GREENHOUSE WEEDS IN THE BOTANICAL GARDEN OF PAS IN WARSAW-POWSIN

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ABSTRACT

Systematic studies carried out in the greenhouses of the Botanical Garden – Center for Biological Diversity Conservation of the Polish Academy of Sciences in Warsaw-Powsin revealed that the flora of weeds was very rich there. A total of 243 taxa of vascular plants and 17 species of bryophytes were recorded. With regard to the division of the flora of vascular plants according to species origin and degree of naturalization, it was found that native plants (89 species), greenhouse-escapes (87 species) and permanently established aliens (48 species) co-dominated there. In addition, 10 species of garden-escapes, i.e. plants cultivated in the immediate neighbourhood of greenhouses, were recorded indoors. Noteworthy were two species that had been brought accidentally to the glasshouses together with plant material – this group of plants is least numerous but quite frequent in the study area. Observations made in the vicinity of Powsin greenhouses showed that relationships between the studied flora and the plants growing outside were unilateral. In Powsin no proved example of expansion of greenhouse plants to other parts of the Garden has been recorded. By contrast, influx of diaspores to the study area is observed frequently – the flora of greenhouse weeds is dominated by plants found also in the immediate neighbourhood (147 species). The most important factors affecting the composition of the weed flora of glasshouses include the flora of the surrounding areas and the mode of greenhouse management (e.g. the range of species cultivated there). The diversity of the flora is not related to greenhouse size.

KEY WORDS: synanthropic flora, weeds, floristic analysis, Botanical Garden of the Polish Academy of Sciences.

INTRODUCTION

Greenhouses are usually associated with horticulture and exhibition of exotic plants. Thus, they are centres of introduction of alien species (originating from warmer climatic zones) and potentially may become sources of spontaneous dispersion of some taxa. Because of this, they are an extremely interesting, although unappreciated, subject of research. Heretofore only one paper on vascular plants growing as weeds in productive greenhouses has been published in Poland (Wiśniewski, Asprou 1974). Short notes were made in monographs on the flora of the Botanical Garden in Moscow (Kozhevnikov 1935) and on the flora of the city of Kraków (Trzcinańska-Tacik 1971 and 1979). These were, however, incidental data, not based on systematic observations. Similarly, there are no comparative data on the greenhouse flora of bryophytes. The reports published to date have been concerned exclusively with alien species (Podpera 1949a,b; Pilous 1956; Menzel 1984; Rusińska, Ratyńska, Galera 1996). A more complete study of bryophytes of the Wrocław Botanical Garden (Berdowski 1988) did not include the area inside greenhouses. The same applies to publications by Filipiak (1996), who did not take into account the area of tunnel houses in the Botanical Garden in Łódź.

This paper concerns the area of exhibition greenhouses and of the greenhouses used for plant propagation. The purpose of

this study was to identify and analyse the spontaneous flora accompanying the plants cultivated in the greenhouses of the Botanical Garden – Centre for Biological Diversity Conservation of the Polish Academy of Sciences in Powsin near Warsaw. Vascular plants and bryophytes were studied, including both the weeds introduced accidentally to greenhouses and exotic plants that escaped from cultivation.

STUDY AREA AND OBJECT OF INVESTIGATION

The study area is a complex of glasshouses (composed of a corridor and twelve separate rooms called chambers), covering an area of 2382 m², and a small one-chamber glasshouse of 92 m² located at the back of the Gardens (Fig. 1). Plants are cultivated in pots, in patches (i.e. in the ground) at the floor level and in so-called windowsills, i.e. metal trays located about 0.7 m above the ground. Some epiphytes are exposed on branches covered with peat moss. There is also a small water body. In the corridor, potting compost is stored. The modernized chambers 5 and 6 are distinguished by the lack of windowsills, and by the presence of supports for epiphytes.

Apart from the permanent exhibitions of exotic plants, the greenhouses are also the place where plants for outdoor collections are propagated and some sensitive plant specimens are kept during the winter season.

Fig. 1. Greenhouses in Botanical Garden in Powsin. I – complex of glasshouses, II – one-chamber glasshouse; a – store, b – patches in the ground, c – windowsills.

Greenhouses are a peculiar study area because of the specific climatic and soil conditions, and because of the pursued agronomic practices. Air temperature and water content are much higher than outside, while exposure to sunlight is much lower. The soil comes from various sources and is highly diverse in terms of mechanical and chemical composition. The substrate for plants is a mixture of compost (produced in the Garden), and sand, bark or peat (purchased from the outside). In the course of substrate preparation, the components are usually not exposed to thermic or chemical sterilization. Most important of the practices pursued in the greenhouses include systematic weeding, application of liquid fertilizers and spraying with pesticides. In a relatively small area, about 1700 taxa have been collected, with thousands of specimens, which results in increased competition between them. Characteristic are also marked differences in conditions between the chambers (Table 1).

The objects of this study were weeds in the broad sense, i.e. undesired plants, brought to the greenhouses either accidentally or deliberately, but self-perpetuating outside their plot without control. According to the definition by Żukowski (1993 – *Słownik botaniczny*, p. 93) weeds are *native and introduced synanthropic plants occurring among cultivated plants in spite of human will and causing marked economic loss by qualitative and quantitative reduction of the yields [...]*. This definition includes also garden-escapes. In the case of greenhouses, some exotic plants may be undesired, too, although they are not usually associated with the term weed. These species are called greenhouse-escapes here.

MATERIAL AND METHODS

Systematic checks repeated every two months were carried out in 1995, but earlier observations from 1992 and 1994

TABLE 1. Greenhouses characteristic.

Chambers	Year of building	Area [m ²]	Min. temp. [°C]	Most important permanent collections
1	1980	324.0	20-22	tropical ferns, <i>Ficus</i>
2	1980	288.0	20-22	useful plants, Araceae, Cactaceae – epiphytes
3	1980	288.0	10-15	succulents, Amaryllidaceae
4	1980	288.0	5-10	subtropical plants, <i>Citrus</i> , <i>Fuchsia</i> , <i>Hibiscus</i>
5	1992	288.0	18-22	tropical plants
6	1992	324.0	10-12	subtropical useful plants
A	1981	21.6	20-22	tropical plants
B	1981	43.2	10-12	<i>Asparagus</i>
C	1981	43.2	5-10	no permanent collections
D	1981	43.2	5-10	<i>Citrus</i> , <i>Coffea</i>
E	1981	86.4	22	no permanent collections
F	1981	86.4	5-10	no permanent collections
corridor (k)	1980-1981	258.0	–	<i>Fuchsia</i> , <i>Hedera</i>
dendrological (x)	1979	92.0	8-10	<i>Camelia</i>

were also taken into account. Floristic lists were made for each chamber separately.

Herbarium materials composed of 126 specimens of vascular plants and 35 samples of bryophytes were deposited in the Herbarium of the Botanical Garden in Powsin.

The scientific nomenclature follows that of Flora Europaea (Tutin et al. 1964, 1968, 1972, 1976, 1980), Zander Handwörterbuch der Pflanzennamen (Encke et al. 1994), Hortus Third (Bates et al. 1976) and Authors of Plant Names (Brummitt, Powell 1992). For some alien taxa other sources were used: Jones (1987) for ferns; Britton and Brown (1898) for *Physalis* spp.; and Jacobsen (1954) for *Sedum* and *Euphorbia* spp. The names of bryophytes used are those found in Ochrya and Szmajda (1992). Some taxa were represented by juvenile specimens only and it was sometimes impossible to identify them to species level, so they were determined at the genus level.

Data on the occurrence of plant species were analysed on the basis of various criteria. One of them was the origin and degree of naturalization of individual taxa. The distinguished elements of the flora were equivalents of geographical-historical groups according to Kornas (1981), modified for the purposes of this study. The classification of life forms used is that of Raunkiaer (1934) and Zarzycki (1984). For the analyses only the basic categories were selected: megaphanerophytes, nanophanerophytes, chamaephytes, hemicryptophytes, cryptophytes and therophytes. In the case of exotic taxa which escaped from cultivation it was only noted whether the plant is an annual, a perennial, a shrub or a subshrub; data on their natural range were also recorded.

The list of taxa of vascular plants found in the greenhouses of the Botanical Garden in Powsin was compared with the register of spontaneously occurring species found outdoors in the area of this Botanical Garden (original research) and in greenhouses in Łódź (Wiśniewski, Asprou 1974).

RESULTS

Floristic diversity

In all the studied glasshouses a total of 243 taxa of vascular plants were found, including 216 taxa of species or lower rank and 4 hybrids (Table 2).

Out of the 67 plant families recorded in the greenhouses, 48 were found represented in the Polish flora (Table 2). The richest among them are: Asteraceae, Crassulaceae, Fabaceae and Polygonaceae. The following genera were represented by the highest number of taxa (i.e. by 5 taxa each): *Begonia*, *Kalanchoe*, *Oxalis*, *Pilea*, *Rumex* and *Sedum*.

Marked differences in the richness of the flora between the individual chambers of the greenhouses in Powsin were recorded (Table 4). The number of recorded taxa ranged from 20 to 90. The correlation between the richness of the flora of a given chamber and its age or area is not strong (Tables 1 and 4).

Among the 17 species of bryophytes found in the glasshouses, 14 were introduced accidentally, while the other 3 were used as a substrate for epiphytes (Table 3). The majority (16 species) were mosses, except for one liverwort, *Marchantia polymorpha*. Among them, *Racomitrium cuspidigerum* and *Taxiphyllum subarcatum* are new to the Polish flora (Rusińska et al. 1996). The others were cosmopolitan synanthropic taxa. Some, like *Leptodictyum riparium*, are associated with wet habitats. Two species typical of forests in general are also present: *Brachythecium rutabulum* and *Plagiomnium cuspidatum*. Bryophytes are most abundant in pots and crevices of the concrete floor. They also colonized the ground frequently.

Elements of the studied flora

The weeds of the greenhouses in Powsin are a very diverse group of plants. The division of the flora of the recorded vascular plants according to species origin and degree of naturalization is presented in the sections below. The flora includes both native species and aliens varying in the degree of naturalization (Table 2A-E). A separate group is composed of other taxa, for which detailed data are missing (Table 2F).

Native plants

Apophytes – here synanthropic species native to the Mazowsze region, were the most numerous group of weeds found in the area of Powsin greenhouses (Table 2A, Fig. 2). This group was composed of 89 taxa, which accounted for 36% of the studied flora. Frequency within this category was quite high – one apophytic species was found in 3.7 chambers on average. They dominated in the flora of all the chambers except Chamber 2 (Table 4), although the degree of their naturalization in the study area varied. Native weeds were most common in pots, near the planted specimens.

The dominant life form are perennials; among them hemicryptophytes rank first, as they are represented by 34 species, i.e. 39% of the native species (Fig. 3A). Annuals were also quite diverse (26 species, i.e. 29% of this group). Among the native species, virtually only therophytes were able to produce seed here. All the others were usually observed as either seedlings or juvenile specimens.

Permanently established aliens

Metaphytes were represented by 48 taxa, accounting for 20% of the studied flora (Table 2B, Fig. 2). This group included 29 archaeophytes, usually found in pots.

The number of permanently established aliens in individual chambers ranged from 3 to 30 taxa (Table 4). Their mean frequency was high – one taxon was found in 4.8 chambers on average. As far as life forms are concerned (Fig. 3B), plants characterized by short life cycles – therophytes – dominated among them (37 taxa, i.e. 77% of this group).

Garden-escapes

This group was represented by only 10 species – 4% of the flora of the greenhouses (Table 2C, Fig. 2). Single specimens were recorded in eight chambers (Table 4). They were cultivated exclusively in the ground, while spontaneously they occurred in the greenhouses – mostly in pots. Each garden-escape was recorded in 1.5 chamber on average. They were mostly therophytes and hemicryptophytes (4 taxa each).

Greenhouse-escapes

This was a very diverse group of weeds – 87 taxa, which accounted for 36% of the studied flora (Table 2D, Fig. 2). Comparison of the individual chambers with regard to the number of greenhouse-escapes (Table 4) showed that it ranged from 0 to 37. They were found mostly in patches of planted specimens and under the windowsills. They were most diverse in Chambers 1, 3 and 5, and dominant in Chamber 2. One taxon of this group was found in 2.1 chambers on average. Most frequent were American and African species (27 and 19 taxa, respectively, see Table 2D). In the study area they were ergasiophygophytes. Among the life forms (Fig. 3C), perennials prevailed here – 66 taxa (i.e. 76% greenhouse-escapes).

Aliens introduced directly to greenhouses

These were represented by two species: *Ruellia carolinensis* and *Pilea microphylla* (Table 2E). They were perennials

TABLE 2. List of the vascular plants in greenhouses in Botanical Garden in Powsin.

A. Native taxa									
Name of taxon	Family	Life-form	Chambers	P	G	O	S	E	
* <i>Achillea millefolium</i> L.	Asteraceae	H	k	+					
* <i>Aegopodium podagraria</i> L.	Apiaceae	H	k	+					
* <i>Anthriscus sylvestris</i> (L.) Hoffm.	Apiaceae	H	B, k	+					
* <i>Arabidopsis thaliana</i> (L.) Meinh.	Brassicaceae	TH	1, 2, 3, 6, A, C, D, E, F, k	+	+	+			
* <i>Arenaria serpyllifolia</i> L.	Caryophyllaceae	T	k	+					
* <i>Artemisia vulgaris</i> L.	Asteraceae	Ch	1, 2, 3, 5, 6, A, C, D, E, k	+	+	+	+		
* <i>Athyrium filix-femina</i> (L.) Roth	Athyriaceae	H	5, F	+					+
* <i>Atriplex hastata</i> L.	Chenopodiaceae	T	3						
* <i>Berteroa incana</i> (L.) DC.	Brassicaceae	HT	k		+				
* <i>Betula pendula</i> Roth	Betulaceae	M	4, 6, F	+	+				
<i>Betula pubescens</i> Ehrh.	Betulaceae	M	5						+
<i>Brachypodium sylvaticum</i> (Huds.) P. Beauv.	Poaceae	H	4		+				
* <i>Cardamine hirsuta</i> L.	Brassicaceae	T	1, 2, 3, 4, 5, A, C, E, F	+	+	+			
* <i>Cardaminopsis arenosa</i> (L.) Hayek	Brassicaceae	H	3, 4, 6	+	+	+			
* <i>Carex</i> sp.	Cyperaceae		5						+
* <i>Carpinus betulus</i> L.	Corylaceae	M	3				+		
* <i>Cerastium fontanum</i> Baumg.	Caryophyllaceae	C	1, 3, 4, 6, E, k	+	+		+		
* <i>Chelidonium majus</i> L.	Papaveraceae	H	1, 3, A, B, C, D, E, F, k, x	+	+	+	+		
* <i>Chenopodium album</i> L.	Chenopodiaceae	TH	1, 2, 3, 5, 6, A, B, C, D, E, F, k, x	+	+	+			
* <i>Chenopodium glaucum</i> L.	Chenopodiaceae	T	3				+		
<i>Chenopodium polyspermum</i> L.	Chenopodiaceae	T	D				+		
* <i>Chenopodium rubrum</i> L.	Chenopodiaceae	T	2				+		
* <i>Cirsium arvense</i> (L.) Scop.	Asteraceae	G	3, 4, 5, 6, C, D, E, F, k, x	+	+	+	+		
* <i>Dryopteris carthusiana</i> (Vill.) H.P.Fuchs	Aspidiaceae	H	5						+
* <i>Dryopteris filix-mas</i> (L.) Schott	Aspidiaceae	H	5						+
* <i>Elymus repens</i> (L.) Gould	Poaceae	G	1, 3	+	+				
* <i>Epilobium adenocaulon</i> Hausskn.	Onagraceae	G	6, B, k	+	+				
* <i>Epilobium hirsutum</i> L.	Onagraceae	H	D		+				
<i>Epilobium roseum</i> Schreb.	Onagraceae	H	B	+	+				
* <i>Equisetum arvense</i> L.	Equisetaceae	G	3, B, C, E, F, k, x	+	+		+		
* <i>Erodium cicutarium</i> (L.) L'Her.	Geraniaceae	TH	E, k	+	+				
* <i>Erophila verna</i> (L.) Chevall.	Brassicaceae	T	1, 2, E, k	+		+			
* <i>Festuca rubra</i> L.	Poaceae	H	5, 6, k	+	+				
* <i>Fragaria vesca</i> L.	Rosaceae	H	5				+		
* <i>Galeopsis bifida</i> Boenn.	Lamiaceae	T	2	+					
* <i>Galium aparine</i> L.	Rubiaceae	T	1, 2, 3, B, E, k, x	+	+	+			
* <i>Galium schultesii</i> West	Rubiaceae	H	B	+					
* <i>Geranium robertianum</i> L.	Geraniaceae	TH	1, 2, 5				+	+	
* <i>Gnaphalium uliginosum</i> L.	Asteraceae	T	1, 3, 4, k	+	+	+			
<i>Hypericum humifusum</i> L.	Hypericaceae	CT	5				+		
* <i>Hypericum perforatum</i> L.	Hypericaceae	H	1, 3, 5, C, D, E, k	+	+	+			
* <i>Juncus bufonius</i> L.	Juncaceae	T	1, 2, 3, 5, 6, B, C, k	+	+	+			
* <i>Juncus effusus</i> L.	Juncaceae	H	3				+		
* <i>Lapsana communis</i> L.	Asteraceae	HT	3				+		
* <i>Lathyrus pratensis</i> L.	Fabaceae	H	5				+		
* <i>Lemna minor</i> L.	Lemnaceae	Hy	1						w
* <i>Linaria vulgaris</i> Mill.	Scrophulariaceae	G	B	+					
* <i>Luzula campestris</i> (L.) DC.	Juncaceae	H	C	+					
* <i>Medicago lupulina</i> L.	Fabaceae	TH	k	+					
* <i>Mycelis muralis</i> (L.) Dumort.	Asteraceae	H	C	+					
* <i>Myosoton aquaticum</i> (L.) Moench	Caryophyllaceae	GH	1, 2, 3		+	+			
* <i>Plantago major</i> L.	Plantaginaceae	H	2, E	+	+				
* <i>Plantago major</i> L. subsp. <i>intermedia</i> (DC.) Arcang.	Plantaginaceae	HT	2, 3, 4, A, D, F, k	+		+	+		
* <i>Plantago media</i> L.	Plantaginaceae	H	2	+					
* <i>Poa annua</i> L.	Poaceae	TH	1, 2, 3, 5, 6, A, B, C, D, E, F, k, x	+	+	+	+	+	
* <i>Poa</i> cfr. <i>trivialis</i> L.	Poaceae	H	6		+				
* <i>Polygonatum odoratum</i> (Mill.) Druce	Liliaceae	G	F, x	+					
* <i>Polygonum aviculare</i> L.	Polygonaceae	T	4, B, C, k	+	+				
* <i>Polygonum nodosum</i> Pers.	Polygonaceae	T	3				+		
* <i>Polygonum persicaria</i> L.	Polygonaceae	T	2, 3, 4, A, C, D, E, k	+	+	+			
* <i>Populus nigra</i> L.	Salicaceae	M	5				+		
* <i>Populus tremula</i> L.	Salicaceae	M	6		+				
* <i>Potentilla collina</i> Wibel	Rosaceae	H	A	+					
* <i>Potentilla</i> sp.	Rosaceae	H	1, 3, 4, 5, 6, C, k	+	+	+			
<i>Quercus petraea</i> (Matt.) Liebl.	Fagaceae	M	2				+		
* <i>Quercus robur</i> L.	Fagaceae	M	1, x	+	+	+			
* <i>Ranunculus ficaria</i> L.	Ranunculaceae	G	4		+				
* <i>Ranunculus repens</i> L.	Ranunculaceae	H	B, k	+	+				
* <i>Ranunculus sceleratus</i> L.	Ranunculaceae	T	k	+					
* <i>Rorippa sylvestris</i> (L.) Besser	Brassicaceae	GH	1, 3, 4, 6, C, k	+	+	+	+		
* <i>Rumex acetosa</i> L.	Polygonaceae	H	3				+		
* <i>Rumex acetosella</i> L.	Polygonaceae	GH	k	+					
* <i>Rumex crispus</i> L.	Polygonaceae	H	2, 3, 6, D	+			+		
* <i>Rumex</i> sp.	Polygonaceae	H	1, 2, 3, 4, A, C, x	+			+		
* <i>Sagina procumbens</i> L.	Caryophyllaceae	C	1, 2, 3, 6, C, E, F, k, x	+	+	+			
* <i>Sambucus nigra</i> L.	Caprifoliaceae	H	x		+				
* <i>Sedum acre</i> L.	Crassulaceae	C	A	+					
* <i>Solanum dulcamara</i> L.	Solanaceae	ChN	C, k		+				
* <i>Sonchus arvensis</i> L.	Asteraceae	GH	3				+		
* <i>Spergularia rubra</i> (L.) J.Presl et C.Presl	Caryophyllaceae	TH	1, 5, 6, C, k	+	+	+			
* <i>Stellaria media</i> (L.) Vill.	Caryophyllaceae	T	1, 2, 3, 5, A, B, C, D, E, F, k, x	+	+	+	+		
* <i>Taraxacum officinale</i> Weber	Asteraceae	H	1, 2, 3, 5, 6, A, B, C, D, E, F, k, x	+	+	+	+		
* <i>Trifolium arvense</i> L.	Fabaceae	T	5		+				
* <i>Trifolium repens</i> L.	Fabaceae	CH	1, 3, 4, 5, 6, B, k	+	+	+			
* <i>Tussilago farfara</i> L.	Asteraceae	G	1, 3, 6, A		+				
* <i>Urtica dioica</i> L.	Urticaceae	H	1, 2, 3, 5, 6, A, B, C, D, E, k, x	+	+	+			
<i>Vaccinium oxycoccos</i> L.	Ericaceae	Ch	5						+
* <i>Verbascum</i> sp.	Scrophulariaceae		1, 2, 3, C, E	+			+		
* <i>Veronica arvensis</i> L.	Scrophulariaceae	T	1, 2, 3, B, C, E, k	+			+		
* <i>Veronica hederifolia</i> L.	Scrophulariaceae	T	1, 3, B, F, k, x	+			+		

TABLE 2. Cont.

B. Permanently established aliens									
Name of taxon	Family	Life-form	Chambers	P	G	O	S	E	
* <i>Amaranthus retroflexus</i> L.	Amaranthaceae	T	3, 4, B, C	+		+			
* <i>Artemisia absinthium</i> L.	Asteraceae	Ch	k				+		
* <i>Atriplex nitens</i> Schkuhr	Chenopodiaceae	T	k		+				
* <i>Atriplex patula</i> L.	Chenopodiaceae	T	6, A, k	+	+				
* <i>Bilderdykia convolvulus</i> (L.) Dumort.	Polygonaceae	T	3, 5, 6, E, k	+	+	+			
* <i>Capsella bursa-pastoris</i> (L.) Medik.	Brassicaceae	T	1, 2, 5, 6, A, C, D, E, F, k	+	+	+	+		
* <i>Conyza canadensis</i> (L.) Cronquist	Asteraceae	TH	1, 2, 3, 5, 6, A, B, C, D, E, F, k	+	+	+	+		
* <i>Descurainia sophia</i> (L.) Webb ex Prantl	Brassicaceae	T	6		+				
* <i>Digitaria sanguinalis</i> (L.) Scop.	Poaceae	T	3, k	+		+			
* <i>Echinochloa crus-galli</i> (L.) P.Beauv.	Poaceae	T	1, 2, 3, 5, 6, A, B, C, D, E, k	+	+	+			
* <i>Euphorbia peplus</i> L.	Euphorbiaceae	T	5, k	+	+				
* <i>Galinsoga ciliata</i> (Rafin.) S.F.Blake	Asteraceae	T	2, 3, 5, A, B, C, E, k, x	+	+	+			
* <i>Galinsoga parviflora</i> Cav.	Asteraceae	T	2, 3, 6, A, B, C, E, F, k	+	+	+			
* <i>Geranium pusillum</i> L.	Geraniaceae	T	1, 3, 5, 6, C, E, F, k	+	+	+	+		
* <i>Impatiens parviflora</i> DC.	Balsaminaceae	T	x	+					
* <i>Lactuca serriola</i> L.	Asteraceae	H	1, 5, A, B, C, D, F, k	+	+	+	+		
* <i>Lamium amplexicaule</i> L.	Lamiaceae	T	1, 2, 3, B, E, k	+	+	+			
* <i>Lamium purpureum</i> L.	Lamiaceae	TH	1, 2, 3, 5, 6, B, C, D, E, k	+	+	+			
* <i>Malva neglecta</i> Wallr.	Malvaceae	HT	k	+	+				
* <i>Matricaria maritima</i> L. subsp. <i>inodora</i> (L.) Dostal	Asteraceae	TH	1, 2, 3, 4, 5, C, E, k	+	+	+			
* <i>Myosotis arvensis</i> (L.) Hill	Boraginaceae	TH	1			+			
* <i>Oenothera biennis</i> L.	Onagraceae	H	k	+					
* <i>Oenothera</i> sp.	Onagraceae		1, 2, 3, 4, 5, C, k	+	+	+			
* <i>Oxalis corniculata</i> L. var. <i>Corniculata</i>	Oxalidaceae	TH	1, 4	+	+	+			
* <i>Oxalis corniculata</i> L. var. <i>repens</i> (Thunb.) Zucc	Oxalidaceae	TH	1, 2, 3, 6, A, B, D, F, x	+	+	+	+	+	
<i>Oxalis corniculata</i> L. var. <i>repens</i> (Thunb.) Zucc f. <i>purpurea</i> Parl.	Oxalidaceae	TH	3, F, k	+			+		
* <i>Oxalis stricta</i> L.	Oxalidaceae	T	1, 2, 3, A, B, C, E, F	+	+	+	+		
<i>Oxalis stricta</i> L. x <i>O. dillenii</i> Jacq.	Oxalidaceae	TH	3		+				
* <i>Papaver dubium</i> L.	Papaveraceae	T	4	+					
* <i>Polygonum tomentosum</i> Schrank	Polygonaceae	T	3	+					
* <i>Quercus rubra</i> L.	Fagaceae	M	1, F			+			
* <i>Raphanus raphanistrum</i> L.	Brassicaceae	T	2, 6, B, k	+	+	+			
* <i>Robinia pseudacacia</i> L.	Fabaceae	M	1, 2, 5, 6, E, k	+	+	+			
* <i>Rumex confertus</i> Willd.	Polygonaceae	H	F	+					
* <i>Senecio vernalis</i> Waldst. et Kit.	Asteraceae	T	k	+					
* <i>Senecio vulgaris</i> L.	Asteraceae	TH	1, 2, 3, 6, A, C, D, E, F, k	+	+	+	+		
* <i>Setaria viridis</i> (L.) P. Beauv.	Poaceae	T	3	+		+			
* <i>Sisymbrium</i> sp.	Brassicaceae		A		+				
* <i>Solanum nigrum</i> L.	Solanaceae	T	E	+					
* <i>Solidago gigantea</i> Aiton	Asteraceae	HG	2	+					
* <i>Sonchus oleraceus</i> L.	Asteraceae	TH	1, 2, 3, 5, 6, A, B, C, k	+	+	+	+		
* <i>Spergula arvensis</i> L.	Caryophyllaceae	T	3, 6, A	+	+	+			
* <i>Urtica urens</i> L.	Urticaceae	T	6, C, E, k	+	+				
* <i>Vicia hirsuta</i> (L.) Gray	Fabaceae	T	4, B, E	+	+				
* <i>Vicia sativa</i> L. subsp. <i>nigra</i> (L.) Ehrh.	Fabaceae	T	1, 3, 5, k	+	+	+			
* <i>Vicia tetrasperma</i> (L.) Schreb.	Fabaceae	T	1, 2, 3, 4, 5, 6, C, D, k	+	+	+			
* <i>Viola arvensis</i> Murray	Violaceae	T	1, 3, 5, 6, B, E, k	+	+	+			

TABLE 2. Cont.

C. Garden-escapes									
Name of taxon	Family	Life-form	Chambers	P	G	O	S	E	
* <i>Amaranthus hybridus</i> L.	Amaranthaceae	T	3			+			
* <i>Artemisia annua</i> L.	Asteraceae	T	3			+			
* <i>Calendula officinalis</i> L.	Asteraceae	T	B	+					
<i>Cotula squalida</i> (Hook f.) Hook f.	Asteraceae	H	x	+					
* <i>Datura</i> sp.	Solanaceae	T	2	+					
* <i>Galega officinalis</i> L.	Fabaceae	H	3, 4, 5, 6	+	+	+			
* <i>Lupinus</i> sp.	Fabaceae		2, 5, 6		+	+			
<i>Samolus valerandi</i> L.	Primulaceae	H	4	+					
* <i>Sedum hispanicum</i> L.	Crassulaceae	H	k	+					
<i>Vinca major</i> L. "Variegata"	Apocynaceae	Ch	B		+				

that originated from the tropics, introduced with plant material imported directly to the Powsin greenhouses. They were recorded quite frequently (in 6.5 chambers on average), but only in the area of the complex of greenhouses (Table 4).

Flora of greenhouses vs. flora of the other parts of the Garden

In glasshouses a numerous group of vascular plants (147 species) was formed by taxa that occurred spontaneously in the Garden also outdoors. These plants accounted for 61% of the flora of greenhouse weeds. The taxa common to these two floras prevailed among the native plants (Table 2A), the permanently established aliens (Table 2B), and garden-escapes (Table 2C).

In this study a total of 96 taxa were found to occur spontaneously exclusively inside greenhouses (40% of the flora).

Neither during the original floristic studies that were carried out in 1991, nor in any earlier unpublished accounts (Bernat et al. 1955, Karcz 1980), these taxa were recorded in the Garden. This group was mostly composed of greenhouse-escapes that could be found exclusively in greenhouses. The only exception were four species that were cultivated both in the area of greenhouses and in other parts of the Garden (Table 2D).

Most widespread taxa

Among vascular plants, the most frequent weeds (15 taxa found in 10 or more chambers: *Arabidopsis thaliana*, *Artemisia vulgaris*, *Capsella bursa-pastoris*, *Chelidonium majus*, *Chenopodium album*, *Cirsium arvense*, *Conyza canadensis*, *Echinochloa crus-galli*, *Epilobium* sp., *Lamium purpureum*,

TABLE 2. Cont.

D. Greenhouse-escapes									
Name of taxon	Family	Life-form	Origin of taxon	Chambers	P	G	O	S	E
<i>Achimenes erecta</i> (Lam.) H.P.Fuchs	Gesneriaceae	p	AM, sAN, nAS	1, 5, E	+	+	+	+	+
<i>Achimenes</i> sp.	Gesneriaceae	p	A	1, 2, 3, 5, k		+	+	+	
<i>Adiantum capillus-veneris</i> L.	Adiantaceae	p	AM, nAS, sAN	1, 2, 6, C, D, E	+		+	+	
<i>Adiantum</i> sp.	Adiantaceae	p		1, 2, 4, 5, A, C, E, k	+	+	+	+	
<i>Adiantum tenerum</i> Sw.	Adiantaceae	p	AM, nAS	E		+			
<i>Anthurium crassinervium</i> (Jacq.) Schott	Araceae	p	sAS	5		+			
<i>Aptenia cordifolia</i> (L. f.) N.E.Br.	Aizoaceae	ss	sAf	2, 3, 4	+	+	+		
<i>Ardisia crenata</i> Sims	Myrsinaceae	s	meAz	2			+		
<i>Asparagus</i> sp.	Liliaceae	p		1, B		+			
<i>Asplenium bulbiferum</i> G.Forst.	Aspleniaceae	p	Au, NZc, nInd	1			+		
<i>Begonia bowerii</i> Ziesenh. 'Nigra Magna'	Begoniaceae	p	hort	2		+			
<i>Begonia bowerii</i> Ziesenh. 'Tiger'	Begoniaceae	p	hort	2	+	+			
<i>Begonia metallica</i> W.G.Sm.	Begoniaceae	p	AS(Bras)	5		+			
<i>Begonia</i> sp.	Begoniaceae	p		1, 2, 4, 5	+	+	+		
<i>Begonia</i> x <i>hybrida</i> hort.	Begoniaceae	p	hort	1		+			
<i>Boussingaultia cordifolia</i> Ten.	Basellaceae	p	meAS	2, E, F		+			+
<i>Bryonia alba</i> L.	Cucurbitaceae	p(H)	Eur, nAf, wAz	k	+				
<i>Chirita lavendulacea</i> Stapf	Gesneriaceae	p	Az(Mal)	5		+			
<i>Chlorophytum comosum</i> (Thunb.) Jacques	Liliaceae	p	sAf	2, 3			+		
<i>Coffea arabica</i> L.	Rubiaceae	ss	tAf	2, 3, 4, A, D			+		+
<i>Crassula multica</i> Lem.	Crassulaceae	ss	sAf	2, 3			+		
<i>Crassula portulacae</i> Lam.	Crassulaceae	s	sAf	2, 3	+	+	+		
<i>Crassula</i> sp.	Crassulaceae			3		+	+		
<i>Cyclosorus dentatus</i> (Forssk.) Ching	Thelypteridaceae	p	pant	1, 2, 4, 5, 6, D, E, F, k	+	+	+	+	+
<i>Cyperus</i> sp.	Cyperaceae	p		1, 2, 3, 6, C, E	+	+	+	+	+
<i>Dioscorea</i> sp.	Discoreaceae	p		1, 2, 5, k	+	+	+	+	
<i>Doodia</i> sp.	Blechnaceae	p		5		+			
<i>Dorstenia</i> sp.	Moraceae	p		5		+			
<i>Euphorbia hubalina</i> Boiss.	Euphorbiaceae	s	sAf	3		+			
<i>Euphorbia characias</i> L.	Euphorbiaceae	p	eMed	3			+		
<i>Euphorbia</i> sp.	Euphorbiaceae			3		+			
<i>Fuchsia arborescens</i> Sims	Onagraceae	s	AM	5		+			
<i>Fuchsia procumbens</i> R.Cunn. ex A.Cunn.	Onagraceae		Au	3, A	+		+		
* <i>Gladiolus</i> cfr. x <i>gandavensis</i> Van Houtte	Iridaceae	p(G)	hort.	1, 4, D, E, k	+	+	+		
<i>Graptopetalum paraguayense</i> (N.E.Br.) E.Walther	Crassulaceae	p	AM?	2					+
<i>Hypoestes phyllostachya</i> Baker	Acanthaceae	s	Af(Madag)	1, 2, 5	+	+			
<i>Impatiens balsamina</i> L.	Balsaminaceae	a	sAz	E	+				
<i>Impatiens walleriana</i> Hook.f.	Balsaminaceae	p	teAf	2, E		+			+
<i>Kalanchoe blossfeldiana</i> Poelln.	Crassulaceae	ss	Af(Madag)	2, k	+		+		
<i>Kalanchoe daigremontiana</i> Raym.-Hamet et H.Perrier	Crassulaceae	p	Af(Madag)	3		+	+	+	
<i>Kalanchoe rotundifolia</i> (Haw.) Haw.	Crassulaceae	p	sAf	3			+	+	
<i>Kalanchoe</i> sp.	Crassulaceae	p	Af?	3		+	+		
<i>Kalanchoe tubiflora</i> (Harv.) Raym.-Hamet	Crassulaceae	p	Af(Madag)	2, 3, C		+	+	+	
* <i>Lycopersicon esculentum</i> Miller	Solanaceae	a	wAS	4		+			
<i>Macrothelypteris</i> sp.	Thelypteridaceae	p		2, E		+			
<i>Nephrolepis exaltata</i> (L.) Schott	Nephrolepidiaceae	p	sAN, AM, nAS	C		+		+	
<i>Origanum majorana</i> L.	Lamiaceae	a	nAf, swAz	C		+			
<i>Passiflora caerulea</i> L.	Passifloraceae	s	seAS	4		+			
<i>Passiflora edulis</i> Sims	Passifloraceae	s	A(Bras)	E		+			
<i>Passiflora</i> sp.	Passifloraceae	s	A?	1, 4, F		+			
<i>Passiflora violacea</i> Vell.	Passifloraceae	s	mAS	1		+		+	
<i>Peperomia caperata</i> Yunc.	Piperaceae	p	AS(Bras?)	5		+			
* <i>Physalis philadelphica</i> Lam.	Solanaceae	a	AS	k	+				
<i>Pilea depressa</i> (Schwartz) Blume	Urticaceae	p	Az(wInd)	E		+		+	
<i>Pilea repens</i> (Sw.) Wedd.	Urticaceae	p	AM	4			+		
<i>Pilea</i> sp.	Urticaceae	p	A	2, 5			+	+	+
<i>Pilea spruceana</i> Wedd.	Urticaceae	p	wmAS	2		+			
<i>Polystichum falcatum</i> (L.f.) Diels	Aspidiaceae	p	Az, sAf	2, 3, 5, 6, D, E, F, k	+	+		+	
<i>Psilotum nudum</i> (L.) P. Beauv.	Psilotaceae	p	pant	2, 5		+			
<i>Pteris cretica</i> L.	Pteridaceae	p	t, subt	5, A, D, E, k	+	+		+	
<i>Pteris cretica</i> L. 'Major'	Pteridaceae	p	hort	1, D, k		+	+		
<i>Pteris cretica</i> L. 'Wilmsetti'	Pteridaceae	p	hort	E		+			
<i>Pteris</i> sp.	Pteridaceae	p		5, E	+	+		+	
<i>Pteris tremula</i> R.Br.	Pteridaceae	p		1, 5, D		+	+		
<i>Pteris vittata</i> L.	Pteridaceae	p	tAz, tAf	2, 5, D, E, k	+	+	+	+	
<i>Saintpaulia ionantha</i> H.Wendl.	Gesneriaceae	p	sAf	1, 2		+	+		
<i>Saxifraga sarmentosa</i> L.f.	Saxifragaceae	p	eAz	1		+			
<i>Scadoxus multiflorus</i> (Martyn) Raf.	Amaryllidaceae	p	esAf	2		+			
<i>Sedum dasyphyllum</i> L.	Crassulaceae	p	sEur, nAf	3			+		
<i>Sedum</i> sp.	Crassulaceae	p		3			+		
<i>Sedum stahlii</i> Solms	Crassulaceae	p	A(Mex)	3			+	+	
<i>Selaginella</i> sp.	Selaginellaceae	p	Az?	1, 2, k	+	+	+	+	
<i>Sinocrassula indica</i> (Decne.) A.Berger	Crassulaceae	p	sAz	2, 3		+	+		
<i>Soleirolia soleirolia</i> (Req.) Dandy	Urticaceae	p	sEur	2, 4		+	+	+	
<i>Streptocarpus grandis</i> N.E.Br. ex C.B.Clarke	Gesneriaceae	p	sAf	5		+			
<i>Streptocarpus rexii</i> (Bowie ex Hook.) Lindl.	Gesneriaceae	p	sAf	C		+		+	
<i>Streptocarpus</i> sp.	Gesneriaceae	p		1, k	+		+		
<i>Streptocarpus</i> x <i>hybridus</i> Voss.	Gesneriaceae	p	hort	1			+		
<i>Syngonium podophyllum</i> Schott	Araceae	s	AM	2		+			
<i>Tectaria cicutaria</i> (L.) Copel.	Aspidiaceae	p	pant	C		+			
<i>Tetranema roseum</i> (M.Martens et Galtotti) Standl. et Steyererm.	Scrophulariaceae	p	AM	5		+			
<i>Tradescantia</i> sp.	Commelinaceae	p	A	1, 2		+	+	+	
<i>Veltheimia</i> sp.	Liliaceae	p	sAf	4		+			
<i>Woodwardia orientalis</i> Sw.	Blechnaceae	p	Az	6				+	
<i>Zebrina pendula</i> Schinzl.	Commelinaceae	p	A(Mex)	2		+			
<i>Zebrina purpusii</i> G. Bruckn.	Commelinaceae	p	A(Mex)	1, 2		+			
<i>Zebrina</i> sp.	Commelinaceae	p	A	2, 3	+	+		+	

TABLE 2. Cont.

E. Aliens introduced directly to greenhouses

Name of taxon	Family	Life-form	Origin of taxon	Chambers	P	G	O	S	E
<i>Pilea microphylla</i> (L.) Liebm	Iridaceae	p	tA	1, 4, 5, A, E, k	+	+	+	+	
<i>Ruellia caroliniensis</i> (J.F.Gmel) Steud	Urticaceae	p	sAN, AM	1, 2, 5, A, B, C, E	+	+	+	+	

TABLE 2. Cont.

F. Others (no datas)

Name of taxon	Family	Life-form	Chambers	P	G	O	S	E
* <i>Epilobium</i> sp.	Onagraceae		1, 2, 3, 4, 5, B, C, E, F, k	+	+	+	+	
* <i>Mentha</i> sp.	Lamiaceae		4		+			
* <i>Populus</i> sp.	Salicaceae	M	6		+			
* <i>Rubus</i> sp.	Rosaceae	N	3					
* <i>Salix</i> sp.	Salicaceae	N	2	+				
* <i>Tilia</i> sp.	Tiliaceae	M	B, F, x	+	+			
* <i>Viola</i> sp.	Violaceae		5, F	+	+	+		

Explanatory notes for Tables 2A, 2B, 2C, 2F

* – taxa common with greenhouses and other part of Garden; Life-form: M – megaphanerophytes, N – nanophanerophytes, H – hemicryptophytes, Ch – chamaephytes, C – cryptophytes, G – geophytes, Hy – hydrophytes, T – therophytes; Chambers – occurrence in each chambers; P – pots, G – patches (i.e. in the ground), O – windowsills, S – slots in concrete, E – supports for epiphytes, w – water body. Abbreviations consistent with Table 1.

Explanatory notes for Tables 2D, 2E

* – taxa common with greenhouses and other part of Garden; Life-form: s – shrub, ss – semishrub, p – perennial plant, a – annual plant; Origin of taxon: e – eastern, n – northern, s – southern, w – western, m – central, t – tropical, pant – pantropical, subt – subtropical, hort – horticultural; A – America, Af – Africa, AM – Central America, AN – Northern America, AS – Southern America, Au – Australia, Az – Asia, Bras – Brazil, Eur – Europe, Ind – India, Madag – Madagascar, Mal – Malaya Archipelago, Med – Mediterranean Area, Mex – Mexico, Nze – New Zealand; Chambers – occurrence in each chambers; P – pots, G – patches (i.e. in the ground), O – windowsills, S – slots in concrete, E – supports for epiphytes. Abbreviations consistent with Table 1

Poa annua, *Senecio vulgaris*, *Stellaria media*, *Taraxacum officinale*, *Urtica dioica*) were species that were also found outdoors, in other parts of the Garden. The majority (9) were species with short life cycles – therophytes (see Table 2). The geographical-historical classification showed that most numerous among them were native taxa.

Among greenhouse-escapes most common were ferns: *Cyrtosorus dentatus*, *Polystichum falcatum* and *Adiantum* spp. (Table 2D). The most frequent bryophytes were *Leptodictyum riparium* and *Amblystegium serpens*.

DISCUSSION

In greenhouses covering 0.6% of the area of the Botanical Garden in Powsin, 243 taxa of spontaneously occurring vascular plants were recorded, while in the other parts of the

Fig. 2. Elements of the studied flora according to species origin and degree of naturalization (in brackets number of taxa).

TABLE 3. List of Bryophyta in greenhouses in Botanical Garden in Powsin.

Name of taxon	Chambers
● <i>Aulacomnium palustre</i> (Hedw.) Schwaegr.	5
● <i>Pohlia nutans</i> (Hedw.) Lindb.	5
● <i>Sphagnum</i> sp.	5
<i>Amblystegium serpens</i> (Hedw.) B., S. & G.	1, 2, 3, 4, A, B, D, k
<i>Brachythecium rutabulum</i> (Hedw.) B., S. ZG.	4, C
<i>Bryum argenteum</i> Hedw.	1, 3, x
<i>Bryum capillare</i> Hedw.	x
<i>Ceratodon purpureus</i> (Hedw.) Brid.	4, 5, B, k, x
<i>Funaria hygrometrica</i> Hedw.	4, 5, F, k, x
<i>Leptodictyum riparium</i> (Hedw.) Warnst.	1, 2, A, B, C, D, E, k, x
<i>Letobryum pyriforme</i> (Hedw.) Wils.	1, 4, 5, 6, F, k, x
<i>Marchantia polymorpha</i> L.	F, x
<i>Plagiomnium cuspidatum</i> (Hedw.) T. Kop.	D
<i>Racomitrium cuspidigerum</i> (Schwaegr.) Angstr.	5, E
<i>Steblotrichum convolutum</i> (Hedw.) P. Beauv.	1, 3, 4, 5, 6, B
<i>Taxiphyllum subarcuatum</i> (Broth.) Iwats	E
<i>Tortula muralis</i> Hedw.	x

● – species which make breeding-ground for epiphytes, Chambers – shortenings consistent with Table 1

Garden 450 species were found (original research). Considering the marked differences in the size of these areas it may be concluded that the Powsin greenhouses are characterized by a very rich flora.

The most numerous group is formed by taxa native to the Mazowsze region (37% of the studied flora). The importance of this element is also attested to by its dominance in the flora of nearly all the greenhouse chambers, the relatively high frequency and among the weeds that were recorded most frequently. The majority of the apophytes are hemicryptophytes and therophytes.

The native flora is relatively poor (36%) while permanently established aliens constitute 20% of the studied flora. Ergasio-

Fig. 3A. Life-form spectrum of native species (in brackets number of taxa).

Fig. 3B. Life-form spectrum of permanently established aliens (in brackets number of taxa).

Fig. 3C. Life-form spectrum of greenhouse-escapes (in brackets number of taxa).

phygophytes i.e. greenhouse-escapes and garden-escapes constituted as much as 40% of the flora.

A comparative analysis of the above data with the results obtained by Sudnik-Wójcikowska (1987) suggests that the flora of Powsin glasshouses was dominated by diaphytes (40% of the flora), while their proportion the present-day sy-

nanthropic flora of Warsaw is only 20%. In the case of apophytes and metaphytes the opposite tendencies are the observed: in the area of Warsaw they account for 56% and 24% of the flora, respectively, while in the flora of the greenhouses their proportion is much smaller (37 and 19%).

Observations made in the areas adjacent to the greenhouses allowed for investigation of the interaction between the spontaneous flora of the greenhouses and the plants growing in their immediate neighbourhood. The flora of greenhouse weeds was dominated by species that occurred spontaneously also in other parts of the Garden, and it may be assumed that most of them derive from the plants growing nearby. A total of 147 taxa were recorded in this group, which accounts for 61% of the greenhouse flora. Most of them were apophytes, and metaphytes.

The taxa occurring spontaneously in the area of the greenhouses were mostly greenhouse-escapes. They formed a group of ergasiophytes specific to the study area and lacking the tendency to colonize the areas around the glasshouses. These were mostly perennials. This results mostly from the fact that selection of exotic species for expositions – about 70% of them are perennials.

Another 13 species found exclusively inside the greenhouses were of various origin. Two of them were cultivated only in the ground outdoors: *Cotula squalida* and *Samolus valerandii*. The former was propagated vegetatively, but it has spontaneously spreading specimens found in the small dendrological greenhouse, which is about 40 m away from the place where it is cultivated. The latter has migrated to the complex of greenhouses from a patch 30 m away. Two other species (*Ruellia caroliniensis* and *Pilea microphylla*) come from the tropics, and have been introduced accidentally to the greenhouses, with imported plant materials. Seeds of *Betula pubescens* and *Vaccinium oxycoccus*, which are native to the Mazowsze region, have certainly been brought to the greenhouses with the substrate which is used as a covering for branches that support epiphytes. The origin of the other seven taxa found only indoors (*Brachypodium sylvaticum*, *Chenopodium polyspermum*, *Hypericum humifusum*, *Epilobium roseum*, *Quercus petraea*, *Oxalis corniculata* var. *repens* f. *purpurea* and *O. stricta* x *O. corniculata*) is not certain, but it is highly probable that their diaspores have been brought here with substrates.

During the regular and detailed floristic observations made in the Botanical Garden in Powsin no case of expansion of exotic plants into the areas outside the greenhouses was recorded, although literature data suggest that this is possible. For example, spontaneous occurrence of three weeds that probably originated from exposition greenhouse were recorded in the Botanical Garden of the Jagiellonian University in Kraków: *Chenopodium giganteum* Don., *Nicandra physaloides* (L.) Gaertn. and *Oxalis corniculata* L. (Trzeńska-Tacik 1971, 1979). The latter species was also recorded in the Moscow Botanical Garden (Kozhevnikov 1935): it was very common in greenhouses, from where it migrated to flower beds outside.

The flora of vascular plants of the greenhouses of the Botanical Garden in Powsin is very rich and varied in comparison with the greenhouse flora studied in the city of Łódź (Wiśniewski, Asprou 1974). In the Powsin glasshouses that cover nearly 2.500 m², 243 taxa were recorded, while in Łódź only 72 species were found to occur spontaneously in seven productive greenhouses (a total of 168 000 m²). These differences result mostly from the types of plants grown there: in Łódź only vegetables and ornamental plants were cultivated,

TABLE 4. Number of vascular plants in each chamber – shortenings consistent with Table 1.

Group of taxa	Chambers															Total
	1	2	3	4	5	6	A	B	C	D	E	F	k	x		
Native taxa	30	25	39	15	25	22	15	19	25	15	21	15	39	15	90	
Permanently established aliens	20	17	24	7	16	18	13	14	16	8	17	11	29	3	47	
Garden-escapes	0	2	3	2	2	2	0	2	0	0	0	0	1	1	10	
Greenhouses-escapes	24	37	22	12	23	5	4	1	9	9	18	4	12	0	87	
Aliens introduced directly to greenhouses	2	1	0	1	2	0	2	1	1	0	2	0	1	0	2	
Others	1	2	2	2	2	1	0	2	1	0	1	3	1	1	7	
Total	77	84	90	39	70	48	34	39	52	32	59	33	85	20	243	

so the weeds were mostly segetal species. According to above authors these are mostly mesophytes.

One of the most persistent greenhouse weeds, both in Łódź and in Powsin, was *Poa annua*. In Powsin it was found in nearly all the chambers. In the glasshouses in Łódź *Stellaria media*, *Galinsoga ciliata* and *Juncus bufonius* were also very frequent, while in Powsin *Chenopodium album* and *Taraxacum officinale* were found in the highest number of chambers.

The floristic diversity does not seem to be affected by glasshouse size. This is confirmed by the comparison of results obtained in Powsin and Łódź (Wiśniewski, Asprou 1974), and of the number of taxa recorded in individual chambers of the Powsin greenhouses. The types of plants cultivated there are of much greater importance.

The mode of greenhouse use is also directly related to the number and combination of vascular plant families found in the study area. Among the 67 plant families recorded in the Powsin glasshouses, 19 have no representatives in the Polish flora. In Łódź (24 families) no exotic species were found. The most numerous members of the Asteraceae dominated also the flora of Łódź greenhouses, and the flora of Warsaw and Poland (Sudnik-Wójcikowska 1987). By contrast, the family Crassulaceae, which ranked second in the study area, has few representatives in the Polish flora, while Wiśniewski and Asprou (1974) recorded no members of this family in Łódź.

Among the 17 species of bryophytes found in the greenhouses of the Botanical Garden in Powsin, 14 may be regarded as introduced accidentally, while the other three as introduced deliberately as a substrate for epiphytes.

CONCLUSIONS

The flora of greenhouses is a very interesting, although poorly studied subject of research. The results, apart from the cognitive aspect, are also of practical importance because some of the plants occurring spontaneously in greenhouses are persistent weeds.

The spontaneous flora of the glasshouses of the Botanical Garden in Powsin is very rich and diversified. It includes 17 species of bryophytes and 243 taxa of vascular plants. The flora is dominated by plants growing also outdoors in the immediate neighbourhood, i.e. in other parts of the Garden. The second largest group are greenhouse-escapes.

The interaction between the weed flora of greenhouses and the plants occurring in the vicinity of the glasshouses is unilateral. No cases of expansion of greenhouse plants into other parts of the Garden have been recorded, although colonization of greenhouses by outdoor plants is very common.

On the basis of observations carried out in the area of the Garden 4 potential sources of diaspores for plants noted in greenhouses can be distinguished. These include:

- plants occurring spontaneously in the area of the Garden,
- plants cultivated in the Garden,
- plants grown exclusively in the greenhouses,
- plants introduced directly to the greenhouses from other sources.

The significance of the individual sources is difficult to evaluate, although the flora of other parts of the Garden seems to be most important. Plants grown in the greenhouses rank second. Some of them have a capacity for intensive spontaneous dispersal, but do not show any tendency to expand outdoors.

The mode of greenhouse use affecting the environmental conditions and sources of diaspores, has a decisive influence on the specificity of the studied flora.

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FLORA CHWASTÓW W SZKLARNIACH OGRODU BOTANICZNEGO PAN W POWSINIE

STRESZCZENIE

Na podstawie systematycznie prowadzonych badań w szklarniach Ogrodu Botanicznego – Centrum Zachowania Różnorodności Botanicznej Polskiej Akademii Nauk stwierdzono, że flora chwastów jest bardzo bogata: zanotowano łącznie 243 taksony roślin naczyniowych oraz 17 gatunków mszaków. Uwzględniając podział flory roślin naczyniowych pod względem pochodzenia i stopnia zdomowienia, stwierdzono współdominację elementu rodzimego (89 gatunków), grupy uciekinierów z upraw szklarniowych (87 taksonów) oraz trwale zdomowionych roślin obcego pochodzenia (48 gatunków). Uciekinierzy z upraw prowadzonych w sąsiedztwie szklarni to element flory liczący 10 taksonów. Na uwagę zasługują dwa gatunki przypadkowo zawleczone do szklarni wraz z materiałem roślinnym – jest to kategoria najmniej liczna, lecz jej przedstawicieli notowano bardzo często. Obserwacje prowadzone w otoczeniu powsińskich cieplarni wskazują, że oddziaływania pomiędzy badaną florą a roślinami występującymi w sąsiedztwie mają charakter jednostronny. W Powsinie nie zanotowano udowodnionego przypadku ekspansji roślin poza cieplarnie, natomiast przepływ diaspory na badany teren jest częstym zjawiskiem – wśród chwastów szklarniowych przeważają rośliny występujące również w bezpośrednim sąsiedztwie (147 gatunków). Do najistotniejszych czynników mających wpływ na zestaw chwastów występujących w cieplarniach należą: flora terenów sąsiadujących oraz sposób użytkowania szklarni (w tym rodzaj upraw).

SŁOWA KLUCZOWE: flora synantropijna, chwasty, analizy florystyczne, Ogród Botaniczny Polskiej Akademii Nauk.