas (Ignalina district). This plant is distributed in a shallow bay and forms a belt of about 600 m long. The status of Botanical Reserve is proposed for the Lake of Rūžas. Up till now it was assumed that Vesicular aldrovanda was growing in Lithuania outside its habitat boundaries. The boundaries of the prevalence of the species should be revised.

Key words: *Aldrovanda vesiculosa*, biology, *Droseraceae*, habitat, Lithuania, Red Data Book.

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Vesicular aldrovanda (*Aldrovanda vesiculosa* L.) is a small light green water plant of the *Droseraceae* Salisb. family.

Though the area of Vesicular aldrovanda is very large - it covers Scandinavia, Central and Atlantic Europe, the Balkans, far East, Central and Near East Asia, India, Japan, Central Africa and Australia (Pipinys 1961) - in many countries this plant is very rare, protected, and in some places it is already extinct or on the verge of extinction. Vesicular aldrovanda is not found in Estonia, Latvia, Finland, Denmark and the Netherlands. It is extinct in Switzerland and Austria. It is a very rare plant, protected and included in the Red Data Books in Russia, Poland, Germany and Slovakia (Sinkevičienė 1992). Vesicular aldrovanda is a species on the verge of extinction in all Europe and in order to preserve it is included in European Union Habitats Directive (92/43/EEC, Annex II), and special protected territories must be established (Baškytė et al. 1997).

In Lithuania this plant has not been found for a long time and it is included in the Red Data Book where it is ascribed to zero category as an extinct species.

For the first time Vesicular aldrovanda was found by I. Šarkinienė in the Lake of Dysnai on the border of Ignalina District in 1955. The later attempts of botanists to find the plant in the large Lake of Dysnai were in vain up till the beginning of the XXI century. Most probably it is already extinct in this lake. Only after a 46-year break, on the 17th of July, 2001 Vesicular aldrovanda was found again some kilometers away from the Lake

of Dysnai in the Lake of Rūžas (Ignalina District). Its population was found in the northern part of the lake, 55?30' North latitude and 25?28' East longtitude in a marshy with plenty of water plants bay of about 1 ha area transforming into a creek that joins the Lakes of Rūžas and Žilmas. The plants were spread along the bank forming a 300-meter-long strip. The majority of them were in marshy areas next to the banks. No flowers were noticed.

While checking the habitat on the 19th of September, 2001 Vesicular aldrovanda were still green with already wintering buds. There were no flowers then either (Obelevičius, 2001).

While examining the composition of the water plants' species in the Lake of Rūžas a wooden boat with roars was used. The surface plants were taken out manually, and from the deeper places - by a special landing-net.

More thoroughly the habitat was examined on the 14th of August, 2002. The period chosen was between the middle of July (the day of discovery) and the middle of September (the day of checking). This time we managed to reach the hardly accessible almost close bays. One more area of 1 ha was examined. In some coves Vesicular aldrovanda predominated, there was plenty of it that even in open waters the boat moved with difficulty among floating Vesicular aldrovanda (*Aldrovanda vesiculosa* L.).

In all the little bays of the creek, as well as in its broader places and in the large bay the water is clear and not deep. Almost all the water surface is covered by water plants' leaves. The most numerous are *Nuphar lutea* (L.) Sm., *Potamogeton lucens* L. and *Myriophyllum spicatum* L. There were less off *Potamogeton natans* L. and *Nymphaea candida* J. Presl et C. Presl. *Ultricularia minor* L. and *Stratiotes aloides* are rare. *Hydrocharis morsus-ranae* L. and *Utricularia vulgaris* L. grow at the banks. The bays and the areas next to the banks are marshy. In the grass cover among *Carex sp.* predominate *Typha angustifolia* L., *Thelypteris palustris* Schott., *Menyanthes trifoliata* L., and more rare are *Ranunculus lingua* L., *Cicuta virosa* L., *Lythrum salicaria* L., *Scutellaria galericulata* L., *Potentilla palustris* (L.) Scop., *Cardamine hirsuta* L., *Peucedanum palustre* (L.) Moench., *Glyceria maxima* (Hartm.) Holmb.

In the eastern part of the bay under examination in the Lake of Rūžas one more rare plant - marsh-grass, sprang-letop (*Scolochloa festucacea* (Willd.) Link.) was discovered. Marsh-grass, sprang-letop is also numerous in another place of the Lake - north-east part, next to Vilnokai village. Here it grows among great reedmace, common cat tail, great bulrush (*Typha latifolia* L.) and among common reed-grass (*Phragmites australis* (Cav.) Trin. ex Steud.), forming a 4-5 meter-long strip.

Vesicular aldrovanda is a very original plant. The stems are 5-15 cm long, string like, rootless, most often with no or with few branches. The leaves in verticils are very original, characteristic only of *Aldrovanda genus* - with the help of them the plant catches small water invertebrates. The stalks are flat, wedge-shaped, 5-8 cm long, setaceous in the top. The leaves are 5-6 mm long and 7-8 mm wide formed of two semicircular parts. Outside of the leaf, closer to the middle fiber, there are digesting glands and perceptive hairs. When a water animal touches the perceptive hairs, the halves of the leaves close and the animal is caught and digested (Pipinys 1961). Often after the digestion, especially after the second or third one the leaves do not open. Then new young top leaves start catching animals. Therefore, the leaves of the lower verticils observed by us were yellowish or yellow, and of the lowest ones – they were dirty and brown and partially or completely dead.

Vesicular aldrovanda spreads by seeds seldom. It seems that on the area borders, and in Lithuania as well, Vesicular aldrovanda has no flowers at all (Tabaka et al. 1993). This assumption is supported by the fact that in the very *hot and damp* summer

of the 2001 (the average summer months temperature is 17, 6?C and precipitation total is 256,1 mm) there were no flowers observed. In the very *hot and dry* summer of the 2002 (the average summer months temperature is 18,4? C and precipitation total is 189,6 mm) there were no flowers either. In Lithuania Vesicular aldrovanda propagates itself vegetatively – by wintering buds. It may be that the seeds were brought by seldom coming birds from the warmer lands.

It is believable that the site in Lithuania is relatively prolific. As supposed that during August in warm summer seasons Aldrovanda could also flower in Lithuania as it may flower prolifically in our region which is not too warm (mean annual temp. cca. 7.8 C?, cca. 430 m a.s.l.) (Adamec 2003).

In 1996 Lithuania ratified the European Wild Nature Protection Convention (The Bern Convention) where Vesicular aldrovanda is in the list of species of international importance and of greater protection interest (Baškytė et al. 1997).

We suppose that after 3 years of inspection it has been supposed that Vesicular aldrovanda has become a plant of permaneat Lithuanian habitat; we think that the status of Vesicular aldrovanda will be changed in The Red Data Book of Lithuania - from the zero category it will be moved into the first category; the Lake of Rūžas will be proclaimed a botanical reserve; and fishing by nets will be banned in it; the boundaries of the prevalence of the species should be revised.

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CONSERVATION OF RARE AND DISAPPEARING PLANT SPIECES IN BOTANIC GARDEN OF SIAULIAI UNIVERSITY AND THEIR USING FOR EDUCATION

Rita Mikaliūnaitė

Mikaliūnaitė R. 2004. Conservation of rare and disappearing plant spieces in Botanic garden of Šiauliai University and their using for education. *Acta Biol. Univ. Daugavp., 4 (1), 43 – 46.*

One of the most important fundamental task of the Botanical garden is forming a collection of rare and disappearing plants. The collection of Lithuanian rare and disappearing plants are established in the Botanic garden of Šiauliai University. In 1999 – 2003 there was a collection presenting more than 160 species of plants. In conformity with the newest classification the species of extinct 0(Ex) are represented by 2 species: Rubus arcticus L, The first category (E) – 14, the second (V) –24, the third (R) – 19, fourth (I) – 1 and 5 (Rs) – 5 species. All plant are growing by seeds or by seedlings. The majority of plants are successfully propagated by seeds and vegetative. Lectures and other training activities take place at the Botanical Garden for Šiauliai Universitety students. Students collect material for their bachelor's thesis at Botanical Gardens too. We suggest the following spheres of activities for the students at the Botanic Garden of Šiauliai University:1. Field trip; 2. Collecting material for subject reports; 3. Individual activity; 4. Participating in projects and scientific themes at the Botanic Garden. Practical activity expands knowledge of natural sciences.

Key words: rare and disappearing plants, Botanic garden, conservation.

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Introduction

The Botanic Garden of Šiauliai University was established in September 1, 1997, instead of agrobiologic station of Šiauliai Pedagogical Institute. The Botanic garden performs researches of plants introduction, acclimatization and ecology in the North Lithuania, also collections of plants are collected and watched for the scientific and educational purposes. In order to preserve biological diversity in Lithuania, since 1999 the collection of Lithuanian rare species of plants has been collected in the Botanic Garden of Šiauliai University. The main purpose of this collection is conservation of ex-situ biodiversity. This collection is unique in Lithuania. One of the most important objectives of environmental science is the research of rare species of plants development outside their sites. Data of the research would allow conserving rare and disappearing species of plants in the funds of genetic recourses of Lithuania. The aim of this paper is to present data about the collection of Lithuanian rare species of plants collected in the Botanic Garden of Šiauliai University, peculiarities of their development, reproduction possibilities, the problem of conservation, and their usage for the educational activity of the Botanical garden.

Methods

The collection of rare species of plants is set into two groups:

1. Species of plants disappearing and put down for Lithuania Red Book Data of conserved plants, mushrooms, and animals (Anonym, 2000); the number of their population decreased and has already reached critical point in the whole range or its part.

2. Species of plants, the populations of which grow in quite small territory, though cover wide range, but their vegetation places are scattered and isolated.

Rare species are not necessary disappearing, some of them can enlarge boarders of their range on the influence of nature and anthropogenic factors. However, it is a risk to disappear of majority of species because of limitation of their prevalence and small variety, as their vegetation places can be transformed while performing farming (lumbering, reclamation, road building and other constructions) (Parfenov, 1987). Rare species are separated in 4 groups: 1) very rare; 2) quite rare; 3) rare; 4) towards rare.

Plants from different regions in Lithuania are being gathered in the collection. The examples of the collection are gathered in two ways: seed is gathered in the finding places and plants received from special collections.

Results

Presently seed is gathered in 75 finding places. Seed examples of plants growing in the North region and included into the Red Book of Lithuania were gathered on Žagarė ozas, Joniškis district: *Astrantia major* L., *Corydalis intermedia* (L.) Mérat, *Sesleria caerulea* (L.) Ard. Examples of plants were received from the Botanic gardens of Vilnius University and Kaunas, collections of Traupis (Anykščiai district) and Antalgė (Utena district).

Performing interchange of seed between the botanic gardens, it was tried to grow species of plants from other European countries, included in the Red Book of Lithuania. However it did not stand up because the plants differed in their morphologic features.

In 1999 the collection was formed of 20 species of plants, in 2000 – 48, in 2001 – 51, in 2002 – 53 species of plants. At the moment 162 species of plants are in the collection, 64 of them are included in the Red Book of Lithuania (Balevičius, 1992) and they are attached to the following categories: 0 (Ex) – 1 specie of plants, 1(E) – 14 species of plants, 2(V) – 24 species of plants, 3(R) – 24 species of plants, 4(I) – 1 specie of plants. Other rare species of plants according to their frequency are attached to: very rare – 22, quite rare – 15, rare – 38, towards rare – 23.

In total 49 species of plants growing in Lithuania are being cultivated. The richest are families of Asteraceae, Apiaceae, Lamiaceae, Fabaceae.

Special references are being studied while trying to introduce new species of plants and the conditions of their vegetation, development, fruiting are looked at; microclimate close to natural conditions of vegetation of the particular specie of plants is formed in the process of cultivation. The plants of the collection are constantly observed; peculiarities of their growth, development and reproduction in the period of their vegetation are studied. In the first stage of introduction plants are raised in the collection field. Preliminary research of their biologic features is performed. It is to be mentioned that quite a big number of plants is lost when seeds do not sprout or plants do not naturalize, some plants do not survive winter (Table 1).

Low fertility of seeds that was 20-50%, sometimes even 2-5% from the total amount of seeds made the results worse. This is characteristic to the majority species of plants. Some species (*Trifolium rubens* L., *Pycreus flavescens* (L.) Beauv. ex Rchb., *Tofieldia calyculata* (L.) Wahleb. and others.) though abound in blossoms, but they mature little seeds. Some plants hardly bear replant-

ing because it is the only way to lay them out when seeds are unfertile.

Some species of plants grow perfectly on the conditions not characteristic to them – *Glaux maritima* L., *Myrica gale* L., *Silene lithuanica* L., *Lathyrus maritimus* L. and some others. Having several individuals of one specie, we perform a control planting on the conditions not characteristic to those species: *Glaux maritima* L. grows in sunlit places, but it did not naturalize in fertile compost, specially formed sand-dune near the pond.

Quite a big affect is made by green winter, especially if there is no coat of snow.

Observations performed in 1999 – 2002 showed that 98 species of plants (60% of all naturalized) pass full process of ontogenesis, fruit and form complete seeds. The fact shows that species of plants naturalize successfully in new growing conditions. The tendency of self-seeding when plants naturalize successfully in new places of growing is noticed. Seeds that fall in soil sprout more successfully than sprouting them after stratification. Sprout of seeds right after fruiting depends on meteorology during the period of vegetation. Top number of species of plants sow in the year, when large amounts of rain fall. Each year annuals largely sow: *Geranium lucidum* L., *Agrostemma githago* L., *Valerianella locusta* L., *Fagopyrum tataricum* (L.) Gaertn., and perennials: *Agrimonia procera* Mill., *Allium scorodoprasum* L., *Prunella grandiflora* L. and others.

In dry weather species of sandy places naturalize much better: it is plants growing in the South and East Lithuania, and the seacoast regions. The following species can be mentioned: *Geranium lucidum* L., *Glaux maritima* L., *Lathyrus maritimus* (l.) Bigelow and others.

The collection of rare plants is in the process of accumulation, so it is necessary to perform studies with plants that are grown, growing them in the North Lithuania region.

After analyzing possibilities of using the Botanic Garden of Ðiauliai University we would suggest the following practical activities:

1. Educational and cognitive excursions to the Botanic garden;

2. Collecting material for subject reports; Individual activity;

3. Participation in scientific projects, which are performed by the Botanic garden.

During educational and cognitive excursions to the Botanic garden, students would get acquainted with the collections of species of plants that are grown (plants of the Red Book of Lithuania, drug plants, potherbs). There is a wide net of biology museums in Finland. Teachers guide the excursions to the museums. This experience can be applied in the Botanic garden. In this case students who are prepared can guide excursions to their course mates. They will get practical knowl-

Table 1. Plants seeded and cultivated in 1999 – 2002

	1999 year	2000 year	2001 year	2002 year
Seeded	45	87	81	95
Sprouted (naturalized)	39	71	69	77
Bloomed	15	31	36	51
Matured seeds	8	29	31	30
Survived winter (annuals finished the period)	20	48	51	43
Total number of plants in the collection:	20	68	119	162

edge, which they will use later while working in school.

Collecting material for subject reports is appliance of research data received in the Botanic garden, untraditional appliance of plants in the fine arts, works. It would expand a creativity of future teachers.

Individual activity is not of less importance that develops skills of self-sufficiency. As a result a student having these skills will not be afraid to participate in different projects, organize studies of the environment to his pupils. Natural science is one of the most attractive spheres of activities. In this activity students mature as citizens, gain knowledge, practical skills, attitudes of ecology and moral values are formed [1]. The following researches can be performed in the Botanic Garden of Ðiauliai University: phonologic observations, researches of introduced flora, observation of changes of the Sun and stars on autumn and spring equinox and winter solstice, etc.

Participating in scientific themes and projects, students, future teachers in primary school, get the basics of scientific work; get acquainted with the requirements of scientific work, the knowledge of it they will be able to apply in their educational work.

Conclusions

162 rare species of plants formed the collection of rare plants in 2002.

According to the research data received in 1999 – 2002, there are 37 species of plants that best naturalized and are included in the list of protected plants in the Red Book of Lithuania.

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DIVERSITY OF LIME FOREST IN THE DIFFERENT REGIONS OF LITHUANIA

Vitas Marozas

Marozas V. 2004. Diversity of lime forest in the different regions of Lithuania. *Acta Biol. Univ. Daugavp., 4 (1): 47 - 52.*

Forest species diversity is very important for conservation of all biodiversity, because many spontaneous plant species concentrate in the forests. Lime forests are particularly important. Lime forests have big species diversity, but are quite rare in Lithuania. The aim of this work was to determinate the diversity of the lime forests and differences of species composition in the different natural forest regions of Lithuania. Species diversity of the lime forests in the natural forest regions of Lithuania was investigated in 1996-2001. The plots were selected in the mature, average stocking level and prevailing productivity stands, where lime trees make more then 50 percent. More than 50 geobotanical descriptions were done. A difference of species composition of lime forests in the different regions was evaluated using Canonical Correspondence Analysis and Dufrene and Legerdre method. Ellenberg's indicator figures were used to evaluate site conditions. Species composition of the lime forests in different regions differed. Analysis of species Ellenberg indicator figures showed that a difference of species composition in forest regions was due to site conditions.

Key words: *Tilia cordata* Mill., lime forest, biodiversity, deciduous forest, species composition.

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Introduction

Biodiversity conservation is becoming important issue (Lietuvos Respublikos biologinės įvairovės... 1996). Diversity of forest ecosystems plays important role, because a lot of native important species concentrate there. Especially rich species diversity we can find in the deciduous forests. These forests have complex structure, big variety of ecological conditions. Broad-leaved forests undergone intensive exploration: clear and selective cuttings. One of the most valuable forests for the biodiversity is lime forests. There are only small remnants of lime forests left in Lithuania.

Lithuania is situated in the transitional zone of three biomes: boreal coniferous forests, nemoral forests and termophile pine forests with oak of the Central Europe. The territory of Lithuania crosses two botanical-geographical borders: between West and East sectors and Northern and Southern zone (Natkevičaitė-Ivanauskienė 1983). The territory of Lithuania passes the northeastern border of the hornbeam (*Carpinus betulus* L.). Hornbeam is common in the southwestern part of Lithuania and is not present in the forests of the northeastern part of Lithuania.

Lime forests in Lithuania occupy 4610 ha and it makes only 0.24% from all forest area. Pure lime

forests make only 3.4% from all lime forest area. Mixed lime forests with other coniferous and deciduous species predominate. Lime forests prevail in the Southern part of Lithuania (fig. 1) and are only sporadic in the Zemaiciu upland.

The aim of this work was to determinate the diversity of the lime forest and differences of species composition in the different natural forest regions of Lithuania.

Materials and methods

Species diversity of the lime forests in the natural forest regions of Lithuania was investigated in 1996-2001. The plots were selected in the mature, average stocking level and prevailing productivity stands, where lime trees make more than 50 percent. More than 50 geobotanical descriptions were done (Dierschke 1994). Nomenclature was according Rothmaler (1972, 1990).

The difference of lime forests species composition in the natural forest regions was evaluated using Canonical Correspondence Analysis (Jongman 1997). Three regions were analyzed, because lime forests are spread only sporadic in the fourth region - Zemaiciu upland (fig. 2). Indicator species were determinated by Dufrene and Legerdre method (McCune, Mefford 1997). The method combined information on the concentration of species abundance and faithfulness of the species occurrence in a particular region. It produced indicator values for each species in each region. These were tested for statistical significance using a Monte Carlo technique. Indicator value ranged from zero (no indication) to 100 (perfect indication).

Ellenberg's indicator figures were used to evaluate site conditions (Ellenberg 1992). ANOVA was used to evaluate differences in the natural forest regions according indicator figures and species number (Jongman et al, 1997; Sokal, Rohlf, 1997).

Results and discussion

Canonical Correspondence Analysis showed good correlation of lime forests species composition with regions and Ellenberg indicator figures (fig. 3). ANOVA analysis (table 1) showed that light figure was significantly higher in the lime forests of Coastal lowland and Southern Lithuania. Moisture figure was slightly higher in the Northeastern Lithuania, but difference was not statistically significant. Reaction and nitrogen figures of the lime forests were significantly higher in the Southern and Northeastern Lithuania. Species number in the lime forests was higher in the Southern and Northeastern Lithuania than in the Coastal lowland of Lithuania.

The differences in site conditions, but not geographical factor, could have caused these

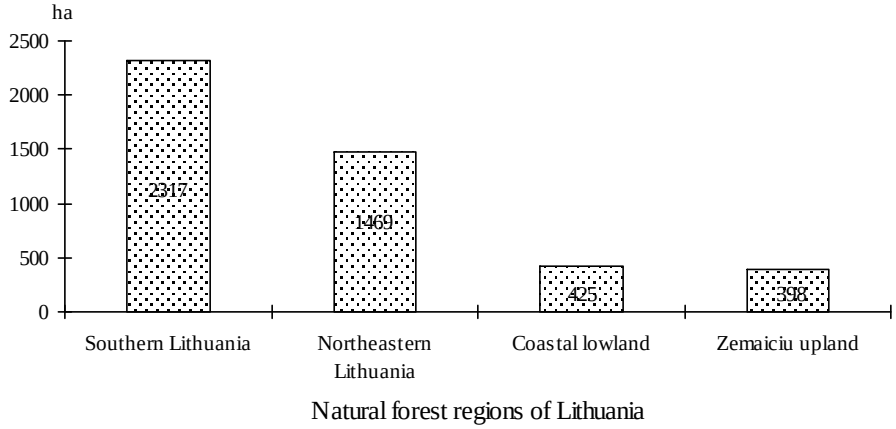


Fig. 1. Distribution of lime forests in natural forest regions of Lithuania

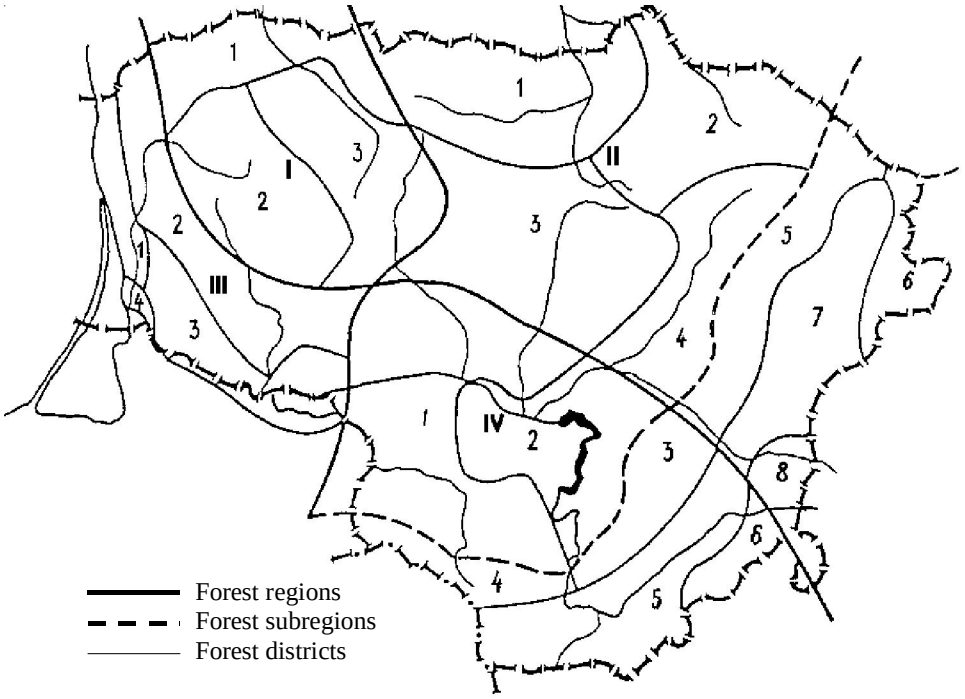


Fig. 2. Natural forest regions of Lithuania. I - Zemaiciu Upland, II - Northeastern Lithuania, III - Coastal lowland, IV - Southern Lithuania (Karazija 1988)

differences. Lime forests usually grow in less fertile and dryer sites in the Coastal lowland. In Southern Lithuania lime forests occur in more fertile sites while in the Northeastern Lithuania lime forests grow in wetter sites.

Analysis of indicator species is presented in the table 2. *Quercus robur L., Aegopodium podagraria L., Pulmonaria obscura Dum., Ranunculus lanuginosus L., Asarum europaeum L., Lonicera xylosteum L., Eurhynchium hians, Chaerophyllum aromaticum L., Lathyrus vernus* Bernh. were more frequent in lime forests of Southern Lithuania. *Milium effusum L., Hepatica*

Table 1. ANOVA of Ellenberg indicator figures and species number of lime dominated forests in forest natural regions

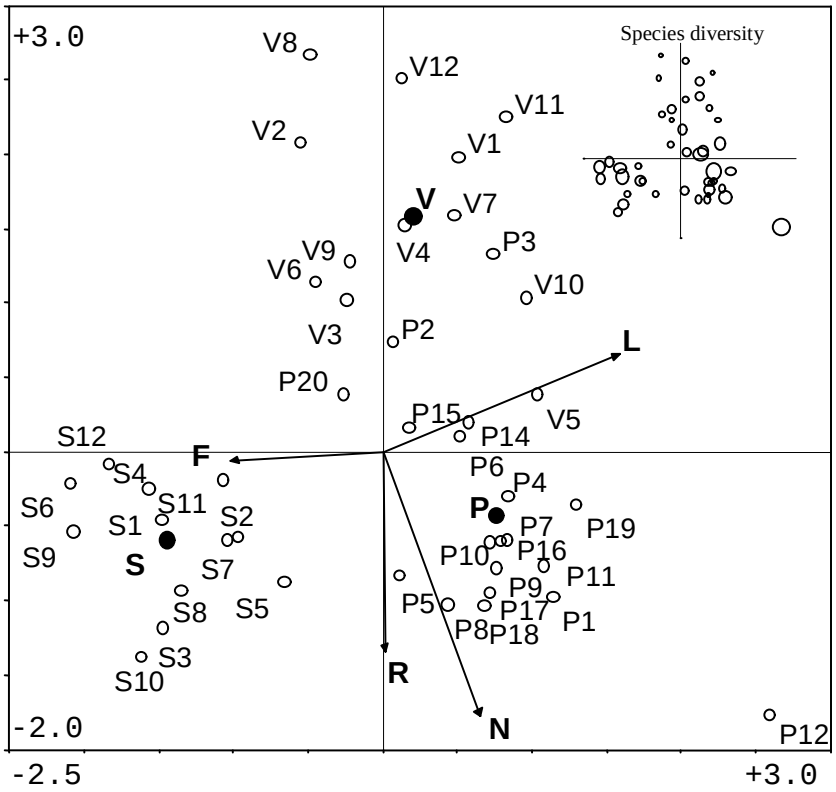
Indices	Mean and standard deviation of indices in regions of Lithuania			F	p
	Southern Lithuania	Northeastern Lithuania	Coastal lowland		
Light figure (L)	4.44±0.18	4.26±0.21	4.45±0.23	3.60	0.036
Moisture figure (F)	5.24±0.18	5.32±0.17	5.26±0.21	1.02	0.369
Reaction figure (R)	6.52±0.27	6.42±0.24	6.14±0.35	6.32	0.004
Nitrogen figure (N)	5.67±0.30	5.50±0.17	5.31±0.33	5.96	0.005
Number of species	38.26±6.06	37.92±4.72	32.92±5.99	3.62	0.035

Table 2. Species indicator values (p<0,05) of lime forests in the natural forest regions

Name of species	Indicator value		Indicator value in the regions of Lithuania			p*
	Average	Maximal	Southern	Northeastern	Coastal lowland	
Quercus robur a1	27	54	**54**	13	15	0.001
Aegopodium podagraria	29	49	**49**	22	17	0.002
Pulmonaria obscura	27	48	**48**	22	12	0.007
Ranunculus lanuginosus	20	48	**48**	1	10	0.003
Asarum europaeum	25	46	**46**	18	11	0.013
Lonicera xylosteum	24	46	**46**	13	13	0.009
Eurhynchium hians	14	36	**36**	0	5	0.010
Chaerophylum aromaticum	9	25	**25**	2	0	0.050
Lathyrus vernus	23	42	**42**	17	10	0.030
Milium effusum	27	43	**43**	**38**	0	0.014
Hepatica nobilis	30	48	**39**	**48**	2	0.004
Galium odoratum	24	46	**27**	**46**	0	0.011
Picea abies a1	20	43	10	**43**	6	0.016
Rubus saxatilis	20	57	0	**57**	3	0.001
Fraxinus excelsior a1	19	56	2	**56**	0	0.001
Brachypodium sylvaticum	17	42	5	**42**	3	0.005
Impatiens noli-tangere	16	42	3	**42**	3	0.012
Cirsium oleraceum	14	42	0	**42**	0	0.004
Picea abies b	15	39	5	**39**	2	0.018
Majanthemum bifolium	14	32	6	**32**	4	0.063
Crepis paludosa	11	28	2	**28**	1	0.046
Anemone ranunculoides	10	28	1	**28**	0	0.040
Dryopteris dilatata	8	25	0	**25**	0	0.050
Fraxinus excelsior b	25	44	12	**44**	17	0.020
Acer platanoides b	29	44	8	**44**	**35**	0.022
Eurhynchium angustirete	27	43	9	**43**	**30**	0.027
Carpinus betulus a2	27	46	**34**	0	**46**	0.012
Convallaria majalis	24	46	17	8	**46**	0.011
Solidago virgaurea	14	32	2	7	**32**	0.049
Carpinus betulus a1	13	35	3	0	**35**	0.011
Calamagrostis arundinacea	18	51	2	0	**51**	0.004

*p – Monte Carlo test of significance
a1 – first stand layer; a2 – second stand layer; b - undergrowth

nobilis Schreb., Galium odoratum (L.)Scop. occurred more frequently in the Southern and Northeastern Lithuania. *Picea abies (L.) Karst., Rubus saxatilis L., Fraxinus excelsior L., Brachypodium sylvaticum (Huds.) P.B., Impatiens noli-tangere L., Cirsium oleraceum (L.) Scop., Majanthemum bifolium (L.).F.W.Schmidt., Crepis paludosa Moench, Anemone ranunculoides L., Dryopteris dilatata (Hoffm.) A.Gray.* were more frequent in the lime forests of Northeastern Lithuania. *Acer platanoides L.* and *Eurhynchium angustirete* grew more frequently in the lime forests of Northeastern Lithuania and in the Coastal lowland region. *Convallaria majalis L., Solidago virgaurea L., Calamagrostis arundinacea (L.) Roth.* were more frequent in the Coastal lowland. *Carpinus betulus L.*, occurred only in the forests of Coastal lowland and Southern Lithuania.



P1-P16 – Plots in the Southern Lithuania; S1-S12 – Plots in the Northeastern Lithuania; V1-V11 – Plots in the Coastal lowland. P - Region of Southern Lithuania, S – Region of Northern Lithuania, V – Region of Coastal lowland, L – light indicator figure, F – moisture indicator figure, R – reaction indicator figure, N – nitrogen indicator figure.

Fig. 3. Canonical Correspondence Analysis of lime forests plots

Conclusions

Species composition of the lime forests differed in natural forest regions of Lithuania.

Analysis of species Ellenberg indicator figures showed that the differences of lime forest species composition in natural forest regions was due to site conditions.

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CONSERVATION AND DEVELOPMENT OF TALSA AND GINKUNAI LAKE ECOSYSTEM

Vida Motiekaitytė, Ingrida Šaulienė, Aldona Grišaitė

Motiekaitytė V., Šaulienė I., Grišaitė A. 2004. Conservation and development of Talsa and Ginkunai lake ecosystem. *Acta Biol.Univ.Daugavp. 4 (1): 53 - 59.*

In the paper a case study "Arrangement of green zones of Lake Talsa and its environs in Siauliai city (Lithuania) due to the establishment of international rowing centre" is introduced. The paper presents many-sided material concerning the readjustment of extensively used ecosystem of Lake Talsa, situated in the central part of the city with over 133 thousand inhabitants, as well as two parks – Talsa and Salduve, together with valuable objects of natural and cultural heritage, into a new centre of the city. Lake Talsa, according to its natural structure, very much resembles special canals built for rowing races. Rowing is not the most popular sport, still while establishing the international rowing centre the complex view to the development of Siauliai city, making it more attractive to investments, giving the stimulus for the arrangement of the Lake is important. While planning the rowing course, the issue of bird biodiversity protection was resolved, as the possibility to join the close laying Ginkunai Lake to Lake Talsa was rejected. Talsa Park spreads through the whole 1.9 km long eastern side of the Lake, on the other side it borders on a hilly Salduve park. It is supposed that these two parks will extend the green zone of the city, and their wholeness will solve not just esthetical but also the issue of historical value, because the managed territory requires specific principles and rules. Implementation of the following actions adjusts the Talsa – Salduve ecological park for short-time sightseeing: 1) maintenance of green basing on a specific forest management plan; 2) organisation of excursions through a fully prepared 5 km long ecological path; 3) monitoring and conservation of natural and semi natural habitats of European importance and endangered species in open areas of the parks according to special plans of nature management.

Key words: conservation, biodiversity, lake, ecological park, toxicology.

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Introduction

Parks, watersheds and sport fields can be joined into wholeness and give an opportunity to sportsmen, sport lovers and citizens to move to the world of green parks. Irrespective of the city size scale, the designers try to realize their urbanistic visions within the limits of incomposite natural-territorial complex. The ecologist of the landscape can easily penetrate natural limits of landscapes in the

complex urban web (Motiekaityte 2002). From the bird's sight the city seems as a unique mosaic of such units.

In the paper a case study "Arrangement of green zones of Lake Talsa and its environs in Siauliai city (Lithuania) due to establishment of international rowing centre" is introduced. A case study was formed according to the project of Siauliai municipality "Arrangement of Lake Talsa and its environs in Siauliai city and the program of international rowing centre establishment". The program was formed and implemented according to the principles of sustainable development, while seeking compatibility of economic, social and ecologic concerns. All means of the program are implemented in the limits of one geosystem – watershed and its catchment together, substantially not changing territorial structure, settled material and energy in ecosystem. The paper presents many–sided material concerning the readjustment of extensively used ecosystem of Lake Talsa, situated in the central part of the city with 133 thousand inhabitants, as well as two parks– Talsa and Salduve, together with valuable objects of heritage, which are situated in the near – shore zone of the Lake, into a new centre of the city. However, not a new centre is being formed but a new concept of the centre, and the Lake should become the axis of the city, not its boundary.

While forming the case study, the aim of the research was formulated: to evaluate the program of Lake Talsa environs' development, according to the used recreational and esthetical resources.

Objectives of the research: to analyse the usage of Lake Talsa environs and facilities of International Rowing Centre (IRC), according to criteria of sustainable development; to assess the rain run-off which are falling into the ecosystem as factor of environmental risk; to evaluate ecological conflicts of Lake Talsa environs, biological and landscape diversity, parks' state according to the methods of urban forestry, the importance of this territory in the integrated structure of the city's Nature Frame; to formulate assumptions making optimum decisions for ecological and social environment.

Materials and methods

The case study is based on the authors together with co-authors' researches (Motiekaityte et al. 2000, Motiekaityte 2002, Motiekaityte et al. 2003, Ðauliene 2001, Ðauliene et al. 2003), the project of forests and parks management and inventory in Siauliai city (Baroniunas et all 2000), detailed plan of the object – the program of development (Jurenas 2001), environmental risk assessment of the development program (Baubinas et all. 2003), the application of sustainable development principles (Kerr 2003).

Results

Geographic location of territories, structure, readjustment

The investigated territory of Lake Talsa environment is sort of a bound between clayey plains and knob-and-kettle moraine landscape. Lake Talsa (area – 62.6 hectare, together with nearby Lake Ginkunai – 72.8 hectare) spreads about 1.9 kilometres to the North – South. Average breadth of the lake is 0.25 kilometres, maximum – 0.45 kilometres. Average depth is 3.5 m, maximum – 8.7 m. Catchment is 17.8 square kilometres (together with Lake Ginkunai – 33.2 square kilometres).

Lake Talsa (as well as Lake Ginkunai) is used for observing water and mires birds, amateur fishing, rowing sport. Southern part of the territory is urbanized, the present status – post-industrial (since 19th century till the beginning of 21st century the factory of leather processing functioned. There are valuable objects of heritage nearby, e.g. modernistic mansion of industrialist Ch. Frenkel. Western part is urbanized; this is the area of personal houses without developed public facilities. Northern part is not used; here a deep (9 m) wetland of 300 m with junction canal to Lake Ginkunai spreads. It is important for birds' protection. Eastern part is the zone of parks and recreation.

Establishing International Rowing Centre (IRC) (including a trace setting according to international rowing standards)

Lake Talsa is parallel to specially built rowing canals. Hills and parks protect the lake from the east side; urbanized territories protect it from west and south. Also international canoeing competitions can be organized in Lake Talsa, as the length of distances necessary for this sport are: 1000 m, 500 m, and 200 m. Meanwhile the distance of 2000 m, necessary for academic rowing, cannot be set, because the lake is too short. Canoeing is more popular sport than academic rowing.

Requirements necessary for establishing IRC:

1. To lengthen the rowing distance up to 2000 m, width – up to 110 m, the depth through the whole distance is to be not less than 3 m.

2. To set start line in the northern part of the lake and finish line in the southern, together with developed competition maintenance facilities.

3. It is necessary to excavate a channel of 250 m length in the wetland between two lakes near the side of start line, to deepen the bottom of the lake in 130 m distance in the side of finish line.

Recreational zone of IRC includes:

1. A light weight construction bridge through the junction channel between two lakes and the wetland in the northern part. This path would disgorge plastically into the parks situated on the lake's coast. But this bridge causes the conflict between architectural object and environment.

2. The developed complex of two city's parks in the eastern part, together with existing ecological path and wild nature areas.

3. Competition maintenance and recreational facilities in the southern coast: marina, recreational facilities.

4. Competition maintenance road also used for walking, and cycling in the western coast.

The establishment of IRC became an important economic and social stimulus to arrange environs of the lake having rare natural structure. The project claims to get support from EU structural funds. Besides environmental priorities (water quality improvement, clearing the lake - removing contaminated layer of sediments, preservation of biodiversity), the aspect of improving recreational recourses is very important.

Assessing the toxicity of the rain run-off as factor of environmental risk

The reaction of living organisms to the toxins depends on the species used for research. The reaction of the tested organisms to toxic solution is specific to their species and the chemical element or solution. When carrying out the quantitative evaluation, we pay attention to species from each trophic groups of water ecosystem).

The rainwater effluents from the territory of Ðiauliai streets surface area flow into lake Talða. The discharge of the rain run-off over 24 hours is 643,4 m^3. The most outflows segregate from the central part of the city. Acute toxicity test has been show that the water of these surfaces was toxic to all the biotic elements researched. This drain was distinguished, because its water was toxic also to micro algae what was not characteristic for others. Crustacean Daphnia pulex gave a strong response to toxin: the lethal concentration (LC_{50}) was 4 mg/l of the rain run-off sample. Daphnia magna was less sensitive - LC_{50} = 70ml/l. However this is an acute toxicity test and we can't say anything about how the rain run-off will affect the organisms and the whole ecosystem during a longer time exposing. The water effluents from the second part of the city were not toxic.

Assessing parks resources for biological conservation

Ecosystem of Lake Talsa, distant from the functional centre of the city only 0.5-1.0 km, has distinctive wild nature habitats that occupy the

northern and eastern coasts. Parks of Talsa and Salduve are established in the sector of end moraines. Knob-and-kettle moraine relief prevails in the territory. Since ecological conditions are varying, the level of biodiversity is high in the whole Siauliai region (the area – 1918 square kilometres). There are 17 parks and forest parks in Siauliai. The general area is 1130.7 hectares. As the research made in 2000 shows, some of these parks, established in partially man-changed and regenerative territories of wild nature, are important places of wetlands or as a contrast to it steppe meadows. Both of these types remain in Talsa and Salduve parks.

Flora resources and habitats of Talsa and Salduve parks (TSP)

155 species of native vascular plants were found in the Territory of Talsa Park. 7 of them are rare in the town and region. Accordingly in Salduve Park they are 169 and 9 species. A stripe of reeds and other tall herbs spread all-over the Lake Talsa coast. This stripe covers the lowest terrace of the lakeside. Ordinary middle wet and swamp meadows dominate in the second terrace. Swamp meadows emerged in the slopes where springs break through. Steppe meadows stretch on the top of slopes. As the sector of end moraines, formed in glacial period, starts here, and the hills are covered by *Pinus sylvestris L.* forests with specific flora elements. Rich flora of tall herbs formed in the floodplain of the affluent that flows in Lake Talsa.

These habitats of European importance are preserved in Talsa and Salduvė parks:

6210 (NATURA 2000 – habitat code) Semi – natural dry grasslands and scrubland facies on calcareous substrates (*Festuco – Brometalia*) (important orchid sites).

6410 *Molinia* meadows on calcareous peaty or clayey-silt-laden soils (*Molinion caeruleae*).

6430 Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels.

7160 Fennoscandian mineral – rich springs and spring fens.

Fauna of TSP

The most valuable parts of the territory mentioned in the development project on the aspect of fauna variety are: the coast of Lake Talsa, TSP and reedbeds stretching between Talsa and Ginkunai lakes. 20 species of the mammal class are noticed in the area. Here otter should be mentioned as a rare and preserved mammal. While establishing a rowing centre that corresponds international standards, it is suggested to avoid earlier discussed idea to connect Talsa and Ginkunai lakes. In this way the peace of birds living in Lake Ginkunai will be preserved. 122 species of birds hatch in Talsa and Ginkunai lakes, another 29 species are migratory birds (1998 record data), 25 species of the mentioned above are involved into the Red Book of Lithuania. In 2000 three species of birds involved into the Red Book of Lithuania hatched in Lake Talsa.

Using light and entomologic traps the entomofauna, related with reedbeds as well as with the parks, was caught in the eastern and western parts of Lake Talsa. 150 species of macro- and micro butterflies were caught, 17 species are rare in Lithuania (Motiekaityte, Budrys, 2000).

Means to reduce negative effect on fauna

While performing hydro technical work it is necessary to avoid significant variation of water level in spring during the period when birds hatch. Reedbeds between the lakes and reedbeds on the Lake Ginkunai coasts remain proper place that has a fair impact on the fauna variety. All motor means are to be strictly limited in Lake Talsa. Swell and noise caused by these means makes hatching difficult and even can cause not hatching. Meanwhile fauna get used to rowing means quickly. Light weight construction bridge, crossing the centre of wetland, and junction channel between two lakes would intensify disturbance in the period of hatching, e.g. marsh-harrier can disappear from these hatching places. Watch-

tower of reedbeds' birds was built in 2003, together with the information about all species of this particular place necessary to visitors.

The Evaluation of Lake Talsa Landscape

Location of district of the development program in Lithuanian Nature Frame

Nature frame is an important instrument of landscape/nature conservation policy in Lithuania (Baskyte 2003). This concept is based on a catchments area and bio structure. The Nature Frame is aimed not only to develop a complete system for natural ecological compensation but also to ensue connections between natural protected areas and the conservation of natural landscape, biodiversity, and natural recreational resources.

Nature Frame consists of:

1. Geo-ecological watersheds – areas which separate large ecosystems and perform the function of ecological compensation between the systems;

2. Geo-ecosystems stabilisation centres – areas which perform the function of ecological compensation in geo-ecosystems;

3. Migration corridors – valleys and hollow valleys through which intensive geodynamic and bio-information circulation takes place.

The ecosystem of Lake Talsa and TSP established in knob-and-kettle landscape is an important geo-ecosystems stabilization centre of ecosystem. Also this territory enters the migration corridor involving system of four lakes that are connected by streams' valleys. This system begins with Lake Rekyva belonging to Siauliai (area – 807 hectares), which is surrounded by the biggest massif of raised bogs in Lithuania (12 square kilometres). Now it is divided into many mires and exploited peat bogs cause of anthropogenic activity. Rekyva Park (area - 423.7 ha), established in the northern coast of Lake Rekyva, is in territory of the city and important for wild nature protection and favourable to its renewal.

Still there exist degraded gaps of Nature Frame in the migration corridor of four above-mentioned lakes. E.g. post-industrial territory (area – 15 ha) situated in the southern part of Lake Talsa. Here the degree of ecological compensation of Nature Frame can be extended employing green and thus forming more favourable environment for continuous migration corridor and car parks.

Rational usage and creation of recreational and esthetical resources

Talsa and Salduvė parks, situated in the surrounding of Lake Talsa, are the most important recreational resources in the eastern part of the city. Next to biodiversity and habitats of European importance, the most important role goes to city's parks of cultural origins that are formed of different species of trees and landscape shrubs. Talsa Park was planted in the fifties of 20th century on the hills 300-800 metres of length stretching parallel with the lake. Earlier it was agricultural land. Now such types of native trees dominate in separate parts of the park: *Tilia cordata* Mill., *Quercus robur* L., *Betula pendula* Roth, *Acer platanoides* L., *Picea abies* (L.) H.Karst., *Fraxinus excelsior* L., *Pinus sylvestris* L., *Sorbus aucuparia* L.. Alongside these favorite types of trees that are formed by grove, half-mature woods introduced species from genera *Larix* Mill., *Populus* L., *Salix* L., *Picea* A. Dietr., *Pseudotsuga* Carri?re, *Acer* L. dominate in some block. In the project of Siauliai forests and parks management and inventory in 2001- 2010 (Baroniunas, Saulis 2000), Talsa and Salduve parks were referred to the forests category of intensive recreational usage.

Talsa and Salduve parks' management on the aspect of urban forestry:

1. Greens of the parks are replanted according to special projects, the priority is given to planting purposive species of trees and shrubs;

2. Formation of greens resistant to recreational effect and forming favourable microclimate;

3. Half-open and open landscapes are to be dominating;

4. Half-open park landscapes are formed from: 1) not thick arrays of trees (it can be fennoscandian wooded meadows in our climatic zone), the area of which is over 5 hectares; 2) groves – 0,5 – 5 hectares; 3) groups that cover area smaller than 0.5 hectares, but is formed at least of three trees. Open landscapes formed from single trees and glades.

5. All three types of landscape slashing are used: space formation, species composition formation together with ornamentals.

6. Priority is given to biologic and mechanic means of protection.

The complex of Talsa and Salduve parks is readjusted to cognitive tourism. Tours of 5 kilometres length, including two informational boards about the path, twenty stations having some information, a footbridge to the lake, birds' watchtower, rest-fields, are organized.

Esthetical resources of Talsa and Salduve parks were used to establish the ecologic path. First of all it is impressive prospects of the city, cultural monuments, landscapes of the north Lithuania plains, and watersheds that unclose from Talsa park hillsides situated on the other side of lake Talsa, two highest hills (absolute height up to 120 metres), and the mound of Salduve.

The influence of the development program on social surroundings

A very positive attitude of citizens and region inhabitants as well as businessmen towards program realization dominates; it is based on social and economic benefit.

Discussion

The program of sport, watersheds and parks' development and wild nature conservation, discussed in this paper can be considered as the project of possibility of constant renewal. It is suggested to start with parks and recreational management while improving the quality of environment in complex development of the territory. According to the experience of IFPRA (International Federation of Parks and Recreation Administration) the municipality was recommended to pay attention to the complexity of problems involved in city's park planning, management and operations. It is necessary to form interdisciplinary group of specialists involving managers of park visitors, education specialists, operational staff, park rangers. The support of the community is essential and will be attained by Rangers providing park visitors with special, unforgettable experiences that bring park magic into their lives (Aldous et al. 1995). Qualification of parks and recreation specialists is very important for Lithuania due to the recent economic growth in the business of parks and recreation, nature and country tourism. Preconditions of this growth are saved natural environment, landscape, biodiversity, and cultural heritage. Coming back to the case study it can be stated that management of the parks discussed in the development program, according to the valid project of forest and parks management and inventory, is insufficient. For this purpose the city municipality was presented a parallel program designed for reorganizing Talsa and Salduve parks into ecologic park – arboretum. The program presents the most important suggestions zone related with readjusting of TSP to itinerary cognitive and local recreational use.

Conclusions

1. The toxic untreated rainwater segregated from the streets surface of central part of the city is the main pollutant, which falls into lakes ecosystem. The lakes treatment programme allows canalize untreated rainwater to water treatment system.

2. The case study proved assumption that complex arrangement of sport fields, natural watersheds, and city's parks allows strengthening usage of objects, situated in one terri-

tory, for recreation, physiotherapy, ecological education, protection of cultural values, and relations between them.

3. Objects of sports, recreation, and natural areas, existing together, make very favourable medium for dualistic decisions of environment management in urbanistics. It is a duality, where being created cultural and existing landscape components are joint into sustainable entirety.

4. The success of sports, parks, and territories of recreation depends on biologic, recreational and other resources. Still not of less importance are the size of territory, situation in urban area and nature frame, and cultural surrounding. Due to the life improvement in Lithuania and Baltic States it is important to improve the sphere of parks and recreation administration and qualify specialists of this sphere.

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THLASPI PERFOLIATUM (L.) F.K. MEY. IN LITHUANIA

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Vilkonis K. K. 2004. *Thlaspi perfoliatum* (L.) F.K. Mey. in Lithuania. *Acta biol. Univ.Daugavp. 4 (1): 61- 62.*

Thlaspi perfoliatum was known occurring in South and South East Lithuania only. New locality of this species was revealed in the village Voveriškės (Šiauliai district) in Nord West Lithuania. Short information on the habitat of *Thlaspi perfoliatum* is presented.

Key words: *Thlaspi perfoliatum, Brassicaceae*, from Nord West Lithuania

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In the genus of penny-cress there are about 70 species, mostly growing in the Med. In Lithuania occur two species including *Thlapsi perfoliatum* that is spread in Europe (except for North Europe), Caucasus, Central Asia, Altai, Iran. It was brought over to North America (Jankevičienė 1961; Kuusk et al. 1993). According to some authors (Gudþinskas 1999), in Lithuania also occurs third adventive species - *Thlaspi caerulescens* J. Presl et C. Presl.

Literature indicates that *Thlapsi perfoliatum* occurs in two Baltic states, but in Lithuania is found only at the southern and southeastern borders – in the approaches of Verseka and Benekoniai (Gudþinskas 1999). In some sources of literature penny-cress is considered to be rare (Jankevičienė 1961), in others - extremely rare (Lekavičius 1989) or growing only in one vicinity (Snarskis 1954). Through Lithuania goes the northeastern border of the range.

Thlapsi perfoliatum is a 7-20 cm high annual plant. The stem is upright, little divaricate, round, smooth, blueish green. Leaves are alternate, blueish green, with smooth or little toothed margins; the base leaves are obovate, clearly stalked; middle and upper leaves are without stalks, their heart-shaped bases clasp the stem. The truss is a thick raceme, the flowers are small. The sepals are green, sometimes with pink tips, 1.0 – 1.5 mm long. The petals are white, oblong, spade-like, twice as long as sepals. The anthers are yellow. The styles are very short. The siliques conversely heart-shaped, 4-7 mm long, with an obtusely pointed base and obtuse clipping at the tip; their bottom side is convex outwards, the top side is a little concave or almost flat; the staples are alar only in the upper part, approximately from the middle; the wings are faintly nervate, with obtuse tips; the dissepiment is oblong, with a very convex bottom side and almost flat upper one. The seedpods contain 2-4 seeds that are round and egg-like, a little flattened, about 1.5 mm long, brownish yellow or yellowish brown, with almost smooth and not sleek surface.

Thlapsi perfoliatum in Lithuania blooms in April and May, though in June there still may be flowers at the tips of axillar sprouts. After seeds are matured the plants wither, therefore in the middle of June, when the main botanical researches are

carried out, the species probably remains unnoticed. In the surroundings of Ðiauliai this species may have been unnoticed before just because until now students˙ outside practice took place in the first decade of July. At this time it is already impossible to find the penny-cress.

The penny-cress grows in fields, fallows, unbroken soils, limy and clayey soils, often in stony places, roadsides, pastures and slopes.

Thlapsi perfoliatum was accidentally noticed in 2004 May 4 in the fields of Voveriškės village that is in Ðiauliai district on the left side of the road Šiauliai – Kuršėnai and in 2004 May 12 – at the southwestern border of Ðiauliai city, about 150 m west away from the new viaduct, near the railway bed. These are the first two localities of this species in the present territory of the Lithuanian Republic.

In the locality of Voveriškės village in new soil made a community with *Thlapsi perfoliatum* – grew and bloomed or grew but did not bloom yet: *Senecio vernalis* Waldst. et Kit., *Taraxacum officinale* F. H. Wigg., *Artemisia vulgaris* L. et *A. campestris* L., *Cirsium vulgare* (Savi) Ten., *Erigeron acris* L., *Tussilago farfara* L., *Leucanthemum vulgare* Lam., *Anthemis tinctoria* L., *Viola arvensis* Murray, *Medicago lupulina* L., *Vicia angustifolia* Reichard, *Arenaria serpyllifolia* L., *Erodium cicutarium* ¼ Hér., *Veronica arvensis* L. et *V. chamaedrys* L., *Cerastium arvense* L. And many other weeds that we could not describe because of inadequate development.

Perfoliate penny-cress by Lithuanian botanists is considered to be an adventive plant. In Lithuania such status it had until now. However, findings in the Voveriškės village give some doubt about that and allows to think that this species, differently from what was thought before, is spread not only at the southern and southeastern borders of the country, but is also found even in the northwestern part. It is possible that the status of this species will stay the same, because it is hard to believe that a weed could have been unnoticed until now if it had permanently grown in the fields of other regions of the country. To deny this by genetic research for the meantime is too expensive.

Thlapsi perfoliatum also grows in Estonia, but in Latvia it has not been found yet (Kuusk et al.1993).

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