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The wall flora of the Nebet Tepe Architectural Reserve in the city of Plovdiv (Bulgaria)

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The flora of the Nebet Tepe Architectural Reserve in the city of Plovdiv (Thracian Plain) was studied in the period 1998–2003. The number of plants growing spontaneously on and around the fragments of the fortification wall and on the pavements is 131. The flora is analyzed with respect to the local distribution of the taxa, their chorology, life form and geoelement characteristics. The flora contains a relatively high proportion of ruderals and weeds. The hemicryptophytes and therophytes constitute the largest group. The following families are distinguished by the greatest number of species: Asteraceae (14), Fabaceae (13), Poaceae (12), Brassicaceae (8), Scrophulariaceae (7), Caryophyllaceae (7). The species *Cerastium tauricum* Spreng. and *Melica transsilvanica* Schur are recorded for the first time for the flora of the Thracian Plain floristic region. The results are compared with other European and Mediterranean wall floras.

Key words: flora, wall flora, Nebet Tepe, Plovdiv, Bulgaria

Introduction

The city of Plovdiv is located in the western part of the Thracian Plain (42° N, 24° 45' E) on both sides of the Maritza River and on seven hills. The city has a long history, since prehistoric times. The most ancient settlement (2000 years BC), dating from the Bronze Age, was excavated on the northern part of Nebet Tepe hill. The prehistoric settlement known as Trimontzium, located on the three joined hills Taksim Tepe (195 m a.s.l.), Dzambaz Tepe (212 m a.s.l.) and Nebet Tepe (207 m a.s.l.), was populated by Thracian tribes. They constructed the first fortification wall on Nebet Tepe. The settlement had existed during the Iron Epoch and later on was reorganized by Phillip II of Macedonia into the town of Phillipopolis. The new town was surrounded by a massive fortification wall constructed of stone blocks, each 3 m long. The wall has been demolished many times and rebuilt again. Remains from Roman, Byzantine and Turkish constructions are found nowadays on its foundations.

From a botanical point of view such walls represent a specific environment, partly similar to rocks and rock fissures (WOODELL 1979). Nevertheless, their artificial origin, location

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in the urban landscape and building technology have an effect on a range of plant species able to colonize such habitats (DUCHOSLAV 2002).

The flora on the northernmost wall remains and pavements in the Nebet Tepe Architectural Reserve was studied during 1998–2003. In former times the length of the fortification wall on the northern part of Nebet Tepe hill reached 1650 m (Fig. 1). Nowadays, only fragments of the wall, 1–5 m high, are preserved. The remains of the wall are surrounded by an open area that is colonized by natural vegetation, highly influenced by anthropogenic activity, ornamental trees (*Koelreuteria paniculata* Laxm., *Acer negundo* L., *Thuja orientalis* L.), shrubs (*Lonicera xylosteum* L., *Spiraea vanhouttei* (Brot.) Zbl., *Philadelphus coronarius* L., *Laurocerasus officinalis* Roem.) and spontaneous vegetation (STANEV 2003).

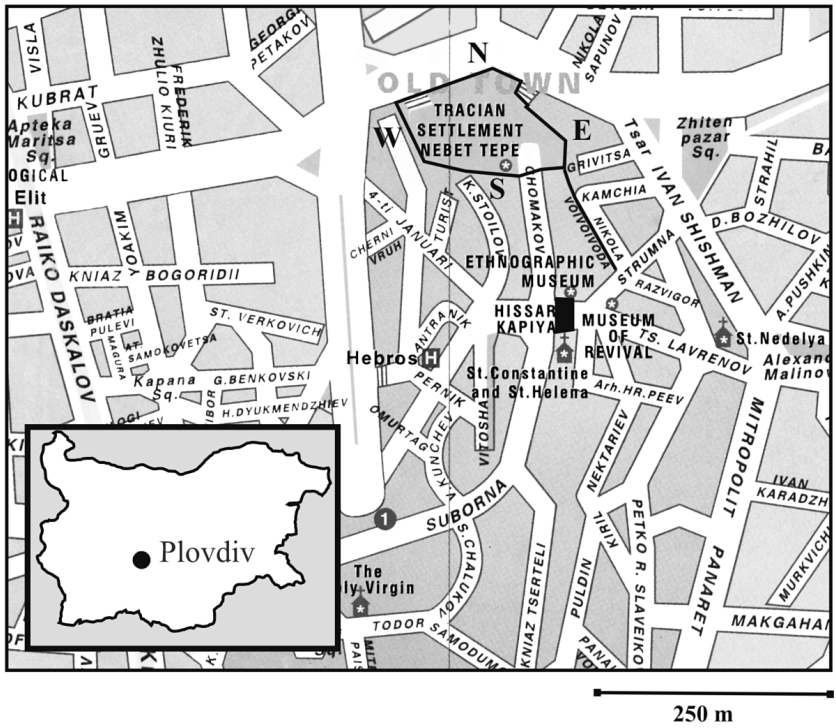

Fig. 1. Map of the study area in Nebet Tepe, the city of Plovdiv (Bulgaria)

The city of Plovdiv is located in the Macedonian-Thracian province of the European Broad-Leaved area characterized by the distribution of xerothermic oaks (*Quercus pubescens* Willd., *Q. frainetto* Ten., *Q. cerris* L.) and mesophilous (*Q. robur* L. and *Ulmus minor* Mill.) forests. Today in the Thracian Plain these forests have been completely destroyed and the area has been turned into arable land (BONDEV 1982). The course of the Maritza River figures as an important phytoclimatic route for the penetration of a number of Mediterranean and sub-Mediterranean species that are concentrated mainly on calcareous terrain.

A floristic catalogue is prepared and comparison with similar floras in Europe and the Mediterranean is presented. Information for a limited number of taxa growing in these spe-

cific habitats on Nebet Tepe is found in two publications prior to the present investigation (DIMITROV and CHESHMEDZHIEV 2001, STANEV 2003).

Materials and methods

The floristic catalogue is arranged in alphabetical order of families, genera and species. At this stage the material collected from Bryophyta and ornamental plants is not included. The plant nomenclature follows KOZUHAROV (1992), Flora Reipublicae Popularis Bulgaricae (JORDANOV 1963–1995) and TUTIN et al. (1968–1993). Information concerning the distribution and life form [phanerophyte (Ph); chaemaphyte (C); chaemicriptophyte (H); therophyte (T); geophyte (G); nanophanerophyte (F); mesophanerophyte (M); chaemiphanerophyte (S)] of the taxa is taken from literature sources (ROTHMALER et al. 1999, DIMITROV and CHESHMEDZHIEV 2001, STANEV 2003). The place of collection for each taxon is indicated by the following abbreviations: E – eastern part of the wall and the surrounding area which extends up to 5 m from each side; N – northern part; W – western part; S – southern part; P – street pavements; t – top and both surfaces of the wall; s – surrounding area.

The floristic analysis is presented after MEUSEL et al. (1965) and DIMITROV (2002). Plant specimens are deposited in the Herbarium of Sofia University (SO).

The proportion of each geoelement (g), life form (lf) and biological type (bt) is calculated separately for each part of walls and pavements as well.

Results and Discussion

The total number of vascular plants growing spontaneously on and around the walls, and on the pavements is 131 from 41 families and 108 genera (Table 1). Among them 15 taxa (11.45%) were recorded only on the walls, 38 (29%) both on the walls and in their surroundings, whereas 78 taxa (59.54%) were found only in the surroundings. 50 plant taxa (38.16%) were established on the pavements in the Nebet Tepe Architectural Reserve.

The share of Liliopsida (monocotyledons) is comparatively low – 4.9% of all families, 12.03% of all genera and 11.45% of all species and infraspecific taxa.

Magnoliopsida (dicotyledons) is the prevailing group with 39 families (95.12%), 95 genera (87.96%) and 116 taxa (88.54%).

The following families are represented by the largest number of taxa: Asteraceae (14), Fabaceae (13), Poaceae (12), Brassicaceae (8), Scrophulariaceae (7), Caryophyllaceae (7),

Tab. 1. Taxonomical structure

	Magnoliophytina Monocotyledons		Dicotyledons		
Taxonomic level	Total	%	Total	%	All Total
Family	2	4.87	39	95.12	41
Genus	13	12.03	95	87.96	108
Species and intraspecific taxa	15	11.45	116	88.54	131

Tab. 2. Number of taxa in the most rich families.

	Genera		Species		
Family	Total	% total	Total	% total	Species to genus ratio
Asteraceae	13	12.03	14	10.68	1
Poaceae	10	9.25	12	9.16	1.2
Fabaceae	8	7.40	13	9.92	1.62
Brassicaceae	7	6.48	8	6.10	1.14
Caryophyllaceae	6	5.55	7	5.34	1.16
Scrophulariaceae	4	3.70	7	5.34	1.75

Rosaceae (4), etc. (Table 2). The most species-rich genera are *Sedum* (5), followed by *Veronica* (4) and *Medicago* (4).

Among the families the most taxa-rich is Asteraceae (14) with low species/genus ratio (1.0) which shows that the distribution of the species is the same as for the genera (Table 2). Conversely, this ratio in Scrophulariaceae (1.75) and Fabaceae (1.62) indicates that the species are distributed within a small number of genera.

The high proportion of Asteraceae species confirms previous data by BRANDES (1992), DUCHOSLAV (2002) and MOSYAKIN and YAVORSKA (2002). According to PYSEK (1997) this proportion is related to its high species number in Central Europe and the remarkable success of this family in terms of dispersal and establishment.

The great majority of taxa refer to the biological type of perennial herbs (43), followed by annuals (39), trees (13), annuals-biennials (15), shrubs (7), biennials (6), shrubs-trees (3), semi-shrubs (3) and annuals-perennials (2).

The larger part of the species found on the walls thrive on the upper parts. From on top of the walls come 85.5% of all the plants recorded. These are mainly heliophilous, drought-resistant annuals or annuals-biennials, with thin and shallow root systems, capable of growing on a thin soil layer. They are plants such as *Allium flavum* L., *Arenaria serpyllifolia* L., *Phleum graecum* Boiss. et Heldr., *Ornithogalum kochii* Parl..

Plants growing on the vertical surfaces of the walls (*Sambucus nigra* L., *Silene flavescens* W. et K. var. *flavescens*, *Cercis siliquastrum* L., *Morus alba* L., *Ficus carica* L., *Melica ciliata* L., *Antirrhinum majus* L., *Cymbalaria muralis* Gaertn., *Ailanthus altissima* (Mill.) Swigle, *Celtis australis* L, etc.) constitute 25.9% of the total. This group comprises mainly perennials, small shrubs and trees. These plants are observed in rock fissures or in close proximity to gardens and houses where the soil layer is thicker. They are heliophilous or shade-tolerant, warm-loving species, some of them requiring higher humidity.

The ecological differentiation and the contrasting topography of the habitats are the factors that may explain the low number of species occurring both on the wall tops and the vertical surfaces (DUCHOSLAV 2002).

According to SEGAL (1969), WOODELL (1979) and KRIGAS et al. (1999) among plants found only on walls are inhabitants of rocky or stony places, their most similar natural habitats. The same situation was observed in our study. The species *Sedum album* L., *S. acre* L., *S. hispanicum* L., *S. pallidum* Bieb., *Allium flavum* L., *Silene flavescens* W. et K., *Melica ciliata* L., *M. transsilvanica* Schur, *Arenaria serpyllifolia* L,. normally distributed on stony

and rocky places in different floristic regions of Bulgaria, were found on the investigated walls. Most of the species growing on the walls (*Ornithogalum kochii* Parl., *Muscari vandasii* Vel., *Allium flavum* L., *Clematis vitalba* L., *Ulmus minor* Mill., *Celtis australis* L., *Ficus carica* L., *Fraxinus excelsior* L., etc.) are part of the relict flora of Nebet Tepe (STOJANOV 1948, STANEV 2003).

Some of the plants that had found favourable conditions for growth on the walls and in their surroundings were brought by man in the past as cultural or ornamental species from Asia (*Ailanthus altissima* (Mill.) Swigle, *Ficus carica* L., *Morus alba* L., *M. nigra* L., etc.) and from America (*Robinia pseudoacacia* L., *Solanum dulcamara* L., *Acer negundo* L., etc).

According to PETROVA and VLADIMIROV (2001) the largest number of synanthropic plants in the Bulgarian flora is related to the following families: Asteraceae, Poaceae, Fabaceae, Brassicaceae, Chenopodiaceae, Caryophyllaceae, Polygonaceae, Scrophulariaceae, Amaranthaceae. In the first four families the synanthropic plants are almost completely represented by anthropophytes. These plants are well adapted to soils with insufficient humus and mineral substances, but rich in nitrates. Such aggressive plants reproduce quite successfully by viable seeds and vegetatively, thus being capable of invading open areas within a short time (GORCHAKOVSKII and KOZLOVA 1998). The most common apophytes and anthropophytes are *Urtica dioica* L., *Erodium cicutarium* (L.) L'Her., *Plantago major* L., *Trifolium repens* L., *Lolium perenne* L., *Hordeum murinum* L., *Taraxacum officinale* Web.

The pattern of life forms recorded on the walls is the same as that found on walls in other parts of Europe (SEGAL 1969, BRANDES 1992, KRIGAS et al. 1999, DUCHOSLAV 2002). The hemicryptophytes (39.69%) and therophytes (32.82%) constitute the largest group (Fig. 2). The percentage of geophytes is higher on the walls. Chaemaphytes were found only on the walls and not in the surroundings. The phanerophytes are well represented in the study area. Among the trees and shrubs only *Ailanthus altissima (*Mill.) Swigle, *Ficus carica* L., *Cercis siliquastrum* L. and *Sambucus nigra* L. have a widespread occurrence. The higher amount of woody plants and geophytes is characteristic of the Eastern Mediterranean (BRANDES and BRANDES 1999). In this aspect, our results show similarities with such floras. On the other hand, our data confirm previous conclusions for the predominant occurrence of hemicryptophytes in the wall floras in Central Europe (HRUSKA 1987, BRANDES

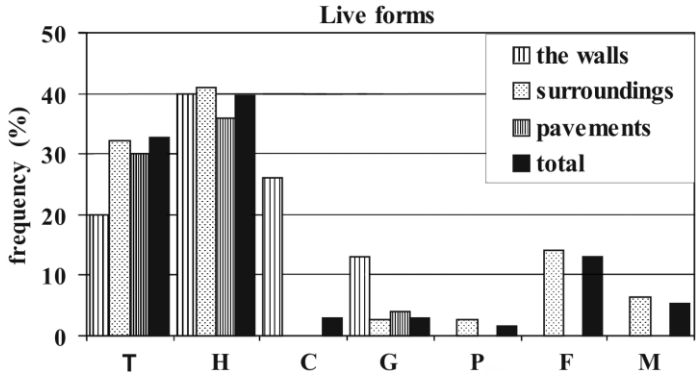

Fig. 2. Distribution of life forms

1992, DUCHOSLAV 2002) but differ from the results of KRIGAS et al. (1999) and KARSCHON and WEINSTEIN (1985). The high amount of chaemaphytes, characteristic of the whole Mediterranean is well represented in the investigated walls.

The geoelement characteristics of the plants growing on the walls reveals that the Mediterranean representatives prevail, followed by the Euro-Asiatic, Euro-Mediterranean and sub-Mediterranean. (Fig. 3). This result confirms the data provided by KARSCHON and WEINSTEIN (1985), KRIGAS et al. (1999) and BRANDES (2001). The wall flora lacks boreal, cosmopolitan and adventive species characteristic of the surroundings and the pavements. The participation of Mediterranean and sub-Mediterranean species in the surroundings of the walls is comparatively low. The distribution of the geoelements on the pavements is similar to that in the surroundings of the walls. This can be explained by the similarity in the ecological conditions in these microhabitats. Balkan species are weakly represented, found mainly in the surroundings of the walls. Only one Bulgarian endemic (*Muscari vandasii* Velen.) was established.

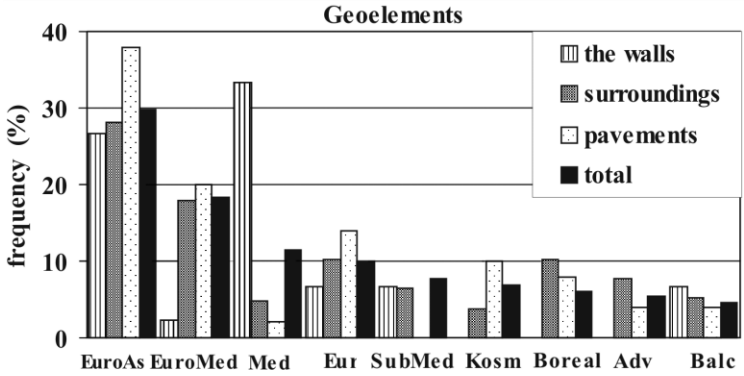

Fig. 3. Distribution of geoelements

Conclusions

1. The wall flora of the Nebet Tepe Architectural Reserve in the city of Plovdiv combines on the one hand features common to Central European floras, taking into consideration the life forms, and on the other – to Mediterranean floras, bearing in mind the geoelement characteristics.
2. The dominance of Euro-Asiatic species indicates the specificity of the wall flora. This fact can be explained by the location of the study site along the course of the Maritza River, which serves as an important route for migration of plants from Asia Minor.
3. In the course of the study we did not find pteridophytes, although the wall floras in Central Europe and in the Mediterranean tend to contain them.
4. The wall flora studied is characterized by several species not previously reported for similar floras – *Primula veris* L., *Sambucus nigra* L., *Cercis siliquastrum* L..
5. The species *Cerastium turcicum* Spreng. and *Melica transsilvanica* Schur are reported for the first time for the floristic region Thracian valley.

Floristic catalogue

ACERACEAE

Acer negundo L. – h2, Ph, W, s.
A. pseudoplatanus L. – h2, Ph, W, s.
A. tataricum L. – h1–h2, F,M; W, s.

AMARANTHACEAE

Amaramthus albus L. – ann, H; E; S, t, s.

ARALIACEAE

Hedera helix L. – h, F; W, N, t, s.

APIACEAE

Anthriscus caucalis Bieb. – ann; T; E, s.
Myrrhoides nodosa (L.) Cannon – ann, T; W, s, P.
Torilis japonica (Houtt) DC – ann-bi; T, H; E, s, P.

ASTERACEAE

Achillea panonica Scheele – per, H; S, E, s.
Artemisia vulgaris L. – per; H; S, E, s.
Aster amellus L. – per; H; W, s.
Chamomilla recutita (L.) Rauschert – ann; T; S, E, N, s, P.
Chondrilla juncea L. – bi, H; W, S; s.
Cichorium intybus L. – per; H; W, S, E, s, P.
Crepis foetida L. – ann; H,T; N,S, t, s, P.
Lactuca serriola L. – ann; H; S, E, N; t, s,P.
Senecio vulgaris L. – ann-per; H; N, S, W, s, P.
Sonchus oleraceus L. – ann; T; W, t, s, P.
Tanacetum vulgare L. – per; H, S, t, s.
Taraxacum officinale Wiggers – per; C; N, s.
Tragopogon dubius Scop. – bi; H; N; s.
Xeranthemun annuum L. – ann; H; S; s.

BORAGINACEAE

Anchusa stylosa Bieb. – ann; T, H; S, s.
Asperugo procumbens L. – ann; T; S, s; P.
Buglossoides purpurocaerulea (L.) I.M. Johnston – per; H; S, t.
Myosotis ramossisima Rochel – ann; H, T; S; t, s.

BRASSICACEAE

Alyssum murale W. et K. – per; H; N, S; t; P.
Cardaria draba (L.) Desv. – per; G; S; s; P.
Capsella bursa-pastoris L. – ann-bi; T; N, W, E, S; t, s; P.
Erophila verna (L.) Chevall. – ann;T, H; N, W, S; t; P.
Erysimum diffusum Ehrh. – bi; H; W; t, s.
Sisymbrium loeselii L. – ann-bi; H; W; t, s.
S. orientale L. – ann-bi; H; W; t, s; P.
Thlaspi arvense L. – ann; H, T; S; s; P.

CANABACEAE
Humulus lupulus L. – per; H; E; s.

CAPRIFOLIACEAE
Sambucus nigra L. – h1–h2; F, M; E; t, s.

CARYOPHYLLACEAE
Arenaria serpyllifolia L. – ann-bi; T,H; N, W, S; t; P.
Cerastium tauricum Spreng. – ann; C; N; t.
Herniaria glabra L. – ann-bi; T, H; W, S; s;P.
Silene flavescens W. et K. var. *flavescens* – per; H; N, W; t.
Stellaria media L. – ann-bi; T, H; N; s, t; P.
S. pallida (Dum.) Pire – ann-bi; T, H; N; s, t.
Polycarpon tetraphyllum (L.) L.– ann; T; S; s; P.

CHENOPODIACEAE
Chenopodium album L. – ann; T; W; s.

CONVOLVULACEAE
Convolvulus arvensis L. – per; H; W; t, s; P.

CRASSULACEAE
Sedum acre L. – per; C; N, W, S; t.
S. album L. – per; C; N, W, S; t.
S. hispanicum L. – bi; H; S; t.
S. pallidum Bieb. – bi; H; S; t.

CUCURBITACEAE
Bryonia alba L. – per; H; E; s.

DIPSACACEAE
Scabiosa triniifolia Friv. – ann; T; N, W, S; s; P.

EUPHORBIACEAE
Euphorbia cyparissias L. – per; H; W, S; s; P.

FABACEAE
Cercis siliquastrum L. – h1–h2; F; N, W; s, t.
Coronila emerus L. ssp. *emeroides* (Boiss. et Sprun.) Hayek – h1; F; E; s.
Medicago arabica (L.) Huds. – ann; T; E, s; P.
M. falcata L. – per; H; W; s, t.
M. lupulina L. – ann-bi; T, H; S; s.
M. minima (L.) Bart. – ann; T; N, W, E; s, t; P.
Melilotus alba Med. – ann; H; N, W, E; s; P.
M. officinalis (L.) DC – bi; H; N, W, E; s, t; P.
Trifolium hybridum L. – per; H; N, W, E; s; P.
T. repens L. – per; H; N, W, E; s; P.
Trigonella monspeliaca L. – ann; T; N, W, E; s.
Robinia pseudoacacia L. – h2; M; E; s.
Vicia cracca L. – per; H; N, W, E, s.

GERANIACEAE

Erodium ciconium (L.) L' Her. – ann-bi; T, H; E; s, t.
E. cicutarium (L.) L'Her – ann-bi; T, H; N, E, S; s; P.
Geranium brutium Gasparr. – ann-bi; T, H; S; s.

JUGLANDACEAE

Juglans regia L. – h2; M; E; s.

LAMIACEAE

Ballota nigra L. ssp. *nigra* – per; C, H; N, W, E, S; s.
Lamium purpureum L. – ann; T, H; N, W, E, S; s, t; P.
Marrubium vulgare L. – per; H; E; s, t.

LILIACEAE

Allium flavum L. – per; G; S; t.
Muscari vandasii Vel. – per; G; S; s.
Ornithogallum kochii Parl. – per; G; N, S; t; P.

MALVACEAE

Malva pussilla Sm. – ann-bi; H; N, s.
M. sylvestris L. – ann-per; H; S; s.

MORACEAE

Morus alba L. – h2; M, F; W, E, S; t, s.
M. nigra L. – h2; F; W, E; s.
Ficus carica L. – h2; F; W, E; t, s.

OLEACEAE

Fraxinus excelsior L. – h2; M; E; s.
Jasminum fruticans L. – h1; F; E; s.
Ligustrum vulgare L. – h1; F; E; s
Sy*ringa vulgaris* L. – h1; F; N, W, E; s.

OXALIDACEAE

Oxalis corniculata L. – ann; T, H; N, W, E; t; P.

PAPAVERACEAE

Chelidonium majus L. – per; H; N, E; s; P.
Fumaria rostellata Knaf. – ann; T, H; W, E; t, s; P.
Papaver dubium L. – ann; T, H; W, E; s.
P. rhoeas L. – ann; T, H; W, E; t, s; P.

PLANTAGINACEAE

Plantago major L. ssp. *major* – per; H; E; s; P.

POACEAE

Arrenatherum elatius (L.) Beauv. ex J. et C. Presl – per; H; E; s.
Bromus sterilis L. – ann; H; N, W, E; s, t.
B. tectorum L. – ann; H; N, W, E; s.
Cynodon dactylon (L.) Pers. – per; H; W, E; s; P.
Dactylis glomerata (L.)Trin – per; H; W, E; s; P.

Hordeum leporinum Link. – ann; T; N, W, E, S; s; P.
Lolium perenne L. – per; H; N, W, E, S; s; P.
Melica ciliata L. – per; H; W; t, s.
M. transsilvanica Schur – per; H; W; s.
Phleum graecum Boiss. et Heldr. – ann; T; W; t, s.
Poa bulbosa L. – per; H; N, S; t, s; P.
Sclerochloa dura (L.) Beauv. – ann; T; W; s; P.

POLYGONACEAE
Bilderdykia convolvulus (L.) Dum. – ann; T; W; s.
Polygonum aviculare L. – per; T; N, E; s; P.
Rumex crispus L. – per; H; E; s.

PORTULACACEAE
Portulaca oleraceae L. – ann; T; N, E; s; P.

PRIMULACEAE
Primula veris L. – per; H; N, E; t, s.

RANUNCULACEAE
Clematis vitalba L. – per; F; W, S; s.

ROSACEAE
Prunus cerasifera Ehrh. – h2; M; E; s.
P. spinosa L. – h1; F; E; s.
Rosa vosagiaca Desportes – h1; F; E; s.
Rubus sp. – h1; F; W; t, s.

RUBIACEAE
Cruciata laevipes Opiz – ann; T; N, E; s.
Galium apparine L. – ann; T; N, E; s.

SCROPHULARIACEAE
Antirrhinum majus L. – per; C; E; t.
Cymbalaria muralis Gaertn. – per; H; E; t.
Linaria vulgaris Mill. – per; H; N, E, S; s.
Veronica hederifolia L. – ann; T, H; N, W, E; s, t; P.
V. persica Poir. – ann; T, H; N, W, E; s, t; P.
V. polita Fries. – ann; T, H; N, W, E; s, t; P.
V. verna L. – ann; H; N, W, E; s, t; P.

SIMAROUBACEAE
Ailanthus altissima (Mill.) Swigle – h2; M; N, W, E; s, t.

SOLANACEAE
Lycium barbarum L. – h; S; W; s.
Solanum dulcamara L. – h; S; E; s.

ULMACEAE
Celtis australis L. – h2; M; N, E; t, s.
Ulmus laevis Pall. – h2; M; N; s.
U. minor Mill. – h2; F, M; N; s.

URTICACEAE

Parieraria officinalis L. – per; H; N, E; s.
Urtica dioica L. – ann; T; N, W, E, S; s.

VIOLACEAE

Viola odorata L. – per; H; N, E; s.

ZYGOPHYLLACEAE

Tribulus terrestris L. – ann; T; S; s; P.

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