

Analysis of plant assortment in the greenhouse complex of Vinnytsia National Agrarian University as a key component of student training

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It is proved that the greenhouse of Podillia Botanical Garden of Vinnytsia National Agrarian University is the place intended for landscaping having over 90 species of exotic plants as well as water devices and small architectural forms that are represented on a limited area. The main purpose of the greenhouse is not only the aesthetic satisfaction of guests and residents of the city and outdoor activities in any season of the year, but also the reproduction and introduction of plant species from other climatic zones. For the first time, a modern assessment of the assortment of greenhouse plants of Podillya Botanical Garden of VNAU has been conducted, according to which there are 44 families, 88 genera and 94 plant species in the greenhouse. It is found that the main components of the greenhouse are the species belonging to different families and differing in the requirements necessary for their growth and development. The assortment of species presented in the greenhouse is extremely wide. It is established that plants belong to different climatic zones according to their requirements for the habitat. Therefore, to ensure their ornamentality and excellent growth in the greenhouse, it is necessary to provide adequate conditions. It has been investigated that plants of different natural habitats are randomly arranged in the greenhouse without a certain order or systematization. In the greenhouse of the Botanical Garden, species of introduced plants differ by their respond to the temperature acceptable for their normal growth and development, so they should be placed in groups or collections, e.g. a plant zone of Tropics, a plant zone of Subtropics, a plant zone of dry Subtropics, a plant zone of the Mediterranean, and a plant zone of Asia. Considering a small number of the representatives of dry Subtropics in the greenhouse of the Botanical Garden, the collection of succulents must be replenished and florarium and cactusarium must be established.

Key words: Winter garden; Introduced species; Habitat; Inventory; Object

Introduction

In the territory of Vinnytsia region, along with famous tourist architectural monuments, there is a research and educational institution that has got a collection of trees and shrubs from different climatic zones, a place of cultivation, preservation and acclimatization of plant species that are perspective for the creation of green plantations to ensure city landscaping. This facility is Podillia Botanical Garden located on the territory of Vinnytsia National Agrarian University Monarkh, 2019.

The greenhouse located in the Botanical Garden is the place intended for landscaping. More than 90 species of exotic plants as well as an ornamental pond are represented on its limited area. The main purpose of the greenhouse is not only the aesthetic satisfaction of guests and residents of the city and outdoor activities in any season of the year, but also the reproduction and introduction of plant species of other climatic zones Cherniak, 2018.

Materials and Methods

The purpose of our work was to analyze the assortment of greenhouse plants in Podillia Botanical Garden. To achieve this goal, the following objectives were set:

- to carry out a taxonomic analysis of the plant assortment in the greenhouse of Podillia Botanical Garden;
- to distinguish available plant assortment according to the natural habitat of plants;
- to group greenhouse plants by climatic zones;
- to provide guidelines for improving the location of plants in the greenhouse.

Practical value of the results obtained. Depending on the plant respond to the temperature regime and its typical climatic zones, it is recommended to place plants that grow in the greenhouse of the Botanical garden in groups or collections, e.g. plants of Tropics, Subtropics, dry Subtropics, plants of the Mediterranean, plants of Asia. Considering a small number of species and genera having their natural habitat in dry Subtropics, the collection of succulents must be replenished in the greenhouse of the Botanical Garden and florarium and cactusarium must be established.

Kryzhanivska (2018) argues that a winter garden is the environment created artificially with the use of structural elements of landscape, floral, and phytodesign and it is a place where people may have a rest depending on its nature. The author notes that it

is the green planting that plays a major role in the formation of winter gardens. In addition, plants need not be alive or natural, though such objects can be formed using artificial flowers that are much cheaper to buy and keep than live plant compositions Kryzhanivska, 2015.

According to Kucheriavyi (2017), the composition organization of the winter garden is expressed in the placement of plant communities, aquatic devices, geoplastics in a certain space with the identification of its stylistics – ornamental landscaping or architectural landscaping Ermolova (2010) argues that ornamental landscaping stylistics characterizes creation of the environment with imitation of the natural landscape, e.g. desert, steppe, forest, mountainous landscape, etc. Arrangement of the spatial and object environment, in accordance with architectural landscape stylistics, usually involves the use of the symbols of a particular country, e.g. Japanese, Chinese, English ones, etc., as well as adhering to the styles of architecture, the most popular of which are baroque, classicism, modernism and many others Ermolova, 2010.

Each winter garden created is unique in its architectural and artistic design. When creating a composition, knowledge of the composition is compulsory as well as the adherence to all the rules for building such objects. Roy (2019) recommends to follow the techniques of natural landscape imitation in order to achieve the artistic expressiveness of the garden. A small winter garden may remind a viewer or a visitor of the "mid-forest", "wet tropics", or "micro-landscape of the desert with cacti" Roy, 2019.

Availability of certain structural elements in the winter garden directly depends on its main functional purpose. What institution will it be located in? What is the age category of its visitors (children, youth, adults or retirees)? These are the basic questions to be answered before you start to design a winter garden, since the things of the winter garden that are interesting for the children may not impress the adults Monarkh, 2019: Votinov, 2011: Mazur, 2019: Neyko, 2019.

Results and Discussion

Plant species that belong to different families are the components of any greenhouse. Considering the fact that plants growing indoors are brought from different countries, the temperature regime for each species is different depending on the natural area of origin. Plants of different climatic zones should be placed separately. It is compulsory to monitor the microclimate of the environment to ensure normal growth of the introduced species. Having evaluated the assortment of the object researched, it has been found that 94 plant species grow in the greenhouse of Podillia Botanical Garden (Figures 1 and 2).

Figure 1. Exotic greenhouse plants.



Results of the research of the greenhouse plant collection are presented in Table 1. The *Araceae* family is characterized by the largest number of genera, hence among 7 genera the following species are available: *Philodendron adamantinum* Mart. ex Schott, *Colocasia esculenta* var. *fontanesii*, *Scindapsus*, *Aglaonema commutatum*, *Zantedeschia aethiopica*, *Monstera obliqua*, *Spathiphyllum floribundum*. The *Asparagaceae* family is represented by 6 genera. Among the species growing in the greenhouse the following ones are available: *Aspidistra elatior* *Variegata*, *Asparagus officinalis* L., *Agave americana* L., *Yucca filamentosa*, *Dracaena draco*, *Chlorophytum comosum*.

The vast majority of families are represented in the greenhouse with only one genus, e.g. *Begoniaceae* – *Begonia* L., *Cornaceae* – *Aucuba*, *Ebenaceae* – *Diospyros*, *Tiliaceae* – *Sparmannia*, *Buxaceae* – *Buxus*, *Asphodelaceae* – *Aloe*, *Musaceae* – *Musa*, *Davalliaceae* – *Nephrolépis*, *Orchidaceae* – *Cattleya*, *Oleaceae* – *Ligustrum*, *Piperaceae* – *Peperomia*, *Paulowniaceae* – *Paulownia*, *Rosaceae* – *Rosa*, *Lamiaceae* – *Coleus*, *Strelitziaceae* – *Strelitzia*, *Lythraceae* – *Granatum*, *Liliaceae* – *Ruscus*, *Myrtaceae* – *Callistemon*, *Fabaceae* – *Caesalpinia*, *Balsaminaceae* – *Impatiens*. In total, there are 44 families, 88 genera and 94 species in the greenhouse (Figure 3). Distribution of the assortment of greenhouse plants according to the natural habitat is presented below (Table 2).

It has been found that plants of different natural habitats are randomly arranged in the greenhouse without a certain order or systematization. In the greenhouse of the Botanical Garden, species of introduced plants differ by their respond to the temperature acceptable for their normal growth and development, so they should be placed in groups or collections (Figures 4 and 5), e.g. a plant zone of Tropics, a plant zone of Subtropics, a plant zone of dry Subtropics, a plant zone of the Mediterranean, and a plant zone of Asia (Table 3).

Table 1. Results of evaluation of the assortment of the greenhouse plant collection.

No	Name of the family	Number of genera	Number of species
1	<i>Malvaceae</i>	2	2
2	<i>Asparagaceae</i>	6	6
3	<i>Begoniaceae</i>	1	1
4	<i>Cornaceae</i>	1	1
5	<i>Araliaceae</i>	2	2
6	<i>Rutaceae</i>	4	4
7	<i>Ebenaceae</i>	1	1
8	<i>Tiliaceae</i>	1	1
9	<i>Buxaceae</i>	1	1
10	<i>Asphodelaceae</i>	1	1
11	<i>Arecaceae</i>	2	2
12	<i>Araceae</i>	7	7
13	<i>Moraceae</i>	1	3
14	<i>Geraniaceae</i>	2	3
15	<i>Davalliaceae</i>	1	1
16	<i>Lamiaceae</i>	2	2
17	<i>Amaryllidaceae</i>	5	5
18	<i>Agavaceae</i>	2	2
19	<i>Orchidaceae</i>	1	1
20	<i>Oleaceae</i>	1	1
21	<i>Urticaceae</i>	2	2
22	<i>Apocynaceae</i>	2	2
23	<i>Acanthaceae</i>	3	3
24	<i>Cupressaceae</i>	2	2
25	<i>Musaceae</i>	1	1
26	<i>Lauraceae</i>	2	2
27	<i>Bignoniaceae</i>	3	3
28	<i>Commelinaceae</i>	5	6
29	<i>Piperaceae</i>	1	1
30	<i>Paulowniaceae</i>	1	1
31	<i>Rosaceae</i>	1	1
32	<i>Bromeliaceae</i>	4	4
33	<i>Cactaceae</i>	2	2
34	<i>Lamiaceae</i>	1	1
35	<i>Strelitziaceae</i>	1	1
36	<i>Crassulaceae</i>	3	3
37	<i>Lythraceae</i>	1	1
38	<i>Xanthorrhoeaceae</i>	2	2
39	<i>Liliaceae</i>	1	1
40	<i>Myrtaceae</i>	1	1
41	<i>Euphorbiaceae</i>	2	2
42	<i>Fabaceae</i>	1	1
43	<i>Balsaminaceae</i>	1	1
44	<i>Vitaceae</i>	1	3
	Total	88	94

Figure 2. Greenhouse of Podillia Botanical Garden.

Figure 3. An ornamental pond of the greenhouse.**Table 2.** Types of greenhouse plants with the natural habitat indicated.

No	Name of species (in Latin)	Natural area of origin
1	<i>Abutilon sellowianum</i> Rgl.	Tropics and subtropics of both hemispheres
2	<i>Aspidistra elatior</i> Variegata	Forests of South China and Japan
3	<i>Asparagus officinalis</i> L.	Central America, Australia
4	<i>Begonia semperflorens</i>	Latin America, Mexico, Shri-Lanka, Africa
5	<i>Aucuba japonica</i>	East Asia, Japan
6	<i>Fatsia japonica</i>	Japan, New Zealand
7	<i>Fortunella hindsii</i>	Asia Pacific region
8	<i>Citrus reticulata</i>	South of China, East Asia
9	<i>Citrus sinensis</i>	Europe, the Caucasus
10	<i>Citrus × limon</i>	Europe, America
11	<i>Diospyros lotus</i>	Europe, America, Australia
12	<i>Hibiscus syriacus</i>	Subtropics and tropics
13	<i>Sparmannia africana</i>	Madagascar, South Africa
14	<i>Buxus sempervirens</i> L.	Africa, Madagascar, Mexico
15	<i>Aloe arborescens</i>	Africa, Madagascar, the island of Socotra
16	<i>Agave americana</i> L.	North and Central America
17	<i>Yucca filamentosa</i>	Florida, the USA, Mexico
18	<i>Trachycarpus fortunei</i> .	China, Japan, Myanmar and India
19	<i>Phoenix canariensis</i>	Greece, the island of Crete, Canary Islands
20	<i>Dracaena draco</i>	South-East Asia, Africa
21	<i>Philodendron adamantinum</i> Mart. ex Schott	Latin America, Mexico, Australia
22	<i>Ficus elastica</i>	Africa, the Mediterranean
23	<i>Ficus benjamina</i>	India, China, Philippines
24	<i>Ficus carica</i>	Mediterranean, Middle East
25	<i>Chlorophytum comosum</i>	South America, Africa, Madagascar, Asia and Australia
26	<i>Pelargonium zonale</i>	East Africa, Middle East
27	<i>Pelargonium grandiflorum</i>	Middle East, the south of Turkey and Iraq
28	<i>Pelargonium graveolens</i>	The temperate zone of the Northern Hemisphere
29	<i>Nephrolepis cordifolia</i> (L.) Presl	Asia, America, Australia
30	<i>Plectranthus fruticosus</i>	Tropics of Africa, Asia, Australia
31	<i>Zephyranthes lindleyana</i>	East Africa
32	<i>Sansevieria trifasciata</i>	Africa, Madagascar and Asia
33	<i>Cattleya</i>	Tropical forests
34	<i>Hedera caucasigena</i>	Europe
35	<i>Ligustrum vulgare</i>	Moderate and subtropical forests
36	<i>Pilea cadierei</i> Gagnep.	Tropical forests throughout the Earth
37	<i>Rosmarinus officinalis</i>	Western Mediterranean
38	<i>Vinca minor</i> L.	Countries of South Europe
39	<i>Justicia adhatoda</i>	Mexico
40	<i>Cryptomeria japonica</i>	Japan, China
41	<i>Musa basjoo</i>	India, Japan
42	(<i>Laurus nobilis</i>)	The Mediterranean
43	(<i>Jacaranda mimosifolia</i>)	Tropics of Brazil

44	<i>(Tradescantia tricolor</i>	Mexico, Central America
45	<i>(Peperomia magnoliaefolia</i>	Asia and America
46	<i>Taxodium distichum</i>	Northern and Southern Hemisphere
47	<i>Paulownia tomentosa</i>	Far East, East Asia
48	<i>Rosa bengalensis</i>	All Europe
49	<i>Billbergia pyramidalis</i>	Brazil, Central America
50	<i>Vriesea splendens</i>	Central and South America
51	<i>Guzmania</i>	Venezuela, Brazil
52	<i>Amaryllis belladonna</i>	Cape Province of the Republic of South Africa, Australia
53	<i>Clivia miniata</i>	South Africa
54	<i>Radermachera chinensis</i>	China
55	<i>Nerium oleander</i>	The Mediterranean
56	<i>Crinum asiaticum</i>	Asia
57	<i>Coleus blumei</i>	Asia and Africa
58	<i>Colocasia esculenta var. fontanesii</i>	Tropical forests of Burma, Himalayas
59	<i>Strelitzia reginae</i>	South Africa
60	<i>Echeveria stolonifera</i>	Mexico
61	<i>Scindapsus</i>	Tropical forests of East Asia
62	<i>Ruellia tuberosa L.</i>	East Asia
63	<i>Ananas comosus</i>	South America
64	<i>Persēa americāna</i>	Europe, America
65	<i>Aglaonema commutatum</i>	South Asia
66	<i>Zantedeschia aethiopica</i>	South Africa
67	<i>Opuntia bigelovii</i>	North and South America
68	<i>Púnica granatum</i>	South Africa
69	<i>Gasteria verrucosa Haw.</i>	South Africa
70	<i>Haworthia truncata</i>	South Africa
71	<i>Setcreasea purpurea</i>	Mexico
72	<i>Tradescantia spathacea Sw</i>	Tropical forests of Florida
73	<i>Ruscus hypophyllum</i>	Asia, the Mediterranean
74	<i>Callistemon citrinus</i>	Australia
75	<i>Euphorbia milii</i>	Tropics and subtropics
76	<i>Codiaeum variegatum</i>	Asia
77	<i>Caesalpinia pulcherrima</i>	West Europe
78	<i>Jacobinia pohliana</i>	Tropical forests of Brazil
79	<i>Tradescantia blossfeldiana</i>	Argentina
80	<i>Tradescantia virginiana</i>	Argentina
81	<i>Cereus peruvianus</i>	Central and North America
82	<i>Cordyline terminalis</i>	Asia, America, Australia
83	<i>Monstera obliqua</i>	Tropics of Africa
84	<i>Bryophyllum manginii</i>	Central Madagascar
85	<i>Kalanchoe blossfeldiana</i>	Australia, Africa, America
86	<i>Callisia frāgrans</i>	Mexico, America
87	<i>Soleirolia Gaud</i>	Tropical regions
88	<i>Vallota speciosa</i>	Subtropics of South Africa
89	<i>Impatiens walleriana</i>	Subtropics
90	<i>Spathiphyllum floribundum</i>	South America, East Asia
91	<i>Vitis amurensis</i>	Western and Eastern Hemisphere
92	<i>Vitis vinifera</i>	Central Asia
93	<i>Vitis vulpina</i>	America
94	<i>Tecoma</i>	Tropics and subtropics

Figure 4. A sketch of the recommended plant placement in the winter garden.

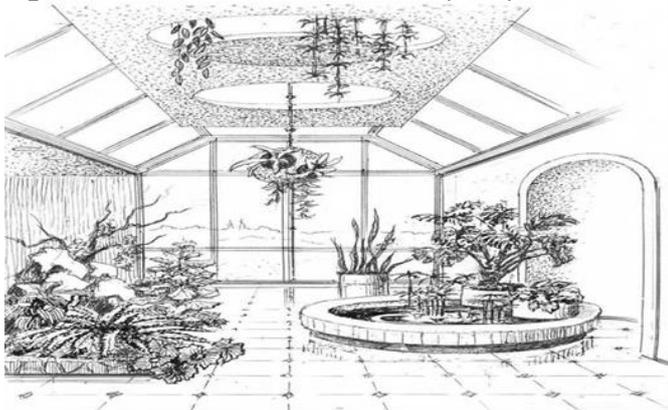


Table 3. Distribution of greenhouse plants by the climatic zones.

Name of the group of plants depending on the natural habitats	Names of genera (in Latin)
Tropical plants	<i>Abutilon, Hibiscus, Aloe, Plectranthus, Zephyranthes, Sansevieria, Cattleya, Pilea Lindl, Musa, Peperomia, Colocasia, Persea, Euphorbia, Cordyline, Monstera, Helxine, Tecoma</i>
Subtropical plants	<i>Aspidistra, Asparagus, Begonia L., Diospyros, Sparmannia, Agave, Phoenix, Justicia, Lamiales, Guzmania, Amaryllis, Coleus, Strelitzia, Ananas, Zantedeschia, Gasteria, Haworthia, Bryophyllum, Kalanchoe, Vallota, Impatiens</i>
Plants of dry subtropics	<i>Clivia, Echeveria</i>
Plants of the Mediterranean	<i>Fortunella, Citrus, Buxus, Yucca, Dracaena, Philodendron, Ficus, Pelargonium L'Her, Ligustrum, Rosmarinus, Vinca, Laurus, Tradescantia, Taxodium, Rosa, Billbergia, Vriesea, Nerium, Opuntia, Setcreasea, Tradescantia, Callistemon, Caesalpinia, Jacobinia, Tradescantia, Cereus, Callisia,</i>
Plants of Asia	<i>Aucuba, Fatsia, Trachycarpus, Chlorophytum, Geranium, Nephrolepis, Hedera, Cryptomeria, Paulownia, Radermachera, Crinum, Scindapsus, Ruellia, Aglaonema, Granátum, Ruscus, Codiaeum, Spathiphyllum, Cissus</i>

In our opinion, considering a great number of plant species with the natural area of origin in the Tropics, the site allocated exactly to this group of plants will be the most effective one in terms of how it looks like and what size it has. Despite the fact that the plants of Tropics continuously vegetate throughout the year, necessary conditions for the development of this group of plants should be thoroughly provided Kryzhanivska, 2015.

Figure 5. Trees and shrubs of the greenhouse.

It is well-known that tropical plants are accustomed to the constantly high indoor temperature (15-20°C), day and night equality and very high humidity (up to 90%), which is the most important condition for their successful existence in our latitudes. If all the requirements are met, all the introduced plants beginning with palm trees and ferns and finishing with other tropical plants will flower or even bear fruit Kryzhanivska, 2015.

A garden having clearly "expressed seasons" is often called a subtropical winter garden. It is claimed that the spring season, which begins in February, is the most ornamental one and rich in plant flowering. From late October till late January, ornamentalness of plants is low, compared to other seasons. After all, this is the period when the plants are dormant and the temperature in the winter garden should drop to 10-12°C Kryzhanivska, 2015. Therefore, it is advisable to have subtropical plants in the greenhouse, e.g. *Alocasia, Areca, Acacia catechu, Dieffenbachia, Pandorea Sansevieria, Syngonium*, etc., which will attract the visitors regardless of the season. Subtropical plants start to bloom actively in March, which greatly increases the number of the greenhouse visitors.

The most popular representatives of dry subtropics are succulents, plants characterized by the ability to accumulate a large amount of moisture and vital substances in their leaves. As for the requirements for the placement where the succulents grow, it should be hot in summer and it should be dry and cool in winter.

Analyzing the greenhouse assortment, it has been found that plants of dry subtropics are represented only by a few species, so the collection of succulents and cacti, representatives of which begin to bloom at the beginning of spring, must be replenished in the greenhouse. A great diversity of species also includes those that naturally live on volcanic rocks in semi-deserts. There can be created interesting compositions in the greenhouse in the form of succulent florariums (special devices made of glass or transparent plastic with floral compositions inside of them) or separate the area under the cactarium that will represent a collection of cacti placed in the conditions that are similar to the natural habitat of these plants.

The choice of plants for the Mediterranean group is very wide, since most plants of this group normally grow and develop in cool gardens in winter. As for the spring period of their growth and development, they need heat and sun by the autumn. In winter, when many greenhouse plants experience a dormant period, they drop their leaves and require mandatory pruning. The requirements for the place where they grow during this period is that it should be light and cool [3].

Plants of Asia are not demanding, compared to the plants of other groups and they can grow in the greenhouse both in warm and cold winter time. The positive aspect is that they are not demanding to the maintenance. To grow and develop, it is enough to meet the temperature regimes.

Due to some available properties like adaptability and environmental plasticity, plants that are naturally distributed in different parts of the Earth can be used to create various compositions in winter gardens or greenhouses. The choice of plants for the winter garden is wide.

Conclusion

The greenhouse of Podillia Botanical Garden includes 94 plant species that represent 88 genera and 44 families. Plants from different natural areas of origin are randomly arranged in the greenhouse without a certain order or systematization. It is recommended to divide all plants of the greenhouse into groups, to create so-called collections of tropical plants, subtropical plants, plants of dry Subtropics, plants of the Mediterranean and plants of Asia. Because of a small number of plants of dry Subtropics in the greenhouse of Podillia Botanical Gardens, the collection of succulents must be replenished, and a florarium and cactusarium must be established.

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