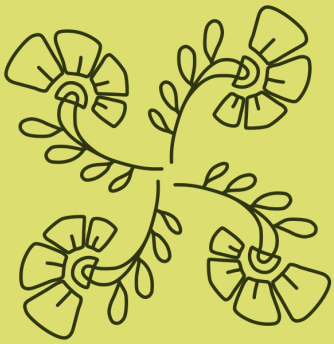
BALTIC BOTANIC GARDENS

IN 2015-2017

ESTONIA LATVIA LITHUANIA



Rīga, Latvia
2019

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The periodical issue of *Baltic Botanic Gardens* includes information about the main events in the botanical gardens of Estonia, Latvia and Lithuanian in 2015-2017. It contains statistical information about the gardens and the articles about collections, research and public activities.
The authors themselves are responsible for the content of papers.

Supported by the project of the University of Latvia *Biological diversity - effects, functions and protection* subproject *Ex situ investigations of plant diversity.*

LATVIJAS UNIVERSITĀTE

LATVIJAS UNIVERSITĀTES BOTĀNISKAIS DĀRZS

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Botanical Garden of the University of Latvia
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LATVIA

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REPORT OF DEVELOPMENT

BOTANICAL GARDEN OF THE UNIVERSITY OF LATVIA

Address	Kandavas str. 2, Riga, LV-1083, Latvia (main territory of the BG)	"Rododendri", Spilve, Babite, LV-2101, Latvia (Rhododendron breeding and testing nursery "Babite")
Phone	+371 67450852	+371 67913127
e-mail	botaniskais.darzs@lu.lv	rodod@lanet.lv
www	www.botanika.lu.lv	www.rododendri.lu.lv
Director	Uldis Kondratovičs	
Territory area	15 ha	11,8 ha

LIVING PLANT COLLECTIONS IN THE BOTANICAL GARDEN

Total No of taxa (2017): **5634**

Main taxa	No. of taxa
Indoor plants, including:	1688
Succulent plants	701
Tropical plants	417
Subtropical plants	443
Azalea	127
Trees and shrubs, including:	895
Rhododendrons	120
Magnolias	17
Herbaceous ornamental plants, including:	1728
Herbaceous perennial plants	1376
Lilies	555
Dahlias	297
Plant beds	365
Biological and morphological groups of plants, including:	855
Medical plants	290
Poisonous plants	47
Mire plants	35
Grasslands and meadows	68

LIVING PLANT COLLECTIONS IN THE RHODODENDRON BREEDING AND TESTING NURSERY "BABITE"

Total No. of taxa (2017): **372**

Main taxa	No. of taxa
Rhododendron species	80
Rhododendron cultivars	275

HERBARIUM

No. of specimens -

SCIENTIFIC ACTIVITIES

Projects

2015-2017

›Lead partner "Conservation and Management of Priority Wetland Habitats in Latvia", LIFE13 NAT/LV/000578, 2015-2017.

›Partner in the project „Climate change mitigation by means of rewetting peatlands", LIFE15 CCM/DE/000138, 2016-2017.

›Individual participation in the project "Development of sustainable and systemic solutions suitable for Latvian climate conditions and providing qualitative living environment in nearly zero energy buildings", 2013/0027/1DP/1.1.1.2.0/13/APIA/VIAA/007, 2015.

›Participation in the project "Development of new cosmetics composition using environmentally friendly technoloy for skin regeneration and pigmentation-regulation", No. 2014/0038/2DP/2.1.1.1.0/14/APIA/VIAA/047, 2015.

›Participation in the project "Development, optimisation and sustainability evaluation of smart solutions for nearly zero energy buildings in real climate conditions", 1.1.1.1/16/A/192, 2017.

2015

Publications

1. A. Sparinska, N. Rostoks. Volatile organic compounds of hybrid Rugosa roses in Latvia // Proceedings of the Latvian Academy of Sciences, Section B, Vol. 69, No. 1/2 (694/695), pp. 57–61. DOI: 10.1515/prolas-2015-00072.

2. I. Apine, L. Orola, A. Jakovics. Effect of Building Envelope Materials on Indoor Air Quality in Low Energy Test Houses // Journal of Environmental Science and Development, 2015, 6: 952–957.

3. I. Apine. Propagation potential of deciduous rhododendron cuttings depending on stock plant and cutting treatments // Doctoral theses, Summary, Rīga: Latvijas Universitāte, 2015, 79 p.

4. I. Rūrāne. Genus *Hesperis* L. in the flora of Latvia // Acta Biologica Universitatis Daugavpiliensis, 2015, 15, 2: 343-348.

8. I. Rūrāne, I. Roze. Genus *Sisymbrium* L. (Rockets) in the flora of Latvia // Proceedings of the Latvian Academy of Sciences, Section B. Natural, Exact, and Applied Sciences, 2015, 69, 1-2: 38–44.

Conferences

1. I. Apine, L. Orola, A. Jakovics. Effect of building envelope materials on indoor air quality in low energy test houses // 6th International Conference on Environmental Science and Development, Amsterdam, Netherlands 14. –15. 02.2015.
2. A. Sparinska, L. Strazdiņa. Ten minutes till hundred in the Botanical Garden of the University of Latvia // 8th International Conference of Botanic Gardens from the Baltic Sea Region, Poznan, Poland, 12.09.2015.
3. I. Rūrāne. Genus *Hesperis* L. in the flora of Latvia // 8th International conference on Biodiversity research, Daugavpils, Latvia, 28.-30.04.2015.

Breeding

Rhododendron breeding and testing nursery "Babite"
Royal Horticultural Society Certificate of international registration: 7 cultivars.

2016

Publications

1. A. Borodušķe, I. Nakurte, S. Tomsone, M. Lazdāne, N. Rostoks, M. Borodušķis. *In vitro* culture type and elicitation affects secoiridoid and xanthone LC–ESI–TOF MS profile and production in *Centaurium erythraea* // Plant Cell, Tissue and Organ Culture (PCTOC), 2016, 126(3), 567-571
2. И. Набурга – Ермакова. Новые сорта бородатых ирисов в коллекции Ботанического сада Латвийского университета [New Varieties of Bearded Irises in the Collection of the Botanic Garden of University of Latvia] // Formation of urban green areas. Scientific Articles, 2016, 1 (13), 257-264
3. И. Набурга – Ермакова. Анализ результатов интродукции альпийских растений в Ботаническом саду Латвийского университета [Analysis of the results of alpine plant introduction in the collections of Botanical Garden of the University of Latvia] // Цветоводство: история, теория, практика.Материалы VII Международной научной конференции (24-26 мая 2016, Минск, Беларусь). Ред. В. В. Титок и др., Минск: Конфидо, 2016, с. 171-173.

Conferences

1. M. Lazdāne, I. Rūrāne, L. Strazdiņa, S. Tomsone. *Dracocephalum ruyschiana* L. propagation using *in vitro* technology // „Current Issues of Plant Conservation", international workshop, Vytautas Magnus University Botanical Garden, Kaunas, Lithuania, 15.-18.08.2016.
2. И. Гудрупа. Интродукция рода *Pinguicula* в Ботаническом саду Латвийского Университета // VII Международная научная конференция «Цветоводство: история, теория, практика». Беларусия (ЦБС), г. Минск. 24-26 мая 2016 года.
3. Л. Страздиня. Дизайн и графика информативных стендов. Теория и практика в контексте образования о среде // VII Международная научная конференция «Цветоводство: история, теория, практика». Беларусия (ЦБС), г. Минск. 24-26 мая 2016 года.
4. И. Набурга–Ермакова. Анализ результатов интродукции альпийских растений в Ботаническом саду Латвийского университета // VII Международная научная конференция «Цветоводство: история, теория, практика». Беларусия (ЦБС), г. Минск. 24-26 мая 2016 года.

5. M. Pakalne. Conservation and management of wetland habitats in Latvia // 25th Meeting of European Vegetation Survey, Rome, Italy, 6-9 April, 2016.
6. M. Pakalne. Peatland Conservation and management in Latvia // 11th Annual Society of Wetland Scientists European Chapter Meeting, Potsdam, Germany. 17-20 May, 2016.
8. M. Pakalne. Nordic-Baltic peatland policy // International expert workshop. Peatland Conservation and Wise Use in the Context of Climate Change. A Contribution to the implementation of the Ramsar Convention. Isle of Vilm, Germany 11-14, September, 2016.
9. M. Pakalne. Conservation and management of wetland habitats in Latvia // Cumbria BogLIFE Conference. Restoring peatlands. Development of Best Practice Techniques. Pernith, Cumbria, UK, 4-6 October, 2016.

Breeding

Rhododendron breeding and testing nursery "Babite"
Royal Horticultural Society Certificate of international registration: 6 cultivars

2017

Publications

1. K. Dokane, D. Megre, M. Lazdane, U. Kondratovics. Influence of Calcarisporium arbuscula preuss on *in vitro* and *ex vitro* adventitious rooting of two elepidote Rhododendron cultivars // Propagation of Ornamental Plants, 2017, 17(2), 39-47.
2. M. Pakalne, O. Aleksāns. Latvia // In: Mires and peatlands of Europe. H. Joosten, F. Tannenerger, A. Moen. (eds.). Schweizerbart Science Publishers-Stuttgart, 2017, p. 478.-485.

Conferences

1. M. Lazdāne, L. Strazdiņa, S. Tomsone. *Magnolia* genus in the Botanical Garden of the University of Latvia // Magnolia Society International 2017 Anual Meeting, Cool Magnolias for Cool Climates. Uppsala, Sweeden, 4.-15.05.2017.
2. M. Lazdāne, S. Tomsone, L. Strazdiņa. Magnolia collection in the Botanical Garden of the University of Latvia // 3rd Conference of Eastern and Central European Botanic Gardens: Botanic Gardens – delivering public goods and suporting society. Budapest, Hungary, 9.-11.10.2017.
3. I. Nāburga-Jermakova. Testing of herbal perennials to invasiveness // 3rd Conference of Eastern and Central European Botanic Gardens: Botanic Gardens – delivering public goods and suporting society. Budapest, Hungary, 9.-11.10.2017.
4. I. Rūrāne, B. Neuffer, P. Evarts-Bunders. Seed characteristics of some *Cruciferae* Juss. species in Latvia // Nasstec (The Native seed science, technology and conservation initial training network) International conference Seed quality of native species ecology, production and policy, Royal Botanic Gardens Kew, London, Great Britain 25.-29.09.2017.
5. M. Pakalne. Wetland Conservation and management in Latvia // SER 2017, 7th World Conference on Ecological restoration. Linking Science and Practice for a Better World. 27.08.-1.09.2017, Foz do Iguassu, Brazil.
6. M. Pakalne, L. Strazdiņa, O. Aleksāns. Habitat monitoring experiences from Latvian peatlands // LIFE Peat Restore Conference: Peatlands and Atmosphere, 28.-29.04.2017, Klein Koris, Germany.
7. O. Aleksāns, L. Strazdiņa, M. Pakalne. Hydrological monitoring experiences from Latvian peatlands // LIFE Peat Restore Conference: Peatlands and Atmosphere, 28.-29.04.2017, Klein Koris, Germany.

8. M. Pakalne. Wetland Conservation and management in Latvia // International Conference on Conservation and Mangement pf Priority Wetland Habitats in Latvia. 11.-12.07.2017, Rīga, Latvia.
9. I. Rūrāne, P. Evarts-Bunders. Distribution trends of some mustard family (*Cruciferae* Juss.) species in Latvia // 9th International conference on Biodiversity research, Daugavpils, 26.-28.04.2017.

Breeding

Rhododendron breeding and testing nursery "Babite"
Royal Horticultural Society Certificate of international registration: 6 cultivars

OTHER ACTIVITIES

2015

Botanical Garden
›Erasmus Lifelong Learning Programme:
-S. Bereza, Botanischer Garten und Botanisches Museum Berlin Freie Universität Berlin, Germany, 31.08.- 04.09.2015.
›Exibitions created by the Botanical Garden UL: Flower Show 9.-12.07.2015, Leaf 23.10.-22.11.2015, Botanist Christmas 27.11.-31.12.2015.
›New fence 592 m, planting of spring bulbous plants, reconstruction of garden paths, installation of a bicycle accommodation, new picnic tables and benches etc. improvements supported by The Boris and Inara Teterev Foundation.
›152 guided tours.

Rhododendron breeding and testing nursery "Babite"
›Award: Riga City Council and Latvian Academy of Sciences award for outstanding work in selection, investment in landscape gardening and popularization of Riga city to Dr. habil, biol., prof., academician Rihards Kondratovičs
›New 1 ha exposition with 14 species, 33 cultivars and 60 hybrids of rhododendrons.
›New observation tower.
›37 guided tours.

2016

Botanical Garden
›Exibitions created by the Botanical Garden UL: Sweet flower 26.03.-18.05.2019 (about the plants used in the production of sweets).
›New fence 332 m, reconstruction of the rhododendron expositions 5500 m^2, reconstruction of garden paths etc. improvements supported by The Boris and Inara Teterev Foundation.
›152 guided tours.

Rhododendron breeding and testing nursery "Babite"
›Award: Acknowledgement from Cabinet of Ministers for long and significant investment in selection of rhododendron varieties, garden design development and popularization of Latvia to Dr. habil, biol., prof., academician Rihards Kondratovičs
›A partnership in two landscaping projects – for the Embassy of Latvia in Germany (Berlin) and for the Embassy of Latvia in the Netherlands (Hague).
›24 guided tours.

2017

Botanical Garden

›Erasmus Lifelong Learning Programme:
-I. Apine, University of Helsinki Botanical Garden, Finland, 04.06.–10.06.2017;
-I. Nāburga-Jermakova, Konstanz University, Germany 24.-28.04. 2017.

Rhododendron breeding and testing nursery "Babite"

›New gates and new 200 m long fence installed.
›A parking lot and walkway along the nursery's fence was built with the support of Babīte Municipality.
›40 guided tours.

VISITORS
PER YEAR IN THE BOTANICAL GARDEN

	2015	2016	2017
Number of visitors	59 848	50 178	65 106

PER YEAR IN THE RHODODENDRON BREEDING AND TESTING NURSERY "BABITE"

	2015	2016	2017
Number of visitors	19 700	19 500	24 500

STRUCTURE AND STAFF
(sum of workloads) of the Botanical Garden and the Rhododendron breeding and testing nursery "Babite"

	2015	2016	2017
Administration	2,44	2,37	2,47
Academic staff	5,84	5,83	6,27
Field staff	10,13	10,77	19,13
Technical staff	11,08	21,61	27,8
TOTAL including:	**29,49**	**40,58**	**55,67**
PhD	6	6	4
Msc	11	13	13

FINANCES (IN EUR)
IN THE BOTANICAL GARDEN

	2015	2016	2017
Income			
University of Latvia granting	-14 345	196 179	174 224
Self-incomes	165 032	187 056	266 796
Research base and performance financing	32 536	76 999	69 699
External grants			11 199
EU LIFE (not included in expenses)	144 575	236 076	145 412
TOTAL	**327 798**	**696 310**	**671 830**
Expenses			
Salary with tax	374 431	414 576	477 790
Goods and services	26 879	12 437	30 119
Business trips	516	1871	5023
Fixed assets	8355	6402	1389
Other expenses	20 305	3780	6754
TOTAL	**430 486**	**439 066**	**488 075**

IN THE RHODODENDRON BREEDING AND TESTING NURSERY "BABITE"

	2015	2016	2017
Income			
State budget subsidy	29 460	29 460	29 460
University of Latvia granting	46 611	46 611	46 611
Own income (tickets, plant sales, etc.)	154 945	144 836	189 966
TOTAL	**231 016**	**220 907**	**266 037**
Expenses			
Salaries (incl. taxes)	161 171	175 452	196 266
Other	60 989	59 989	55 344
TOTAL	**222 160**	**226 441**	**251 610**

NATIONAL BOTANIC GARDEN OF LATVIA

Address	Miera Street 1, Salaspils, LV-2169, Latvia
Phone	+371 67945460
Fax	+371 67945459
e-mail	nbd@nbd.gov.lv
www	www.nbd.gov.lv
Director	Andrejs Svilāns
Territory area	129 ha

LIVING PLANT COLLECTIONS

Main taxa	No. of taxa
Indoor plants, including:	2180
Greenhouse flowers (gerberas, chrysanthemums, alstroemerias, cyclamen a.o. cultivars.)	480
Orangery plants	2100
Trees and shrubs, including:	4233
Conifers (incl. new forms)	700
Rhododendrons	200
Crataegus	230
Rosa cv.	413
Other woody plants	2690
Herbaceous plants, including:	
Bulbous plants species collection	1800
Dahlia cv.	351
Astilbe cv.	152
Phlox paniculata cv.	137
Hosta cv.	52
Paeonia cv.	203
Hemerocallis	234
Iris	208
Tulips	304
Narcissus, Hiacinths	152
Lillium sp. +cv.	236

Rock garden plants	706
Other perennials	455
Annual flowers	120
Utility plants (berry, medicinal, spice etc.)	1113
Rare and endangered plants of Latvia	135 (incl. 72 *in vitro*)

HERBARIUM

50 000 specimens

SCIENTIFIC ACTIVITIES

2015

Projects

›Followed up the project in the framework of the State Research Program EVIDEnT "Research in situ and conseration ex situ of protected species and their byotopes" (started in 2014)

Publications

1. A. Karlovska, I. Grīnfelde, I. Alsiņa, G. Priedītis, D. Roze. Plant reflected spectra depending on biological characteristics and growth conditions // Proceedings of the 7th International Scientific Conference Rural Development, 2015. Article DOI: http.://doi.org/10.15544/RD2015.045.
2. D. Roze, D. Megre, G. Jakobsone. Mikrobiotopu izpēte Lēzela lipares (*Liparis loeselii*) Latvijas populāciju ekoloģijai un apsaimniekošanai // Latvijas Veģetācija, 24: 5–25.

2016

Projects

›Followed up the project in the framework of the State Research Program EVIDEnT "Research in situ and conseration ex situ of protected species and their byotopes"

Publications

1. P. Evarts-Bunders, G. Evarte-Bundere, A. Bojāre, D. Krasnopoļska, M. Nitcis. Native bugseed species *Corispermum intermedium* Schweigg and alien *Corispermum pallasii* Steven in coastal habitats of Latvia – new knowledges of distribution and invasions // Acta Biologica Universitatis Daugavpiliensis, Vol. 16, No. 2.

2017

Projects

›Followed up the project in the framework of the State Research Program EVIDEnT "Research in situ and conseration ex situ of protected species and their byotopes". Started and followed up 5 projects financially supported by Latvian Found of Environment Protection.
›Started the project "Assessment and use of factors impacting the byotopes of Pulsatilla patens in the National park "Gauja" and nature park "Blue Mountains of Ogre".
›Started the project of building of the Environmental Information Center with financial support of European Cohesion fund.

Publications

1. D. Megre, K. Dokane, D. Roze, L. Strode. Effect of environmental factors of growth and physiological status of generative shoots of *Cladium mariscus* in a protected calcareous fen habitat // Environmental and Experimental Biology (2017) 15:137-142.
2. D. Kļaviņa, A. Osvalde. Soil conditions of *Cypripedium calceolus* sites in Latvia // Proceedings of the Latvian Academia of Sciences, Section B. 71 (1-2): 43-51. DOI: 10.1515/prolas-2017-0008.
3. D. Roze, E. Smiltniece. "Latviskie" augi Ogres pilsētas kultūrainavā ["Latvian" plants in the cultural landscape of Ogre town] // DU Humanitārās fak. XXVI starpt. zin. lasījumu materiāli. Vēsture XX. Vēsture: avoti un cilvēki. 326-333.
4. N. Krasņevska, D. Grauda, D. Kļaviņa, I. Rashal. Endopolyploidy of endangered plant species *Ligularia sibirica* in different environments // Environment. Techology. Resources, Rezekne, Latvia. Proceedings of the 11th International Scientific and Practical Conference. Volume I, 161-164.

OTHER ACTIVITIES

2015

›Plant fairs – 7.
›Other events in the garden: Opening ceremony of the new Conservatory with common area of 3200 m^2, build by financial support of the ERDF; Final event of Latvian presidency in the EU Council, organized in the Garden by the Ministry of Envirenment Protection and Regional Development, including the concert of "Nature Concert Hall"; European Scientist's night in the theme "Light", with orientation game, chemistry show and illumination, visited by about 2000 visitors.
›Exhibitions in NBG – 2, participation in exhibitions outside the NBG – 9.
›Guided excursions – 95; lessons for pupils – 15.
›Two popular scientific booklets and about 30 scientific popular publications were published by NBG specialists.

2016

›Plant fairs – 7.
›Other events in the garden: European scientist's night in the theme "Fabaceae" with orientation game, illumination and music show, exhibition and lesson; "Christmas between cacti", as well as participation in carrying on Salaspils town events like "Salaspils science week", "Town fest", velomarathon.
›Exhibitions in NBG – 10; participation in exhibitions outside NBG – 5.
›Guided excursions – 133, lessons for pupils – 47, lessons for general public – 16.
›Concerts – 7.
›Two popular scientific books, 22 articles were published by NBG specialists as well as they took part in 4 TV and 4 radio programs, gave more as 30 interviews and consultations in printed media.

2017

›Plant fairs – 7
›Other events in the garden: "European scientist's night" in the theme "Painting With the Pollen - Plant Breeding in Latvia", with orientation game, meeting and workshop with Latvian breeders, two exhibitions.
›Exhibition in the garden – 7; participation in the exhibition outside the garden – 6.

›Concerts – 7.
›Guided excursions – 115, lessons for pupils – 43, lessons for general public – 9.
›In co-operation with "Latvian Railway" organized environment friendly action "Go to Botanic Garden with the train" – showing the railway ticket visitors get discount for entrance tickets. In the framework of this co-operation the "Christmas wagon" was decorated in one of the suburb trains. The co-operation followed up in the next years.
›NBG specialists published 36 scientifically popular publications, as well as took part in 3 TV and 4 radio programs.
›In the NBG homepage the database "Hall of faim of Latvian breeding" was created, which contains descriptions of 618 cultivars bred in Latvia.

VISITORS PER YEAR

	2015	2016	2017
Number of visitors	51 321	63 968	68 811

STRUCTURE AND STAFF
(sum of work loads)

	2015	2016	2017
Administration	7	7	7
Scientific staff	16	16	16
TOTAL including:	**96**	**96**	**100**
PhD	11	11	11
Msc	15	15	15

FINANCES (IN EUR)

	2015	2016	2017
Income			
State financing (incl. projects)	1 317 112	1 022 787	972 449
Own income (tickets, plants, etc.)	198 420	234 417	236 638
TOTAL	**1 515 532**	**1 257 204**	**1 209 087**
Expenses			
Salaries (incl. social insurance)	650 012	664 427	713 779
Maintenance expenses (goods and services)	359 712	266 683	281 288
Capital expenditures	450 223	364 043	177 957
TOTAL	**1 483 078**	**1 321 627**	**1 201 063**

KALSNAVA ARBORETUM

Address	"Ogu īves", Jaunkalsnava, Madona, Latvia
Phone	+371 28380280
e-mail	j.zilins@lvm.lv; arboretums@lvm.lv
www	www.lvm.lv
Director	Jānis Zīliņš
Territory area	143196 ha

LIVING PLANT COLLECTIONS

Main taxa	No. of taxa
Trees and shrubs	~ 4000
Peonies	276

VISITORS PER YEAR

	2015	2016	2017
Number of visitors	18 865	19 368	24 386

STRUCTURE AND STAFF
(sum of work loads)

	2015	2016	2017
Administration	1	1	1
Manager of arboretum	1	1	1
Dendrolog	1	1	1
Manager of information center	1	1	1
Specialist of information center	1	1	1
Manager of educational programs	1	1	1
TOTAL including:	**10**	**10**	**10**
Msc	2	2	2

FINANCES (IN EUR)

	2015	2016	2017
Income			
TOTAL	**29065**	**31709**	**41514**
Expenses			
Budget	149 000	356 000	364 000
Investment	458 309	46 802	415 725
TOTAL	**607 309**	**402 802**	**779 725**

TALLINN BOTANIC GARDEN

Address	Kloostrimetsa tee 52, 1193, Tallinn, Estonia
Phone	+372 606 2679
e-mail	aed@botaanikaaed.ee
www	www.botaanikaaed.ee
Director	Urve Sinijärv
Territory area	42 ha

LIVING PLANT COLLECTIONS

Total No of taxa: 8917 in 2015, 8780 in 2016, 8813 in 2017.

Main taxa	2015	2016	2017
Indoor plants, including:	2119	2087	2054
Tropical plants	521	520	510
Subtropical plants	431	435	435
Orchid species	272	265	260
Cultivars of Cymbidium	155	155	157
Succulents	740	712	694
Trees and shrubs, including:	2513	2424	2522
Trees and shrubs in arboretum	1715	1700	1739
Roses	798	724	783
Herbaceous plants, including:	4285	4269	4237
Lilies	353	353	355
Hyacinths	80	80	81
Dwarf bulbous and bulbotuber plants	512	494	485
Crocuses	129	123	128
Daffodils	136	126	128
Tulips	344	323	320
Ornamental onions	128	123	125
Ornamental grasses	155	157	140
Useful plants	326	369	379
Mountain plants	678	684	685
Tall perennials	385	402	402
Irises	262	254	253
Peonies	305	301	301

Phloxes	113	106	89
Astilbes	83	81	81
Daylilies	144	141	141
Ornamental perennials around the Palm House	8917	8780	8813

HERBARIUM

No. of specimens: 50 353 in 2015, 55 903 in 2016, 58 724 in 2017.

Herbarium collection	2015	2016	2017
Woody plants	9720	10 728	10 950
Wood collections	401	401	401
Carpological collection	754	754	770
Fungi	8654	8672	8672
Mosses	17 370	19 126	21 024
Lichens	4364	4866	4908
Exchange specimens	100	450	504

SCIENTIFIC ACTIVITIES

The main goal of the research in the Tallinn Botanic Garden is to study the diversity of the plant kingdom, the distribution of plant species, as well as biology and ecology. Since 1994, the Tallinn Botanic Garden has participated in the sub-programs of the Estonian national environmental monitoring program, which monitors the diversity of living nature and landscapes, as well the atmospheric deposition of heavy metals by means of epigeic mosses.

Projects

2015–2017

›Artificial habitats for protected plant species of limestone areas in Tallinn Botanic Garden. Funded by the Estonian Environmental Investment Centre.

2015

›Ex situ conservation of *Asplenium septentrionale* and *Woodsia ilvensis* in Tallinn Botanic Garden. Funded by the Estonian Environmental Investment Centre.

Since 1989 until now

›European biomonitoring program: Heavy metals and nitrogen in mosses: spatial patterns and long-term temporal trend in Europe. LRTAP Convention, International Cooperative Programme on Effects of Air Pollution on Natural Vegetation and Crops.

Since 1994 until now

›Estonian Environmental Monitoring Program: Heavy metals and nitrogen in mosses: spatial patterns and long-term temporal trend in Estonia. Funded by the Ministry of the Environment of Estonia.

Publications

2015

1. H. Harmens, G. Mills, F. Hayes, K. Sharps, M. Frontasyeva, [Participants of the moss survey: ..., S. Liiv, ...]. Air pollution and vegetation: ICP Vegetation Annual Report 2014/2015 // ICP Vegetation Programme Coordination Centre, Centre for Ecology and Hydrology, Environment Centre Wales, Moss Survey Coordination Centre, Frank Laboratory of Neutron Physics, Joint Institute for Nuclear Research, 2015. 36 pp.

2. H. Harmens, D.A. Norris, K. Sharps, G. Mills, R. Alber, Y. Aleksiayenak, O. Blum, S.-M. Cucu-Man, M. Dam, L. De Temmerman, A. Ene, J.Á. Fernández, J. Martinez-Abaigar, M. Frontasyeva, B. Godzik, Z. Jeran, P. Lazo, S. Leblond, S. Liiv, S.H. Magnússon, B. Maňkovská, G. Pihl Karlsson, J. Piispanen, J. Poikolainen, J.M. Sanramaria, M. Skudnik, Z. Spiric, T. Stafilov, E. Steinnes, C. Stihi, I. Suchara, L. Thöni, R. Todoran, L. Yurukova, H.G. Zechmeister. 2015. Heavy metal and nitrogen concentrations in mosses are declining across Europe whilst some „hotspots" remain in 2010// Environmental Pollution, 200, pp. 93-104.

3. Ü. Napa, N. Kabral, S. Liiv, E. Asi, T. Timmusk, J. Frey. Current and historical patterns of heavy metals pollution in Estonia as reflected in natural media of different ages: ICP Vegetation, ICP Forests and ICP Integrated Monitoring data // Ecological Indicators, 2015, 52, 31–39. 10.1016/j.ecolind.2014.11.028.

2016

1. W. Schröder, S. Nickel, S. Schönrock, M. Meyer, W. Wosniok, H. Harmens, M.V. Frontasyeva, R. Alber, J. Aleksiayenak, L. Barandovski, A. Carballeira, H. Danielsson, L. de Temmermann, B. Godzik, Z. Jeran, G.P. Karlsson, P. Lazo, S. Leblond, A. J. Lindroos, S. Liiv ... H.G. Zechmeister. Spatially valid data of atmospheric deposition of heavy metals and nitrogen derived by moss surveys for pollution risk assessments of ecosystems // Environmental Science and Pollution Research, 2016, 23 (11), 10457–10476. 10.1007/s11356-016-6577-5.

2017

1. St. Nickel, W. Schröder, ... S. Liiv et al. Modelling and mapping heavy metal and nitrogen concentrations in moss in 2010 throughout Europe by applying Random Forests models // Atmospheric Environment, 2017, 156, 146-159. https://doi.org/10.1016/j.atmosenv.2017.02.032

2. W. Schröder, St. Nickel, ... S. Liiv et al. Bioindication and modelling of atmospheric deposition in forests enable exposure and effect monitoring at high spatial density across scales // Annals of Forest Science, 2017, 74 (2), 31. 23 pp. https://doi.org/10.1007/s13595-017-0621- 6

3. L. Kannukene, T. Kupper, M. Leis. 2017. Viimsi mõisa pargi samblad [Bryophytes of the park of Viimsi manor] // Samblasõber, 20, 9–15.

4. K. Ots, M. Tilk, K. Aguraijuja. The effect of oil shale ash and mixtures of wood ash and oil shale ash on the above- and belowground biomass formation of Silver birch and Scots pine seedlings on a cutaway peatland // Ecological Engineering, 2017, 108 (Part A), 296–306. 10.1016/j.ecoleng.2017.09.002.

5. K. Ots, M. Orru, M. Tilk, L. Kuura, K. Aguraijuja. Ammendatud freesturbaväljade taasmetsastamine: puutuha mõju biomassi formeerumisele ja süsiniku bilansile [Afforestation of cutaway peatlands: effect of wood ash on biomass formation and carbon balance] // Metsanduslikud uurimused = Forestry studies, 2017, 67, 17–36.

6. M. Tilk, T. Tullus, K. Ots. Effects of environmental factors on the species richness, composition and community horizontal structure of vascular plants in Scots pine forests on fixed sand dunes // Silva Fennica, 2017, 51 (3). 10.14214/sf.6986.

Conferences

2015

1. M. Rattur. *Ex situ* conservation of rock ferns *Asplenium septentrionale* and *Woodsia ilvensis* in Estonia // 8th International Conference on Biodiversity Research, Daugavpils, 28.04.-30.04.2015.
2. M. Rattur. Artificial habitat for *ex situ* and *in situ* conservation – case study on *Asplenium septentrionale* and *Woodsia ilvensis* in Estonia // 6th World Conference on Ecological Restoration, August 23.-27. 2015, Manchester, United Kingdom.
3. H. Kösta, S. Liiv. Airborne heavy metal deposition and accumulation in mosses in Estonia – spatial and temporal trends // BIOMAP, 7th International Workshop on Biomonitoring of Atmospheric Pollution, 14-19. June, 2015.

2016

1. R. Aguraiuja, A. Kaur. Research and conservation efforts at Tallinn Botanic Garden, oral presentation // The 9th International Meeting and Conference of Botanic Gardens Network from the Baltic Sea regioon, The new challenges and collaboration tasks for botanic gardens from the Baltic Sea Region, October 5-8, 2016 Przelewice, Poland.
2. M. Tilk, K. Ots, T. Tullus. Ground vegetation diversity on dune forests // The challenge of global change: disturbance and risk in forest ecosystem management, Workshop of SNS/EFINORD network Natural Disturbance Dynamics Analysis for Forest Ecosystem Based Management (FORDISMAN), October 27.–29. 2016, Narva, Estonia.

2017

1. M. Rattur. Population dynamics and structure of locally rare fern *Aspenium septentrionale* in Estonia, oral presentation // 9th International Conference on Biodiversity Research, Daugavpils, 26.04.-28.04.2017.
2. S. Liiv, M. Kasemets, K. Kähr. Educational activities in Tallinn Botanic Garden // 6th Global Botanic Gardens Congress, 26-30 June 2017, Geneva, Switzerland.
3. T H. amm, J. Sild, S. Liiv. Development of botanic gardens of Estonia in the period between the EastCentGard 1 – 3 (2003-2016) // 3rd Conference of Eastern and Central European Botanic Gardens, Budapest, Hungary. 9 to 11 October 2017.

Expeditions

2015, 2016 and 2017

›Fieldworks for population monitoring of *Asplenium dielpallidum, Asplenium diellaciniatum, Asplenium dielmannii* on Kaua'i, Hawaiian Islands. Ruth Aguraiuja.

2017

›Fieldworks for population monitoring of *Asplenium septentrionale* and *Woodsia ilvensis* in their natural habitats in southern part of Finland. Maris Rattur.

OTHER ACTIVITIES

Educational activities

›Guided tours of TBG collections are conducted in Estonian, Russian, English and

Finnish. The total of 211 tours were conducted in 2015, 204 in 2016 and 251 tours in 2017.
›An audio guide is a popular free tour guide in Estonian, Russian, English and Finnish for both the greenhouses and the garden collections but also for the nature trail in TBG. The audio guides were used 1254 times in 2015, 1093 in 2016 and 1056 in 2017.
›TBG has a new exhibition almost every month. These are very popular among the visitors of TBG, which is proved by the multiplied number of visitors on the days of exhibitions. The most popular of all is the annual orchid exhibition in March.
›Lichens, mosses and tree fungi suit well for all year round outdoor display, as they are relatively resistant to extreme weather conditions. The permanent exhibition of lichens, mosses and tree fungi can be visited throughout the year when there is no snow. Around 60–70 most common in Estonia species from each group of organisms are presented on this exhibition.
›TBG is located in the Pirita River Valley Landscape Protection Area. Here, TBG has set up educational nature trail supplied with 22 information boards. The explanatory posters, booklets in different languages and worksheets for students are available at the ticket office free of charge and on the website of TBG: http://botaanikaaed.ee/en/teadus_ja_loodusharidus/naitused
›The nature education programmes to school students from Grades 2-11 (the Nature School) were conducted by the specialists of the TBG – biologists, geographers and gardeners. The most popular themes were "Trees, shrubs and herbaceous plants", "House plants and useful plants" and "Natural and climatic zonation" in 2015-2017.
›1560 students from 27 schools and 86 classes participated in the 66 study days in TBG in 2017 as part of the project-based (the funding from Environmental Investment Centre (EIC)) curriculum related education activities.
In 2016, 2194 students from 37 schools and 101 classes participated in the 92 study days related to the basic school and upper secondary school curricula.
In 2015 altogether 1530 students from 29 schools and 85 classes participated in the 65 study days in TBG.
›A course called "Children of Nature" for students from the 1st to the 6th grade runs from October to May. Children find out to identify plants, mosses, lichens; many TBG exhibitions are visited, healthy eating is discussed etc. Various environmental education specialists and other departments participate in carrying out the programmes.
›TBG also shares botanical information by phone or by e-mail. Many plant enthusiasts ask advice on plant diseases and pests, unknown plants identification and tips for the growing healthy houseplants.

2015

›May 2015 – the Tulip Festival (75 varieties, 550 m²).
›18–19 July 2015 – Rose Days "Sea of flowers ripples in the summer sun or Rose Days with Floribunda roses". The TBG had 2100 visitors during this period.
›May 2015 – a "nursery area" was created for growing the seedlings of *Ericaceae* (heather) that require partial shade, covered with horticultural fleece.
›July 2015 – the greenhouse was built for cultivating the seedlings of plants for the Garden of Senses and the front square.
›12 August 2015 – the Garden of Senses was opened (authors: landscape architect Kaija Arroval and chief gardener Ave Visnapuu). In designing the Garden, special attention was paid to people with special needs: the useful plants displayed there can be watched and sniffed but also touched, tasted and heard, so all senses are engaged in exploration. To

make walking easier for people with impaired vision, pathways are bordered with metal edges, and there is a relief pavement strip which fulfils the same function. Descriptions of the exposition are provided on tactile diagrams and by the audio-guide providing visual description.
›Garden received the "Deed of Year 2015" award from the Estonian Blind Union.

2016

›May 2016 – the Tulip Festival (80 varieties, 700 m²).
›16–17 July 2016 – "Days of climbing roses in the Tallinn Botanic Garden" were held. The TBG had 2086 visitors during this period.
›In the summer of 2016, the expositions of crocuses (45 varieties and species, 26 m²) and hyacinths (46 varieties, 100 m²) were relocated.
›April – May 2016 – terraces for lime-loving plants were built and filled with appropriate soil mixes on the western edge of the square in front of the Palm House within the project of the Environmental Investment Centre "Artificial habitats for endangered plant species in the Tallinn Botanic Garden".
›November 2016 – the Garden of Senses received the Best Garden award in the competition for Estonian Architecture Awards 2016 issued by the Estonian Landscape Architects' Union.

2017

›In 2017, work was done on the renovation of the rose garden and alpine garden.
›May – June 2017 – vegetation of the alpine plant terraces started with the use of the crevice garden method also known in Estonia as the Czech mountain garden (project of the Environmental Investment Centre "Artificial habitats for endangered plant species in the Tallinn Botanic Garden").
›22–23 July 2017 – Rose Days "What are you, modern roses".
›August 2017 – a new joint exposition of daffodils (57 varieties) and lilies (112 varieties) on an area of 300 m² was created.
›November 2017 – 350 tulip bulbs of the "Eesti" variety presented as a gift by the embassy of the Netherlands were planted on the font square.
›April – November 2017 – field work was performed on the territory of the TBG and in its vicinity (the area of approximately 80 hectares) for the recording of the plant species composition of the area in order to check the habitats of protected plants which had been known before. A total of 618 taxa of plants growing beyond the collections, having spread unaidedly, were identified, and more than 2800 photographs of plants were sorted out and captioned out of all the photos made.

VISITORS PER YEAR

	2015	2016	2017
Number of visitors	65 751	56 039	57 422

STRUCTURE AND STAFF
(sum of workloads)

	2015	2016	2017
Administration	10,5	9,5	8,5
Dept. of Environmental Education	13	13	11
Dept. of Outdoor Collections	14	15	14
Dept. of Tropical and Subtropical Collections	6,8	7	7
Technical Department	6	6	8
TOTAL including:	**50,3**	**50,5**	**48,5**
PhD	2	2	2
Msc	18	21	20

FINANCES (IN EUR)

	2015	2016	2017
Income			
Revenue	229 556	238 156	209 040
Targeted financing	21 599	41 699	208 642
TOTAL	**251 155**	**279 855**	**417 682**
Expenses			
Operation expenditure	467 278	502 735	496 300
Salaries	545 620	589 389	633 727
TOTAL	**1 012 898**	**1 092 124**	**1 130 027**

BOTANICAL GARDEN OF THE UNIVERSITY OF TARTU

Address	Lai 38, Tartu, 51005, Estonia
Phone	+372 7376180
e-mail	botaed@ut.ee
www	www.botaanikaaed.ut.ee
Director	Urmas Kõljalg
Territory area	3,5 ha

LIVING PLANT COLLECTIONS

Total No. of taxa (2018): **11 563**

Main taxa	No. of taxa
Indoor plants, including:	1670
Palm house	560
Tropical + succulents plants	1110
Trees and shrubs	1140
Herbaceous plants, including:	7200
Alpine plants	1530
Native species	710

SCIENTIFIC ACTIVITIES

›"Collection and Conservation of Plant Genetic Resources in 2014-2020".

OTHER ACTIVITIES

›Development of Moss Garden.
›Building of department of Estonian native species.
›Annual exhibitions (Orchids, the Garden Day, Researchers Night).

VISITORS PER YEAR

	2015	2016	2017
Number of visitors	~115 000	~120 000	~120 000

STRUCTURE AND STAFF
(sum of work loads)

	2015	2016	2017
Administration	1	1	1
Gardener	10	10	10
Administrators	2	2	2
Technician	1	1	1
Other	2	2	2
TOTAL including:	**16**	**16**	**16**
PhD	1	1	1
Msc	4	4	4

FINANCES (IN EUR)

	2015	2016	2017
Income			
Tartu University	300 000	300 000	300 000
Other	100 000	100 000	100 000
TOTAL	**400 000**	**400 000**	**400 000**
Expenses			
Staff	200 000	200 000	200 000
Materials, economic cost	200 000	200 000	200 000
TOTAL	**400 000**	**400 000**	**400 000**

VILNIUS UNIVERSITY BOTANICAL GARDEN

Address	Kairėnų 43, LT-10239 Vilnius, Lithuania
Phone	+370 5 219 3133
e-mail	hbu@bs.vu.lt
www	www.botanikos-sodas.vu.lt
Director	Audrius Skridaila
Territory area	198,9 ha

LIVING PLANT COLLECTIONS

Total No. of taxa (2017): **10 024**

Main taxa	No. of taxa
Indoor plants, including:	700
Cactaceae	137
Crassulaceae	131
Woody plants, including:	3784
Ericaceae	678
Oleaceae	206
Conifers	438
Lianas	133
Alpine flora	300
Rosa	351
Syringa	155
Ribes	442
Herbaceous plants, including:	4842
Dahlia	492
Hemerocallis	605
Hordeum	581
Iris	378
Lilium	451
Paeonia	265
Tulipa	386
Native species in natural habitats	698

HERBARIUM

Herbarium at Vilnius University is part of Centre of Life Science.

SCIENTIFIC ACTIVITIES

Main research areas: plant Geno taxonomy, biotechnology (including micro propagation *in vitro* and mycorrhiza) cultivation and reproduction of plants; conservation and preservation of plant genetic resources.

Projects

›Program of conservation of three endangered plant species on Baltic Sea shore: propagation and transfer of plants and experimental restoration of two habitats of protected in Lithuania species (*Aster trifolium* L., *Glaux maritima* L., *Juncus gerardii* Loisel), 2015-2017. A. Skridaila, G. Štukėnienė (2015-2016). Contractual project financed by Klaipėda Seaport.

›COST program: activity FP1305, linking belowground biodiversity and ecosystem function in European forests. A. Aučina, A. Skridaila http://www.cost.eu/COST_Actions/fps/Actions/FP1305?management

›Coordination Centre: since 2002 the Botanical Garden of Vilnius University is the Centre of Coordination of Research of Ornamental Plants Genetic Resources in Lithuania.

›Data Bases:

-Ribes/Rubus European Central Data Base. D. Ryliskis. The Database managed by the IPGRI and ECP/GR request. Website: www.ribes-rubus.gf.vu.lt

-Data Base of Vilnius University Botanical Garden Plants - Index Plantarum. D. Ryliškis, http://botsodas.lt/indexplantarum

2015

Publications

1. R. Vyšniauskienė, D. Naugžemys, J. Patamsytė, V. Rančelienė, T. Čėsnienė, D. Žvingila. ISSR and chloroplast DNA analyses indicate frequent hybridization of alien *Medicago sativa* subsp. *sativa* and native *M. sativa* subsp. *falcate* // Plant Systematics and Evolution, 2015, Vol. 301, p. 2241-2350.

2. R. Šiukšta, V. Vaitkūnienė, G. Kaselytė, V. Okockytė, J. Žukauskaitė, D. Žvingila, V. Rančelis. Inherited phenotype instability of inflorescence and floral organ development in homeotic barley double mutants and its specific modification by auxin inhibitors and 2,4-D // Annals of Botany, Vol. 115, 2015, p. 651-663.

3. G. Statkevičiūtė, A. Aleliūnas, V. Kemešytė, I. Pašakinskienė, T. Lubberstedt, G. Brazauskas. Association analysis of five candidate genes with plant height and dry matter yield in perennial ryegrass // Plant Breeding, Vol. 134, iss. 4, 2015, p. 454-460.

4. S. Dapkūnienė, G. Štukėnienė, G. Busevičiūtė. Characterization Descriptors of Bearded Irises // Acta Horticulture, 2015, 1087, p. 267-272.

5. R. Šiukšta defended PhD thesis - "Inherited phenotypic instability of barley homeotic single and double mutants and its possible causes".

Conferences

1. "Creative natural science education: diversity towards harmony", 08.10.2015, VUBG, Lithuanian Centre of Non-formal Youth Education.

2. "Lithuanian botanical gardens collections and their influence on Lithuanian farmsteads and suburban greenery", 23.10.2015, VUBG, Association of Lithuanian Floriculturists.

2016

Publications

1. S. Dapkūnienė, R. Maršelienė. Viendienių (*Hemerocallis* L.) veislių morfologinių dekoratyvių savybių apibūdinimo aprašas // Akademija, 2016, 39 p.
2. S. Gliožeris, S. Dapkūnienė. Dvispalvių kaladžių (*Caladium bicolor* (Aiton) Vent.) veislių morfologinių ir dekoratyviųjų savybių aprašas // Akademija, 2016, 35 p.
3. S. Dapkūnienė, S. Gliožeris. Gumbinių begonijų (*Begonia tuberhybrida* Voss) veislių morfologinių ir dekoratyviųjų savybių aprašas // Akademija, 2016, 23 p.
4. R. Juodkaitė, G. Štukėnienė. Criteria of Tulip Cultivars for Cultured Plants Gene Fund // Floriculture: history, theory, practice. Proceedings of the VII Int. Sc. Conf. May 24-26, 2016, Minsk, Belarus, p. 126-128.
5. G. Štukėnienė, J. Puociauskiene, G. Buseviciute, S. Gataveckiene, R. Turla, R. Juodkaite. Herbaceous Ornamental Perennial Plants of the Vilnius University Botanical Garden // Floriculture: history, theory, practice. Proceedings of the VII Int. Sc. Conf. May 24-26, 2016, Minsk, Belarus, p. 249-251.
6. A. Bumblauskas, Z. Butkus, V. Gricius, R. Griškaitė, G. Kirkienė, S. Matulaitytė, L. Skurvydaitė, S. Žilinskaitė, A. Pacevičius, V.B. Pšibilskis, J. Sūdžius, L. Šabajevaitė, I. Leonavičiūtė (sudaryt.). Alma Mater Vilnensis: Vilniaus universiteto turtai istorijos skersvėjuose (XVI-XXI amžiai): kolektyvinė monografija, Vilnius: VUL, 2016, 912 p.

Conferences

1. "Educational spaces and the process of education": Ministry of Education and Science of the Republic of Lithuania, 09.11.2016, VUBG, Lithuanian Centre of Non-formal Youth Education.
2. "Novelties and trends in greenery", 25.11.2016, VUBG, Association of Lithuanian Dendrologists.

2017

Publications

1. M. Rudawska, T. Leski, A. Aučina, L. Karlinski, A. Skridaila, D. Ryliškis. Forest litter amendment during nursery stage influence field performance and ectomycorrhizal community of Scots pine (*Pinus sylvestris* L.) seedlings out planted on four different sites // Forest ecology and management. Amsterdam: Elsevier. 2017, Vol. 395, p. 104-114.
2. V. Tunaitienė, J. Patamsytė, D. Naugžemys, V. Kleizaitė, T. Čėsnienė, V. Rančelis, D. Žvingila. Genetic and allelopathic differences between populations of daisy fleabane *Erigeron annuus* (L.) Pers. (*Asteraceae*) from disturbed and stable habitats // Biochemical systematics and ecology. Oxford: Pergamon-Elsevier Science. 2017, Vol. 70, p. 294-303.
3. T. Čėsnienė, V. Kleizaitė, S. Bondzinskaitė, R. Taraškevičius, D. Žvingila, R. Šiukšta, V. Rančelis. Metal bioaccumulation and mutagenesis in a *Tradescantia* clone following long-term exposure to soils from urban industrial areas and closed landfills // Mutation research / genetic toxicology and environmental mutagenesis. Amsterdam: Elsevier BV. 2017, Vol. 823, p. 65-72.
4. J. Butkuvienė, Z. Sinkevičienė, D. Naugžemys, J. Patamsytė, D. Žvingila. Genetic diversity of *Batrachium (Ranunculaceae)* species reveals the necessity of their protection in Lithuanian rivers // Aquatic Botany, 2017, 142, p. 61-70.
5. S. Dapkūnienė, R. Maršelienė. Lelijos (*Lilium* L.) veislių morfologinių ir dekoratyvinių savybių apibūdinimo aprašas // Akademija, 2017, 48 p.

6. S. Dapkūnienė, G. Štukėnienė. Kardelio (*Gladiolus* L.) veislių morfologinių ir dekoratyvių savybių apibūdinimo aprašas // Akademija, 2017, 48 p.

Conferences

1. "Changes in Flower culture and New Technologies", 28.04.2017, VUBG, Association of Lithuanian Floriculturists.
2. "Gardens: traditions, images, symbols in Lithuanian culture", 11.-12.05.2017, Vilnius Academy of Arts, Institute of Art Research, VUBG.
3. "Novelties and trends in greenery", 17.11.2017, VUBG, Association of Lithuanian Dendrologists.
4. "Educational spaces and the process of education": Ministry of Education and Science of the Republic of Lithuania, 22.11.2017, VUBG, Lithuanian Centre of Non-formal Youth Education.

OTHER ACTIVITIES

2015

›57 educational and cultural events for public.
›The system of walkways was enlarged (1048 m^2).
›Reconstructed some collections and exhibits of ornamental woody plants, lilacs and fruiting plants.
›On 09 September 2015 was signed agreement of scientific collaboration between VUBG and Institute of Dendrology of Polish Academy of Science.
›The work of reconstruction of the laboratory/administrative building of the Garden was continued (project financially supported in 2015 by State investment program – 394 000 € and additionally by launched other new project – of the Building energy performance improvement, supported by Lithuanian fund of investments for protection of environment – 260 000 €).

2016

›74 (non-commercial) educational and cultural events were organised for visitors (2 fairs, 9 public lectures, 6 fiestas, 1 presentation of book, 12 exhibitions of art etc.).
›The sculptural composition „Inukshuk" was created by Canadian and Lithuanian soldiers and built in the Garden to commemorate the 25th anniversary of Lithuanian-Canadian cooperation.
›The Policy (Guidelines) for improvement of the Garden plant collections quality and a unified system of plant collections mapping started to be developed.
›The reconstruction of the Fence (685 m) of the oldest Department (Vingis) of the Garden was accomplished by financial support (37 000 €) of Vilnius municipality.
›In Kairėnai there was enlarged a system of walkways (1360 m^2) and areas (of about 4,72 ha) for new plant collections (peonies, rhododendrons, dahlias etc.).
›A new project was developed and started (in collaboration with Vytautas Magnus University and Klaipėda University botanical gardens) of awareness raising of Lithuanian botanical gardens using e-marketing tools (the project financed by EU funds, total project budget - 178 484,76 €).
›Finished the reconstruction of the laboratory/administrative building at Vilnius University Botanical Garden (project financially supported in 2016 by State investment program – 542 000 € and by Lithuanian fund of investments for protection of environment – 341 900 €).

›78 (non-commercial) educational and cultural events.
›The track for orienteering sports (3,2 km) was equipped in the Garden.
›By financial support of Vilnius municipality (35 000 €) there were enlarged system of walkways (1515 m^2) and areas (of about 2,2 ha) for new plant collections (ornamental plants, genus *Vaccinium, Hordeum* etc.).
›The Garden has joined the international project Green Legacy Hiroshima. The ginkgo tree (*Ginkgo biloba* L.) grown from seeds of survivor after Hiroshima bombing was planted in the Japanese Garden in Kairėnai. His Excellence the Ambassador of Japan to Lithuania Mr. T. Shigeeda attended the event.
›The apple tree commemorating the 25th anniversary of Belarusian-Lithuanian diplomatic relations was planted in The Garden (His Excellence Belorussian Ambassador to Lithuania Mr. A. Krol attended the event).
›The Garden visited Slovenian Parliament delegation led by chair Milan Brglezo, the President of Lithuania Her Excellence D. Grybauskaitė and many other officials.
›Head of Tasmania Arboretum (Australia) Phill Parson visited (02.06.2017) VU BG and signed an agreement of collaboration (collaboration between VUBG and Tasmania Arboretum was proposed and supported by BGCI and Arbnet – join project was financed by them - 4000 $).
›The project of „Exchange of experience between Vilnius University and Reykjavik botanical gardens through bilateral visits, field days and seminars“ was implemented. The Project financially supported by Lithuanian Ministry of Environment and the EEA Grants and Norway Grants - 24 316 €. Implementing the Project VU BG organised (21.09.2017) international seminar - „Working together for plant conservation: challenges, networking and capacity building“ (attending 50 representatives from Iceland, Latvia and Lithuania).
›VU BG was awarded by “European Garden Association – Natur im Garten International” (Headquarter in Austria) as a winner of the first place in Competition of ecological gardening, category – “Gardening without garden” (for transformation of VU BG lab to the green multifunctional building).
›VU BG was awarded by the website „Tripadvisor“ – did get the “Certificate of Excelence” for the “continually increasing number of visitor-friendly responses”.

The laboratory/administrative building of the Vilnius University Botanical Garden

VISITORS PER YEAR

	2015	2016	2017
Number of visitors	78 700	83 500	86 400

STRUCTURE AND STAFF*
(sum of work loads)

	2015	2016	2017
Administration	3	3	3
Dept. of Plant Collections	34,5	33,5	35,5
Dept. of Science Programs	7,25	7,25	7,25
Dept. of Public relationships	8,25	9,25	9,25
Dept. of Maintenance	30,5	29	29
Dept. of Vingis	9	9	9
TOTAL including:	**92,5**	**91**	**93**
PhD	10	11	11
Msc	4	5	6

**Number of permanent working staff on 1st of January (every year). During the summer season VU BG employed 11-26 persons per season additionally.*

FINANCES (IN EUR)

	2015	2016	2017
Income			
VU University Grant	661 119	661 224	819 050
VU BG self-generated revenue	141 600	161 984	173 140
Vilnius municipality financial support	17 375	37 300	35 000
Other Projects and Grants	839 549	1 054 940	33 950
TOTAL	**1 659 643**	**1 915 448**	**1 061 140**
Expenses			
Salaries (including taxes)	755 763	815 975	831 044
Other expenses	903 880	1 099 473	230 096
TOTAL	**1 659 643**	**1 915 448**	**1 061 140**

BOTANICAL GARDEN OF VYTAUTAS MAGNUS UNIVERSITY

Address	Ž. E. Žilibero str. 6, Kaunas, 46324 Lithuania
Phone	+370 37 390033
e-mail	botanikos.sodas@vdu.lt
www	www.botanika.vdu.lt
Director	Nerijus Jurkonis
Territory area	62.5 ha

LIVING PLANT COLLECTIONS

Total No. of taxa (2017): **13 663**

Main taxa	No. of taxa
Sector of Floriculture, including:	9443
Greenhouse	1078
Ficus	39
Mammillaria	39
Agave	30
Aloe	21
Begonia	20
Euphorbia	19
Peperomia	19
Opuntia	18
Gasteria	16
Open-field collections	8365
Rosa	1537
Dahlia	1102
Hemerocallis	444
Paeonia	294
Hosta	252
Lilium	228
Phlox	195
Astilbe	184
Aster	127
Sedum	124
Campanula	62

Geranium	57
Sector of Medicinal plants, including:	899
Medicinal plants	625
Aromatic plants and spices	226
Humulus lupulus	48
Sector of Pomology, including:	583
Vaccinium	349
Viburnum	25
Actinidia	65
Group of Plant Systematics and Flora, including:	725
Protected plants of Lithuania	54
Sector of Dendrology, including:	2013
Rhododendron	222
Hydrangea	132
Juniperus	114
Thuja	108
Chamaecyparis	76
Picea	73
Potentilla	63
Syringa	47

HERBARIUM

No. of specimens: about **10 000**

SCIENTIFIC ACTIVITIES

Projects

›Estimation of an impact of climate change on biological diversity in The Southwest Lithuania and development of measures for adjustment (BOTANICA SUDAVICA). No. EEE-LT03-AM-01-K-01-010, EEE and Norwegian Environment Agency grant. Project duration 2015-2016.

›Research on application of plant extracts and their fractions for the inhibition and control of animal environment viruses (FITOKONTROLĖ). No. MIP-065/2015, Grant of Research Council of Lithuania. Project duration 2015-2017.

›Impact of clear cuttings on transformation of biodiversity in forest ecosystems (MEKODINA), No. SIT-1/2015. Grant of Research Council of Lithuania: National Research Programme "Sustainability of agro-, forest and water ecosystems". Project duration 2015-2017.

Breeding

›Five clones of European cranberry (*Vaccinium oxycoccos* L.,) were breeded and approved as new Lithuanian cultivars by names 'Reda', 'Vita', 'Amalva', 'Žuvinta', and 'Vaiva' in 2017

›2016-2017 nine new cultivars of Dahlia registed in the International Dahlia Register: 'Meška Slapukė', 'Tumė', 'Dalelytė', 'Giedrės Kasos', 'Lapė', and 'Orija', 'Constantin von Regel', 'Jean-Emmanuel Gillibert' and 'Janusz Bogdan Faliński'.

Publications

2015

1. A. Paulauskas, J. Žukauskienė, D. Žiaukienė, L. Česonienė, R. Daubaras, E. Kupčinskienė, J.R. Lazutka, G. Slapšytė, V. Dedonytė, J. Mierauskienė, A. Stapulionytė, Paškevičius A., L. Levinskaitė, J. Švedienė, P. Viškelis. Differentiation of *Viburnum* accessions according to their molecular, biochemical, genotoxic and microbiological features of importance to selection // Academia journal of agricultural research. New York: Academia Publishing House. ISSN 2315-7739. Vol. 3, iss. 6, 2015, p. 81-93.

2. V. Kraujalytė, P.R. Venskutonis, A. Pukalskas, L. Česonienė, R. Daubaras. Antioxidant properties, phenolic composition and potentiometric sensor array evaluation of commercial and new blueberry (*Vaccinium corymbosum*) and bog blueberry (*Vaccinium uliginosum*) genotypes // Food chemistry. New York, NY: Elsevier. ISSN 0308-8146. 2015, Vol. 188, p. 583-590.

3. L. Česonienė, R. Daubaras, I. Jasutienė, I. Miliauskienė, M. Zych. Investigations of anthocyanins, organic acids, and sugars show great variability in nutritional and medicinal value of European cranberry (*Vaccinium oxycoccos*) fruit // Journal of applied botany and food quality. Göttingen: Liddy Halm. ISSN 1439-040X. 2015, Vol. 88, p. 295-299.

4. V. Kaškonienė, M. Stankevičius, T. Drevinskas, I. Akuneca, P. Kaškonas, K. Bimbiraitė-Survilienė, A. Maruška, O. Ragažinskienė, O. Kornyšova, V. Briedis, R. Ugenskienė. Evaluation of phytochemical composition of fresh and dried raw material of introduced *Chamerion angustifolium* L. using chromatographic, spectrophotometric and chemometric techniques // Phytochemistry. London: Elsevier Ltd. ISSN 0031-9422. 2015, vol. 115, p. 184-193.

5. V. Stravinskienė, V. Snieškienė, A. Stankevičienė. Health condition of *Tilia cordata* Mill. trees growing in the urban environment // Urban forestry & urban greening. Netherland: Elsevier. ISSN 1618-8667. 2015, vol. 14, iss. 1, p. 115-122.

2016

1. M. Kaya, L. Česonienė, R. Daubaras, D. Leskauskaitė, D. Zabulionė. Chitosan coating of red kiwifruit (*Actinidia melanandra*) for extending of the shelf life // International journal of biological macromolecules. Amsterdam: Elsevier B.V. ISSN 0141-8130. 2016, vol. 85, p. 355-360.

2. N. Tiso, J. Mikašauskaitė, M. Stankevičius, V. Snieškienė, A. Stankevičienė, Ch. Polcaro, E. Galli, E. Donati, M. Zacchini, D. Levišauskas, T. Tekorius, O. Ragažinskienė, T. Drevinskas, V. Bartkuvienė, O. Kornyšova, V. Kaškonienė, A. Maruška. Isolation and identification of fungi tolerant to polycyclic aromatic hydrocarbons and coal tar from different habitats in Lithuania // Toxicological & environmental chemistry. Oxford: Taylor & Francis. ISSN 0277-2248. 2016, Vol. 98, iss. 1, p. 77-89.

3. V. Šulniūtė, O. Ragažinskienė, P.R. Venskutonis. Comprehensive evaluation of

antioxidant potential of 10 Salvia species using high pressure methods for the isolation of lipophilic and hydrophilic plant fractions // Plant foods for human nutrition. Dordrecht: Springer. ISSN 0921-9668. 2016, vol. 71, iss. 1, p. 64-71.

4. V. Kaškonienė, A. Maruška, I. Akuneca, M. Stankevičius, O. Ragažinskienė, V. Bartkuvienė, O. Kornyšova, V. Briedis, R. Ugenskienė. Screening of antioxidant activity and volatile compounds composition of *Chamerion angustifolium* (L.) Holub ecotypes grown in Lithuania // Natural product research: formerly natural product letters. Abingdon, UK: Taylor & Francis. ISSN 1478-6419. 2016, vol. 30, no. 12, p. 1373-1381.

5. V. Mildažienė, G. Paužaitė, A. Malakauskienė, R. Žūkienė, Z. Naučienė, I. Filatova, V. Azharonok, V. Lyushkevich. Response of perennial woody plants to seed treatment by electromagnetic field and low-temperature plasma // Bioelectromagnetics. New-York: Wiley Periodicals, Inc. ISSN 0197-8462. 2016, Vol. 37, iss. 8, p. 536-548.

6. V. Snieškienė, L. Baležentienė, A. Stankevičienė. Urban salt contamination impact on tree health and the prevalence of fungi agent in cities of the central Lithuania // Urban forestry & urban greening. Netherland: Elsevier. ISSN 1618-8667. 2016, vol. 19, iss. 1, p. 13-19.

7. P. Kaškonas, Ž. Stanius, V. Kaškonienė, K. Obelevičius, O. Ragažinskienė, A. Zilinskas, A. Maruška. Clustering analysis of different hop varieties according to their essential oil composition measured by GC/MS // Chemical papers. Cham: Springer international publishing. ISSN 0366-6352. 2016, vol. 70, iss. 12, p. 1568-1577.

2017

1. T. Drevinskas, G. Naujokaitytė, A. Maruška, M. Kaya, I. Sargin, R. Daubaras, L. Česonienė. Effect of molecular weight of chitosan on the shelf life and other quality parameters of three different cultivars of *Actinidia kolomikta* (kiwifruit) //Carbohydrate polymers. Amsterdam: Elsevier. ISSN 0144-8617. 2017, Vol. 173, p. 269-275.

2. R. Daubaras, L. Česonienė, M. Zych, V. Tamutis, V. Stakėnas. Effect of forest clear cuts on plant–pollinator interactions: the case of three ericaceous subshrubs in Lithuanian pine forests // Acta agrobotanica. Warszawa: Polish Botanical Society. ISSN 2300-357X. 2017, Vol. 70, No. 1, p. 1-8.

3. V. Šulniūtė, R. Baranauskienė, O. Ragažinskienė, P.R. Venskutonis. Comparison of composition of volatile compounds in ten Salvia species isolated by different methods // Flavour and fragrance journal. Chichester: John Wiley & Sons. ISSN 0882-5734. 2017, Vol. 32, no. 4, p. 254-264.

4. L. Pudžiuvelytė, M. Stankevičius, A.S. Maruška, V. Petrikaitė, O. Ragažinskienė, G. Drakšienė, J. Bernatonienė. Chemical composition and anticancer activity of *Elsholtzia ciliata* essential oils and extracts prepared by different methods // Industrial crops and products. Amsterdam: Elsevier. ISSN 0926-6690. 2017, vol. 107, p. 90-96.

Conferences

1. BG of Vytautas Magnus University organized international conference “New trends of biodiversity conservation” in 2016 and national practical conference “Horticulture and research of Humulus lupulus in Lithuania” and workshop “Science in botanical gardens: for studies and business” in 2017.

2. Every year BG of Vytautas Magnus University together with partners organizing international conference “The Human and Nature Safety”.

OTHER ACTIVITIES

2015

›Biggest events – Fascination of Plants Day, "Night of Scents", musical festival "Cozy evenings in botanical garden (6 concerts), exhibition of exotic animals "Magic world of jungles", event for local community "Aleksotas festival", joint event together with Lithuanian zoo "Week of Winter Gardens".
›Continues implementation of science education project "Development of a National Science Communication System Tools in Lithuania" (for period 2015-2017).
›Three international volunteers from the European Voluntary Service organization accepted for nine-month period.
›New volume of scientific journal "Scripta Horti Botanici Universitatis Vytauti Magni" (ed. Dr. V. Snieškienė) Published
›President of Lithuania Mr. Valdas Adamkus and Embassy of the Kingdom of the Netherlands donated two varieties of tulips "Alma" and "Amber Lithuania".

2016

›Created and approved the new strategy of the of VMU Botanical garden for 2016-2020.
›Biggest events – Fascination of Plants Day, "Night of Scents", event for local community "Aleksotas festival", "Festival of Pumpkins", musical event "Flowers and Music Festival" (4 concerts), exhibition of exotic butterflies.
›Two informal education programs approved by Kaunas city authorities.
›National level competition 'Lithuanian Naturalist' for secondary schools' children organized together with partner Lithuanian Centre of Non-formal Youth Education.
›Published educational book 'Conservation of botanical diversity in south-western Lithuania'. 224 p. (in Lithuanian and English).
›Rebuild of historical pergola (160 m length) and completely renewed rosary.

2017

›Biggest events – Fascination of Plants Day, "Night of Scents", event for local community "Aleksotas Festival", "Festival of Harvest", international folklore festival "Atataria lamzdziai", exhibition of exotic butterflies.
›Made an oral presentation "Botanic Garden as an Environment for Informal Education: Experience of Kaunas Botanical Garden" at the 6th Global Botanic Gardens Congress in Geneva (Dr. N. Jurkonis).
›Opened replaced national collection of hops (*Humulus lupulus*).
›BG was working with reconstruction of rose garden and perennial plats (*Astilbe, Hosta, Geranium*) expositions, enlarging dahlias, rhododendrons and pomological collections.

Hops collection in the Botanical Garden of Vytautas Magnus University

VISITORS PER YEAR

	2015	2016	2017
Number of visitors	76 600	81 320	85 230

STRUCTURE AND STAFF
(sum of work loads)

	2015	2016	2017
Administration	2	3	3
Dept. of Collections including:	33,5	34	33
Collections and database management	3	2,5	3
Sector of Pomology	6	6	6
Sector of Medicinal Plants	5,5	5,5	5
Sector of Dendrology	4,5	4,5	4
Sector of Floriculture	10,5	11,5	11
Plant Pathology Group	2	2	2
Flora Systematics Group	2	2	2
Dept. of Service and Education	9	9,5	10,5
Nursery	3	3	2
Seasonal staff	13	13,5	13
TOTAL including:	**60,5**	**63**	**61,5**
PhD	1	1	2
Msc	1	5	5

FINANCES (IN EUR)

	2015	2016	2017
Income			
State budget subsidy	410 560	428 870	432 620
Other state budget assignations	87 820	149 600	346 700
Grants	156 540	280 196	186 560
Other income	145 241	159 922	171 797
TOTAL	**800 161**	**1 018 588**	**1 137 677**
Expenses			
Salaries (including taxes)	544 232	552 033	632 883
Other	253 560	428 117	514 013
TOTAL	**797 792**	**980 150**	**1146 896**

KLAIPĖDA UNIVERSITY BOTANICAL GARDEN

Address	Kretingos str. 92, LT-92327 Klaipėda, Lithuania
Phone	+ 370 46 39 88 33, + 370 616 40371
e-mail	botanikos.sodas@ku.lt
www	www.ku.lt/botanikos-sodas/
Director	Asta Klimienė
Territory area	9,3 ha

LIVING PLANT COLLECTIONS

Total No. of taxa (2017): **3645**

Main taxa	No. of taxa
Indoor plants, including:	
Cactus	55
Indoor plants	32
Trees and shrubs, including:	
Deciduous	1136
Conifers	470
Naturally growing plants	251
Herbaceous plants, including:	
Medicinal and spice plants	479
Herbaceous ornamental plants	1179
Seaside dune plants	43

SCIENTIFIC ACTIVITIES

Projects

›European Regional Development Fund project "Enhancing the awareness of Lithuanian botanical gardens by e-marketing tools ", 2016-2017 with Lithuanian universities botanic garden association.

›„Plungė smart park" partners with Plungės district municipality library. 2016.

Publications

2015

1. R. Nekrošienė. Parterres in Southern Sweden: Diversity and Prevalance of Flowers. Miestų želdynų formavimas. Mokslo darbai // Formation of Urban Green Areas. Scientific Articles, 2015, Nr. 1 (12). P. 202-207.

2016

1. R. Skuodienė, K. Katutis, R. Nekrošienė, R. Repšienė, D. Karčauskienė. Effects of soil properties and humidity regimes on semi-natural meadow productivity // Acta Agriculturae Scandinavica, Section B – Soil and Plant Science. Vol. 66, Issue 8: Soil degradation: theory, evidence and protection activities, 2016. P. 653-663.
2. A. Klimienė. Botanical garden of Klaipėda university: location, landscape and collections situation // The 9th International Meeting and Conference of Botanic Gardens Network from the Baltic Sea Region "The new challenges and collaboration tasks for botanic gardens from the Baltic Sea Region". October 5-8, 2016 Przelewice, Poland.

2017

1. A. Klimienė, L. Normantė. *Larix* genus in Botanic garden of Klaipėda University – West Lithuania // III Rytų ir Centrinės Europos Botanikos sodų konferencija. Budapest, October, 2017, Hungary.
2. A. Klimienė, R. Goliakovienė. The situation of green areas of towns in Klaipėda district and their planting trend // Tarptautinė mokslinė-praktinė konferencija miestų želdynų formavimas 2017. Klaipėda, gegužės mėn., 2017, Lietuva.

VISITORS PER YEAR

	2015	2016	2017
Number of visitors	20 398	20 420	20 450

STRUCTURE AND STAFF
(sum of work loads)

	2015	2016	2017
Administration	3	3	3
Scientists	1	1	1
Specialists (agronomists, biologists)	4	4	4
Field workers	7	6	5
TOTAL including:	**15**	**14**	**13**
PhD	1	1	1
Msc	2	2	2

FINANCES (IN EUR)

	2015	2016	2017
Income			
State budget subsidy	115 560	126 000	121 000
Other income (tickets, plants, etc.)	18 000	26 000	19 000
TOTAL	**133 560**	**152 000**	**140 000**
Expenses			
Salaries, with tax	115 560	126 000	121 000
Infrastructure maintenance and development	18 000	26 000	19 000
TOTAL	**133 560**	**152 000**	**140 000**

ŠIAULIAI UNIVERSITY BOTANICAL GARDEN

Address	Paitaičių g. 4, LT-77175, Šiauliai, Lithuania
Phone	+370 659 93748
e-mail	rita.sulskiene@su.lt
www	www.bs.su.lt
Director	Martynas Kazlauskas
Territory area	6,54 ha

LIVING PLANT COLLECTIONS

Total No. of taxa (2017): **4400**

Main taxa	No. of taxa
Indoor plants, including:	300
Succulents	180
Pelargonium	60
Others	60
Trees and shrubs, including:	960
Coniferous	280
Deciduous	680
Herbaceous plants, including:	3140
Native flora species	190
Introduced species	1800
Ornamental	1150

HERBARIUM

No. of specimens (2017): **12 500**

SCIENTIFIC ACTIVITIES

The scientific research carried out in the botanical garden is related to the introduction and acclimatisation of ornamental plants, plant biodiversity conservation *ex-situ* and *in-situ* as well as phenological observations under programme of Phenological Gardens of Europe (IPG). Garden serves as a experimental place for some species of pharmaceutical interest. The garden also serves as a training and research base for Šiauliai university students.

Publications

2015

1. A. Klimienė, R. Vainorienė, K. Grušas, V. Juknevičius. Natūralistinio gėlyno įrengimas Šiaulių miesto viešojoje erdvėje // Miestų želdynų formavimas, 2015, 1(12) 183–188.
2. A. Klimienė, R. Dubosaitė-Lepeškevičė, I. Šakytė,V. Juknevičius.Žoliniai dekoratyvieji

augalai viešųjų erdvių želdinimui // Miestų želdynų formavimas, 2015, 1(12): 177-182.

2016

1. A. Klimienė, R. Vainorienė, R. Klimas. Phenological research of climate changes in the north part of Lithuania by the phenological garden of Šiauliai University // International journal of biometeorology, 2016, 1-9.
2. R. Vainorienė. Modelinio augalo žaliosios šerytės (*Setaria viridis* (L.) P. Beauv.) savybės, paplitimas agrocenozėse ir urbanizuotoje aplinkoje // Miestų želdynų formavimas, 2016, 1(13) 381–388.

2017

1. L. Raudone, K. Zymone, R. Raudonis, R. Vainoriene, V. Motiekaityte, V. Janulis. Phenological changes in triterpenic and phenolic composition of *Thymus* L. species // Industrial crops and products, 2017, 109: 445-451.

OTHER ACTIVITIES

2015

›The section of alpine plants increased by 230 species, dendrology – 220, ornamental plants – 120 taxa. Two environmental protection projects, funded by municipality were completed. Personnel of the botanical garden took part in nine conferences and seminars, thirty two interviews press were provided.

2016

›One environment protection project, funded by municipality were completed. Personnel of the botanical garden took part in one conference, press was provided with twenty interviews. International festival “Tarptautinis Tytuvėnų festivalis” held in territory of botanical garden.

2017

›Herbarium with 12 500 specimens, registered in New York database was incorporated in structure of Botanical garden. Two environment protection projects, funded by municipality were completed. Personnel of the botanical garden took part in four conferences, press was provided with seven interviews.

VISITORS PER YEAR

	2015	2016	2017
Number of visitors	15 000	12 000	11 000

STRUCTURE AND STAFF
(sum of work loads)

	2015	2016	2017
Administration	1,25	1,25	1,25
Cleaning Service	1	1	1
Researchers	2,75	2,75	1
Collection curators	3,5	3,5	3,5
Landscape architect	0,5	0,5	0,5
Laboratory technician	0,5	0,5	0
Staff of museum	0	0	0,25
Field workers	2,75	2,75	3,25
TOTAL	12,25	12,25	10,75

FINANCES (IN EUR)

	2015	2016	2017
Income			
Subsides from university	105 034	95 553	85 105
Subsides from state government	14 922	29 200	0
Other income (tickets, educations, etc.)	3588	4180	8827
TOTAL	123 544	128 933	93 932
Expenses			
Salaries	82 841	92 231	84 968
Infrastructure	14 922	29 200	0
Other expenditures	25 781	7502	8964
TOTAL	**123 544**	**128 933**	**93 932**

ARTICLES

Collection of wild rhododendron species at the University of Latvia Botanical Garden and Rhododendron Breeding and Experimental Nursery "Babīte"

Gunita Riekstiņa

Rhododendron Breeding and Experimental Nursery "Babīte", Botanical Garden of the University of Latvia, "Rododendri", Spilve, Babītes pag., LV-2101, Latvia, gunita.riekstina@lu.lv

Abstract

Under the guidance of Prof. Rihards Kondratovičs, the University of Latvia Botanical Garden and Rhododendron Breeding and Experimental Nursery "Babīte" have established a remarkable collection of outdoor rhododendrons consisting of 83 wild species and 289 cultivars, which have successfully passed the test of time and are suitable for Latvian climatic conditions. The collection is used for breeding, and the work has resulted in 117 new outdoor rhododendron cultivars.

Keywords: Rhododendrons, plant collection, introduction, breeding.

CLIMATIC CONDITIONS

The history of rhododendrons as ornamental plants in Latvia is quite recent. They first appeared at the beginning of the 19th century, gaining extensive popularity only at the end of the 20th century. This can largely be explained with Latvian climate, which is much more severe and volatile than in Central and Western Europe. The climate of Latvia is determined by the Baltic Sea, which does not freeze in the winter, and the prevailing winds of the south, south-west and west. The average annual precipitation is 667 mm. The highest observed air temperature in Latvia is +36.4°C, while the lowest air temperature is -43.2°C. Milder climate reigns in the western part of the country along the Baltic Sea and the coast of the Gulf of Riga, where wet and warm air masses from the Atlantic often cause cloudy and rainy weather.

Such a climate is generally suitable for rhododendron cultivation; however, some years bring very unfavourable conditions for hibernation of rhododendrons. The main challenge is the changing weather in winter, when frost is often succeeded by thaws. Temperature fluctuations sometimes exceed 15 to 20°C within 24 hours. Such conditions cause flower bud and leaf damage in many rhododendron species and cultivars, whereas very harsh winters, when the earth is deeply frozen for long periods on time, cause drying out of the evergreen rhododendrons in spring, – as the weather becomes warm, water evaporates from the leaves, while the frozen soil prevents the roots from delivering the water. The early flowering rhododendrons are also imperilled by spring frosts that cause damage to flowers, young shoots, as well as leaves.

BOTANICAL GARDEN

The Botanical Garden of the University of Latvia in Riga laid the foundations of its outdoor rhododendron collection as early as in the 1930s. The rhododendron plants at the time were purchased in Germany. The collection comprised approximately 30 rhododendron varieties, including wild species like *R. brachycarpum* D. Don ex G.Don, *R. calendulaceum* (Michx.) Torr., *R. catawbiense* Michx., *R. degronianum* Carriere, *R. ledebourii* Pojark., *R. ponticum* L., *R. smirnowii* Trautv., *R. viscosum* (L.) Torr., as well as cultivars 'Cunningham's White' and 'Aida'. Most of them were destroyed in the severe winters of 1939/40 and 1940/41. Only a few winter hardiest survived, and thus after World War II just three evergreen rhododendrons remained at the Botanical Garden: *R. brachycarpum, R. ledebourii,* 'Cunningham's White', and one deciduous cultivar 'Aida'. Only 'Aida' has persevered through the years and remains in the collection today. In 1952, agriculturist Viktors Vārna supplemented the collection by planting a large group of R. luteum 'Sweet', which continues rich and exquisite blossoming.

Intensive work with rhododendrons began in 1957 under the leadership of Rihards Kondratovičs, the director of the Latvian State University Botanical Garden. At that time, the theme of introduction and acclimatization of rhododendron genus was included in the scientific research plans. The original goal was to collect as large a collection of rhododendron species and cultivars as possible to test their winter hardiness and ability to survive in Latvian conditions. The opportunities offered by seed exchange among the world's botanical gardens enabled ordering seeds of rhododendron wild species from botanical gardens and parks of different countries (Germany, Norway, Great Britain, Russia, USA, Canada, Netherlands, and Czechoslovakia).

The seeds were also collected during expeditions to Far East, Caucasus and the Carpathian Mountains. Many plants were also obtained through personal contacts, and in the 1960s, V. Zorikova *(Зорикова В.Т.)* from the Vladivostok Botanical Garden sent the seeds of *R. sichotense* Pojark., *R. ledebourii* and *R. dauricum* L. harvested in the wild, as well as the seeds of *R. dauricum*. The suitability of 102 wild species for growing in Latvia was tested within the period from 1957 to 1964. A part of these species perished in the first or second year after planting outdoors. 76 species were recognized as suitable. The results of eight years of work were summarized in candidate thesis of R. Kondratovičs "Introduction of Rhododendrons to LSSR".

In addition to wild species, the collection was augmented with rhododendron cultivars developed in Western Europe. In 1966 and 1968, chemist and gardener Prof. S. Kruglikov *(Кругликов С.С.)* from Moscow, owing to his contacts with the British Embassy, helped organize sending of seedlings and grafts through diplomatic mail. Thus, the collection was supplemented with the evergreen rhododendron varieties grown in England: 'Blue Diamond', 'Blue Peter', 'Britannia', 'Elizabeth', 'Midsummer', 'Purple Splendor', 'Earl of Athlone', 'Elspeth', 'Goldsworth Crimson', 'Goldsworth Orange', 'Letty Edwards', 'May Day', 'Mrs. Charles E. Pearson', 'Mrs. Furnivall', 'Mrs. P.D. Williams', 'Mrs. R.G. Shaw', 'Philip Martineau', 'Saturne', 'Scandinavia', 'Sir John Ramsden', 'Souvenir of W.C. Slocock', 'Susan'.

Collaboration was also established with rhododendron breeders Alžběta Dostálková and Karel Hieke from Průhonice Rhododendron Breeding Centre, the then Czechoslovakia. From 1972 to 1976, evergreen rhododendron seedlings and grafts were received from Průhonice, including the cultivars 'Arnošt Silva-Tarouca', 'Don Juan', 'Humoreska', 'Petr', 'Lajka', 'Marka', 'Panenka' and 'Sputnik'. Unfortunately, most of these breeds did not

survive the harsh outdoor conditions. Only the winter-hardiest cultivars withstood the weather: 'Blue Peter', 'Elizabeth', 'Midsummer', 'Petr' and 'Purple Splendour'. The cuttings of ten deciduous rhododendron cultivars were received from Průhonice in 1987: 'Gibraltar', 'Golden Eagle', 'Golden Sunset', 'Homebush', 'Hotspur Red', 'Silver Slipper', 'Toucan', 'Feuerwerk'; 'Ledikanense' and 'Luzi', as well as the evergreen rhododendrons 'Lunik' and 'Milan'.

In addition to rhododendron introduction work, the nursery developed the specific cultivation and propagation techniques, studied physiological and biochemical processes and organogenesis in the rhododendron adaptation process, as well as their application potential in public and individual greenery.

The collection of rhododendron species and cultivars created in the Botanical Garden provided the opportunity for starting the breeding of new cultivars. The most interesting hybrids grown from free pollination seeds were selected during the initial years. Targeted cross-breeding of outdoor rhododendrons began in 1971. Since the main task of Latvian breeders was to create resilient and winter-hardy rhododendrons, the species of wild rhododendrons suitable for Latvian weather conditions were used for cross-breeding: *R. arborescens* Torr., *R. catawbiense* Michx., *R. caucasicum* Pall., *R. brachycarpum* D. Don ex G. Don f., *R. japonicum* Suring., *R. luteum* Sweet, *R. prinophyllum*, *R. smirnowii*, *R. yakushimanum*. These species were interspersed with ornamental but rather fragile Western European cultivars: 'Mrs. P. O. Williams', 'Britannia', 'Mrs. Furnivall', 'Purple Splendour', 'Scandinavia', 'Philip Martineau', 'A. Silva Tarouca', 'Mrs. R. G. Shaw' and others. As a result, tens of thousands of hybrid seedlings were produced, which required large areas of land to grow until flowering. Since the Botanical Garden could not provide sufficient space, a specialized nursery for rhododendron breeding had to be established.

RHODODENDRON NURSERY "BABĪTE"

Rhododendron Breeding and Experimental Nursery "Babīte" was established in 1980, opening up new possibilities for the introduction and selection of rhododendrons. Currently, it is the only specialized rhododendron nursery in the Baltic states, covering the area of 11.8 ha. The nursery was headed by Rihards Kondratovičs until February 2017, when he passed away. With the establishment of the nursery, work with rhododendrons was mainly implemented in the newly established nursery, and the Botanical Garden retained only the rhododendron display and part of the breeding material.

The nursery is located close to Riga, in the territory of Babīte, in a beautiful pine forest. The location proved to be very suitable for rhododendron cultivation. Pine forest soil, enhanced by sphagnum peat, is an ideal substrate for rhododendron cultivation. Pine trees, in turn, provide the rhododendrons with the required half-shade. The master plan of the nursery was developed by garden architect Kārlis Barons. The area is divided into quarters of 600 m^2, which are used for growing plants, breeding and experiments. An asphalt road runs along the perimeter of the nursery, and the expositions of rhododendron species and cultivars stretch alongside it. 83 wild species from the USA, Europe, China, Japan and 289 cultivars developed by breeders are represented in the collection.

A significant part of the plants was brought from the Botanical Garden at the time of creating the collection. Continued cooperation with rhododendron breeders from other countries: *Baumschule Hachmann, Baumschule Bruns, Rhododendron Park Bremen,*

Piccoplant in Germany; Helsinki University and Arboretum Mustila in Finland; *Weston Nurseries* in the USA contributed the most beautiful cultivars created by breeders – *T.J.R. Seidel, H. Hachmann, M. Uosukainen, E.V. Mezitt* and others.

The main task of the nursery was rhododendron breeding with the aim of creating decorative and winter-hardy outdoor rhododendron cultivars suitable for Latvian climate conditions. Registration of new cultivars commenced in 1999. The cultivars are registered in the International Rhododendron Register maintained by the British Royal Horticultural Society. 117 outdoor rhododendron cultivars has been registered, 65 of which are evergreen, and 52 – deciduous rhododendrons. The author of cultivars is plant breeder, Professor Rihards Kondratovičs.

To promote fast propagation of the new cultivars and to maintain the collection of cultivars *in vitro*, the Botanical Garden Plant Tissue Culture Laboratory was established in 1992. The laboratory cultivates 5000–6000 saplings of rhododendron cultivars and hybrids annually.

Simultaneously with the introduction and selection of rhododendrons, specialists of the nursery extensively promote these plants, introducing the genus to gardeners and anyone interested in rhododendrons, providing advice regarding rhododendron cultivation and propagation techniques, as well as their practical use in planting the green areas. Books and brochures are published, excursions and seminars organized. The nursery is a place of study and practice for students. Every year in May and June, during the rhododendron flowering, the University of Latvia Botanical Garden and the Rhododendron Nursery "Babīte" overflow with visitors who admire the exquisite plants, many of which in the course of 60 years have reached impressive height – 4 to 5 metres.

Grassland species collection in the Botanical Garden of the University of Latvia

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Abstract

The aim of the Grassland species collection at the Botanical Garden of the University of Latvia is to create different grassland habitat species sample collection which is obtained from the characteristic, as well as rare and endangered species of grassland habitats in Latvia.

Species are collected in the wild in different parts of Latvia as seeds or seedlings. In total, there are 76 species collected in grassland habitats comprising not only common species, but also rare, endangered as well as indicator species of biologically valuable grasslands. From the species represented in the collection, 10 are included in the Red Data Book of Latvia and 19 are indicator species for natural grasslands in Latvia. These are characteristic species of semi-natural dry grasslands and species-rich dry to mesic grasslands.

Keywords: natural habitats, grasslands, rare species.

INTRODUCTION

The issue of preservation and protection of native plants has become more and more important due to natural habitat degradation, increasing anthropogenic impact (Heywood, Iriondo, 2003) and extensive agriculture (Sutherland, 2002). Plant diversity is currently being lost at an unprecedented rate (Chen, Sun, 2018). Human land use is among the most important determinants of grassland biodiversity (Maurer et al., 2006). Intensification of management on both grassland and arable areas has had profound impacts on the nature conservation value and landscape integrity throughout much of Europe (Hopkins, Holz, 2005; Wissman et al., 2008). Species composition and diversity in grasslands depends on management, its intensity and methods (Maurer et al., 2006; Priede, 2017) and low-intensity farming promotes biodiversity (Maurer et al., 2006). Many grassland species are persisting in the modern landscape and mostly these are non-threatened species (Wissman et al., 2008).

Semi-natural grasslands are one of the species richest habitats in the world (Rūsiņa, 2018) and the highest vascular plant species numbers are found at the tiny scale of a few square centimeters to one square meter in temperate grasslands (Pärtel et al., 2005). Semi-natural grasslands are very important for the conservation of biological diversity in Europe (Rūsiņa, 2005). The common feature of all European species-rich natural grasslands is that they have a relatively low vegetation and low productivity (Pärtel et al., 2005). Low-intensity farmland provides habitats for invertebrate and other faunal groups and delivers a range of ecosystem and socio-economic functions (Hopkins, Holz, 2005).

Semi-natural grasslands are only 10% of all grassland territory of Latvia (Rūsiņa, 2018). The largest number of rare species in Latvia is found in forests and grasslands, which are the dominant vegetation types in Latvia (Gavrilova, 2003). In semi-natural grasslands in Latvia there are about 33% of rare and endangered plant species which are included in the Red Data Book of Latvia (Rūsiņa, 2018).

The aim of the Grassland species collection at the Botanical Garden of the University of Latvia is to create different grassland habitat species sample collection which is obtained from the common species, as well as rare and endangered species of grassland habitats in Latvia. The task for Grassland collection is to collect species samples and grow them *ex situ*.

MATERIAL AND METHODS

All plant material is collected in the wild. Seeds or seedlings are collected depending from plant quality and conditions. The seeds are sown either in the autumn to have stratification or in the spring in pots providing the necessary germination and growth conditions. A mixture of peat, gravel and compost is used for seed sowing. Seedlings after collection are planted in pots, to provide the necessary moisture conditions and increase the chance of growth.

RESULTS AND DISCUSSION

Grassland species collection is one of the most recent collection which was created in 2014. It is available for viewing and is significant for public awareness (Photo 1). In total, it occupies 265 m^2 and consists of 76 plant species (Table 1). The location and soil composition are suitable for characteristic species of semi-natural dry grasslands, species-rich dry to mesic grasslands as well as other species characteristic for dry soils.

Photo 1. Grassland species collection in the Botanical Garden of the University of Latvia. *Photo by Lauma Strazdiņa*

Table 1. Species in Grassland species collection in the Botanical Garden of the University of Latvia

Species	Family	Indicator species of biologically valuable grasslands	Red Data Book of Latvia, definition of the categories	Regulations of Minister Cabinet, specially protected species list
Achillea millefolium L.	Asteraceae			
Agrimonia eupatoria L.	Rosaceae	x		
Allium oleraceum L.	Liliaceae			
Antennaria dioica (L.) Gaert.	Asteraceae	x		
Anthemis tinctoria L.	Asteraceae			
Armeria vulgaris Willd.	Plumbaginaceae		I	
Artemisia campestris L.	Asteraceae			
Artemisia vulgaris L.	Asteraceae			
Astragalus glycyphyllos L.	Fabaceae			
Campanula persicifolia L.	Campanulaceae			
Carlina vulgaris L.	Asteraceae			
Centaurea jacea L.	Asteraceae			
Centaurea phrygia L.	Asteraceae			
Cichorium intybus L.	Asteraceae			
Cirsium acaule Scop.	Asteraceae	x		
Corynephorus canescens (L.) P. Beauv.	Poaceae		III	
Crepis praemorsa (L.) Tausch	Asteraceae		III	x
Dactylis glomerata L.	Poaceae			
Deschampsia cespitosa (L.) P. Beauv.	Poaceae			
Dianthus arenarius L.	Caryophyllaceae			x
Dianthus deltoides L.	Caryophyllaceae	x		
Digitalis grandiflora Mill.	Scrophulariaceae		III	
Echium vulgare L.	Boraginaceae			
Euphorbia virgata Waldst. et Kit.	Euphorbiaceae			

Festuca ovina L.	Poaceae			
Festuca trachyphylla (Hack.) Krajina	Poaceae			
Filipendula vulgaris Moench	Rosaceae	x		
Fragaria viridis Weston	Rosaceae	x		
Gentiana cruciata L.	Gentianaceae		III	x
Geranium pratense L.	Geraniaceae			
Helianthemum nummularium (L.) Mill.	Cistaceae		III	x
Helichrysum arenarium (L.) Moench	Asteraceae			
Helictotrichon pratense (L.) Besser	Poaceae	x		
Heracleum sibiricum L.	Apiaceae			
Hylotelephium triphyllum (Haw.) Holub	Crassulaceae			
Hypericum perforatum L.	Hypericaceae			
Jovibarba globifera (L.) J. Parn.	Crassulaceae			x
Koeleria glauca (Spreng.) DC.	Poaceae	x		
Lathyrus sylvestris L.	Fabaceae			
Leucanthemum vulgare (Lam.) DC.	Asteraceae			
Linaria vulgaris Mill.	Scrophulariaceae			
Lychnis viscaria L.	Caryophyllaceae	x		
Melandrium album (Mill.) Garcke	Caryophyllaceae			
Melilotus albus Medik.	Fabaceae			
Molinia caerulea (L.) Moench	Poaceae			
Onobrychis arenaria (Kit.) DC.	Fabaceae		II	x
Ononis arvensis L.	Fabaceae			
Origanum vulgare L.	Lamiaceae			
Pastinaca sativa L.	Apiaceae			
Peucedanum oreoselinum (L.) Moench	Apiaceae		III	
Phleum phleoides (L.) H. Karst.	Poaceae	x		
Pilosella officinarum F.W. Schultz et Sch. Bip.	Asteraceae			
Plantago lanceolata L.	Plantaginaceae			

Plantago major L.	Plantaginaceae			
Plantago media L.	Plantaginaceae	x		
Polygala amarella Crantz	Polygalaceae	x		
Potentilla arenaria Borkh.	Rosaceae			
Potentilla reptans L.	Rosaceae			
Primula veris L.	Primulaceae	x		
Prunella vulgaris L.	Lamiaceae			
Rumex thyrsiflorus Fingerh.	Polygonaceae			
Sedum acre L.	Crassulaceae	x		
Senecio jacobaea L.	Asteraceae			
Seseli libanotis (L.) K. Koch	Apiaceae		III	
Solidago virgaurea L.	Asteraceae			
Stachys officinalis (L.) Trevis.	Lamiaceae	x		
Tanacetum vulgare L.	Asteraceae			
Thymus ovatus Mill.	Lamiaceae	x		
Thymus serphyllum L.	Lamiaceae	x		
Trifolium montanum L.	Fabaceae	x		
Verbascum nigrum L.	Scrophulariaceae			
Verbascum thapsus L.	Scrophulariaceae			
Veronica officinalis L.	Scrophulariaceae			
Veronica spicata L.	Scrophulariaceae	x		
Veronica teucrium L.	Scrophulariaceae			
Vincetoxicum hirundinaria Medik.	Asclepiadaceae		III	

Status of indicator species of biologically valuable grasslands is determined by S. Rūsiņa (2017). From the species present in the collection, 19 are indicator species for natural grasslands in Latvia: *Agrimonia eupatoria* L., *Antennaria dioica* (L.) Gaert., *Cirsium acaule* Scop., *Dianthus deltoides* L., *Filipendula vulgaris* Moench, *Fragaria viridis* Weston, *Helictotrichon pratense* (L.) Besser, *Koeleria glauca* (Spreng.) DC., *Lychnis viscaria* L., *Phleum phleoides* (L.) H. Karst., *Plantago media* L., *Polygala amarella* Crantz, *Primula veris* L., *Sedum acre* L., *Stachys officinalis* (L.) Trevis., *Thymus ovatus* Mill., *Thymus serphyllum* L., *Trifolium montanum* L. and *Veronica spicata* L.

Of all species present in the collection 10 are included in the Red Data Book of Latvia (Andrušaitis, 2003) – *Armeria vulgaris* Willd., *Corynephorus canescens* (L.) P. Beauv., *Crepis praemorsa* (L.) Tausch, *Digitalis grandiflora* Mill., *Gentiana cruciata* L., *Helianthemum nummularium* (L.) Mill., *Onobrychis arenaria* (Kil.) DC., *Peucedanum oreoselinum* (L.) Moench, *Seseli libanotis* (L.) K. Koch and *Vincetoxicum hirundinaria* Medik. Most of the species represent the 3rd – rare species – category from the Red Data book of Latvia. They have no threat of extinction yet, but may probably disappear.

6 species are included in regulations of Minister Cabinet, Terms of specially protected species and limited use of specially protected species list (Anonymus, 2000) – *Crepis praemorsa* (L.) Tausch, *Dianthus arenarius* L., *Gentiana cruciata* L., *Helianthemum nummularium* (L.) Mill., *Jovibarba globifera* (L.) J. Parn. and *Onobrychis arenaria* (Kit.) DC.

The collection contains both biennial and perennial herbs. It is important to evaluate the growth form of existing species to provide the necessary growth conditions for each species and to prevent the impact of increased competition. Evaluating plant habitus, it is possible to ensure optimal conditions of competition for plant growth. Many plants show good self-sowing, so plants in the collection need to be limited and controlled. Adding new species to the collection will provide greater diversity of grassland species and will enable them to be grown ex situ.

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100 years of horticulture in Tallinn Botanic Garden

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Abstract

Most of the exposition of the Tallinn Botanic Garden (TBG), founded in 1961, is located in the grounds of Kloostrimetsa farm formerly owned by Konstantin Päts, the first president of Estonia. In 2018, it was 100 years since the Republic of Estonia had been established and also since Kloostrimetsa horticultural farm had been set up. The festive occasion was celebrated with the year of horticultural history, featuring the installation of information stands with materials about the how Kloostrimetsa farm was run as well as horticulture in general in 1920s–1930s. Special information labels also marked the remaining trees of the farm's orchard. The layout of the beds of summer flowers in the TBG front square drew inspiration from the principles of garden design of the respective time period. The sources of information primarily comprised materials from the Estonian National Archives and horticultural publications of the time. The comparison of species and cultivars used in ornamental horticulture showed that the species used today are generally the same and only cultivars differ. Thematic guided tours for the TBG visitors were organised. The symbolic opening event of the anniversary year was the blooming of 'Estonia' tulip cultivar, a gift from the embassy of the Netherlands.

Keywords: history of Tallinn Botanic Garden, summer flowers, horticulture of 1920s–1930s.

INTRODUCTION

The period of 1920s–1930s was characterised by extensive changes in Estonian horticulture as domestic horticultural research started developing, forming the terminology base for the emergence of horticultural education. Latest guidelines reached enthusiasts through specialist literature. The predecessor of the Tallinn Botanic Garden, Kloostrimetsa farm, used science-based methods of farming and horticulture.

KLOOSTRIMETSA FARM AS THE PREDECESSOR OF THE TBG

Founded by President Konstantin Päts, who was a gardening enthusiast, Kloostrimetsa farm excited attention because of its diverse state-of-the-art garden, rational layout and the buildings which blended harmoniously with the landscape (Photo 1). According to the Estonian National Archives (ENA), in addition to the cultivation of commonly grown crops, the farm experimented with growing grapes, artichokes and watermelons. Nowadays, the foundation of the greenhouse built back then for heat-loving crops, supports the tropical glasshouse of the TBG, symbolising continuity. The gems of the Kloostrimetsa farm orchard with its 1,500 fruit trees were apple trees received as presents, some of which were exceptionally rare for Estonia, for example, the Finnish

'Kuninkala', the 'Korobovka' cultivar bred by non-professionals in Russia over the course of history, and the 'Komsomolets' bred by the Russian selectionist Ivan Michurin (ENA; Kask 2018). The last two cultivars are characterised by such remarkable winter-hardiness that they survived the severe winter of 1939–1940 and still grow by the entrance to the farm grounds and next to the rose garden.

Information stands provide TBG visitors with information about the trees remaining from the original farm, which are the 'Korobovka' apple cultivar and common beech (*Fagus sylvatica*). If the summer is dry, traces of planting holes can still be seen in the area of the former orchard. Namely, according to TBG chief dendrologist Olev Abner, planting holes 3 metres in diameter were made for each plant in the sandy soil, lined with clay and filled with a mixture of soil and compost.

Photo 1. President Konstantin Päts in the garden on Kloostrimetsa farm.
Photo: ENA, ERA 1278.1.314.16p.1

Photo 2. Orchard with beds of dahlias.
Photo: ENA, ERA 1278.1.314.18p.1

Pesticides and equipment that were developed in Estonia on the basis of scientific recommendations were used in the orchard of Kloostrimetsa farm for the production of export-grade fruit. Continuous supply of young plants was provided by the farm's own nursery garden (ENA). Currently the apple cultivars mentioned above can be found in the Polli Horticultural Research Centre collection garden of the Estonian University of Life Sciences, and their grafts have been taken to private gardens (Kask 2018).

In addition to the market garden on Kloostrimetsa farm, a gardener with appropriate education also cared for the ornamental garden, in which the selection of cultivars and the layout reflected the landscape design trends of the period (ENA; Port 1935). Straight paths between the buildings were edged with long rows of dahlias and peonies (Photo 2).

While dahlias, despite their labour-consuming maintenance, had been growing in the farm garden since the period of the Russian Empire, peonies became the centre of attention in the early years of the era of the Republic of Estonia (Banner 2018).

The ornamental garden of Kloostrimetsa farm had primarily been situated in front of the manor, where standard tree roses caught one's eye, creating a distinct Art Nouveau effect. To recognise President Konstantin Päts's interest in horticulture and fruitful cooperation, the Späth nursery in Berlin named a rose cultivar bred by Christoph Weigand in 1937 'Staatspräsident Päts'. The hybrid tea rose cultivar was developed by cross -breeding the 'Ofelia' and 'Souvenir de Claudius Perne' cultivars. The cultivar has large cream-primrose flowers with petal colour fading to a lighter shade. The shrub grows 70 cm tall. The rose cultivar displays medium disease and winter hardiness and

is the most susceptible to rose rust fungus. Work is performed on cultivar sanitation in collaboration with the German gene bank. The rose cultivar named after the president is a rare one can only be found in collection gardens outside Estonia. In addition to the TBG, it also grows in the rose garden of the Presidential Palace in Kadriorg.

One of the garden design trends of the period was closeness to nature, which is why preference had been given to free-form shrubs over labour-consuming trimmed hedges on Kloostrimetsa farm (ENA). Mock-oranges, which were gaining popularity in the 1930s, were added to the lilac cultivars that were fashionable in the 1920s. Spots of colour in the garden of Kloostrimetsa farm were provided by Siberian crab apples (*Malus baccata*), purple crab apples (*Malus ×purpurea*) and common beech (*Fagus sylvatica*). The introduction of the latter tree species in Estonia was especially boosted in 1930s due to its shade hardiness and beautiful autumnal colours (Abner, personal communication). However, the general selection of ornamental plant species in 1920s–1930s was relatively similar to the selection of the present day - the only difference is the cultivars.

The leading horticultural farm served as practice grounds for students of home economics schools. The scholarship awarded by President K. Päts allowed Aleksander Niine, future landscape architect at the botanic garden, to obtain higher education in England. By designing the layouts, Aleksander Niine had largely shaped today's general landscaping solution of the botanic garden.

The overall image of Estonian landscapes was greatly influenced by the home decoration campaign held in 1936-1938 under the patronage of President Päts. During the campaign, Dozens of kilometres of new roads were constructed. Green hedges and alleys were laid, and thousands of fruit trees and berry shrubs were planted, and the nursery on Kloostrimetsa farm was among those to have provided participants with young plants. In addition to private gardens, the surroundings of public buildings and monuments were landscaped, plans for new school gardens and parks were devised, and thousands of buildings were painted. Acclimatization of introduced tree species continued in the parks of Kadriorg, Keila-Joa and Oru, and experimental gardens were laid for the cultivation of indigenous ornamental plants found in natural habitats. Recommendations were given on how to plant a flower garden or an alpine garden (Tammet 2003).

SUMMER FLOWERS 100 YEARS AGO

Summer flowers were broadly used in garden design as early as in the first years of the existence of the Republic of Estonia not only in urban gardens and parks, but also in rural gardens. Simple lines were preferred in the design of flower beds while hearts, stars and other complex geometric figures were out of the question. Flower towers and mound beds, so popular nowadays, were considered tasteless. Flowers were placed on the bed in groups or in uniform rows. Haphazard and patchy arrangements were not use. Simple pattern flower beds with low flowers, large groups of flowers in grass and edging pathways with 'ribbons' of flowering plants were popular (Tääger 1939).

In selecting plant cultivars, preference was given to pure colours and combinations of contrasting colours: blue and yellow, red and green, etc. Approaches to decorating public spaces and city squares included powerful colour effects and mass planting of the same cultivar of flowers. As far as species of summer flowers were concerned, their selection in the 1920s–1930s was similar to what is today, but the cultivars differed. One wide-spread solution featured planting exotic greenhouse plants, for example, agaves

Photo 3. Bed of summer flowers on the TBG front square in the style of 1920s–1930s. *Photo by Krista Kirotar*

Photo 4. President Konstantin Päts's grandson Madis Päts during the opening of an information stand on 25 May 2018. *Photo by Marit Mäesaar*

(*Agave*), palm trees (*Palmae*), laurel trees (*Laurus*), cordylines (*Cordyline*), fuchsias (*Fuchsia*), etc. among summer flowers for emphasis (Port 1935).

The main source of know-how at that time was Jaan Port's major three-volume work "Handbook of practical horticulture and beekeeping" [Tegeliku aianduse ja mesinduse käsiraamat], in which volume III focuses on ornamental horticulture (Port 1935). Jaan Port was one of the most prominent pioneers of the ornamental horticulture science in Estonia and a founder of Estonian school gardens. The magazine "Aed" [Garden] was published between 1923 and 1940, featuring comprehensive articles on ornamental horticulture and general trends in garden design. To ordinary people, the magazine was

more easily accessible than books were.

Publications of the 1920s and 1930s also provide rather detailed recommendations on taking care of an ornamental garden to ensure that it stays in order and looks nice. One of the most memorable quotes from J. Port's book is the following: "It is not right when taking care of the garden becomes an obligation of only one family member whereas others think they have the right to comment and criticize. No, garden maintenance is a job for the whole family, preferably following the advice given by the most experienced of them (garden owner)." (Port 1935).

In 2018, the front square of the TBG became an illustration of the use of summer flowers in garden design during the early years of the Republic of Estonia. The cultivars that were common 100 years ago have not been preserved, so we planted the flower beds with modern cultivars of the species used at the time. The shape and design of the flower beds in front of the palm greenhouse perfectly matched the design principles of the period: long straight beds arranged symmetrically and one round bed in the centre.

On these flower beds, we planted summer flowers that are sown on the spot as well as those pricked out as seedlings; in addition, there were some annual climbing plants. During the summer, the square displayed 68 species and cultivars of summer flowers in colour combinations of blue and yellow and of red and white. On the round patterned flower bed, we planted low blue and yellow flowers and placed a stunning mediterranean dwarf palm (*Chamaerops humilis*) in the centre (Photo 3).

As we researched the selection of summer flowers recommended by 100-year-old sources, it was surprising to learn that a number of plants currently perceived as novel were already known back then. These are, for example, lindheimer's beeblossom (*Gaura lindheimeri*), Mexican creeping zinnia (*Sanvitalia procumbens*), butterfly flower (*Schizanthus × wisetoniensis*), Mexican ivy (*Cobaea scandens*), hyacinth bean (*Lablab purpureus*) and swan river daisy (*Brachyscome*). A number of our elderly visitors liked it very much that we had used such widespread plants of their childhood years as sweet william (*Dianthus barbatus*), common foxglove (*Digitalis purpurea*), common hollyhock (*Alcea rosea*), annual phlox (*Phlox drummondii*), garden cosmos (*Cosmos bipinnatus*), sweet pea (*Lathyrus odoratus*), garden mignonette (*Reseda odorata*) and brompton stock (*Matthiola incana*).

CONCLUSION

The historic overview of horticulture in 1920s and 1930s, namely on Kloostrimetsa farm, captured the interest of both our visitors and the media.

Thematic guided tours held as a part of the celebration programme for the anniversary of the Republic of Estonia gave elderly visitors the joy of recognition and provided younger guests a thrill of discovery. The information stands describing horticulture on Kloostrimetsa farm will remain in place in the coming years (Photo 4).

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Garden of Senses: a new fascinating exposition in Tallinn Botanic Garden

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Abstract

The Garden of Senses, set up in Tallinn Botanic Garden in 2015, mainly contains useful plants. The target group primarily comprises people with disabilities, but other visitors who would like to study plants are welcome too. This is where one can have an opportunity to experience contact with medicinal plants, aromatic plants, cereal plants, oil crops, fibre plants, vegetables and herbs. The Garden of Senses also features fruit trees and berry bushes. Lattice side walls of pergolas climbing plants with edible fruit and clematis cultivars bred in Estonia. The Garden of Senses is an excellent place for studying new and fascinating edible plants, learn something about medicinal plants or just stopping for a rest to experience the plants with all your senses. The Garden of Senses has received a number of awards in Estonia.

Keywords: Garden of Senses, useful plants, people with disabilities.

INTRODUCTION

In 2000, a garden of useful plants was set up in Tallinn Botanic Garden (TBG) to cater for the need of introducing well-known and novel interesting commercially grown plants to visitors. For a long while, the collection of useful plants was the smallest in size and the number of taxa. In 2013, a decision was made to create a new exposition in the TBG: the Garden of the Senses, which would allow a variety of useful plants to be displayed and at the same time more diverse opportunities to be created for people with disabilities to experience contact with those plants. The two objectives were merged, construction started in April 2015, and the opening ceremony of the Garden of Senses was held on 12 August.

THE GARDEN OF SENSES AND ITS PLANTS

A number of Estonian organisations uniting people with special needs assisted in drafting the design. The authors of the design of the Garden of Senses are Kaija Arroval and the author of the paper. The layout of the Garden of Senses primarily follows the principles of healing landscape design (Maikov 2011).

In addition to people with special needs, the Garden of Senses is intended for professional and amateur gardeners, those interested in medicinal plants, food enthusiasts and also school students. Plants in the Garden of Senses can be watched, touched, sniffed, and some can even be tasted and heard, so all senses are engaged in exploration.

Most of the plants in the Garden of Senses spreading over the area of 3500 m²

were grown from seeds or collected in the wild by the author of the article. Some were purchased from Estonian nurseries. A large part of the exposition comprises annuals that are sown, which allows the species and varieties in the exposition to be changed every year.

The cross-cutting theme of the Garden of Senses is Life, so the area is divided into parts respectively: the Path of Life (A), Circle of Life (B), vegetable garden (C), meadow of medicinal plants (D) and paradise garden (E) (Figure 1).

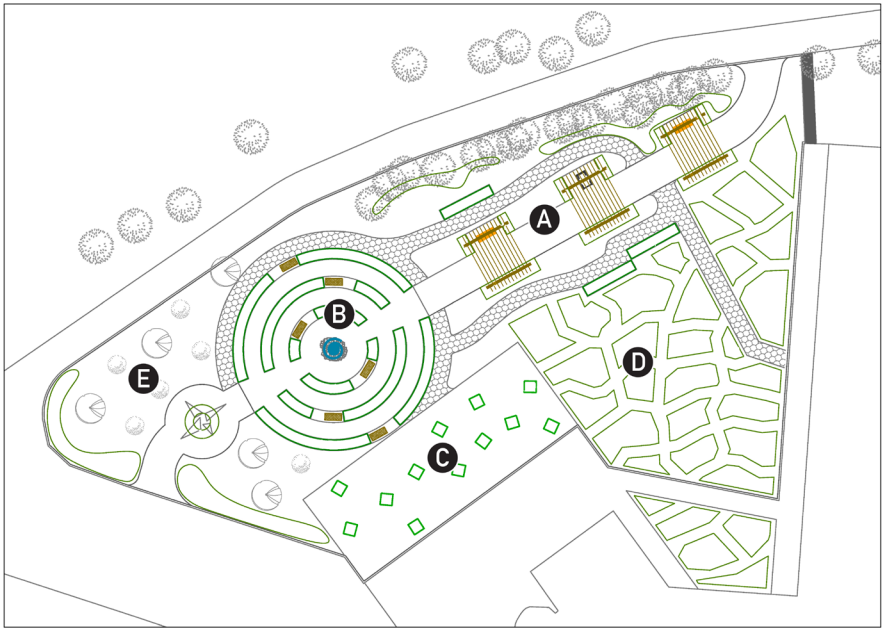

Figure 1. Diagram of the Garden of Senses

As we enter the Garden of Senses, we start on the Path of Life (Photo 1); it is seemingly long, straight, safe and peaceful, but joy and sadness go hand in hand here like they do in life. The path runs between the shaded and sunlit area, symbolising the choice between the good and evil in life. The plants on the Path of Life can be, figuratively speaking, divided into good and evil ones. The good plants include sun-loving medicinal plants, aromatic plants and herbs. The co-called evil ones can tolerate shade and are poisonous, for instance, hazelwort (*Asarum europaeum*), common snowdrop (*Galanthus nivalis*), lily-of-the-valley (*Convallaria majalis*), liverleaf (*Hepatica nobilis*) and black hellebore (*Helleborus niger*).

Along the Path of Life, there are pergolas which form a tunnel with gaps. Lattice side walls of pergolas house Estonian clematis varieties (*Clematis*). Three swing benches are hung on the beams of the pergolas, and one of these is actually a swing platform accommodated for wheelchair users.

The Path of Life takes us to the Circle of Life (Photo 2). In the centre of the Circle of Life, a small fountain quietly purrs, and this is the focus point of the Garden of Senses because water is the source of life.

The Circle of Life features curved elevated plant beds with walls of metal with a rusty

Photo 1. Path of Life. *Photo by Ave Visnapuu*

finish. On the platform paved with "Unikivi" paver outside the Circle of Life there are simple wooden crates on wheels. Their height makes exploring the plants convenient for people with impaired mobility and visually impaired visitors alike. These high plant beds mostly house annual vegetables and herbs. This is where you can find peculiar varieties of popular vegetables, for example, purple carrot (*Daucus carota* subsp. *sativus* 'Purple Haze') or yellow beets (*Beta vulgaris* subsp. *vulgaris* var. *vulgaris* 'Albina Verduna'). The herbs represented in the Garden of Senses include celery (*Apium graveolens*), parsley (*Petroselinum crispum*), dill (*Anethum graveolens*), common onion (*Allium cepa*), coriander (*Coriandrum sativum*), etc. In addition, there also are different cultivars of lettuce (*Lactuca sativa*) which have recently gained popularity.

The exposition also contains plants widely used in fresh salads, for example, rocket (*Eruca vesicaria*), cornsalad (*Valerianella locusta*), salad chicory (*Cichorium intybus* var. *foliosum*), purslane (*Portulaca oleracea* subsp. *sativa*), garden cress (*Lepidum sativum*) and many others. There is a number of cabbage varieties and legumes. Mouth-watering smells come from the beds of a number of basil (*Ocimum*) species and cultivars, rosemary (*Rosmarinus officinalis*) and garden thyme (*Thymus vulgaris*). Lemon grass (*Cymbopogon citratus*), lemon verbena (*Aloysia citriodora*) and pineapple sage (*Salvia elegans*) smell good, too. This is the section where you can study the plants known as superfoods as well, for instance, prince's-feather (*Amaranthus hypochondriacus*), chia (*Salvia hispanica*) and quinoa (*Chenopodium quinoa*). The wooden crates outside the Circle of Life also house heat-loving cultivars of squash and pumpkin (*Cucurbita*), cucumbers (*Cucumis*), tomatoes (*Lycopersicon*) and bell peppers.

Each year, the Garden of Senses is focused on one specific group of plants or theme. In 2018, a "sugar plant bed" was laid in the Garden of Senses, consolidating various sweet plants, for example, sugar beet (*Beta vulgaris* subsp. *vulgaris* var. *altissima*), sweet sorghum (*Sorghum saccharatum*), yacon (*Smallanthus sonchifolius*), liquorice (*Glycyrrhiza glabra*), candyleaf (*Stevia rebaudiana*) and honeyherb (*Lippia dulcis*).

As we walk out of the Circle of Life, we can see the Tree of Life. It was created by the employees of the Department of Ceramics of the Estonian Academy of Arts under the guidance of Urmas Puhkanen. The Tree of Life symbolises a forest giant whom people

Photo 2. Circle of Life. *Photo by Ave Visnapuu*

Photo 3. Meadow of medicinal plants. *Photo by Ave Visnapuu*

turn to with questions or wishes and to gain mental strength and energy.

From the Tree of Life, we walk on to reach the paradise garden, where lesser-known and more exotic fruit trees and berry shrubs can be found. Among other plants, this is where you can see Siberian apricot (*Prunus armeniaca*) and nanking cherry (*Prunus tomentosa*), and feel free to taste the fruits if they are ripe. The path from the paradise garden is on both sides bordered with beds planted with silvergrass (*Miscanthus*). Silvergrass is a genus of beautiful imposing herbaceous plants which rustle pleasantly in the wind, so this is where one can also listen to the plants.

As we return to the Garden of the Senses and walk through the wooden crate-beds, we reach the sunlit meadow of medicinal plants containing plant beds of curious shapes bordered with wooden fences (Photo 3). Here we have a great variety of medicinal plants,

aromatic plants and herbs. The meadow features a number of mint (*Mentha*) species and cultivars, giant hyssops (*Agastache*), hyssops (*Hyssopus*), the catmints (*Nepeta*), myrrh (*Myrrhis odorata*), lavender (*Lavandula angustifolia*) and sage (*Salvia*). Various thymes (*Thymus*) form soft cushions. The medicinal herbs comprise those well-known in our country, for instance, common yarrow (*Achillea millefolium*), wormwood (*Artemisia absinthium*), creeping thyme (*Thymus serpyllum*), oregano (*Origanum vulgare*), valerian (*Valeriana officinalis*), Greek valerian (*Polemonium caeruleum*), wild strawberry (*Fragaria vesca*) and others.

This is also where you can explore such lesser-known medicinal plants as marsh-mallow (*Althaea officinalis*), great burnet (*Sanguisorba officinalis*), skirret (*Sium sisarum*) and common rue (*Ruta graveolens*). The example of grains cultivated in Estonia are barley (*Hordeum vulgare*), wheat (*Triticum aestivum*), rye (*Secale cereale*) and oat (*Avena sativa*). In addition, there are lesser-known grains such as sorghum (*Sorghum bicolor*), common millet (*Panicum miliaceum*), common buckwheat (*Fagopyrum esculentum*) and maize (*Zea mays*). The fiber plants and oil crops displayed in the Garden of Senses are common flax (*Linum usitatissimum*), common sunflower (*Helianthus annuus*), hemp (*Cannabis sativa*), false flax (*Camelina sativa*) and rapeseed (*Brassica napus* subsp. *napus*).

The pathways in the Garden of Senses fall into those easier and more difficult to pass through. The Path of Life is even, broad and paved with wheelchair-friendly material. The pathways between the elevated plant beds are also easily accessible for wheelchair users. However, moving in the meadow and on curvy grassy paths will require some strength and manoeuvring ability. Lawn grid solutions were used in areas which might look like ordinary lawns. A partway paved with clinker brick runs throughout the entire northern part of the garden. The paths in the Circle of Life features decomposed granite paving. To make it easier for people with impaired vision and those using the white cane to move around, pathways are bordered with metal edges. A relief pavement strip fulfils the same function, with its dotted section serving as a warning and ribbed section indicating the direction. The area is bordered with stone "dice" marking the boundary of the Garden of Sense. There are tactile diagrams including the pathways, sitting areas, the fountain, benches and other items in the garden for the blind and visually impaired. Relief paved strips go from one diagram to another. Visually impaired visitors can also use the audio-guide providing visual description.

There are concrete benches next to the fountain as well as swinging benches near the pergolas for those who would like to have a rest and contemplate their surroundings. The semi-automatic watering system makes the garden maintenance less labour-consuming. In the evening, various lighting solutions enhance the atmosphere.

RESULTS

TBG visitors gave the Garden of Senses a warm reception. It has been the site of a variety of thematic day-long events, excursions and field trips for schoolchildren. The TBG received the "Deed of the Year 2015" award from the Estonian Blind Union. The Garden of Senses was also the winner of the Estonian Cultural Endowment award in 2016 in the Best Garden category.

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Ground vegetation diversity and geobotanical analysis in the south-west Estonian dune pine forests

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Abstract

In 2018, Tallinn Botanic Garden researcher Mari Tilk acquired degree of Doctor of Philosophy in Forestry. The doctoral work focused on effects of environmental factors on the ground vegetation species richness, composition and community horizontal structure. Factors controlling the complex of ground vegetation were light conditions, soil water content, thickness of the moderately decomposed litter layer and potassium and calcium content in the soil. Vascular plant species richness and composition was dependent on the absolute height of the dune, its zone and aspect, soil moisture and pH, soil nitrogen, potassium and phosphorus content, the cover of the bryophyte-lichen layer and light conditions. Bryophyte and lichen layer species composition was determined by the height, aspect and zone of the dune, light conditions, soil pH and electrical conductivity, soil water content, vascular plant species cover and thickness of the moderately decomposed litter horizon.

Keywords: dune forests, ground vegetation, bryophytes, lichens, vascular plants.

INTRODUCTION

In 2018, Tallinn Botanic Garden researcher Mari Tilk was awarded with the degree of Doctor of Philosophy in Forestry. Defence of a thesis took place in Estonian University of Life Sciences, room 1A5, Kreutzwaldi 5, Tartu on December 12th, 2018, at 10:00. The supervisors were Katri Ots, Malle Mandre and Tea Tullus and opponent was honoured Annamari Markkola from University of Oulu.

Thesis focused on vascular plants, bryophytes and lichens of forested dunes of various heights in south-west Estonia, with the overall aim to determine the environmental factors that shape ground vegetation communities.

METHODOLOGY

To investigate the ecosystems on dunes, five typical dunes were selected in the coastal area of the Baltic Sea in south-west Estonia between Uulu and Häädemeeste. The average distance of the study sites from the Baltic Sea coast was approximately 2–3 km. Lower dunes were situated in the Uulu-Võiste landscape protection area, where three priority habitats according to the European Commission (2013) are present: wooded dunes of the Atlantic, Continental and Boreal region (type 2180); Western Taïga (type 9010*); and Fennoscandian deciduous swamp woods (type 9080*). Higher dunes were located in the Luitemaa nature reserve, where fixed coastal dunes with herbaceous vegetation (grey dunes) (type 2130*); wooded dunes of the Atlantic, Continental and

Boreal region (type 2180); and humid dune slacks (2190) are under protection.

For ground vegetation species richness, species composition and horizontal structure determination, 251 squares of 1 m^2 in size were established. For all squares, descriptions of vascular plants, bryophytes and lichen species were provided, and the total coverages of vascular plants, bryophytes and lichen species as well the coverage of each layer were estimated.

Various topographical and environmental factors were determined for non-metric multidimensional scaling analysis to describe species distribution patterns in relation to environmental factors like canopy cover, photosynthetically active radiation, soil organic horizon thickness and decomposition rates, soil volumetric water content, soil pH and electrical conductivity and soil nutrients.

RESULTS

In total, 133 ground vegetation species were recorded on the five dunes: 42 vascular plant, 43 bryophyte and 48 lichen species. Ground vegetation species richness and composition on the forested dunes were not determined by one or two factors, but rather by a complex system of environmental variables that showed different effects on different ground vegetation life-forms.

Vascular plant species richness and composition on forested dunes was also dependent on the absolute dune height, zone and aspect of the slope, soil nitrogen, potassium and phosphorus contents, soil pH and moisture, the cover of the bryophyte-lichen layer and light conditions. Soil higher nitrogen content decreases vascular plant species richness.

Regarding bryophyte and lichen layer species composition, some of the most important factors were the aspect of the dune, vascular plant species cover, light conditions, the thickness of the moderately decomposed organic soil horizon, soil pH, electrical conductivity and volumetric water content. Lichen species richness was highest on the slopes of the dunes, while bryophyte species richness was higher at the bottoms and decreased towards the tops of the dunes.

Ground vegetation species richness and species horizontal and vertical structure on forested dunes were highly dependent on topography-induced differences, aspect, height and zone of the dunes. The most important factors controlling the complex of ground vegetation were light conditions, soil water content, thickness of the moderately decomposed litter layer and soil potassium and calcium contents.

Ground vegetation species richness and composition on the forested dunes studied in the Uulu-Rannametsa area were found not to be controlled by one or two factors but rather by a complicated system of environmental variables that showed distinct effects on different ground vegetation life-forms.

Thesis were based on the following papers, where further detailed information can be acquired: Kösta, Tilk 2008, Tilk et al. 2011, Tilk et al. 2017 and Tilk et al. 2018.

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TALL – Herbarium at Tallinn Botanic Garden, Estonia

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Abstract

The herbarium of the Tallinn Botanic Garden (TALL) was founded in 1962. The expeditions and studies of the scientists working in the Tallinn Botanic Garden laid the foundation for the herbarium. Over decades, extensive work on the herbarium resulted in the collections of vascular plants, woody plants, the carpological collection, bryophytes, lichens and fungi. In 2018, the quantity of arranged and digitized herbarium materials amounted to 60,399 specimens.

Keywords: TALL, herbarium, lichens, fungi, bryophytes, vascular plants.

The Tallinn Botanic Garden (TBG) was founded on 1 December 1961 as an institute of the Academy of Sciences of the Estonian SSR. Starting in 1959, over 50 expeditions were organized to build up the collections of TBG. The expeditions covered the area of the USSR from the Crimea to the Kuril Islands (Annuka, Sander 2000).

Expeditions and research created a solid basis for the formation of the herbarium, and the amount of the preserved herbarium materials was substantial, which allowed the TBG herbarium to be registered in the global herbaria database *Index Herbariorum* assigned with the acronym TALL in 1962. The herbarium was based on the collection of *Erysiphaceae* fungi containing over 5,000 specimens and curated by Harry Karis (Parmasto 1985). Today, TALL is one of Estonia's largest herbarium collections, following those of the University of Tartu (TU), Estonian University of Life Sciences (TAA) and the Estonian Museum of Natural History (TAM).

By 2018, 60,399 herbarium specimens of the TALL herbarium had been arranged and digitized (Figure 1). The largest collection of the herbarium, collection of lichens, containing approximately 40,500 specimens, has not been arranged yet. Most of the lichens specimens of Estonia has been collected by Siiri Liiv and Enel Sander (24 March 1953 – 18 October 2015) during their lichenological research, epiphytic lichens and air pollution. Lichenologist Taimi Piin-Aaspõllu (03 September 1940 – 02 September 2012), former curator of the TALL herbarium, took part in numerous expeditions on the Taymyr Peninsula, where she gathered a massive quantity of unique lichenological materials.

The TALL collection of bryophytes contains 21,000 herbarium specimens. Despite its modest size, the bryophyte herbarium is very rich in species, comprising samples of more than 1,200 species. Extensive collection gathering started in 1970s under the guidance of bryologist Ene-Külli Tamm, but contribution within the scope of a number of studies was also made by other bryologists: Leiti Kannukene, Helen Haab and Raimolt Vilde (24 April 1954 –27 June 2004). The largest collections of bryophytes come from the Russian region of the Arctic, namely, the Taymyr Peninsula, as well as Australia and Estonia (Pajur 2014). The bryophyte herbarium also expanded due to cooperation with Russian research facilities (the Komarov Botanical Institute of the Academy of Sciences

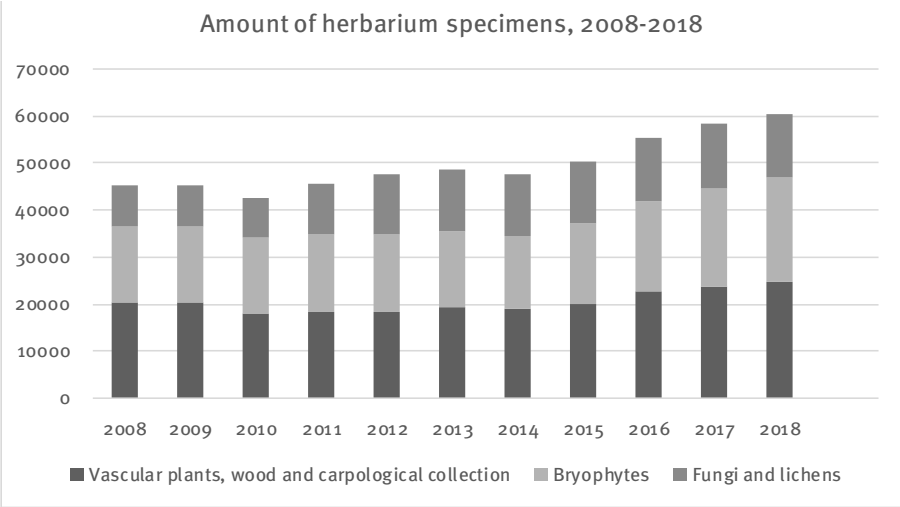

Figure 1. Number of specimens arranged and digitized in the TALL herbarium during 2008-2018

Photo 1. The carpological collection and wood samples are stored in boxes in the herbarium. *Photo by Merlyn Pajur*

of the USSR; the Institute for Agricultural Chemistry and Soil Research of the Russian Academy of Sciences): in 1975–1988, there was a number of joint expeditions as well as the scientific processing of the gathered bryological materials and documentation of data (Kannukene 2017).

The other botanic collections contain herbaceous plants, woody plants, wood samples and a variety of fruits and cones (Photo 1), 24,730 items in total. The collection of herbaceous and woody plants is also used for keeping plant materials from the outdoor collections and greenhouse collections of the TBG. The most substantial contribution

to the collection of woody plant herbarium materials was made by TBG dendrologists Aleksei Paivel (30 March 1929 – 15 September 2003), Jüri Elliku (27 February 1947 – 17 April 2011) and Olev Abner as well as gardeners Jaak Sultson and Anu Kaur. Dendrologist Jüri Elliku brought a great amount of herbarium materials from his 13 introduction-related expeditions to the Far East of Russia (Tamm 1996). Herbaceous plant materials for the TBG herbarium were collected by a number of botanists, for example, Tõnu Ploompuu, Urmas Laansoo and Ruth Aguraiuja, and also gardeners Mare Liik, Mari Seidelberg and Krista Kirotar.

The TALL fungi collection comprises 8,673 arranged specimens, which have been included in the database. There is a small number of tree fungi, but also species of the *Erysiphaceae* family in this collection. The *Erysiphaceae* collection is a most remarkable one: phytopathologist Harry Karis (23 August 1930 – 27 February 2018) collected, classified and preserved the materials gathered both in Estonia and in the expeditions to the Far East (Kamchatka, Okhotsky District, Uda River and Ussuri River region) (Karis, 1994). This research was used as the basis for the following publications, among others: "*Erysiphaceae* Lév. in Eastern Europe and North Asia" (1995) and "The powdery mildews (*Erysiphaceae*) of Estonia" (1987).

In addition to the microfungi collected by Harry Karis, the TALL fungi collection also contains items gathered by the former TBG mycologist Thea Normet. Both researchers specialized in studying fungal damage and fungal diseases of plants.

TALL herbarium specimens are widely used for scientific purposes: items from the wood collection, bryophyte collection and fungi collection alike have been borrowed. The TBG herbarium maintains international cooperation with various research institutions, for instance, the University of Lodz, the Slovak Academy of Sciences, the National Tropical Botanical Garden, the Agriculture & Agri-Food Canada Vascular Plant Herbarium, the University of Helsinki, and also domestic museums and universities (University of Tartu, Estonian University of Life Sciences and the Estonian Museum of Natural History). Herbarium items are lent for researching the distribution of plants and fungi, identification control and verification and research; extensive herbarium exchange is practiced as well.

TALL herbarium data are entered in the database on the PlutoF platform (https://plutof.ut.ee/). PlutoF allows web-based input, viewing and updating of data related to natural sciences. The data entered in the database on the PlutoF platform are forwarded to the Global Biodiversity Information Facility portal (https://www.gbif.org), which makes the data of the TALL herbarium available to researchers around the world. According to the GBIF portal, the data entered by the TALL herbarium have been accessed 53,263 times, downloaded 19,717 times and cited in research papers 60 times.

The factors which hinder the development of the TBG herbarium are the lack of financing and sufficiently qualified personnel; the facilities unsuitable for the preservation of herbarium collections are another issue. The highest priority is the provision of suitable conditions for the storage of herbarium collections, which would ensure the preservation of nearly 100,000 items in the TBG herbarium as well as allow them to be used for research and educational purposes.

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Digitalization and conservation in geotadabase of plant genetic resources at the Botanical Garden of the University of Tartu

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Abstract

The participation in the project „Smart Botanic Gardens" brought the possibility of mapping and conservation of plant genetic resources in newly created geodatabases in the Botanical Garden of the University of Tartu. During the project a GIS data model was developed for the mapping of the plant collections. The data of local cultivars of ornamental plants, medicinal and aromatic plant species was imported into an ESRI geodatabase, managed with the ArcMap 10.2 program. Topographic maps were developed to reflect the location of 97 local cultivars of *Clematis, Rosa* and woody plants in the BGTU. The interactive map with mapped plants and significant data from the geodatabase is available in the website – http://gis.ut.ee/map/. Development of topographic maps and data digitalization in the BGUT will be continued.

Keywords: plant genetic resources, „SmartGardens" project, development of topographic map, plant mapping, plant geodatabase, interactive map for visitors.

INTRODUCTION

The conservation of biological diversity in Estonia started with the ratification of the Convention on Biological Diversity (CBD) in 1994. In accordance with the CBD and other international commitments, the Estonian National Programme „Collection and Conservation of Plant Genetic Resources for Food and Agriculture" (hereafter referred as the PGR programme) was established in 2002, begining the conservation of plant genetic resources for food and agriculture in Estonia.

The activities of the programme are governed by the National Council on Plant Genetic Resources for Food and Agriculture under the auspices of the Ministry of Rural Affairs. The Botanical Garden of the University of Tartu (BGUT) became the responsible institution for the collection, long-term preservation, characterization, evaluation and documentation of ornamental, medical and aromatic plant genetic resources (Volkova 2006).

Alongside, the participation in the project „Smart Botanic Gardens" („SmartGardens") brought the opportunity for the mapping of local cultivars of ornamental plants in the botanical garden collections, and for data conservation of plant genetic resources in the newly created geodatabases of the botanical garden.

Being that the objectives of the international project „Smart Botanic Gardens" was the creation of topographic maps, plant geodatabases and interactive maps for visitors, as well as important experience exchange for personnel of the Latvian and Estonian botanic gardens. The project lasted from 2011 to 2013 in cooperation between the Latvian National Botanic Garden, the Botanical Garden of the University of Tartu and its

Society of Friends, and the Environmental Development Association of Latvia with part-financing by the European Regional Development Fund (ERDF).

MATERIALS AND METHODS

Since 2007, geodetic measurements, carried out with an electronic tachometer Trimble 3305DR, started in BGUT, allowing plantbeds, pavements and woody plants to be mapped.

During the "SmartGardens" project, a Geographic Information System (GIS) data model was developed to enable the mapping of plant collections. Later on, plant locations were monitored with an electronic tachometer Trimble S3 Autolock 5". Plant data of existing collections from the previous system, FoxPro (Database Management System), database was imported into ESRI (Environmental System Research Institute) geodatabase. ArcMap 10.2 program, as part of the Esri's ArcGIS suite of geospatial processing programs, is used to manage the database, allowing to view, edit, create and analyze the geospatial data.

RESULTS

In the beginning of the programme, the history of ornamental plant breeding in Estonia was investigated. This reasearch involved the study of many papers from libraries and archives of botanical gardens. Also, meetings with private breeders with the purpose of familiarization with their plant collections were organized. In accordance with collected information, the 40-es of the 20th Century can be regarded as the beginning of ornamental plant breeding in Estonia. Mr. Adolf Vaigla, teacher of the Räpina Gardening College, can be considered the first who started with Syringa selection and then continued with other groups, breeding *Dahlia, Phlox, Primula* and *Clematis*.

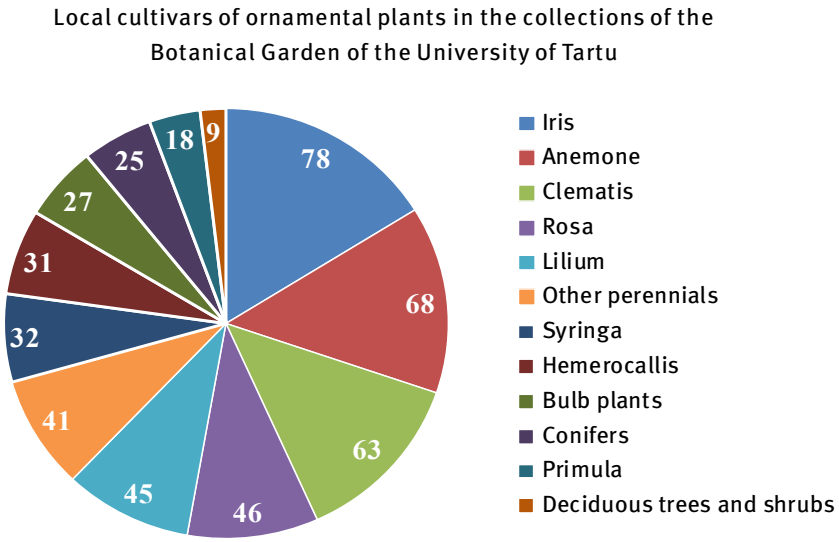

Figure 1. The overview of local cultivars of ornamental plants in the collections of BGUT

Since 1947, in the Polli Branch of the Plant Breeding Institute of the Academy of Sciences of Estonian SSR, Alli Süvalepp, PhD started *Begonia×tuberhybrida, Dianthus, Gladiolus* breeding and selection. Later her research continued in the Experimental Station of the Academy of Sciences, in the Institute of the Experimental Biology and in the Tallinn Botanic Garden. Many local cultivars and seedlings of *Dianthus, Begonia×tuberhyrida, Gladiolus, Lilium, Rosa* and *Primula* were bred in the Tallinn Botanic Garden during the approximate 20 years of work (Veski 1967). Many valuable cultivars of *Clematis, Rosa, Syringa, Lilium, Hemerocallis, Anemone*, decorative woody plants and other cultures have been bred in private gardens all over Estonia, as well. All found varieties, currently

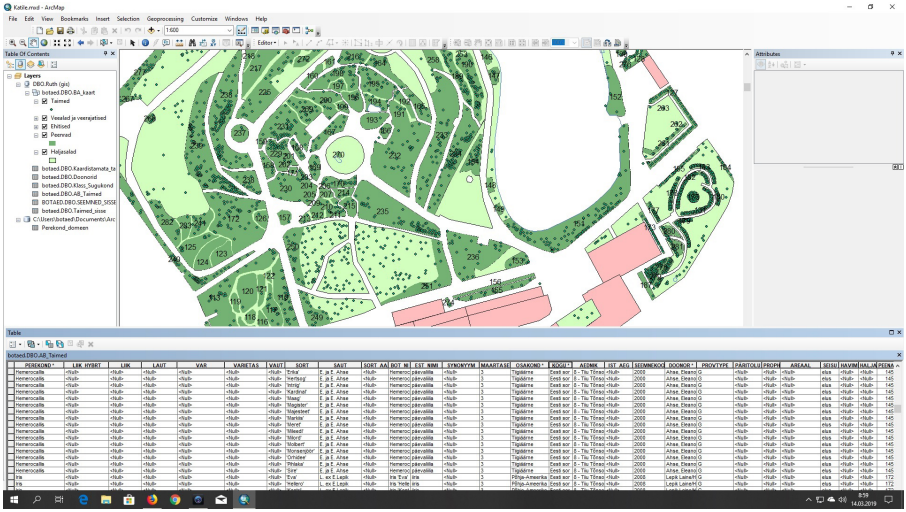

Figure 2. The topographic map and geodatabase of BGUT in ArcMap 10.2 program

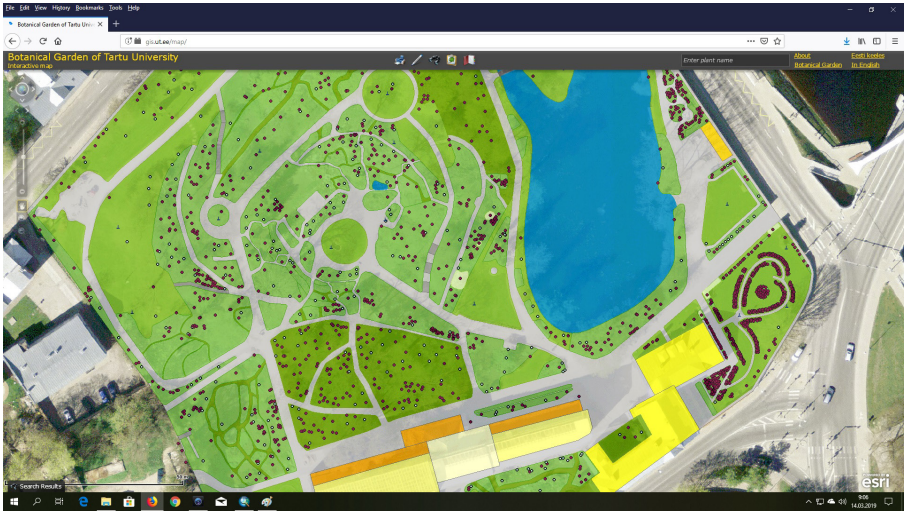

Figure 3. The interactive map of BGUT on „SmartGardens“ project website (http://gis.ut.ee/map/)

present in Estonian private and public gardens, were included into the genetic resources database. Since 2002, new cultivars were added to database each year, and by the year 2018 the number of accessions reached 707.

During the time of the PGR programme, the collections of the botanical garden have been enriched with 483 local cultivars of ornamental plants from a total of 707 entries present in the genetic resources database (Fig. 1). In 2011, the garden of medicinal and aromatic plants was established in the botanical garden, where present 73 species from the genetic resources database of medicinal and aromatic plants. The important data of local cultivars, medicinal and aromatic plants that had been entered initially to the FoxPro database was later transferred to the ESRI geodatabase during the "SmartGardens" project. This geodatabase contains information about taxonomic classification, physical location in the garden (coordinates), breeding, planting time, donors, distribution, status and International Plant Exchange Network (IPEN) number (Fig. 2). The ArcMap 10.2 program, is used to modify the data of plant genetic resources in the database.

During the "SmartGardens" project, many plants were mapped and related data was digitalized. Topographic maps were developed to reflect the location of local cultivars of *Clematis, Rosa* and woody plants in the BGTU. A total of 42 local cultivars in the *Clematis* garden, 26 local cultivars in the Rose garden and 29 local varieties of woody plants were mapped during the project. The mapping process of local cultivars of ornamental plants, medicinal and aromatic plant species is ongoing, adding each year to the topographic map all new local cultivars from the collections of the BGUT.

Finally, an interactive map of the BGTU with mapped plants and other significant data was developed for the general public (Fig. 3). The interactive map, available at the address http://gis.ut.ee/map/, where can be observed all mapped local cultivars in the collections of the BGUT. Each cultivar of the map contains a label with the name, name of collection, planting year and source.

CONCLUSIONS

The collections of the botanical garden were enriched with 483 local cultivars of ornamental plants during the PGR programme. As part of the "SmartGardens" project, data of local cultivars, medicinal and aromatic plant species was transferred to a new ESRI geodatabase, managed with ArcMap 10.2. A total of 97 local cultivars in the collections of the garden have been mapped. A topographic map reflecting the location of local cultivars of *Clematis, Rosa* and woody plants in the BGTU was created. Development of topographic maps and data digitalization in the BGUT opens the opportunity to continue the mapping of local cultivars in the botanical garden collections. The interactive map with mapped plants and related significant data from the geodatabase can be found in the website http://gis.ut.ee/map/.

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Policy of plant collections management, assessment and development at Vilnius University Botanical Garden

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Abstract

Many Botanic Gardens are looking for answer to the questions of the relevancy and the value of living plant collections. Is it worth to have, to keep, to develop one or other collection? How to evaluate the collection? What kind of instrument should be used to have comparable indicators for assessment of collections and accessions? After analysis of some qualitative parameters of living plant collections at Vilnius University Botanical Garden, a new policy was launched in for living plant collections management. There were compiled the new methodology and created an instrument for assessment of quality of accessions and collections. As a background of this methodology the indicator panel was produced, - the table with 56 positions-questions. After answering the questions, evaluating and giving scores, the instrument provides the possibility to compare very different in their matter collections. The system (with maximum total sum - 100 scores, divided into four groups of different weight) reveals not only comparable value of different accessions and collections, but even recognizes gaps of work of staff. Implementation of this system for collections management provides objective background to have clear understanding of priorities and ways to improve quality of living plant collections.

Keywords: policy, plants, quality, collections, methodology, instruments of evaluation.

INTRODUCTION

Contemporary collections of Vilnius University Botanical Garden contain more than 10000 taxa of living plants (58,7% of them are representatives of plants of cultural origin, 41,3% - representatives of native species). These collections represent a wide array of thematic groups, botanical families, genera, species and cultivars. Age and history of occurrence of collections are quite different too. A few plants are growing in the Garden (in Vingis Department) since the first quarter of XX c., up to 200 trees and shrubs today are 70-90 years old. Since 1950-60'ies collection of indoor plants (which contains about 700 taxa of subtropical plants and succulents) was accumulated in the Garden. However, the largest number of plant collections (as of taxa, as of accessions, as of different groups) were accumulated since 1974 in new main location of the Garden in Vilnius district – Kairėnai. During this time very different kinds of plant collections were accumulated in the Garden.

Today large collections of fruit producing plants, representing species and cultivars of genera such as *Ribes, Lonicera, Chaenomeles, Sorbus, Vitis, Hippophae* (which material is used for plant breeding aim) are growing here. There are collections of ornamental plants, which contains a few thousands of cultivars, collection of barley mutants (used

for research of plant mutagenesis) as well. Currently work of accumulation of rare and endangered plants of Lithuania (with aim to work out methods and technologies for conservation of these plants) is started. No less important the use of these plant collections for educational purposes. Most of collections are open to the public. Main objective of the Garden always was to serve the University: for implementation of study programs, and as a base for scientific work. Nevertheless, during the different periods of University development, there were many changes and new challenges in the Garden as well. Today the most important questions for the Garden's policy are to understand: how relevant are our collections for different purposes; what is quality and value of collections; are there benefits to cultivate so many plants; which collection is worth to be developed and which to reduce; what kind of collections we would like to see in 10-20 years or later? So, the first step to seek answers to these questions was to collect, systematise and analyse the data.

BUILDING OF PLANT DATABASE AT VILNIUS UNIVERSITY BOTANICAL GARDEN

In 1986 the Garden has started work of building database system for accounting of plants in collections. However, there were very poor technical possibilities to develop modern database. Only one computer (one of the first of models, made in Russia – "Iskra 226") there was at the Garden at a time. The information of only 1500 taxa of plants was possible to keep in two rewritable discs (two times wider than a modern CD). The disc operating system was similar to Microsoft Disk Operating System (DOS). This was main reason why back then built database was using information only of 30% of plants growing in the Garden.

In 1990 the second step was taken, we started to use IBM 486 computer. Nevertheless, the database containing information of all plants collections (including new soft programming, design of the system), was developed in 2003. This program is used for the Garden collections data to this day without significant changes. The database is partly open for public, using internet address: http://www.botsodas.lt/indexplantarum. As a basis for design and content of information accumulated in this database was used the system of The International Plant Transfer Format (ITF1 and ITF2) for Botanic Garden Plant Records. The database was very helpful for unification of plant registration system in the Garden, for development of accessioning system, for creating unified system of accumulation of information of plants growing in the Garden. It provided possibilities to improve quality of plant collections, update quality of work for plant curators, but didn't answer the questions: what is the value of the Garden plants collections, what should be done to have better collections, and which way for the future development should be chosen.

RESULTS OF STATISTICAL ANALYSIS OF THE GARDEN PLANTS COLLECTIONS DATA

In 2017 the general information of the Vilnius University Botanical Garden database – "Index Plantarum" was analyzed. Analyzes was done of collections few parameters: the origin of plants, donors of material, level of the verification of plants names and the description of accesses in the database (information provided by curators of plants in database). The results were not as cheerful as suspected. It was learned that approximately only 9,7 % of representatives of native species were propagated using material collected in wild (4% of all taxa in collections) and additionally, approximately

65,3 % of the material (of native species) obtained from trustworthy donors (Fig. 1). Nevertheless, the significant number (25%) of representatives of native species were received from not reliable places. The situation in collections of cultivars was a few better: in 92% (in total in all collections - 54%) of cases, the material was received from trustworthy donors or places of its origin.

It turned out that the situation of verification of plants names (in collections of living plants) must be strongly improved. In more than half of these cases, the names of plants have never been verified even by persons curating collections (Fig.2). Plant names (in 56% of cases) were used provided by donors without any verification. After this analysis, we did understand that we need work out clear policy for collections development, we need more instruments (the traditional database is not enough) for assessment and monitoring of situation in collections and for planning of useful measures.

So, in 2017 we developed the policy (Milestones for Vilnius University Botanical Garden plant collections development in 2018-2020), described priorities and strategy of the organisation, the methodology of management of collections, responsibilities and planed measures for 5 years period. Parallel we have established a permanent commission to address the development and quality of plant collections and worked out the new instrument for assessment of value as of plant accessions, as of collections (units, groups of accessions). We worked out the system for assessment of accessions and plant collections based on two levels. The first level is used for assessment of the accessions as single units (using 100 score indicator panel). However there is possibility to see amounts of scores (as in total, as in different blocs, Fig.3) as of single accession as averages of all group of accessions (evaluated per one sheet).

The instrument for the use of curators was created as an active Excel file, which should be fulfilled (writing scores) answering to the questions in table. The maximum score in total (reachable only theoretically for one accession), is – 100. There are possible to see value of the accession in different blocks too, answering to the questions on 56 positions (See Annex No. 1). An example of fulfilled Excel file (part of it) see Fig. 4.

The second level is used for assessment of different collections (as units) and contains some information from the first level (of assessment of accessions) in composition with some additionally components (assessment of the collection from the point of view of representation of taxonomical, genetic diversity, importance of collection on national or international level etc.). The second level assessment table and scheme design were constructed on the same attitude – there is possibility to evaluate the collection up to the same maximum – 100 score (See Annex No. 2.). There is the same graduation to different blocs, only there is a few different construct and weight of blocks Fig. 5).

CONCLUSIONS

Presented system of assessment of living plant collections is compiled to provide us such information:

(1) how relevant and useful are our collections for conservation and preservation purposes of biodiversity and genetic resources;

(2) what are gaps in our work of accumulating the plant material and how could it be improved;

(3) do we have really very valuable plants (even collections) or some of them aren't valuable and important, and could be removed from the Garden;

(4) could we use our collections in more effective way;

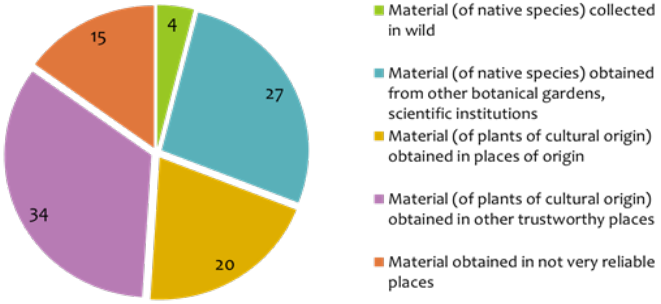

Fig. 1. Percentage of plants in collections of VU BG according to the origin of material

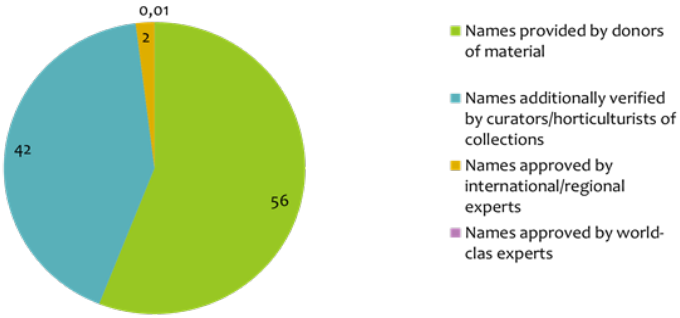

Fig. 2. Percentage of plants in VU BG collections, according to the level of determination

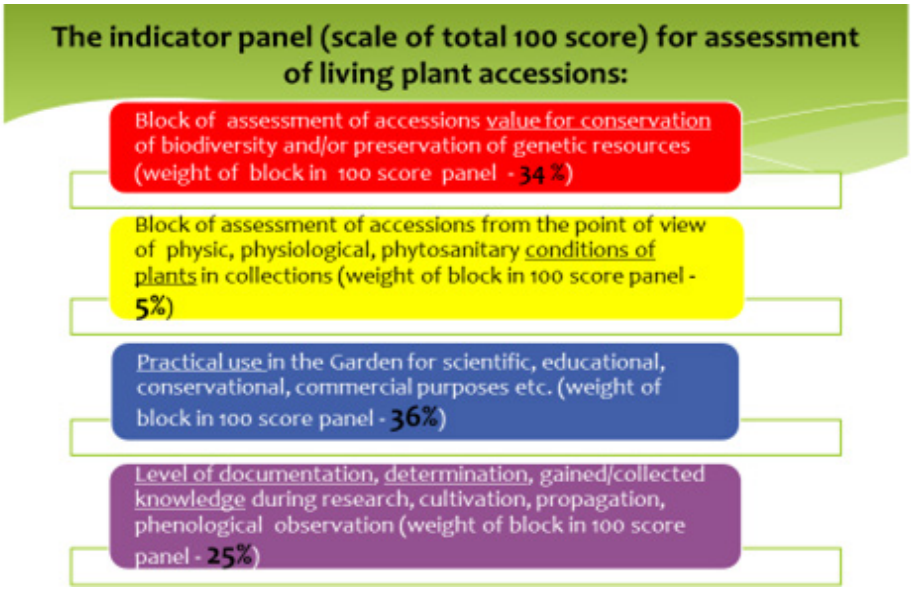

Fig. 3. The weight of different blocks in 100 score panel (first level) for assessment of accessions

(5) is there progress in our work;

(6) what priorities and directions for development of our collections are most promising.

Annex No. 1. The scheme of assessment of accessions

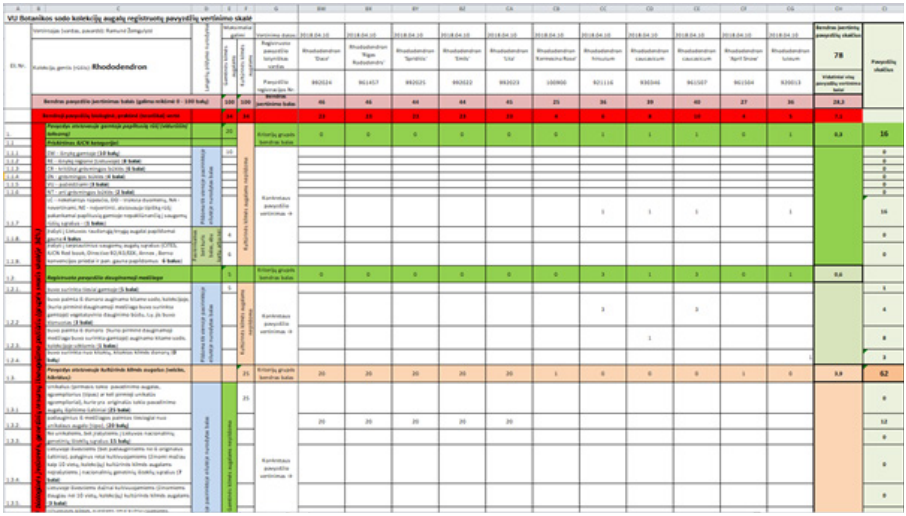

Fig. 4. An example of fulfilled table for a group (of 11 accessions) of rhododendrons, first level assessment

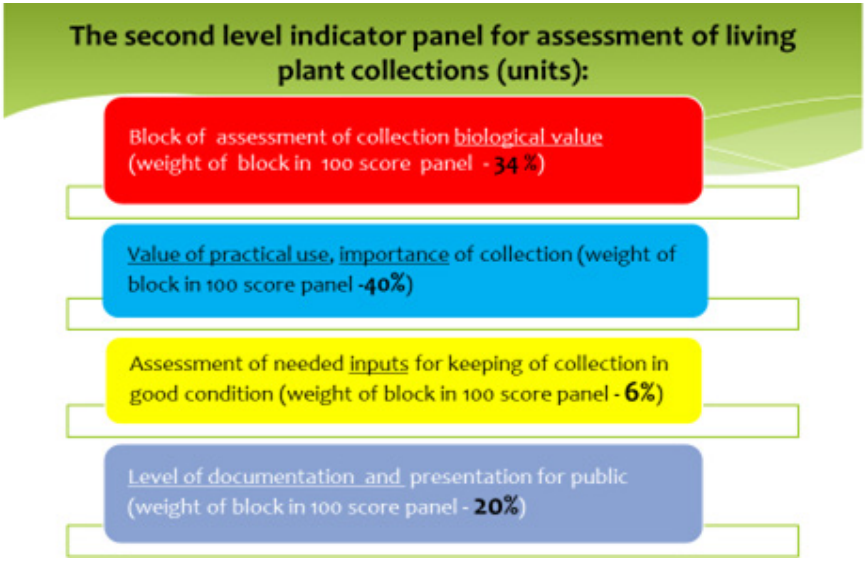

Fig. 5. The weight of different blocks in 100 score panel (second level) for assessment of collections (units)

No.	Name of accessions group:	Maximum possible scores	
	Curator of collection:		
	Curate since (year):	Natural origin accessions	Cultivated plants accessions
	Evaluation categories, scores, instructions for filling fields		
0.	***Overall accesion score:*** (total of 1-100)	***100***	***100***
1.	***The overall biological (particularly biodiversity and genetic resources conservation) and practical value of the accession:*** (total of 1.1., 1.2. and 1.4. for natural origin accessions and total of 1.3. and 1.4. for cultivated plants)	***34***	***34***
1.1.	**Status in lists of threatened species (only for natural origin accessions)** (total of 1.1.1-1.1.3.)	**20**	For cultivated plants are not filled
1.1.1.	**Status in IUCN Red List of Threatened Species:** Extinct in the wild (EW) (10 points) Critically endangered (CR) (7 pts) Endangered (EN) (5 pts) Vulnerable (VU) (3 pts) Near threatened (NT) (1 pt)	10	
1.1.2.	**Plants from local Red book** (4 pts)	4	
1.1.3.	**Plants from international lists of protected plants** (CITES, Directive 92/43 / EEC Annex, Berne Convention supplements, etc) (6 pts)	6	
1.2.	**Accession origin** (only for natural origin accessions): Collected directly in nature (5 pts) Taken from a donor whose primary propagating material was collected in nature and propagated vegetatively, i.e. it was cloned (3 pts) Taken from a donor whose primary propagating material was collected in nature and propagated generatively, i.e. by seeds (1 pt) Collected from plant donors of other origin (0 pts)	5	
1.3.	**Accession origin , spread, and status by law** (only for cultivated plants) (total of 1.3.1. and 1.3.2.)	For natural origin plants are not filled	**25**
1.3.1.	**Accession origin and spread:** Unique (first specimen or several first unique specimens of this name) that are original, the first sources of the name (15 pts) Propagated from the material directly from the unique plant (12 pts) Lithuanian origin (but not propagated from the original source), comparing the rare cultivated (known less than 10 collections), not included in the national genetic resource lists (7 pts) Lithuanian origin (but not propagated from the original source), often cultivated (known more than 10 collections), not included in the national genetic resource lists (5 pts) Foreign origin, comparing the rare cultivated (known less than 10 collections) (2 pts) Foreign origin, often cultivated (known more than 10 collections) (1 pt)		15
1.3.2.	**Status by law:** Included in Lithuanian National Genetic Resources Lists (10pts)		10
1.4.	**The value of plants for practical purposes** (total of 1.4.1-1.4.3.)	**9**	**9**

1.4.1.	**Aesthetic value:** High (expressive shapes, colors, especially blooming, etc.) (3 pts) Average (elements of hedges, mixed ornamental plants groups, etc.) (2 pts) Low, but in some cases used for other practical purposes in the creation of greenery (like background, coverings, air purifying, noise reducing, etc.) (1 pt)	3	3
1.4.2.	**Use for food or food supplements, or feed, or technical purposes:** An important nutritional culture (widely used in agriculture) (3 pts) Moderately important for food or food supplements or feed, technical culture (2 pts) Use for food in very small quantities (1 pt)	3	3
1.4.3.	**Use in the manufacture of medicinal products** (3 pts)	3	3
2.	***Physical / physiological / phytosanitary status of accession:*** Excellent (plants are well developed, reach their age-specific parameters and physiological developmental stages in time, there are no signs of diseases and pests (5 pts) Very good (plants are well developed, reach their age-specific parameters and physiological developmental stages in time, there are few signs of diseases and/or pests (4 pts) Good (plants are developed moderate, reach their age-specific parameters and physiological developmental stages in time, sometimes vulnerable to diseases and/or pests as well as bad climatic conditions. After special phytosanitary or additional agrotechnical measures recovering during the season (3 pts) Satisfactory (plants are developed moderate, reach their age-specific parameters and physiological developmental stages average in time, vulnerable to diseases and/or pests as well as bad climatic conditions. After special phytosanitary or additional agrotechnical measures recovering during the two season (2 pts) Bad (the plants are poor, do not reach their age-specific parameters and physiological developmental stages in time, suffering from diseases and/or pests, many resources are needed to fight them; after the adverse weather conditions, the deteriorated condition does not recover, or only partially resolves after 3 and more years, even using a lot of agrotechnical measures (1 pt) Very bad (they are barely growing and/or their condition is getting worse every new season) (0 pts)	***5***	***5***
3.	***Use of accession in the garden:*** (total of 3.1.-3.6)	***36***	***36***
3.1.	**For research, if the data about the accession are/were used in the preparation of:** A scientific article quoted in the database ISI Web of Science in the last 5 years (8 pts) Peer-reviewed scientific article quoted in other databases or preparing a book or part of it in the last 5 years (6 pts) Scientific articles, books were prepared 5-10 years ago (4 pts) The data is still accumulated and not processed (2 pts)	8	8

3.2.	**In biodiversity or genetic resource conservation programs, project implementation activities:** Accession used in the last 5 years, or listed in state national plant genetic resource lists and their material is continuously stored (8 pts) Used in fixed-term programs 5-10 years ago (4 pts) Used earlier (2 pts)	8	8
3.3.	**To study program service:** Used during the assessment (7 pts) Used during the last 5 years (5 pts) Earlier (2 pts)	7	7
3.4.	**To educational programs** when the use of the specific name of plants (matching accession name) planned and approved in official program descriptions and these programs are officially offered to garden visitors (5 pts)	5	5
3.5.	**For general educational activities:** Freely accessible to all garden visitors, labeled according to the determined format used in the garden, and their collections visited during common and specialized guided tours (4 pts) Meet 3 activities listed in the 4-point category (3 pts) Labeled and only specialized tours are held in their collections (2 pts) Only one specialized tour per year (1 pt)	4	4
3.6.	**Used, fully or partially used, or potentially could be used as a material for propagation of plants (ornamental, pharmacy, fruit, technical, etc.) intended for a market with:** High market demand (4 pts) Average market demand (3 pts) Low market demand (2 pts)	4	4
4.	***Documentation and knowledge:*** (total of 4.1.-4.5.)	***25***	***25***
4.1.	**Level of characterization of accession's name:** Identified, verified by the world-class expert (3 pts) Identified, verified by country or regional authority expert (2 pts) Identified, verified by a curator of a collection/specialist with relevant education (1 pt) Donor name used (0 pts) Approved by molecular research specifically designed for this purpose (2 pts)	5	5
4.2.	**Completeness of information in the Garden database:** The full name of the plant (according to the requirements of the nomenclature codes) provided and all possible fields filled in the graph "Taxonomy" (1 pt) Description of the plant (taxon) according to the prescribed format presented in Lithuanian and English (2 pts), in Lithuanian only (1 point), absent (0 pts) All available fields in the graph "Accession and its cultivation" filled (1 pt)	4	4
4.3.	**Plans:** Plants are marked in general garden GIS plan (3 pts) Plants are marked in individual paper plans based on a general garden plan held by the curator (2 pts) Plants are marked in individual paper plans held by the curator (1 pt) Plants are not marked in any plan (0 pts)	3	3

4.4.	**Photos:** 5 and more photos showing the plant at different times of the year, showing not only a general but also a detailed view of the individual parts - trunk, leaf, blossom, fruit presented (3 pts) 3-4 photos presented at different times of the year or in different scale (2 pts) 1-2 photos presented (1 pt)	3	3
4.5.	**Additional information** (phenological observations, size of plants, the condition of different years, etc.) collected in the database and recorded. For each year of activities one point up to 10 points	10	10

Annex No. 2. The scheme of assessment of plant collection (unit of accessions)

No.	Name of collection:		Maximum possible scores	
	Curator of collection:			
	Curate since (year):		Natural origin accessions	Cultivated plants accessions
	Evaluation categories, scores, instructions for filling fields			
1.	***Total score rating (0 to 100)***		***100***	***100***
2.	***The overall biological value of the collection***		***34***	***34***
2.1.	***Average of the overall biological (particularly biodiversity and genetic resources conservation) and practical value of the accession x 0.5***		17	17
2.2.	***Representation of taxonomic diversity (i.e., the number of sub-lower taxa constituents of a taxonomic unit (eg family, genus, species) or group (e.g., a hybrid group) selected on the basis of the collection)***		12	12
2.2.1.	70-100% of all known taxa (associated with a collection of top-ranked taxa, selected on the basis of a collection) is in the collection (12 pts)	Only the score specified in one selected row is to be filled	12	12
2.2.2.	50-69% of all known taxa is in the collection (10 pts)			
2.2.3.	25-49% of all known taxa is in the collection (6 pts)			
2.2.4.	10-24% of all known taxa is in the collection (2 pts)			
2.2.5.	5-9% of all known taxa is in the collection (1 pt)			
2.2.6.	Less than 5% of all known taxa is in the collection (0 pts)			

2.3.	***Representation of genetic diversity of species or subspecies (for accessions of natural origin)***		5	For cultivated plants are not filled
2.3.1.	Over 50% of the taxa is represented in the collection by more than 5 samples (from different natural regions, populations) (5 pts)	Only the score specified in one selected row is to be filled	5	
2.3.2.	Over 50% of the taxa is represented in the collection by 3-5 samples (from different natural regions, populations) (4 pts)			
2.3.3.	25-50% of taxa are represented by 3 or more samples (3 pts)			
2.3.4.	10-24% of taxa are represented by 3 or more samples (2 pts)			
2.3.5.	5-9% of taxa are represented by 3 or more samples (1 pt)			
2.4.	***Authenticity of cultivated plants***			5
2.4.1.	Over 50% of the samples are unique (first / second plant / specimen) or their propagation material is taken directly from the unique plant (5 pts)	Only the score specified in one selected row is to be filled	For natural origin plants are not filled	5
2.4.2.	30-49% of the samples are unique (first / second plant / specimen) or their propagation material is taken directly from the unique plant (4 pts)			
2.4.3.	Over 30% of the accessions are listed in the Lithuanian National Genetic Resource Lists (3 pts)			
2.4.4.	15-29% of the accessions are unique, multiplied directly from the unique material or are listed in the Lithuanian National Genetic Resource Lists (2 pts)			
2.4.5.	10-14% of the accessions are unique, multiplied directly from the unique material or are listed in the Lithuanian National Genetic Resource Lists (2 pts)			
3.	***International, regional, a national importance of the collection***		***40***	***40***
3.1.	Important international (one of the largest, most significant in the world or Europe) (12 pts)	Only the score specified in one selected row is to be filled	12	12
3.2.	Regional (significant in the Baltic Sea and neighboring countries or Eastern, Central or North Europe) (10 pts)			
3.3.	Important national scale (biggest, highest quality, oldest, most original, etc.) (8 pts)			
3.4.	**Importance of the collection for Botanical Garden**		10	10

3.4.1.	Very important (a collection of one of the forming public image of the Garden, or helping to achieve strategic goals - both general Vilnius university and Botanical Garden) (10 pts)	Only the score specified in one selected row is to be filled	10	10
3.4.2.	Important (important for performing the functions delegated by Vilnius University to the Garden) (8 pts)			
3.4.3.	Moderately important (useful for educational activities/ commercial/non-basic research programs, etc.) (6 pts)			
3.4.4.	Not important (not rich and only episodic educational or economic/commercial use) (3 pts)			
3.4.5.	Meaningless (not rich, if it does give up, it would have no effect on the image of the garden or its functions) (0 pts)			
3.5.	**Average of use of accession in the garden x 0,5**		18	18
4.	***Overall assessment of collection status and cost to maintain it***		***6***	***6***
4.1.	**Average of physical / physiological / phytosanitary status of accession x 0,4**		2	2
4.2.1.	Necessary agrotechnical-phytosanitary measures (for good plant condition) are not applied or only very rarely applied (once per year or less) (4 pts)	Only the score specified in one selected row is to be filled	4	4
4.2.2.	Necessary agrotechnical-phytosanitary measures (for good plant condition) are applied episodically (every year or twice per year) (2 pts)			
4.2.3.	The necessary agrotechnical-phytosanitary measures (for good plant condition) are applied periodically, or during the season more than twice, but for some time without applying, for example, one season - the condition of the collection would not deteriorate significantly) (1 pt)			
4.2.4.	Necessary agrotechnical-phytosanitary measures (for good plant condition) are applied several times/a dozen times per season (for some time without measures the condition of the collection would deteriorate rapidly) (0 pts)			
5.	***Documenting the collection and presentation to the public***		***20***	***20***
5.1.	**Average of completeness of information in the garden database x 0,5**		10	10
5.2.	The general description of the collection (history, structure, etc.) presented on the garden's website (1 pt)	Evaluated, calculated, and/or not both fields	1	1
5.3.	The collection is constantly being promoted by various means: TV, Radio, press, online (non-garden) portals, excursions, educational programs (at least once in the last 5 years - 0.5 points for each listed measure (max. 3 pts))		3	3

5.4.1.	Over 50% of visitors to the garden visited the collection each year (6 pts)	Only the score specified in one selected row is to be filled	6	6
5.4.2.	25-49% of visitors to the garden visited the collection each year (4 pts)			
5.4.3.	10-24% of visitors to the garden visited the collection each year (2 pts)			
5.4.4.	Less than 10% of visitors to the garden visited the collection each year (1 pt)			
5.4.5.	Collection inaccessible (0 pts)			

Conservation of botanical diversity in south-western Lithuania: project Botanica sudavica

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Abstract

In 2015–2016, Botanical Garden of Vytautas Magnus University prepared a successful project "Estimation of the impact of climate change on the biological diversity in the south-western Lithuania and development of measures for adjustment (Botanica sudavica) funded by the EEE and Norwegian Environment Agency. The project Botanica sudavica was focused on the estimation of the impact of climate change on plant biodiversity in south-western Lithuanian forests, wetlands, meadows, inland bodies of water, and heath ecosystems.

Keywords: Botanical diversity, endangered plant species, impact of climate change, conservation.

INTRODUCTION

In any consideration of the human impact on the natural environment, it is probably appropriate to start with vegetation and its cover. Thus, it is very important to have knowledge and understanding both of the diversity of vegetation, and its changes in order to avert the threats of extinction of rare species' communities and endangered plant species. The project Botanica sudavica was focused on the estimation of the impact of climate change on plant biodiversity in south-western Lithuanian forests, wetlands, meadows, inland bodies of water, and heath ecosystems. Goals of the project: to determine the impact of climate change on plant diversity in south-western Lithuanian forest, wetlands, meadows, inland bodies of water, and heath ecosystems; to develop practical methodological and organizational conditions to better protect the botanical diversity in the territory of the project; to develop theoretical methodological and organizational conditions to better preserve plant biodiversity. The project opened up the possibility to establish a new exposition of endangered plant species in Botanical Garden of Vytautas Magnus University. Plants for the exposition were taken from their natural habitats.

MATERIALS AND METHODS

Data on the distribution of the endangered plant species was collected from various information sources such as books, scientific articles, herbariums, and vegetation databases. An annotated check list of the endangered plant species has been prepared using collections of former Herbarium Sudavicum (HSUD), currently in BILAS, and the Suvalkija region vegetation database (PHYTOSUD). From data collected, 33 endangered plant species, which are considered to be at a high risk of extinction, were selected, and

the inventory of their localities was carried out.

By conducting inventory of the protected plant species, their habitats were described too. Complete phytosociological relevés of vegetation communities were made in the studied habitats. To assess changes in the plant communities, Suvalkija region vegetation database (PHYTOSUD) was employed. New phytosociological relevés were compared with ones gathered since 1992 until 2012 in the same plots. Plant communities were classified so that we could identify them and compare with other communities of the same association in the studied region, in the country and in Europe. This allowed us to analyse the habitat changes, to get some knowledge about the cenological amplitude of endangered plant species as well as tendencies in the dynamics of the communities where protected plant species grow. The ongoing processes of the dynamics in the plant communities were analysed and identified following K. Falińska (1987). Phytosociological studies and classification of communities follows traditional principles of the foristic-phytosociological approach (Braun-Blanquet, 1964). Plant names were followed after Z. Gudžinskas (1999). Syntaxonomic names follow mostly by M. Chytrý (2007, 2009, 2011, 2013).

RESULTS

For the further investigations, 33 plant species have been selected which are facing a high risk of extinction, and belonging to five different ecosystems (forests, wetlands, meadows, waters, and sands) (Table 1).

Analysis of available sources showed that selected endangered plant species for further investigations have superficial data on their distribution and habitats, i.e. locations have been described inaccurately (especially in old data sources), the species' habitats characterised laconically, and some data is not available on them at all. There can be no doubt that, data which has been collected in a vague manner is insufficient for understanding the ecological amplitude of species and for the assessment of optimal conditions of their habitats under the conditions of the Lithuanian climate (especially on species of south-west distribution). Complete data on vegetation habitats where endangered plant species grow or grew in the past (phytocenological relevés) is maintained and updated only in the Suvalkija vegetation database (PHYTOSUD) and in a few literature sources; therefore, according to the following data it is impossible to assess some plant species' habitat's changes.

Within southwestern territory of Lithuania 13 investigated species out of 33 were confined to meadow ecosystems, 8 plant species associated with forest ecosystems, and 6 species encountered in wetland ecosystems (Table 1). *Cladium mariscus* grows in water ecosystems and *Dianthus arenarius* – in heaths (sands). Two more species (*Dianthus superbus* and *Trisetum sibiricum*) were associated both with meadows and forests, and one species (*Dactylorhiza majalis*) occurs both in meadows and wetlands. *Polemonium caeruleum* is a species of broad ecological amplitude. These species of plants occur in meadows, wetlands, forests and ruderal habitats.

During inventory of 33 plant species localities 11 species have not been found and numbers of 13 species localities out of 33 declined obviously. In known localities 8 plant species survived (or vanished in one or two localities). Just one species – *Campanula bononiensis* new locality was discovered in the area (Table 1). Over the last 20–30 years, a larger part of monitored plant communities with the endangered plant species in them has changed and the main reasons were: dynamics in the communities (a secondary succession, recession, regeneration, degeneration), zoogenic activities, anthropogenic activities.

Table 1. Engendered plant species, which are facing a risk of extinction, key habitats and dynamics of localities' numbers

No.	Species	Habitat	Dynamics of localities' numbers			
			Constant number of localities	Increased number of localities	Vanished plant species	Number of localities considerably declined (a species vanished in more than 1/4 of localities)
1	*Bromopsis erecta*	Meadows	x			
2	*Campanula bononiensis*	Meadows		x		
3	*Campanula cervicaria*	Meadows			x	
4	*Cephalanthera rubra*	Forests				x
5	*Chaerophyllum hirsutum*	Forests			x	
6	*Cladium mariscus*	Waters				x
7	*Coeloglossum viride*	Meadows			x	
8	*Dactylorhiza maculata*	Wetlands				x
9	*Dactylorhiza majalis*	Meadows, wetlands				x
10	*Dactylorhiza ochroleuca*	Wetlands				x
11	*Dactylorhiza traunsteineri*	Wetlands			x	
12	*Dianthus arenarius*	Heaths (sands)				x
13	*Dianthus superbus*	Meadows, forests				x
14	*Festuca altissima*	Forests	x			
15	*Gentiana pneumonanthe*	Meadows				x
16	*Gymnadenia conopsea*	Meadows				x
17	*Gymnadenia odoratissima*	Meadows			x	
18	*Gladiolus imbricatus*	Meadows				x
19	*Gratiola officinalis*	Meadows			x	
20	*Hedera helix*	Forests				x
21	*Hypericum montanum*	Forests			x	

No.	Species	Habitat	Dynamics of localities' numbers			
			Constant number of localities	Increased number of localities	Vanished plant species	Number of localities considerably declined (a species vanished in more than 1/4 of localities)
22	*Hordelymus europaeus*	Forests	x			
23	*Iris sibirica*	Meadows			x	
24	*Laserpitium prutenicum*	Meadows				x
25	*Lathyrus pisiformis*	Meadows				x
26	*Melittis melissophyllum*	Forests	x			
27	*Neottianthe cuculata*	Forests			x	
28	*Pedicularis sceptrum-carolinum*	Wetlands				x
29	*Polemonium caeruleum*	Meadows, wetlands, forests, ruderal habitats	x			
30	*Trisetum sibiricum*	Meadows, forests			x	
31	*Senecio conguestus*	Wetlands			x	
32	*Tofieldia calyculata*	Meadows	x			
33	*Viola persicifolia*	Wetlands	x			

Some parts of the plant communities, particularly from the *Carpino-Fagetea* and *Festuco-Brometea* classes, remained stable; protected plant species survived there, and even a few plant populations increased. A significant part of the studied phytocenoses has been destroyed, but not by the usual anthropogenic activities, but due to zoogenic factors.

The project opened up the possibility to establish a new exposition of endangered plant species in Botanical Garden of Vytautas Magnus University. Plants were taken from their natural habitats and placed for storage in ex-situ collections. An educational book "Conservation of botanical diversity in south-west Lithuania" was published (Mildažienė et. al., 2016). The results of investigations and proposals for adjustment measures were presented in this book.

DISCUSSION

In the investigated territory, the highest risk of endangered plant species' extinction occurs in meadow ecosystems (Table 1). In these ecosystems 39 % of the investigated plant species became extinct and numbers of localities where they grow decreased significantly. In above mentioned localities, 22 % of plant species were stable. Just one species – *Campanula bononiensis* localities increased in number.

However, the major part of the protected species is disappearing, has vanished completely in meadow ecosystems and we found out two main reasons why: the first one is a natural environmental factor – a secondary succession in meadows, i.e. their being overgrown by trees and scrub, and the second one is a factor of zoogenic origin – increased numbers of beavers. Rivulets or hollows situated between hills were dammed by beavers, and meadow habitats have been destroyed by having been transformed into wetlands.

Thus, the key protection activities for meadow habitats and endangered plant species in them are: mowing, grazing, removal of scrub and trees and regulation of the beaver population. These nature management measures bear quick results, for example, in the Žuvintas Biosphere Reserve in Dambavaragis, due to mowing of abandoned meadows for a few years, the sparse *Gentiana pneumonanthe* populations re-established themselves and spread extensively.

A similar trend of distribution changes to the endangered plant species in wetland ecosystems is also observed. Here, 42 % of the investigated species disappeared and localities of 55 % of species declined in numbers. In wetland ecosystems, protected plant species are disappearing due to the same reasons as in the meadows but here wild boars and beavers deteriorate habitats.

Most stable distribution dynamics of the endangered plant species are in the forest ecosystems: a quantity of 50 % of the studied plant species localities remained constant or decreased slightly. In the studied territory, 38 % of the species disappeared, 12 % of them are vanishing. In deciduous broadleaf forests rare plant species are stable in all known sites and their abundance increased in the communities (*Hordelymus europaeus, Hedera helix* and *Festuca altissima*). We have to mention that all Hordelymus europaeus disappeared in two sites in Bukta forest, but on the other hand, populations established themselves in other areas. The reasons for their disappearance is, we keep feeding wild boars and at the same time promoting process of forest communities regeneration. If wild boar feeding stations are established in the habitat or next to it then it gradually becomes degraded, due to the animals' frequent visit, uprooting of the forest leaf litter and spreading of their excrements in the area. In such places nitrophilous plants fill the niche by squeezing broad leaved herbs out from the forest communities' herb layer. A clear-cutting or thinning of forest stands engenders a regeneration of forest communities, fostering thickets of scrub, and the densification of the tree canopy, which throws the forest floor into shade.

In coniferous forests *Neottianthe cuculata* vanished. The disappearance of this species is, presumably determined by a few factors. As a result of thinning of stand of pine trees in the community where this plant grew, *Corylus avellana* established itself and the shrub layer densified, therefore *Juniperus communis* was eliminated from the area. Closed scrub storey shadowed communities' herbaceous layer. In other communities, after the recent thinning of forest stands, branches were stacked into piles, therefore nitrophilous plants started to thrive around the piles. The disappearing

of *Neottianthe cuculata* also was influenced by wild boars which uprooted a leaf-litter in the area with thinned stands of trees. Characteristic species of the thermophilous oak forest *Melittis melissophyllum* survived due to nature management measures which have been applied on its habitats by removing *Corylus avellana* shrubs from the area.

In total two species were investigated in heath (sands) and water ecosystems. Both plant species began to vanish and their localities declined critically. *Cladium mariscus* is vanishing because of beavers' dams and *Dianthus arenarius* – due to afforestation of heaths (sands). The vanishing of plant species of broader ecological amplitude, which are confined to meadows and forest or to meadows and wetlands, is observed. *Polemonium caeruleum* is a species of wide ecological amplitude. As a consequence of degraded meadows, *Polemonium caeruleum* plants are relegated to forests and ruderal habitats, therefore they are in stable condition.

The life span of the different kind of plants that grow within phytocenoses of distinct vegetation classes differs in plant communities. For example, the numbers of *Polemonium caeruleum* localities remained constant in plant communities of the *Molinio-Arrhenatheretea* class, whereas, in the communities of the *Galio-Urticetea* class, numbers of localities increased. However, *Polemonium caeruleum* has vanished within *Phragmito-Magno-Caricetea* communities.

Most species became extinct in the plant communities from classes like *Molinio-Arrhenatheretea* (6 out of 13 ascertained species), *Phragmito-Magno-Caricetea* (3 out of 5), *Vaccinio-Piceetea* (2 out of 4), *Scheuchzerio palustris-Caricetea nigrae* (2 out of 4) and *Alnetea glutinosae* (2 out of 5).

Dynamics of localities quantities remained fairly good in the communities from the *Carpino-Fagetea* class: there more species occurred throughout, with stable dynamics of distribution (4 out of 6). The dynamics of numbers of localities are bad in the plant communities from classes like *Scheuchzerio palustris-Caricetea nigrae* (2 out of 4 ascertained species have vanished and two species' habitat numbers have considerably declined), *Molinio-Arrhenathereta* (6 out of 13 ascertained species have vanished, four species' habitat numbers have declined considerably) and *Quercetea pubescentis* (3 out of 6 species have vanished and one species' habitat numbers have declined drastically). All endangered plant species have disappeared within the plant communities from the classes of *Bidentetea tripartiti, Koelerio-Corynephoretea* and *Nardetea strictae* (each community included one species).

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Preservation of European cranberry germplasm in Lithuania and selection of new cultivars of local origin at Botanical Garden of Vytautas Magnus University

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Abstract

European cranberry is found in raised bogs but drainage of the swamps during soviet times caused the critical decreasing of the natural resources of this plant in Lithuania. The ex situ genes pool collection was established in the Botanical Garden of Vytautas Magnus University to preserve genetic biodiversity of the natural cranberry species and clones. Evaluation of productivity as well as biological properties of collected samples allowed to sort out the best of them in terms of suitable for new cultivars selection. Five wild clones of European cranberry were tested in international center for approving of new cultivars. In the year 2016 new cultivars of Lithuanian origin were approved, and namely 'Reda', 'Vita', 'Amalva', 'Žuvinta' and 'Vaiva'.

Key words: European cranberry, clones, collection, evaluation, cultivars.

INTRODUCTION

The species *Vaccinium oxycoccos* L. (syn. *Oxycoccus palustris* Pers.) belongs to the family *Ericaceae* Juss. Natural resources of *V. oxycoccos* can found in Scandinavia, Baltic States, Poland, Byelorussia, Ukraine, Russia, and Alpine zone of Switzerland, France, Italy (Kardell 1986, Pliszka, 1997). Natural resources of European cranberry are found in raised bogs. This species grows on peat in poorly drained, subhygric or hygric sites that have a very high-water level. The existence of bogs vegetation was seriously threatened by the effects of land reclamation in Lithuania during soviet times. Large areas of raised bogs suffered from eutrophication, which has adverse effect on existent bog vegetation. Land reclamation caused the critical decreasing of the natural resources of European cranberry in Lithuania (Budriūnienė, 1998, Daubaras and Česonienė, 2004). Despite cranberries are still harvested in the wild, decreasing of their natural resources have stimulated initiatives to domesticate this crop (Daubaras et al., 2003). Consequently, *V. oxycoccos* germplasm collection was established at Kaunas Botanical Garden of Vytautas Magnus University in 1995. The samples of wild cranberry clones were collected in largest swamps of Lithuania - Žuvintas, Čepkeliai, Kamanos, Velniabalė, Gervėčiai. This ex situ collection is the largest in Baltic region and became the object of broad-based investigations and provided essential research input for preservation of *V. oxycoccos* genetic resources and breeding. This species distinguishes itself for high intraspecific diversity. Other researchers described cranberry clones growing in the same bog, however, differing mostly in berry size, color, and shape or in shoot length and diameter (Budriūnienė, 1998; Cherkasov, 1998). In year 2008 the cranberry collection of BG was proclaimed as National gene pool collection with special status of protection.

MATHERIAL AND METHODS

Plant material for the evaluations was collected during expeditions to the largest and most important swamps starting from year 1995. Evaluation criterion for collecting of different clones of cranberries were fruit color, shape, size, ripening time, leaves color and shape, and more. Descriptor for the clones of European cranberries was created.

A detailed evaluation of morphological diversity of the collected clones was carried out in 1999-2009. For the morphological characterization different stems, leaves and berry properties per clone were used: leaf size and shape, shape of leaf apex and base, leaf margin bending, color of a fully opened flower, length of peduncle, berry size, shape, color, cross-section shape, and waxy layer intensity, as well as berry flesh color.

Photo 1. European cranberry clone 'REDA'

Photo 2. European cranberry clone 'AMALVA'

The average weight of a berry was measured by using an analytical balance with a sensitivity of 0.01 g (ISHIDA company, Japan, model DJ-150E). The yield production of the clones was estimated. Composition of the main biochemical substances was investigated. Mathematical - statistical assessment on the data has been fulfilled using programmes and specific differences were identified with LSD (the least significant difference).

RESULTS

The cranberry *ex situ* collection in Botanical Garden of Vytautas Magnus University demonstrates wide range of morphological diversity. *V. oxycoccos* clones were characteristic of significant phenological plasticity and the determination of berry shape of European cranberry revealed high variability. Statistically reliable differences in the average weight of a berry were ascertained since Fisher's criterion was $F_{01(fact)}=31.69>F_{01(theor)}=1.54$. It has been found that the berries of twelve clones fall into the group of medium-sized (0.6-1.0g), the berries of seven clones were large (1.1-1.5g). The estimation of the berry yield ex situ indicated quite big differences among the clones.

Significant differences in the yield and the berry size of clones in the *ex situ* collection indicate a good possibility for European cranberry breeding. Integrated evaluation of morphological and economical peculiarities of clones based the selection of the valuable clones 95-A-09, 95-A-05, 96-Ž-11, 96-Ž-10, and 99-Ž-10. These clones were entitled, respectively 'REDA' (Photo. 1), 'VAIVA', 'AMALVA' (Photo. 2), 'VITA', and 'ŽUVINTA', and for four years (2013-2016) DUS-testing (distinctness, uniformity and stability) was carried out at the specialized center for testing in Poland (COBORU) for the purpose of granting the Breeders' Right. In the year 2016 they were approved as new cultivars of Lithuanian origin.

Lithuanian cultivars of European cranberries are of high productivity (1.5-2.8 kg/m^2 or around 3-4 l/m2) and berries are quite large – from 0.8 to 1.1 g. The most productive was the clone 95-A-05 with an average yield 2.3 kg/m^2. The average yield of other clones varied from 1.6 kg/m^2 (the clones 95-A-09 and 99-Ž-10) to 2.1 kg/m^2 (the clone 96-Ž-10).

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Picea plants diversity in Klaipėda University Botanic Garden

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Abstract

In Klaipeda University Botanical Garden (KUBG) dendrological department grow 70 taxa of *Picea* plants – 18 species and 52 varieties. By the climatic conditions KUBG has a limited prevalence of *Piceae* plants. The average precipitation per year is from 149 to 86 mm, the average air temperature varies from -8 to +22 oC. The ordering of *Picea* seeds in LUBG started since 2003, in the period from 2003 to 2018 we made 65 requests from 19 botanic gardens (14 countries). Seeds germinated from 9 gardens only. Five of these *Picea* species were germinated and planted in collection: *Picea koyamai* Shiras, *P. asperata* Mast., *P. wilsonii* Mast., *P. maximowiczii* Regel ex Mast. and *P. koraiensis* Nakai. Distribution of ordering by the country was as follows: 3 from Lithuanian, 2 – from Poland and 1 – Czech Botanic gardens. Totally, the biggest number of seeds was ordered from Lithuanian botanic gardens – 24 times, but only 20% germinated from them. From the seed exchange, the seeds with good germination came from Canada, Romania and Lithuania. Since 1998 in our *Index Seminum* 14 taxa of *Picea* are included.

Keywords: climatic parameters, Pinaceae family, taxa, seeds, botanic garden.

INTRODUCTION

Picea is a genus of about 35 species of coniferous evergreen trees in the family *Pinaceae* (http://conifersociety), or by the other authors consisting of 11 genera and about 220 species of trees (rarely shrubs) (www.fpl.fs.fed.us) native to the northern temperate and boreal regions. In Lithuania, most widespread is *Picea abies* (L.) H. Karst. The limit of natural area of this species in the North Baltic region is near the Southern Lithuania border (Schmidt-Vogt, 1977). From the North to South, the proportion of spruce in the stands decreases accordingly. The spruce is a so-called boreal species and more adapted for cooler climate. The marine climate is not favourable for the species (Dahl, 1990, 1998). By the theory of physiological stress and after the dendrochronological research, the trees growing near at the limit of geographical distribution are sensitive for environment factors as plants growing in the optimum of this area (Lovelius, 1997). Many authors divide the spruce habitat into three distinct regions: I - Alpine-South-East Europe (Balkans), II - Carpathians, III – North Baltic, included with Lithuanian spruce (Schmidt-Vogt, 1977; Dering, Lewandowski, 2009; Žemaitis, 2014). North Baltic region is distinguished by a strip of spruce in forest ecosystems, which is referred as the spruceless belt. The formation of this division was determined by the migration of spruce from different ice age zones (Latałowa, Knaap, 2006; Tollefsrud et al., 2008). This is confirmed by studies of the genetic structure between the populations of Central and Southern Europe (Tollefsrud et al., 2008; Dering, Lewandowski, 2009). However, number of scientists show that the Northern and Southern regions have merged in the past, and the current division is the result of human activity (Latałowa, Knaap, 2006;

Środoń, Tobolski, 2007; Dering, Lewandowski, 2009).

Spruces are large trees, from 20–60 m tall when mature, and can be distinguished by their whorled branches and conical form. The needles are shed when 4 to 10 years old, leaving the branches rough with the retained pulvinus (an easy means of distinguishing them from other similar genera, where the branches are fairly smooth). DNA analyses have shown that traditional classifications based on the morphology of needle and cone are artificial (http://conifersociety).

The spruce is characterized by good growth, abundance and natural regeneration, wide range of tolerance for biotic and abiotic factors in the range and longevity (Schmidt–Vogt, 1977), but in the time of vegetation the Picea plants are sensitive for frosts in spring and early autumn (Ellenberg, 1988). Seasonal spruce transition to resting time and frost resistance is related to the concentration of trisaccharide raffinose in shoots and roots. During the resting period the concentration of this saccharide in these parts of the plant is high (Wiemken et al., 1996).

MATERIALS AND METHODS

Study area and object. The Klaipeda University Botanical Garden (KUBG) was established in 1993, but since 2002 it has the status of dendrological park. Since 2005, Botanical Garden is a member of the International Phenological Gardens (IPG). In the Dendrological department of KUBG 70 taxa plants of Picea are growing.

For research we evaluated data from *Index Seminum* in period 2003–2018 and from the plant data base. The seed orders, plant obtainment and growth data were investigated. The growing conditions were comparable.

Meteorological data. Territory of Lithuania is in the middle of latitude bar, which is characterized by the change of seasons. The length of growing season usually depends on annual air temperature and precipitation. The data of climate factors (air temperature and precipitation), average monthly and annual parameters were supplied by Lithuanian Hydrometeorological Service under the Ministry of Environment, Department of Klaipėda. This weather station is close to research place, in a distance of about 3.5 km. Data were collected since 2005 to 2018. The precipitation by the years is present in Fig. 1. Average air temperature by the months is present in Table 1. The average of humidity in Western part of Lithuania in whole year are around is 80% (Table 2).

RESULTS

The total precipitation in Klaipėda area was highest in summer time – 3014.5 mm. In other season, this indicator was respectively: in spring – 1273.5 mm, autumn – 2890 mm and winter – 2145.9 mm. If compare the range of temperatures per seasons, the highest temperature in spring was in 2014 (8.1 ºC) and lowest – in 2005 (4.9 ºC). The warmest months in spring season was the May of 2018 (15.5 ºC) and the coldest – March of 2013 (-2.6 ºC). Temperature in the summer ranged in average 17.5 ºC (from 16.8 ºC in 2012 to 18.4 ºC in 2010) and in autumn – lowest in 2010 (8 oC) and highest – in 2011 (10.3 ºC). The warmest months in summer season was July (21.1 oC) in 2014, coldest – June (13.3 ºC) in 2014. Winter season was mutable per period: temperature ranged from – 5.4 (2010) to 2.3 ºC (2015), but mostly it was about o ºC (on average per period was -0.7 ºC). If compared by the months in seasons, the coldest was in January (-8.1 ºC) in 2010, the highest temperature was in 2007 in December (5.3 ºC) (Table 1).

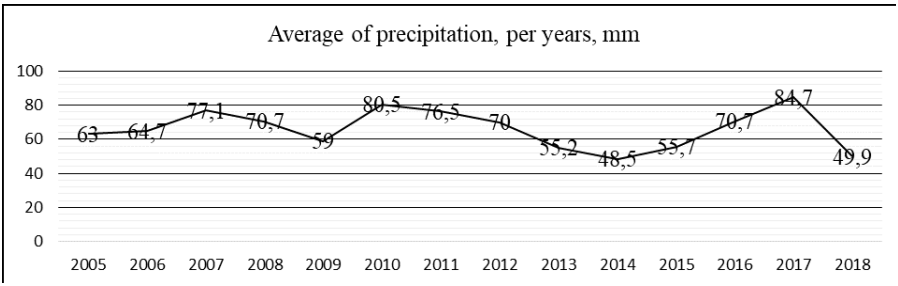

Fig. 1. Average of distribution of precipitation (mm). Data of Klaipėda meteorological station

Table 1. Distribution of average air temperature (°C) in seasons. Klaipėda, 2005-2018

Year/Month	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I	II
2005	-2	6.2	10.6	14.2	19.3	17.4	15.5	9.5	4.9	0.3	1.6	-2,9
2006	-1.5	5.4	11.6	15.7	19.6	18.8	16.4	11.7	6.4	6.7	-5.5	-3,7
2007	5.3	6.0	12.5	17.5	16.8	19.0	14.2	8.9	3.6	2.7	3.1	-3,6
2008	3.3	7.7	11.3	15.9	18.4	17.9	12.5	10.1	5.1	2.0	1.2	3,3
2009	1.5	8.3	11.3	15.0	18.7	18.2	15.4	6.9	5.1	-0.9	-0.3	-1,9
2010	1.2	5.6	10.6	14.8	20.9	19.5	13.2	6.9	3.9	-4.9	-8.1	-3,3
2011	0.9	6.9	11.3	17.3	19.0	18.0	15.1	9.9	6.0	3.6	-0.9	-5,5
2012	1.7	6.8	11.8	14.3	18.7	17.3	14.9	8.9	6.1	-3.0	-1.0	-6,5
2013	-2.6	4.5	14.2	16.7	18.0	18.4	13.2	9.8	6.6	3.9	-4.7	-0,5
2014	3.8	8.3	12.3	13.3	21.1	18.7	14.6	8.8	3.9	2.2	-4.0	1,1
2015	4.4	6.3	10.5	14.2	17.2	19.6	14.7	7.6	6.7	4.7	1.0	1,1
2016	2.8	7.0	14.1	16.0	18.7	17.5	15.1	6.5	3.5	3.2	-4.1	2,5
2017	3.2	4.9	11.4	15.2	17.0	18.0	14.3	9.2	5.8	3.6	-0.9	-0,5
2018	-1.0	8.6	15.5	16.2	19.3	20.3	16.0	10.6	4.4		-0.1	-4,7

Table 2. Average of humidity in 2005-2017. Data of Klaipėda meteorological station

Season	Spring			Summer			Autumn			Winter		
Month/ year	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I	II
2005	75.2	71.1	79.5	80.6	75.8	82.9	80.0	81.8	77.7	83.7	82.1	72.3
2006	79.0	79.5	72.8	74.8	73.0	80.0	83.0	86.7	92.7	86.2	85.2	86.9
2007	78.6	71.5	76.2	73.4	84.8	78.0	79.3	82.0	85.6	89.5	87.8	82.1
2008	79.8	75.4	70.8	72.0	75.9	81.9	84.8	87.2	89.6	91.5	84.0	85.2
2009	85.7	73.8	81.6	82.5	80.5	72.2	77.4	83.5	89.8	84.5	86.9	87.5
2010	82.0	83.0	88.5	84.9	84.4	84.7	85.9	83.2	91.4	91.2	78.5	83.6
2011	83.3	80.7	80.1	81.7	82.8	79.8	91.0	80.0	87.2	87.2	92.5	79.8
2012	85.0	70.9	73.7	77.0	79.0	79.7	77.3	83.4	87.0	85.2	84.3	82.5
2013	62.9	80.1	73.5	77.5	80.9	77.0	81.6	84.4	85.1	85.5	85.5	84.5
2014	83.9	68.5	74.5	83.2	68.1	72.8	76.8	81.2	85.9	85.4	78.9	84.4
2015	76.5	81.6	77.8	75.3	76.3	66.7	77.1	74.4	84.6	83.5	83.9	82.6
2016	77.8	73.4	69.1	76.2	79.2	79.0	78.2	79.7	83.4	83.7	80.0	84.6
2017	82.4	76.9	65.0	75.4	75.7	73.6	80.0	84.0	87.4	87.4	83.9	78.6
Average	79.1	75.8	76.5	78.3	78.4	77.9	81.0	82.3	86.7	86.4	84.1	83.0

The ordering of *Picea* seeds in LUBG started in 2003, in the period from 2003 to 2018 we made 65 requests from 19 botanic gardens (14 countries). Seeds germinated from 9 gardens only (Table 3). Five of these *Picea* species were germinated and planted in collection: *Picea koyamai* Shiras, *P. asperata* Mast., *P. wilsonii* Mast., *P. maximowiczii* Regel ex Mast. and *P. koraiensis* Nakai. Distribution of ordering by the country was as follows: 3 from Lithuanian, 2 – from Poland and 1 – Czech Botanic gardens. Totally, the biggest number of seeds was ordered from Lithuanian botanic gardens – 24 times, but only 20% germinated from them. Once per period the seeds were ordered from Canada, Romania, France, Georgia. Except Canada, these countries are in warmer biogeographically zone. The seeds from Georgia, Ukraine and Belarus never reached us, while the seeds from France did not germinate. The greatest success was with the seeds from Romania and Canada – their seed material germinated and plants now are in our collection (Table 3).

Table 3. Seed order of Picea plants (country and germination)

No.	Species	Donation country	Seed order year	Seeds obtained	Germination
1	Picea koyamae Shiras.	Estonia	2003	+	-
2		Czech Republic	2005	+	+
3		Poland	2008	+	+
4	Picea bicolor (Maxim.) Mayr.	Germany	2007	+	-
5	Picea mariana (Mill.) Britton & et al.	Estonia	2003	+	-
6		Lithuania	2004	-	-
7	Picea jezoensis (Siebold & Zucc.) Carrière	Lithuania	2004; 2010	+	-
8		Germany	2004	+	-
9		Russia	2011	+	-
10	Picea sitchensis (Bong.) Carrière	Lithuania	2004; 2006	+	-
11		Ukraine	2016	-	-
12		Germany	2012	-	-
13	Picea asperata Mast.	Lithuania	2004; 2007; 2008; 2015	+	-
14		Russia	2008; 2011	+	+
15	Picea wilsonii Mast.	Lithuania	2004; 2005; 2006; 2015	+	+
16	Picea orientalis (L.) Peterm.	Germany	2004	+	-
17		Ukraine	2016	+	-

18	Picea koraiensis Nakai	Germany	20014	+	-
19		Ukraine	2016	-	-
20		Estonia	2012	+	+
21	Picea schrenkiana Fisch. & C.A. Mey.	Russia	2006	-	-
22		Belarus	2013	-	-
23		Ukraine	2016	-	-
24	Picea likiangensis (Franch.) E. Pritz.	Germany	2008	-	-
25	Picea purpurea Mast.	Poland	2008	+	-
26		Lithuania	2006; 2007; 2008; 2013	+	-
27	Picea engelmannii Parry ex Engelm.	Lithuania	2006; 2007; 2008; 2013	+	-
28		France	2015	+	-
29		Ukraine	2016	-	-
30		Latvia	2014	-	-
31	Picea obovate Ledeb.	Ukraine	2016	-	-
32	Picea torano (Siebold ex K. Koch) Koehne	Germany	2008	-	-
33		Georgia	2013	-	-
34	Picea maximowiczii Regel ex Mast.	Poland	2008	+	+
35	Picea rubens Sarg.	Lithuania	2008; 2013; 2014; 2018	+	+
36		Estonia	2009	-	-
37		Latvia	2010; 2017; 2018	+	-
38		Canada	2014	+	+
39		Ukraine	2016	+	-
40	Picea ajanensis Mast.	Russia	2009	-	-
41	Picea smithiana (Wall.) Boiss.	France	2012	+	-
42		Georgia	2013	-	-
43	Picea engelmannii Parry ex Engelm. 'Glauca'	Lithuania	2004	-	-
44	Picea brachytyla var. complanata (Mast.) W. C. Cheng ex Rehd.	Latvia	2014	-	-
45	Picea abies f. palustris	Lithuania	2007	+	+
46	Picea orientalis (L.) Peterm. 'Nutans'	Latvia	2017	+	-

47	Picea pungens 'Argentea'	Romania	2016	+	+
48	Picea schrenkiana var. tianshanica (Rupr.) W. C. Cheng & S.H. Fu.	Germany	2004	+	-

In 2018 in Klaipėda University Botanic Garden, 70 taxa of *Picea* plants were growing – 18 species and 58 varieties (Table 4). However, number of plants growing from seeds are only 25%, others are cultivated from the seedlings.

Table 4. Picea plants growing in KUBG, distribution by species and variety

No.	Species	Planting from seed	Variety number	Species number
1	Picea abies (L.) H. Karst.		22	1
2	Picea alcoquiana (Veitch ex Lindl.) Carr.			1
3	Picea asperata Mast.	2015		1
4	Picea breweriana S. Wats.			1
5	Picea glauca (Moench)Voss.		11	1
6	Picea glehnii (Fr. Schmidt) Masrers	2008-2009		1
7	Picea jezoensis (Siebold et Zucc.) Carr.			1
8	Picea koyamae Shiras	2010-2012		1
9	Picea montigena Masters			1
10	Picea mariana (Mill.) B.S.P.		3	1
11	Picea x mariorika Boom			1
12	Picea maximowiczii Regel ex Masters	2012		1
13	Picea obovata Ledeb.		1	
14	Picea omorica (Pančic) Purk.		3	1
15	Picea orientalis (L.)Link.		2	1
16	Picea pungens Engelm.		9	1
17	Picea purpurea Masters			1
18	Picea retroflexa Masters	2006-2008		1
19	Picea sitchensis (Bong.) Carriere		1	
20	Picea wilsonii Masters	2012		1

Since 1998, in the *Index Seminum* of KUBG the seeds from 14 taxa of *Picea* plants are included. *Picea abies* L., *P. orientalis* L., *P. glauca* (Moench) Voss, *P. mariana* L. are most often maturing from seeds in *Index Seminum*.

DISCUSSION

Picea trees are very important for ecosystem of boreal biogeographically zone but also for human needs. The wood is used for paper, furniture, medicine, while the trees are used for landscaping. However, by the State Forest Service in the 2017 Lithuanian forest land was 2189,6 thous. ha or 33.5%, including coniferous – 1145 ha and spruce – 429,5 ha (http://www.amvmt.lt, 2017). In 2007, spruce cover was 424,7 thous. ha area (http://www.amvmt.lt, 2007), however, in the national level the composition of spruce is not analysed (Žemaitis, 2014).

Spruce is considered as a sensitive plant to climate change both in Southern and Northern spruce regions (Yousefpour et al., 2010). The research on the climatic changes is mainly based on the range of the existing species areas (Schmidt Vogt, 1977; Klimienė et al., 2016). In KUBG the Picea plants were started growing since 1994, the first species was *Picea abies* (L).

CONCLUSIONS

(1) By the climatic conditions KUBG has a limited prevalence of *Picea* plants. The average precipitation per years is from 149 to 86 mm, the average air temperature varies from -8 to +22 ºC.

(2) In KUGB, 18 species and 52 varieties of *Picea* are growing.

(3) After testing the material gained in seed exchange, the seeds with good germination came from Canada, Romania and Lithuania.

(4) Since 1998, 14 taxa of *Picea* plants are included in the *Index Seminum*.

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Rosa L. collection in Klaipėda University Botanical Garden

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Abstract

The Botanical Garden of Klaipeda University (KUBG) is located in Western part of Lithuania, in Klaipėda city, in the valley of the Dane River. The collection of *Rosacea* family was started in 1995 when plants were collected for ornamental purpose. In two separate collections, there are 17 taxa of *Rosa* L. genus growing now: in Dendrological and Herbaceous ornamental plants. According to the American Rose Society approved classification they belong to all three groups of roses. The beginning of rose exposition in KUBG is dated with year 2006. At that time the rose collection contained 40 cultivars, and it enriched each year by new cultivars from private collections. The preference was given to those cultivars which showed their blossoming properties and resistance to diseases or low temperature. The biggest part of roses now belongs to Floribunda group – 47, Hybrid tea – 19 and Shrub roses – 17.

Keywords: Roses, genus, Botanic garden, systematic groups.

INTRODUCTION

Roses are members of the family *Rosaceae*, which is one of the largest families of flowering plants with about 3,400 species including apples, berries, peaches, plums, cherries, the hawthorn tree, the mountain ash, and many others. A rose is a flowering shrub of the genus *Rosa*. There are more than a hundred species of wild roses, which are endemic (native) only to the Northern Hemisphere. The term is also used to refer to the flower of this shrub. The genus *Rosa* L. is one of the taxonomically most complicated groups of vascular plants. Total number of rose species is assessed by modern taxonomists between 200 and 300 (Wissemann, 2003), while the total number of described infrageneric taxa of various rank excesses 4000 (http://www.ipni.org). No other flower has a wider range of size, color, shape and flower form than the rose for attractive and easy adaptation to any garden setting. Roses are among the most versatile of plants. They come in every shape, size and color imaginable with architectural dimensions, both in bloom and plant size, that make it possible to please everyone. They bloom constantly from early spring to late fall, providing a rich tapestry of color in the garden.

Starting out on the rose selection pathway, the architectural shape and dimensions are of prime importance. To navigate this panorama of size and space, the following explanations have been compiled to explain the range of classifications available.

The American Rose Society recently approved a new classification scheme that reflects both the botanical and evolutionary progress of the rose. There are three main groupings: Species (i.e. wild roses); Old Garden Roses (classes in existence before 1867); and Modern Roses (classes not in existence before 1867).

Species Roses — often referred to as “wild roses” are usually single-petaled (with

4-8 petals), once-blooming and have a bush size ranging from two to 20 feet. They are listed according to their Latin name, beginning with R. for Rosa and can have common synonyms.

Old Garden Roses — in 1966, the American Rose Society defined old garden roses as those types that existed prior to 1867, the year of introduction of the very first hybrid tea, 'La France'. Within this generic definition, a number of popular subdivisions exist based on natural historical developments and characteristics. The flower form can be quartered, cupped, imbricated or expanded, reflexed, globular or compact. After an initial spring crop of blooms, some varieties may produce no more flowers the rest of year, but their hip production does add a different kind of beauty to the garden. The beauty of the old garden roses often lies in the heavy fragrance they can impart to the garden.

The era of Modern roses was established in 1867 with the introduction of the first hybrid tea, 'La France', by the French breeder Guillot. This variety was considered unique for a number of important horticultural reasons. First, it possessed the general habit of a hybrid perpetual as well as the elegant shaped buds and free-flowering character of a tea rose. By the late 20th century, more than 10,000 hybrid teas had been bred with great success. The introduction of 'La France' heralded the era of modern roses. Breeders were quick to recognize that planned parenthood could evolve new flower forms, size, growth habit and colors. Therefore, the following new classifications based on growth habit evolved (Wissemann, 2003).

MATERIALS AND METHODS

The Botanical Garden of Klaipeda University is located in Western part of Lithuania, in Klaipėda city, in the valley of the Dane River. It occupies 9.3 hectares, and there are 4 departments, 3 expositions, that includes over 4 000 taxa plants in total.

For research, the data about KUGB *Rosacea* plants were gathered from plant data basis in time period from 2006 to 2018. Characters of interest were as follows: plant obtainment years, distribution in family and genus, growing section and the growth data. All plants are growing in the soil of the same type – FLc-ar (Fluvisol Areni-Calcicaric). The texture of soil in the 0.30 m is 84.8% sand, 9.4% dust, 5.8% clay. The soil pH 6.2, mobile phosphorus – 581 mg/kg, mobile potassium – 135 mg/kg, common nitrogen – 0.114, biohumus – 2.05%.

RESULTS AND DISCUSSION

In KUBG, the *Rosacea* plants are collected since 1995. In two separate collections, there are 17 taxa of *Rosa* L. genus growing now (Table 1). According to the American Rose Society approved classification they belong to all three groups of roses.

The beginning of rose exposition in KUBG is dated with year 2006. At that time the rose collection contained 40 cultivars, and it enriched each year by new cultivars from private collections. The preference was given to those cultivars which showed their blossoming properties and resistance to diseases or low temperature. The biggest part of roses now belongs to Floribunda group – 47, Hybrid tea – 19 and Shrub roses – 17 (Table 2).

Table 1. Rosa L. genus plant in KUBG collection

No.	Species	Donation country	Planting date
1	R. rugosa Thunb	Lithuania	1995
2	R. rugosa Alba Thunb	Lithuania	1995
3	R. canina L.	Lithuania	1995
4	R. cinnamonmea L.	Lithuania	1995
5	R. roxburgii A. Barra	Germany	2013
6	R. multiflora Huds	Lithuania	1995
7	R. palustris Marshal	Lithuania	2018
8	R. virginiana Mill.	France	2005
9	R pimpinellifolia L.	Sweden	2003
10	R. glauca Pourr	Poland	2012
11	R. moyesii Hemsl.	Latvia	2008
12	R. nitida Willd	Latvia	2008
13	R. libani	Israel	2013
14	R. villosa L	Estonia	2013
15	R.luciae var. luciae	Romania	2014
16	R. jundzilii Besser	Austria	2015
17	R. dumalis ssp. dumalis	Finland	2016

There is a great interest worldwide in wild *Rosa* species for they contributed a lot in the foundation of modern cultivated roses. Wild *Rosa* species with important traits, such as powdery mildew (*Podosphaera pannosa*) resistance, large flowers and hips, and cold and drought resistance are regarded as valuable breeding materials. They have a wide range of use, from medicine to hybridization programs (Ma and Chen, 1992; Zlesak, 2006; Sparinska, Rostoks, 2012). In Modern roses group, a number of research in molecular level is made now, the results are discussed in a few publications (Schanzer, Vagina, 2007; https://www.rose.org).

CONCLUSIONS

(1) Since 1995, in KUBG are collected roses of all three groups. There are 17 taxa of *Rosa* L. plants.

(2) For the education purpose in separate exposition are growing 100 Modern group roses, here the largest part consists of cultivars from Floribunda group.

Table 2. Dynamics of rose collection during 2006-2017 in KUBG

Modern garden rose group	Year of planting			
	2006	2009	2014	2017
Floribunda	17	20	28	47
Hybrid Tea	11	15	28	19
Shrub	9	11	13	17
Miniature	-	2	5	3
Climbing	7	7	9	8
Old Garden roses	2	2	2	3
Polyantha	1	1	2	3
Total	**47**	**58**	**87**	**100**

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Seed demand according to seed exchange data of Šiauliai University Botanical Garden

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Abstract

The exchange of seed, including other types of diaspora, is one of means for biodiversity conservation – seed banks, *ex situ* protection, public awareness through exposition, but also, is essential way for collection expansion for significant part of Botanical gardens. Šiauliai University Botanical Garden (ŠUBG) is among many other institutions participating in programme and exchange ca. 250 seed batches annually contacting with 337 partners worldwide, especially partners in Europe. The aim of this text – present brief analysis of seed demand expressed by partner gardens other institutions. Average size of batch obviously differs depending on country, in some cases almost two times. The analysis of orders revealed decrease of demand by decreasing seed offered. The seed exchange for Šiauliai University Botanical Garden is an important way to develop living collections.

Key words: *Index Seminum*, seed exchange, Šiauliai, University, Botanical Garden

INTRODUCTION

The Botanical Garden – representative and educational research base, which has been developed since 1961. Officially, it was founded in September, 1997 and was named "Šiauliai University Botanical Garden". The scientific research carried out in the botanical garden is related to the introduction and acclimatisation of ornamental plants, plant biodiversity conservation *ex situ* (Meškauskaitė, 2010) and *in situ* as well as phenological observations. The garden also serves as a training and research base for Šiauliai University students. Various events for the community of university, city and region are continually organized and held, in addition, educational and cognitive activities are developed in the botanical garden.

The exchange of seed, including other types of diaspora, is one of means for biodiversity conservation - seed banks, *ex situ* protection, public awareness through exposition, but also, is essential way for collection expansion for significant part of Botanical gardens. ŠUBG is among many other institutions participating in programme and exchange ca. 250 seed batches annually contacting with 337 partners worldwide, especially partners in Europe.

The first seed catalogue *Index Seminum* of ŠUBG was published in 2002 eg. in Vilnius University Botanical Garden it was done much earlier – in 1824 (Indrišiunaitė et al., 2004). Since then, process was never interrupted although species quantity in *Index seminum* varied (Grišaitė et al., 2009). Largest amount of seeds offered is those from *Apiaceae, Asteraceae, Caryophyllaceae, Ranunculaceae* and *Scrophulariaceae* families. Seeds from plants of Lithuanian flora are always presented in separate list. Actual and earlier catalogues are available online at: www.bs.su.lt.

The aim of this text – present brief analysis of seed demand expressed by partner gardens other institutions.

MATERIAL AND METHODS

The data of seed exchange process is collected annually and used in this text. In 2015–2017 ŠUBGpresented seeds of 741, 615 and 305 taxa respectively. Orders of 2015–2017 seed exchange seasons were analysed. Basic statistical analysis of seed order data collected in ŠUBG conducted.

RESULTS

ŠUBG in 2015–2017 distributed *Index Seminum* catalogue via e-mail to partners and all institutions requesting it. Depending on season, the list of seeds covered 6.9–18% of all plant collections kept in ŠUBG. During the period analysed here, 354 batches of seeds were prepared and distributed: 1028 taxa in 2015, 1547 in 2016, and 1080 in 2017.

Geographically, most orders we got from Europe – 79.9%, from Eurasia (Russia) – 12.7%, N. America – 3.1%, S. America 0.6%, from Asia – 2.8% and Middle east – 0.3%. The largest proportion of orders ŠUBG received from institutions in Germany (17,8% of all batches), Russia (12.7%), France (9.9%), Poland (7.1%), Czech Republic (5.6%), Hungary (5.1%), Austria (4%), Italy (4%) and Romania (3.4%). Other 29 countries made up all rest – 30,5%. In Table 1 there is seed demand differences between gardens from countries.

Table 1. Means of taxa ordered by botanical gardens from different countries (only most common seed receiver countries mentioned here)

Partner's Country	Number of species ordered				
	mean in the batch	standard deviation	min	max	sum
Russia	14	7	2	26	625
Poland	14	8	1	34	338
Hungary	13	7	3	27	233
Italy	12	6	2	20	171
Romania	11	7	1	20	126
Czech Republic	10	6	2	20	207
France	9	6	2	20	302
Austria	9	6	1	20	130
Belgium	8	7	1	18	76
Germany	7	6	1	24	433
all rest countries	10	7	1	24	1014
				Total	**3655**

Average size of batch obviously differs, in some cases almost two times. It could be due to various possible reasons: narrow specialization of gardens (in Germany, Belgium); numbers can indicate process of fast garden growth and expansion of collections (eg. Russia, Poland, Hungary) or just tradition to have smaller gardens. Explanation needs further and wider research.

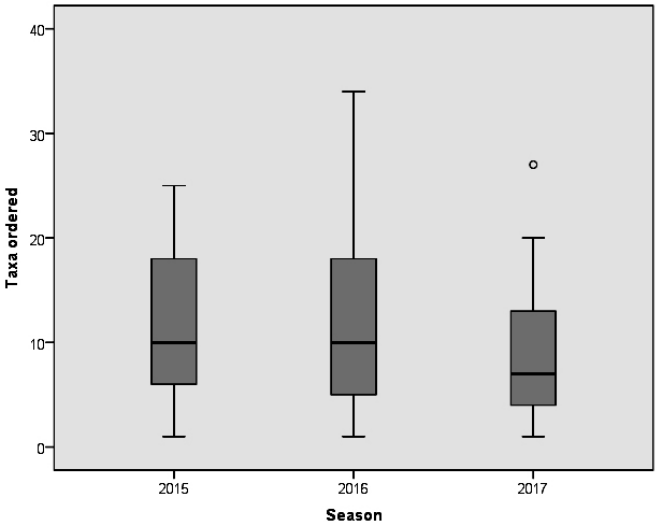

Figure 1. Average numbers of taxa ordered in 2015–2017 by partner gardens and other institutions related to botany

The fact of decreasing seed list of our botanical garden provides opportunity to check the interaction between amounts of seed listed in Index seminums and average bath sizes ordered by partner institutions. In Fig. 1 clearly seen fall of batch size.

The Botanical Garden in period analysed got 796 taxa in 2015, 1258 – 2016, 1031 – 2017, overall 3085 batches. Numbers is obviously depended on effort making orders but not on anything else.

DISCUSSION

The seed exchange for Šiauliai University Botanical Garden is an important way to develop living collections. The analysis of orders revealed decrease of demand by decreasing seed offered. In analysis we can see decrease of orders, which depends upon nothing but size of the offer of seeds e.g. in 2015 we offered 741 species, while in 2017 only 305. Got/send ratio is 796/1028=0.77 in 2015; 1258/1547=0.81 in 2016; 1031/1080=0.95 in 2017. It shows that ŠUBG is giving more seeds to the network than receiving. In order to keep idea of seed exchange viable, ratio should not rise more than 1, thus, the list of offered seeds in the future should not be smaller than in 2017.

To balance benefits, keep connections and *ex situ* conservation and the seed exchange programme viable, the Botanical Garden also makes it's small input. Participation in the network of seed exchange is valuable activity for ŠUBG and should be continued with proper size of *Index Seminum*.

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INSTRUCTION FOR THE AUTHORS

I Report of development

NAME OF THE GARDEN

Address	
Phone	
e-mail	
www	
Director	
Territory area	

LIVING PLANT COLLECTIONS

Total No. of taxa (year):

Main taxa	No. of taxa
Indoor plants, including:	
....	
....	
Trees and shrubs, including:	
....	
....	
Herbaceous plants, including:	
....	
....	
etc.	

(if necessary, please add short text about this topic)

HERBARIUM

No. of specimens

SCIENTIFIC ACTIVITIES

The main scientific projects, list of scientific publications, conferences, expeditions etc.

OTHER ACTIVITIES

Please describe shortly main, really important activities (projects for development, fund raising, new expositions, exhibitions, public awareness activities etc.).

VISITORS PER YEAR

	YEAR	YEAR
Number of visitors		

STRUCTURE AND STAFF

Please indicate in sum of work loads, for instance, in case, if in the Dendrarium work: head of the dendrarium (full time), researcher (0,3 time), gardener No.1 (full time), gardener No. 2 (full time), gardener No. 3 (0,5 time), then in the table indicate 3,8.

	YEAR	YEAR
Administration		
....		
....		
etc.		
Season workers		
TOTAL including:		
PhD		
Msc		

FINANCES (IN EUR)

	YEAR	YEAR
Income		
....		
....		
TOTAL		
Expenses		
....		
....		
TOTAL		

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- Abstract
- Key words
- Introduction
- Material and methods
- Results
- Discussion (results and discussions could be integrated if necessary)
- Acknowledgements
- References
- Figure legends
- Table legends
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Conservation of *Arabis alpine* L. in the Botanical Garden of the University of Latvia

Anna Kalna[1], Uldis Upe[2], Rita Kalsone[1]
[1] Botanical Garden, University of Latvia, Kandavas str. 2, Riga, LV-1083, Latvia, anna.kalna@lu.lv
[2] Faculty of Biology, University of Latvia, Kronvalda bulv. 4, Riga, LV-1056, Latvia

Abstract. State the aim of the work, used methods and principal results. Do not exceed 600 to 1000 characters. Do not include references.

Keywords. No more than six keywords (or short phrases) characterizing the aim of the work should be provided.

Introduction. Only information necessary to understand an aim of the work as well as to provide a background for performed investigations should be given here. Formulate the aim of the experiments at the end of the introduction.

Materials and methods. This section should contain all the details about performing of experimental procedures (both experimental design as well as analytical methods). References to appropriate methods should be given. Include complete scientific names (genus, species, authority for the binomial, and, when appropriate, cultivar or variety etc.) for all experimental organisms. Identify the number of replications, the number of individuals, analytic replications etc. Include methods of statistical analysis. Give appropriate references on general ethic rules if necessary.

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Discussion. Describe importance of acquired results, analyzing discovered relationships in a logical sequence. References to figures and tables as well as literature sources should be given.

Acknowledgements. First, provide any details on financial support received. Second, acknowledge any person you need to thank for essential help during experiments or writing your work.

References. Include only publications cited in the text. Place references in strict alphabetic order, i.e., firstly by the name of the first author, then by the name of the second author if the first author is identical for more than one reference, then by the name of the third author if the first two authors are identical, and so on. Include the names of all authors and a full title of each paper or a book. Publications by the same author or the group of authors place in a chronological order. Abbreviate journal names according to ISI standards. Provide English translations for titles of all publications other than English, German, French or Russian. The corresponding author has a full responsibility for an accuracy in citations.

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Book articles

Hammerschmidt R., Nicholson R.L. 1999. A survey of plant defense responses to pathogens. In: Agrawal A.A., Tuzun S., Bent E. (eds) Induced Plant Defenses Against Pathogens and Herbivores. APS Press, St. Paul, pp. 55-71.

Monographs

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Nomenclature. In the abstract, at first mention in the text, and in Materials and methods, include complete biological names for all experimental organisms. Following first mentions, generic names should be abbreviated to the initial, except when confusion could arise by reference to genera with

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Abbreviations. Use only standard scientific abbreviations accepted internationally. Abbreviations can be used if the term appears at least three times in the text. Do not use abbreviations in the abstract except if used at least three times. At first use of the term in the text or in the abstract spell it out and introduce the abbreviation parenthetically.

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