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Eco-biological characteristics of the medicinal plants in the floodplain forests of the maintained reserve “Dolna Topchiya” (the river Tundzha hilly valley)

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ABSTRACT

In the present study we made eco-biological characteristics of the medicinal plants we found in the maintained reserve “Dolna Topchiya”; the reserve is located in the middle course of the Tundzha River near the town of Elhovo (the floristic region of Tundzha hilly valley). In the period of time 2010-2012, inventory of medicinal plants in the reserve was conducted. They were distributed in biological groups, life forms, floral elements and flowering time. Medicinal plants are also grouped according to their relation to the main environmental factors – water, light and heat. Negative factors on the flora and habitats in the reserve were indicated.

Key words: the maintained reserve “Dolna Topchiya“, floristic characteristics, ecological characteristics, medicinal plants

Introduction

The purpose of our study is to compose a complete list of medicinal flora within the maintained reserve (MR) “Dolna Topchiya”, and analyses to be made, as well as to make eco-biological characteristics of the plants found in it.

Nikolay Stoyanov, in his article “The Forest Longoz at the River Kamchiya and longozes as plant formation” (Stoyanov, 1928), mentioned for the first time the riparian forests that are located in the valley of the Tundzha river, not far from the town of Elhovo. Popov (1995) in his report under the contract: “Assessment of the state of the reserves “Dolna Topchiya”, “Gorna Topchiya” and “Balabana” provided a list of 135 plants in the three reserves without distinguishing which ones can be found in each reserve. A more detailed study on plant diversity of MR “Dolna Topchiya” was carried out when the first management plan for its development was done (Berberova, 2001). Basing on this plan, the syntaxonomic diversity in the reserve was analyzed, as well as the phytogeographic elements and biological spectrum of the flora of the reserve (Pavlov & Dimitrov, 2001).

The findings of our present study complement and correct the conclusions drawn by Berberova (2001), and Pavlov and Dimitrov (2002) and they are the first that generalize the genetic resources of higher plants in MR “Dolna Topchiya“.

Materials and Methods

The subject of this study are the medicinal plants in the maintained reserve (MR) “Dolna Topchiya“. Its area is 467.6 ha and it is located in the middle course of the river Tundzha, not far from the town of Elhovo. The reserve was declared with Order № 225/29.02.1960, by GFM with area of 763.3 ha. It was established with the purpose to restore and preserve natural habitats and places of nesting colonies of *Phasianus colchicus* L. In 1984, the boundaries of the reserve were corrected; its area was reduced to its present size, and a buffer zone of 270 ha was added. In 1998, by the Protected Areas Act, Order № RD-377/15.10.1998 of MEW, it was categorized as a “maintained reserve”.

The protected area is in the field of Elhovo of the river Tundzha hilly valley, between 41°15' and 41°18' N, and 26°24' and 27°07' E. According to the phytogeographic

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subdivision of Bulgaria, the reserve is located within the region of Sakar of Sakar-Dervenska phytogeographic region (Bondev, 1991).

In climatic terms, the territory of MR “Dolna Topchiya” falls within the European continental climatic sub-region to the east region of Central Bulgaria (Stanev *et al.*, 1991), and according to Tishkov (1982) – in the southern Bulgarian subregion of the Continental-Mediterranean climatic region, and this implies the significant Mediterranean influence on the flora in the area.

We made characteristics of the main components of the climate in the research area with the data from the meteorological station in Elhovo. The average annual temperature for the last 10 years (as shown in Table 1) is relatively high and varies between 11.5°C – 13.3°C (average 12.5°C). For comparison, the average annual temperature for most of the country is 11-12°C (Galabov, 1982). The sum of annual rainfall varies from 400.5 to 1018.6 mm (average 629.1 mm). Their seasonal distribution is relatively constant, with autumn-winter maximum (110-160 mm) and spring-summer minimum (100-140 mm). Precipitation is mostly rain. Snow cover does not last long and due to this fact soils freeze at some times in winter.

Table 1. Annual rainfall and average annual temperature in the region of MR “Dolna Topchiya” based on the data of the meteorological station Elhovo for the period 2002-2011.

Year	Rainfall mm/m ²	Average annual temperature (°C)
2002	656.9	12.5
2003	400.5	12.0
2004	824.2	12.3
2005	1018.6	12.0
2006	414.0	12.1
2007	568.1	13.3
2008	389.0	12.9
2009	728.3	12.9
2010	733.7	13.1
2011	556.8	11.5
Average	629.1	12.5

The diversity of medicinal plants in MR “Dolna Topchiya” was explored through systematic observation and collection of materials during the vegetation seasons of 2010-2012. The frequency of visits was consistent with the climatic conditions in the area and the resulting phytorhythmic. The earliest collecting started in the beginning of February 2010, and the latest is from the end of November 2012. This allows

the most complete taxonomic diversity of flora in the reserve and its seasonal dynamics to be covered. The identification of species was done using the Flora of the Republic of Bulgaria (Yordanov, 1963-1979; Velchev, 1982-1989), Flora of Bulgaria (Kozhuharov, 1995; Kozhuharov, Anchev 2012), Flora of Bulgaria (Stoyanov *et al.*, 1966-1967), Identifier of trees and shrubs in Bulgaria (Gramaticov, 1992), Identifier of Plants in Bulgaria (Delipavlov *et al.*, 2011).

The processing of herbarium materials and characteristics of flora were carried out by standard methods (Stanev, 1976; Vassilev & Andreev, 1992; Gusev *et al.*, 2004). Characteristics of medicinal plants was done according to biological types and life forms of Raunkiaer (1934). Floral elements were characterized by the classification of Stefanov (1943) and the adapted to the flora of Bulgaria classification of Walter (Asyov & Petrova, 2006). The identified taxa are divided into ecological groups in terms of the most important ecological factors – water, temperature and light. An account and analysis of the flowering period for all identified species were done. The names of the plants are by The Euro + Med PlantBase – the information resource for Euro-Mediterranean plant diversity (2011), Qualifier of Plants in Bulgaria (Delipavlov *et al.*, 2011).

Results and Discussion

As a result of the floristic studies in 2010-2012 on the territory of MR “Dolna Topchiya”, 263 species higher plants from 181 genera and 67 families were found. This represents 6.6% of the species, 20.0% of the genera and 43.8% of the families in the flora of Bulgaria. All species belong to Division Magnoliophyta. Basing on the literary analysis of the publications concerning medicinal plants of the flora of Bulgaria (Appendix № 1 of the Law on Medicinal Plants, 2000, 2006; Nikolov, 2007; Tashev & Tsavkov, 2008; Landzhev, 2010; Delipavlov *et al.*, 2011), we found that in MR “Dolna Topchiya” there are 168 species medicinal plants from 129 genera and 58 families, representing 63.7% of the species, 76.4% of the genera and 87.0% of the families in the protected territory. These plants represent 22.6% of the species listed in Appendix № 1 of the Law on Medicinal Plants (2000, 2006). Of these, 21 species belong to Class Liliopsida, distributed in 16 genera and 10 families, and 147 species belong to class Magnoliopsida, distributed in 113 genera and 48 families.

The richest families of medicinal species in the reserve are: Fabaceae with 18 species, Asteraceae – 16 species,

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Rosaceae – 15 species, Lamiaceae – 11 species, etc. The genera with most medicinal plants are: *Acer*, *Lathyrus*, *Plantago*, *Polygonatum*, *Potentilla*, *Salix* and *Vicia* - all represented by four species.

The distribution of taxa in biological types shows that the perennial herbaceous species have the most significant presence – 87 species or 51.8% of all medicinal plants, followed by the annual ones – 22 species (13.1%), trees – 19 species (11.3%) and shrubs – 16 species (9.5%) The remaining species belong to transient biological types (as shown in Table 2).

Table 2. Distribution of medicinal plants from MR “Dolna Topchiya” by biological types.

Biological type	Number of taxa	Percentage (%) of the medicinal plants in MR “Dolna Topchiya”
tree	19	11.3
tree-shrub	1	0.6
shrub-tree	6	6.3
shrub	16	9.5
perennial	87	51.8
biennial-perennial	2	1.2
biennial	5	3.0
annual-perennial	1	0.6
annual-biennial	9	5.3
annual	22	13.1
Total	168	100

According to the biological spectrum of the studied species (as shown in Table 3), most are hemicryptophytes (H) – 61 species or 36.3 % of the total number of medicinal plants in the reserve, followed by phanerophytes (Ph) – 39 species (23.2%), cryptophytes (Cr) – 26 species (15.5%), therophytes (Th) – 22 species (13.1%) and chamephytes (Ch), which are only 3 species (1.8%). The remaining species are of transitional life forms – among them the most – 12 species (7.1%) are those which can be therophytes or hemicryptophytes (Th-H), depending on the habitat conditions.

The distribution of higher plants in phytogeographic centers according to the classification of Stefanov (1943) shows that the greatest part – 29.5% are thermophytes from the Southern Continental Center, followed by thermophytes and mesotherms from the Mountainous Center – 21.1%,

mesotherms of Silvo-boreal Center – 20.5%, thermophytes from the Northern Continental Center – 19.9 % and thermophytes from Mediterranean Centre – 5.4%. Plants from Other phytogeographic centers – 3.6% (as shown in Figure1) are least.

Table 3. Biological spectrum of medicinal plants from MR “Dolna Topchiya”.

Biological form by Raunkiaer (1934)	Number of taxa	Percentage (%) of MP in MR “Dolna Topchiya”
Phanerophytes (Ph)	39	23.2
Chamephytes (Ch)	3	1.8
Hemicryptophytes (H)	61	36.3
Cryptophytes (Cr)	26	15.5
Therophytes (Th)	22	13.1
Therophytes to hemicryptophytes (Th-H)	12	7.1
Hemicryptophytes to therophytes (H-Th)	5	3.0
Total	168	100

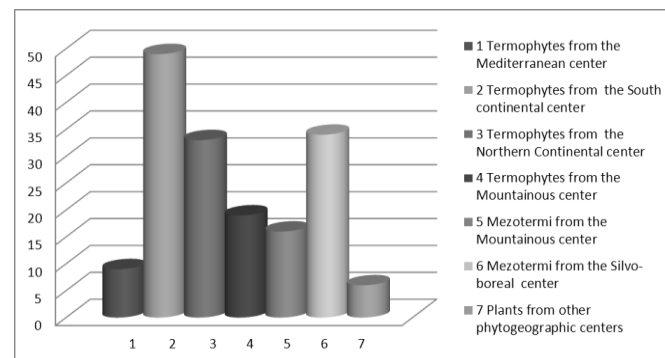


Figure 1. Distribution of medicinal plants in phytogeographic centers (Stefanov, 1943).

According to their mobility the analyzed plants are distributed as follows: the fixed species are 58 (34.5%), the moving ones with secondary broadened areas are 41 species (24.4%) and the species that have appeared by secondary displacement are 69 (41.1%) (Stefanov, 1943). These data are evidence of significant anthropogenic interference within the territory of the reserve in the past.

Analyses of medicinal plants by floral elements, according to the classification of Walter, shows that geoelements with European component – 82 species or 48.8%

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are the greatest part, as among them most are Euro-Asian (*Eur-As*) – 34 species (20.3%), Euro Mediterranean (*Eur-Med*) – 20 species (11.9%), Euro Siberian (*Eur-Sib*) – 12 species (7.1%) and the European (*Eur*) – 11 species (6.5%). Second is the group of species with Mediterranean component – 59 species or 35.1%, among them most are Euro Mediterranean (*Eur-Med*) and sub-Mediterranean (*subMed*) – 20 species each (11.9%), Pontic-Mediterranean (*Pont-Med*) are 6 species (3.6%), and pure Mediterranean (*Med*) are 5 species (3%). Cosmopolitan (*Kos*) and boreal (*Boreal*) species are nearly equal in number – 15 and 13 species, respectively, etc. (as shown in Table 4).

Table 4. Distribution of medicinal plants from MR “Dolna Topchiya” by floral elements according to the adapted classification of Walter (Asyov & Petrova, 2006).

Floral elements by Walter (2012)	Number of taxa	Percentage (%) of MP in MR “Dolna Topchiya”
<i>Adv</i>	8	4.8
<i>Bal-Anat</i>	1	0.6
<i>Boreal</i>	13	7.7
<i>Eur</i>	11	6.5
<i>Eur-As</i>	34	20.3
<i>Eur-Med</i>	20	11.9
<i>Eur-Med-As</i>	2	1.2
<i>Eur-OT</i>	1	0.6
<i>Eur-Sib</i>	12	7.1
<i>Eur-subMed</i>	2	1.2
<i>Kos</i>	15	8.9
<i>Med</i>	5	3.0
<i>Med-As</i>	3	1.8
<i>Pont</i>	3	1.8
<i>Pont-Med</i>	6	3.6
<i>Pont-subMed</i>	1	0.6
<i>subBoreal</i>	11	6.5
<i>subMed</i>	20	11.9
Total	168	100

The distribution of the studied plants according to their period of flowering shows that the most active period is from May to September. During this period 136 taxa flower, 80.9% of all the plants. Among them, most species flower in June – August – 22 species, May – June and May – August – 17 species, June – September – 16 species, May – July – 14 species, etc. (as shown in Table 5).

Table 5. Distribution of medicinal plants from MR “Dolna Topchiya” according to their period of flowering.

Flowering period, months	Number of flowering species	Percentage (%) of MP in MR “Dolna Topchiya”
I-XII	1	0.6
II-III	2	1.2
II-IV	2	1.2
III-IV	8	4.8
III-V	3	1.8
III-VIII	2	1.2
IV-V	14	8.3
IV-VI	9	5.3
IV-VII	2	1.2
IV-VIII	2	1.2
IV-IX	5	3.0
V	2	1.2
V-VI	17	10.1
V-VII	14	8.3
V-VIII	17	10.1
V-IX	9	5.3
V-X	4	2.4
VI	1	0.6
VI-VII	6	3.6
VI-VIII	22	13.1
VI-IX	16	9.5
VI-X	3	1.8
VII-VIII	2	1.2
VII-IX	1	0.6
VII-X	1	0.6
VIII-X	1	0.6
IX-X	1	0.6
IX-XI	1	0.6
Total	168	100

The fact that a big part of the territory of MR “Dolna Topchiya” is covered with floodplain or longose forests (Berberova, 2001) determines the presence of water plants. Thus, in the flora of the reserve mezophytes dominate, represented by 112 species (66.6%), followed by hygrophytes and hygromezophytes – 20 species each (11.9%) and mezohygrophytes – 8 species (4.8%). 7 species (4.2%) can be related to xeromezophytes (as shown in Table 6).

The analysis of medicinal plants distribution in terms of the light factor shows prevalence of heliophytes that are more than half of the species – 115 (68.4%), followed by the groups of hemi-scyophytes – 34 species and schyophytes represented with 19 species (as shown in Table 7).

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Table 6. Distribution of medicinal plants from MR “Dolna Topchiya” according to their relation to water.

Ecological groups	Number of taxa	Percentage (%) of MP in MR “Dolna Topchiya”
Hydrophytes	1	0.6
Hygrophytes	20	11.9
Hygromezophytes	20	11.9
Mezohygrophytes	8	4.8
Mezophytes	112	66.6
Xeromezophytes	7	4.2
Total	168	100

Table 7. Distribution of medicinal plants from MR “Dolna Topchiya” according to their relation to light.

Ecological groups	Number of taxa	Percentage (%) of MP in MR “Dolna Topchiya”
Heliophytes	115	68.4
Hemi-scyophytes	34	20.3
Scyophytes	19	11.3
Total	168	100

According to their relation to heat the species are divided into only 2 groups. Thermophytes go to the bigger group with 118 species (70.3%), and the remaining 50 species (29.7%) refer to the group of mesotherms (as shown in Table 8). The dominance of thermophilic species is directly related to the influence of the Mediterranean climate, penetrating along the river Tundzha (Galabov, 1982).

Table 8. Distribution of medicinal plants from MR “Dolna Topchiya” according to their relation to the thermal regime.

Ecological groups	Number of taxa	Percentage (%) of MP in MR “Dolna Topchiya”
Microtherms	-	-
Mesotherms	50	29.7
Thermophytes	118	70.3
Total	168	100

Only one species that is used in medicine can be brought to conservation significant plant species in the reserve: *Leucojum aestivum* L., which is in the category “vulnerable” (*Vulnerable*) in “Bulgarian Red Lists of vascular plants” (Evstatieva, 2009) and it is included in Appendix 4 of the Law of Biological Diversity (2002), and in Annex 4 of the Bulgarian Biodiversity Act (2002).

Conclusion

The floristic study in MR “Dolna Topchiya”, conducted in the period 2010-2012, showed that there are 168 species medicinal plants from 129 genera and 58 families. Among these plants most are the perennial herbaceous plants, hemicryptophytes, the species of European and Mediterranean origin. They are most often thermophytes, mesophytes and heliophytes, whose most intensive flowering time is from May to September. The relatively great involvement of the secondary and cosmopolitan plants within the studied territory points to the fact that there is a significant anthropogenic interference in the processes occurring in the vegetation cover of the reserve. There are processes of xerophytization which can be due to the observed dramatic climate drying, especially in 2003, 2006 and 2008 (as shown in Table 1), as a result of the reduced precipitation and lower water level of the river Tundzha in the last decade, and also as a result of the increase in mean annual temperature for the same period. However, a significant gene-fund of valuable plants is protected in the MR “Dolna Topchiya” to be used in folk and official medicine.

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Appendix

Systematic list of medicinal plants in MR "Dolna Topchiya"

Liliopsida

Alliaceae: *Allium scorodoprasum* L.; Amaryllidaceae: *Leucojum aestivum* L.; Asparagaceae: *Asparagus officinalis* L., *A. tenuifolius* Lam.; Dioscoreaceae: *Tamus communis* L.; Iridaceae: *Crocus chrysantus* (Herb.) Herb., *C. pallasii* Goldb., *Iris graminea* L., *I. pseudacorus* L.; Lemnaceae:

Lemna minor L.; Liliaceae: *Colchicum autumnale* L., *Convallaria majalis* L., *Scilla bifolia* L., *Polygonatum latifolium* Desf., *P. multiflorum* (L.) All., *P. odoratum* (Mill.) Druce; Poaceae: *Anthoxanthum odoratum* L., *Cynodon dactylon* (L.) Pers., *Elymus repens* (L.) Gould; Smilacaceae: *Smilax excelsa* L.; Typhaceae: *Typha latifolia* L.

Magnoliopsida

Aceraceae: *Acer campestre* L., *A. negundo* L., *A. tataricum* L.; Apiaceae: *Chaerophyllum temulentum* L., *Conium maculatum* L., *Daucus carota* L., *Heracleum sibiricum* L.; Araliaceae: *Hedera helix* L.; Aristolochiaceae: *Aristolochia clematitis* L.; Asclepiadaceae: *Periploca graeca* L., *Vincetoxicum hirundinaria* Medik.; Asteraceae: *Achillea millefolium* L., *Anthemis cotula* L., *Arctium lappa* L., *Bellis sylvestris* Cirillo, *Carduus acanthoides* L., *Carlina vulgaris* L., *Chamomilla recutita* (L.) Rauschert, *Cichorium intybus* L., *Cirsium arvense* (L.) Scop., *Lactuca serriola* L., *Matricaria trichophylla* (Boiss.) Boiss., *Senecio vulgaris* L., *Silybum marianum* (L.) Gaertn., *Taraxacum officinale* F. H. Wigg., *Tragopogon pratensis* L., *Xeranthemum annuum* L.; Berberidaceae: *Mahonia aquifolium* (Pursh) Nutt.; Boraginaceae: *Buglossoides purpureo-caerulea* (L.) I. M. Johnston., *Lithospermum officinale* L., *Symphytum officinale* L.; Brassicaceae: *Alliaria petiolata* (M. Bieb.) Cavara & Grande, *Capsella bursa-pastoris* (L.) Medik., *Thlaspi arvense* L.; Caesalpiniaceae: *Gleditsia triacanthos* L.; Cannabaceae: *Cannabis sativa* L., *Humulus lupulus* L.; Caprifoliaceae: *Sambucus ebulus* L., *S. nigra* L.; Caryophyllaceae: *Saponaria officinalis* L., *Stellaria media* (L.) Cirillo; Celastraceae: *Euonymus europaeus* L.; Chenopodiaceae: *Chenopodium album* L.; Convolvulaceae: *Convolvulus arvensis* L.; Cornaceae: *Cornus mas* L., *C. sanguinea* L.; Corylaceae: *Carpinus betulus* L., *Corylus avellana* L.; Euphorbiaceae: *Euphorbia cyparissias* L., *E. palustris* L., *E. serrulata* Thuill., Fabaceae: *Amorpha fruticosa* L., *Astragalus glycyphyllos* L., *Coronilla varia* L., *Galega officinalis* L., *Lathyrus pratensis* L., *L. sativus* L., *L. sylvestris* L., *Lotus corniculatus* L., *Melilotus albus* Medik., *M. officinalis* (L.) Lam., *Ononis spinosa* L., *Robinia pseudoacacia* L., *Trifolium pratense* L., *T. repens* L., *Vicia cracca* L., *V. grandiflora* Scop., *V. sativa* L.; Fagaceae: *Quercus robur* L. subsp. *pedunculiflora* (K. Koch) Menitsky, *Q. robur* L. subsp. *robur* L.; Fumariaceae: *Corydalis solida* (L.) Clairv.; Geraniaceae: *Erodium cicutarium* (L.) L'Hér., *Geranium pyrenaicum* Burm. f.; Hypericaceae: *Hypericum hirsutum* L., *H. perforatum* L.; Lamiaceae: *Ajuga reptans* L., *Ballota nigra*

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L., *Glechoma hederacea* L., *Lamium maculatum* (L.) L., *L. purpureum* L., *Melissa officinalis* L., *Mentha aquatica* L., *M. pulegium* L., *Prunella vulgaris* L., *Scutellaria altissima* L., *Stachys officinalis* (L.) Trevis.; Lythraceae: *Lythrum salicaria* L.; Malvaceae: *Alcea pallida* (Willd.) Waldst. & Kit., *Althaea officinalis* L., *Malva sylvestris* L.; Moraceae: *Morus alba* L.; Oleaceae: *Fraxinus angustifolia* subsp. *oxycarpa* (Willd.) Franco & Rocha Afonso, *F. ornus* L., *Ligustrum vulgare* L.; Papaveraceae: *Chelidonium majus* L., *P. rhoeas* L.; Plantaginaceae: *Plantago lanceolata* L., *P. major* L., *P. media* L.; Polygonaceae: *Persicaria hydropiper* (L.) Opiz, *P. maculata* (Rafin.) S.F.Gray, *Polygonum aviculare* L., *Rumex acetosa* L., *R. crispus* L.; Primulaceae: *Lysimachia nummularia* L.; Ranunculaceae: *Anemone ranunculoides* L., *Clematis recta* L., *C. vitalba* L., *Ficaria verna* Huds.; Rhamnaceae: *Frangula alnus* Mill.; Rosaceae: *Agrimonia eupatoria* L., *Crataegus monogyna* Jacq., *Fragaria vesca* L., *Geum urbanum* L., *Malus sylvestris* (L.) Mill., *Potentilla argentea* L., *P. erecta* (L.) Räsch., *P. reptans* L., *Prunus cerasifera* Ehrh., *P. spinosa* L., *Pyrus communis* subsp. *pyraster* (L.) Ehrh., *Sorbus domestica* L., *Rosa canina* L., *Rubus caesius* L., *R. discolor* Weihe & Nees; Rubiaceae: *Cruciata laevipes* Opiz, *Galium aparine* L., *G. verum* L.; Salicaceae: *Populus alba* L., *P. nigra* L., *Salix alba* L., *S. fragilis* L., *S. purpurea* L.; Scrophulariaceae: *Veronica anagalis-aquatica* L., *V. officinalis* L.; Simaroubaceae: *Ailanthus altissima* (Mill.) Swingle; Solanaceae: *Solanum dulcamara* L., *S. nigrum* L.; Tamaricaceae: *Tamarix tetrandra* Pallas ex Bieb.; Tiliaceae: *Tilia cordata* Mill.; Ulmaceae: *U. minor* Mill.; Urticaceae: *Urtica dioica* L. *U. urens* L.; Verbenaceae: *Verbena officinalis* L.; Violaceae: *Viola odorata* L.; Vitaceae: *Vitis sylvestris* C. C. Gmelin; Zygophyllaceae: *Tribulus terrestris* L.