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USE AND ASSORTMENT OF ORNAMENTAL EPIPHYTES SUITABLE FOR VERTICAL GARDENS IN THE INTERIOR

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Abstract

Vertical gardens are a special type of interior phytodesign, getting more and more popular in the world landscape practice. They are specific arrangements of ornamental plants created in the exterior as well as in the in-door spaces, forming a self-maintaining system. In the interior the most appropriate and commonly used are the epiphytes. Principles of nutrition and their requirements to the environmental conditions are prerequisites for a successful use in the vertical gardens. In specialized collections and sales network in our country, that offer a variety of ornamental epifitytes, the plants are used and often treated as terrestrial plants. This article presents an analysis of the species composition of epiphytes in real world models of vertical gardens and the assortment of such species kept in collections or commercially available in our country. A survey on the diversity of imported and grown epiphytes carried out in June-September 2009 is presented. Totally 10 sites are audited (9 commercial garden centres and also the greenhouses of the Institute of Ornamental plants – Negovan).

Key words: indoor vertical gardens, species variety of the vertical gardens, assortment of ornamental epiphytes.

Introduction

The construction of vertical gardens it the interior is connected exclusively with the usage of epiphyte and hemiepiphyte tropical species. The use of representatives from the terrestrial species is restricted or admissible in vertical green constructions in the exterior. The use of epiphytes is recommended because of the vertical positioning of green plates, the specific fabric that substitutes the soil substrate and the method of attachment of roots in it, as well as the specific nutrition of plants.

The description of the epiphytic flora from the end of the 19-th century till today has passed through different stages. (Lüttge 1989). About 28,000 epiphyte species from 65 families and 850 genera. (e.g. nearly 10% of the vascular flora) are defined.

The numerous studies in recent years require the supplementing and updating of the list of epiphytes. These changes concern mainly genera and families from Araceae, Asteraceae, Bromeliaceae,

Clusiaceae, Cactaaceae, Cyclanthaceae, Ericaceae, Marccgraviceae, Melastomataceae, Onagraceae, Orchidaceae, Rubiaceae, Scrophulariaceae, Solanaceae. A contemporary research of De Guzman et al. (1998) enlarged the spectrum of epiphyte species from the genus *Peperomia* Ruitz. et Pav. On the basis of detailed field experiments Zotz and Schultz (2008) suggested some taxonomic changes.

The analysis (ex Lüttge 1989) shows that there are no epiphytes in Gymnosperms. Among all higher plants 23,466 species are epiphytes, included in 879 genera (7% of all higher plants genera). Most of the epiphytes belong to the angiosperms and they are mostly used as a source of *ornamental plants* (20,863 species or 89% of all epiphytes of the higher flora). The fern group follows (29% of the species variety in that group are epiphytes). Unfortunately the big variety of taxa among ferns hasn't been broadly used for ornamental purposes. At the same time about 90% of ferns cultivated as interior species are epiphytes or facultative epiphytes: members of *Nephrolepis, Davalia, Platycerium, Asplenium, Phlebodium* etc.

Monocots are the richest group of epiphytes among the angiosperms, being 67% of the epiphytes (522 genera) and 80% from the epiphyte species (16,610 species).

The richest in epiphytes is *Orchidaceae* with 440 genera (50% of all genera including epiphytes) and 13 951 species (67% of all epiphytes among the angiosperms). Unfortunately, a small part of the epiphyte forms of orchids are introduced as ornamentals and the introduced ones usually participate as parental forms of modern cultivated hybrids.

Families of higher plants containing less than 5 epiphytes are 45% of all plant families and 18% of the families contain only one epiphyte. As a whole, 52% of the epiphyte genera (454) include less than 5 epiphytes and 218 (25%) – just one.

The epiphytes is a group, often cultivated for ornamental purposes. In our country the richest collection of epiphytes belongs to the Botanical Garden of the Bulgarian Academy of Sciences. The extremely wide variety of taxa does not allow us to summarize them in this paper. Only two of the collections of representatives of the richest and most commonly used (in vertical gardens) families numbers as follows: 133 specimens of 121 taxa of Bromeliaceae Juss (Petrova 1995) and 67 samples from 51 taxa of Begoniaceae C. A. Agardh (Stoeva 1995). In addition to their rich assortment, these collections are valuable, because more epiphytes are grown for years and are adapted to conditions of high intensity of light. The collections of the University Botanical Gardens with its branch in Balchik are also rich. According to some reports from 2010 the collection of the richest in epiphytes families contains as follows (Sofia and Balchik): Bromeliaceae – 10 genera and 13 species (Sofia); 16 genera and 43 species (Balchik); Orchidaceae – 19 genera and 32 species (Sofia); 19 genera and 34 species (Balchik); Araceae – 4 genera.

Kabatliyska (2001) offers an analysis of the possibile use and classification based on aesthetic features of one of the richest group of epiphytes (bromeliads).

The first steps in building a vertical garden in our country has made land.arh. Kamen Popov (from the 'Mr. Green'company). His recently built inte-

rior vertical garden covers 60 m² and includes representatives of over 15 taxa.

However, in flower production the great ornamental potential and variety of epiphytes is still partially studied. The peculiarities of epiphytes as an unique group from physiological point of view (Benzing 1990, 2000; Griffiths et al. 1986; Zotz and Schultz 2008) are still neglected in the technologies of ornamental plant production and breeding.

Aim and tasks

The aim of the present study is to describe the epiphyte species variety in real vertical gardens from the world practice as well as a survey on the assortment of ornamental epiphytes offered by commercial greenhouses in our country.

The following tasks are set:

1. A study of the plant diversity in the world famous vertical gardens and the deployment of plants according to their morphological peculiarities and ecological requirements;

2. Analysis of the taxa variety of epiphytes, imported and grown commercially in our country.

Methods and objects

The diversity of plants in vertical gardens (Patrick Blanc's projects and associates) has been defined by sketches and illustrative material. An analysis of the full sets of species used in 5 implemented projects is made, from which 3 in interior and 2 in exterior (for warm and moderate climate respectively). The predominant taxa were identified in 43 projects implemented by the same author (Blanc 2008). The determination of taxa to a different taxonomic level is in accordance with the available information and opportunities for identification.

The study of the greenhouses in the country was made in June-September 2009. The following greenhouses were studied: 3 in Sofia: the Flora Center Drujba, the Plantava Company and the L2-company; 4 in the Varna region: the "Mimosa" garden center, the "Exotic" garden center, the "Erica Co" garden center and the Flower shop "The Jungle"; 2 in the Burgas region: the "Burgastsvet" greenhouses and the Ravda village garden center "Kozarevi". Some ancillary data for the collections was received from the University Botanical Garden (Sofia) with branch in Balchik, and the Institute of Ornamental plants (Negovan).

Discussions

In general, the number of successful examples of vertical gardens is growing larger. Many companies engage themselves in technological development, improvement and maintenance of this definitely new type of interior landscaping.

1. Species composition of the vertical gardens.

Results of the plant diversity analyses of the studied objects are summarized in Table 1.

The analyses shows that in *interior panels* the ratio between the different growing types – epiphyte species (including facultative epiphytes too) to the terrestrial species is as follows: In **Project No 1** – epiphytes/terrestrials – 39:10;

Table 1. Species variety and characteristics based on the types of epiphytism.

No	Place	Total number of genus used	Total number of species used	E	N	N:E	E:N	He	Predominant genus
1	**Interior**, Cite de'espace Toulouse, France	37	56	32	10	4	3	5	*Ficus, Aechynanthus, Peperomia, Philodendron, Aechmea, Asparagus, Pilea, Rhipsalis, Rhoeo*.
2	**Interior**, Lexington, Great Btitain	15	17	10	6	1	0	0	*Asparagus, Schefflera*.
3	**Interior**, French embassy New Delhi, India	15	29	15	7	0	1	6	*Aglaonema, Dracena, Ficus, Philodendron, Pilea, Schefflera*.
4	**Exterior**, Mall in Seul, South Korea (tropical climate)	7	7	2	2	3	0	0	*Euonymus, Heloniopsis, Heuchera,Liriope,Mukdenia Pachysandra, Saxifraga*.
5	**Exterior**, Hotel Persing hall, Paris France	88	90	12	68	5	0	0	*Abutilon, Iris* + hygrophytes (5 species).

Legend: E – epiphytes; N – terrestrials; N:E – terrestrials as facultative (or occasional epiphytes); E:N – epiphytes as facultative terrestrials; He – hemi epiphytes.

epiphytes/semi epiphytes – 32:5; epiphytes/ facultative epiphytes – 32:7; In **Project No 2** – epiphyte/terrestrials – 11:6; no semi epiphytes or facultative epiphytes are found out. In **Project No 3** – epiphyte/terrestrials – 16:7; epiphytes:semi epiphytes – 15:6 and epiphytes/facultative epiphytes – 15:1.

The average percentage distribution of species is 57% for the epiphytes (no facultative epiphytes included) and 18% for the terrestrials. The representatives of genera: *Ficus, Aechynanthus, Peperomia, Philodendron, Aechmea, Asparagus, Pilea, Rhipsalis, Rhoeo, Schefflera, Aglaonema, Dracaena* are prevailing.

As a whole *in the exterior* panels the epiphytes are neglected. This can be explained by the higher intensity of light and direct sunshine and the fact that most of them are built in temperate climate zones. The increasing presence of epiphytes in the lower part of the panels should be explained with the decreasing light and creation of warmer micro-

climate, permitting the inclusion of even more tender-frost representatives. Here the ratio between the epiphytes and terrestrials is as following: from 1:29 at the top to 10:14 at the basis of the panels, where the group of the shadow tolerant plants and hygrophytes species also increases. Among the species for the exterior terrestrial forms are dominating together with representatives of blossoming or foliage shrubs. In the indoor panels representatives are identified of 83 epiphyte species from 59 genera, 19 facultative epiphytes from 14 genera and 11 semi epiphytes from the genus *Ficus*.

In the interior vertical gardens the epiphyte species predominate, most of them being herbaceous plants, followed by the bushy climbers, the shrubs and the trees. Shrubs occupy the top whereas climbers take up elongated diagonal spots. In all panels the presence of ferns is obligatory, as well as the presence of aroids (situated always in the middle and in the lower part of the panels) and representatives of genus *Ficus* (situated always on the top part of the panels). The preferences are towards broad-leaved species mostly climbers. A certain rhythm is observed in the designed spots and pasting of certain patterns.

In the exterior vertical gardens an exclusive variety of life forms is observed – perennials and annuals. Blossoming plants, including some weeds are prevailing. Having in mind the frost resistance, more tender-frost species are used in contrast with the case of traditional horizontal flower compositions. The most tender frost species are situated on a sheltered position in the panel's base, such species being traditionally used in a warm interior. Some grass species are used including hygrophytes. Species with tiny leaves are predominating and the spots are considerably smaller than those created in the interior.

2. Species variety in commercial greenhouses in our country.

As a result of the study, representatives of 80 genera from 32 families have been recorded. Species diversity is presented in Table 2, including species in mass production or sale, imported and produced in larger quantities. Single individuals or such with collector's value are not included.

Results of the present study can be summarized as follows:

- Out of all 80 genera described, representatives of 10 are found in 80 to 100% of the surveyed greenhouses, representatives of 13 – in 60 to 80%; representatives of 17 – in 40 to 60%, representatives of 22 – in 20 to 40%. Representatives of 18 genera are found occasionally (in less than 20% of surveyed sites).
- The most commonly available species and varieties are from the following genera: *Anthurium, Syngonium, Hedera, Begonia, Guzmania, Tillandsia, Calathea, Marantha, Nephrolepis* and *Pillea.*
- The highest species diversity is found in the following genera: *Peperomia, Begonia, Anthurium, Philodendron, Nephrolepis, Hedera, Guzmania, Neoregelia, Tillandsia, Vriesea, Calathea, Ficus, Fittonia, Hypoestes.*
- Excluding the richest collections of the Botanical garden at the BASci, the University Botanical garden and it's branch in Balchik, in 2009 the greatest diversity of

Table 2. Species of commercial interest imported and grown in greenhouses

No	Family	Genus	Total number of species and cultivars in the sites of observation	Sites of observation*
1.	Acanthaceae Juss.	*Fittonia* Coem.	26	3, 4, 6, 7, 8, 9, 10
2.	Acanthaceae Juss.	*Hypoestes* Sol. ex R. Br.	25	1, 2, 3, 4, 5, 10
3.	Acanthaceae Juss.	*Pachystachus* Nees.	3	1, 10
4.	Araceae Juss.	*Aglaonema* Schott.	21	2, 7, 8, 9, 10
5.	Araceae Juss.	*Alocasia* (Schott.) G. Don	12	2, 5, 6, 7, 8, 9, 10
6.	Araceae Juss.	*Anthurium* Schott.	49	2, 3, 4, 5, 6, 8, 9, 10
7.	Araceae Juss.	*Dieffenbachia* Schott.	17	2, 3, 7, 8, 9, 10
8.	Araceae Juss.	*Epipremnum* Schott.	2	7, 9,
9.	Araceae Juss.	*Monstera* Adans.	6	2, 7
10.	Araceae Juss.	*Philodendron* Schott.	40	2, 5, 7, 8, 10
11.	Araceae Juss.	*Scindapsus* Schott.	14	2, 3, 4, 7, 8
12.	Araceae Juss.	*Spathiphyllum* Schott.	13	2, 6, 7, 8, 9, 10
13.	Araceae Juss.	*Syngonium* Schott.	27	1, 2, 3, 4, 5, 7, 9, 10
14.	Araliaceae Juss.	*Hedera* L.	40	1, 2, 3, 4, 7, 8, 9, 10
15.	Araliaceae Juss.	*Schefflera* Forst.	10	1, 2, 8
16.	Asclepiadaceae R. Br.	*Dischidia* R. Br.	3	10
17.	Asclepiadaceae R. Br.	*Hoya* R. Br.	21	4, 7, 8
18.	Asparagaceae Juss.	*Asparagus* L.	20	3, 4, 6, 7, 9
19.	Antericaceae J. G Agardh.	*Chlorophytum* Ker.Gawl.	9	2, 5, 6, 9
20.	Begoniaceae C. A. Agardh	*Begonia* L.	91	1, 2, 3, 4, 5, 6, 7, 8, 9, 10
21.	Bromeliaceae Juss.	*Aechmea* Ruiz. et Pav.	18	2, 3, 4, 5, 6, 8, 9
22.	Bromeliaceae Juss.	*Ananas* Mill	5	2, 5
23.	Bromeliaceae Juss.	*Billbergia* Thunb.	7	2, 5
24.	Bromeliaceae Juss.	*Bromelia* LAdans.	4	5, 10
25.	Bromeliaceae Juss.	*Cryptanthus* Otto & Dietr.	8	2, 5
26.	Bromeliaceae Juss.	*x Cryptbergia* Hort.	3	10
27.	Bromeliaceae Juss.	*Dyckia* Schult.f.	2	10

No	Family	Genus	Total number of species and cultivars in the sites of observation	Sites of observation*
28.	Bromeliaceae Juss.	*Guzmania* Ruiz. et Pav.	28	2, 3, 4, 5, 6, 7, 8, 10
29.	Bromeliaceae Juss.	*Neoregelia* L. B. Sm.	25	2, 3, 4, 5, 6, 9
30.	Bromeliaceae Juss.	*Nidularum* Lem.	7	2, 8, 10
31.	Bromeliaceae Juss.	*Orthophytum* Beer.	2	5
32.	Bromeliaceae Juss.	*Tillandsia* L.	33	2, 3, 4, 5, 6, 7, 9, 10
33.	Bromeliaceae Juss.	*Puya* Molina	8	10
34.	Bromeliaceae Juss.	*Vriesea* Lindl.	24	2, 3, 4, 6, 9, 10
35.	Cactaceae Juss.	*Rhipsalis* Gaertn.	13	2, 3, 5, 6, 9
36.	Cactaceae Juss.	*Hatiora* Britton & Rose	3	10
37.	Cactaceae Juss.	*Schlumbergera* Lem	9	2, 3
38.	Cactaceae Juss.	*Callisia* Loefl.	6	3, 4, 8, 10
39.	Clusiaceae Lindl.	*Clusia* L.	2	2 **
40.	Commelinaceae R. Br.	*Setcreasea* K.Schum & Sydow	3	6, 10
41.	Commelinaceae R. Br.	*Tradescantia* L.	17	1, 2, 3, 10
42.	Eriocaulaceae Desv.	*Syngonanthus* Ruhland	1	2**
43.	Gesneriaceae Dum.	*Aeschyananthus* Jack	6	1, 2, 3,
44.	Gesneriaceae Dum.	*Columnea* L.	5	3, 7, 10
45.	Gesneriaceae Dum.	*Gloxinia* L'Her	16	2, 3, 4, 10
46.	Gesneriaceae Dum.	*Kohleria Regel*	2	10
47.	Gesneriaceae Dum.	*Saintpaulia* H.Wendl.	4	2, 3, 4
48.	Maranthaceae Petersen	*Calathea* G.Mey	36	1, 2, 3, 4, 5, 7, 8, 9, 10
49.	Maranthaceae Petersen	*Ctenanthe* Eichler	15	2, 3, 4, 6, 7, 9, 10
50.	Maranthaceae Petersen	*Maranta* L.	14	1, 2, 4, 6, 7, 3, 9, 10
51.	Maranthaceae Petersen	*Stromanthe* Sond.	9	2, 3, 4, 9, 10
52.	Melastomataceae Juss.	*Medinilla* Gaudich	1	10

No	Family	Genus	Total number of species and cultivars in the sites of observation	Sites of observation*
53.	Moraceae Link	*Ficus* L.	22	2, 3, 4, 6, 9
54.	Nepenthaceae Dum.	*Nepenthes* L.	2	2
55.	Orchidaceae Juss.	x *Vuystekeara* Hort.	4	2, 3, 4
56.	Orchidaceae Juss.	*Cattleya* Lindl.	2	2
57.	Orchidaceae Juss.	*Cymbidium* Sw.	11	2, 3, 4, 9
58.	Orchidaceae Juss.	*Dendrobium*	11	2, 4
59.	Orchidaceae Juss.	*Ludisia* A. Rich.	6	2, 5, 6, 9
60.	Orchidaceae Juss.	Miltonia Lindl.	6	2, 4
61.	Orchidaceae Juss.	*Oncidium* Sw.	2	2
62.	Orchidaceae Juss.	*Phalenopsis* Blume	17	2, 3, 4, 6
63.	Orchidaceae Juss.	*Vanda* Jones ex R. Br.	4	2, 8
	Polypodiophyta:			
64.	Adianthaceae Newm.	*Adiantum* Burm. f	22	1, 2, 4, 6, 9, 3
65.	Adianthaceae Newm.	*Pellaea* Link.	5	1, 2, 3,
66.	Aspleniaceae Newm.	*Asplenium* L.	7	1, 2, 3, 6, 9
67.	Blechnaceae (C. Prel) Copel.	*Blechnum* L.	1	2
68.	Davalliaceae (Gaud.)M.R.Schob.	*Davallia* Sm.	12	2, 3, 4, 7, 8, 9,
69.	Dryopteridaceae Ching	*Didymochlaena* Desvaux	1	6
70.	Dryopteridaceae Ching	*Dryopteris* Adans	1	2
71.	Oleandraceae Ching ex Pic.Serm.	*Nephrolepis* Schott	28	1, 2, 3, 4, 5, 6, 7, 8, 9
72.	Polypodiaceae Bercht. & J. Presl	*Platycerium* Desvaux	9	2, 3, 5, 7, 8, 9
73.	Polypodiaceae Bercht. & J. Presl	*Polypodium* L.	13	2, 3, 4, 6
74.	Pteridaceae Ching	*Pteris* L.	3	2, 7, 8

No	Family	Genus	Total number of species and cultivars in the sites of observation	Sites of observation*
75.	Woodsiaceae (Diesl) Herter	*Athyrium* Roth	1	2
76.	Piperaceae C. A. Agardh	*Peperomia* Ruitz & Pav.	43	2, 3, 4, 6, 7, 8, 9
77.	Piperaceae C. A. Agardh	*Piper* L.	3	8
78.	Selaginellaceae P. B.	*Selaginella* P. Beauv.	15	1, 2, 3, 4, 6, 9
79.	Saxifragaceae Juss.	*Saxifraga* L.	6	1, 2, 5
80.	Urticaceae Juss.	*Pilea* Lindl.	23	1, 2, 3, 4, 5, 6, 9, 10

***Sites of observations:** 1. Institute of ornamental plants – Negovan, Sofia; 2. Flora Center – Drujba, Sofia; 3. L2-company – Sofia; 4. Plantava Company – Sofia; 5. Ravda village "Kozarevi" Garden centre; 6. "Burgastsvet" greenhouses – Burgass; 7. Garden centre "Erica Co" – Varna; 8. Flower shop "The Jungle" – Varna; 9. Garden centre "Exotic" – Varna; 10 Garden centre "Mimosa" – Varna.
** representatives of the following genera are rarely imported.

taxa for commercial use was found in the "Flora Centre", Sofia (57 taxa).

• The observations show that the greater part of the plants from the taxa described above are grown as a traditional soil crop not regarding their specificity as epiphytes. This results in deterioration of their condition and ornamental qualities, atypical appearance and vulnerability to diseases and pests.

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