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Eco-biological characteristics of the flora in the floodplain forests of the reserve “Gorna Topchiya” (the river Tundzha hilly valley)

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ABSTRACT

The present study examines the flora in the reserve “Gorna 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). The received data is based on three-year research in the floodplain forests in the reserve and analyses of the literary sources. Eco-biological characteristic of the higher plants is made, and the species are distributed by biological groups, by life forms, by floral elements, and by time of flowering. The plants are classified by ecological groups according their regard towards the water, the light and the heat as a factor. Conclusions for the presence by percentage of medicinal flora in the protected area are made, as well as their anthropogenic influence and the perspectives regarding security and business use.

Key words: reserve “Gorna Topchiya”, floristic characteristic, ecological characteristic, conservation species

Introduction

The purpose of this study is to make a list and to do floristic analysis and eco-biological characteristics of the plants that were found within the reserve (R) “Gorna Topchiya”. (Tundzha hilly valley), as a result of our fieldwork and literature data analysis.

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 river Tundzha, not far from the town of Elhovo. Popov in his report under the contract: Assessment of conditions of the reserves” Dolna Topchiya”, “Gorna Topchiya” and “Balabana” (1995) provided a list of 135 plants in the three reserves without distinguishing which ones can be found in each reserve.

Materials and Methods

The subject of this study is to characterize the flora in the reserve (R) “Gorna Topchiya”, which was declared as a

protected territory by Council of Ministers Decree No.1171 of 24.09.1951 for the purpose of protecting the longoz forests. The size of the protected area was corrected twice after that. The first extension was done with Order № 754 of 19.07.1984, published in the State Gazette, 69/1984. The area increased to 160.2 ha. The second extension increased the area of the reserve to 164.3 ha, with Order № RD-942 of 28.12.2007, published in the State Gazette, 32/2008. The protected area is in the field of Elhovo in the hilly valley of the river Tundzha between 42°14' and 42°15' N and 26°33' and 26°35' E.

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

The territory of R “Gorna 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 a significant Mediterranean influence on the flora in the area.

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We characterized the main climatic components in the research area with the data from the meteorological station in Elhovo. The average annual temperature for the last 10 years (Table 1) is relatively high and it 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 is perishable and therefore soil sometimes freezes in winter.

Table 1. Annual rainfall and average annual temperature in the region of R “Gorna Topchiya”, basing 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 higher plants in R “Gorna 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 collecting – from the end of September 2011. This allows the most complete taxonomic diversity of flora in the reserve and its seasonal dynamics to be covered. The species identification was done using the Flora of Bulgaria (Yordanov, 1963-1979; Velchev, 1982-1989), Flora of Bulgaria (Kozuharov, 1995), Flora of Bulgaria (Stoyanov *et al.*, 1966-1967), Identifier to trees and shrubs in Bulgaria (Gramatikov, 1992), Identification Guide to the 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).

Characteristic 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), Identification Guide to Plants in Bulgaria (Delipavlov *et al.*, 2011).

Results and Discussion

As a result of the floristic studies in 2010-2012 on the territory of R “Gorna Topchiya”, 187 species of higher plants from 101 genera and 56 families were found. All species belong to Division Magnoliophyta. Forty five species of these belong to Class Liliopsida, distributed in 30 genera and 15 families, and 142 species are related to Class Magnoliopsida, distributed in 71 genera and 41 families.

List of the higher plants in the reserve “Gorna Topchiya”

Liliopsida

Alliaceae: *Allium scorodoprasum* L.; Amaryllidaceae: *Galanthus elwesii* Hooker f., *Leucojum aestivum* L.; Araceae: *Arum elongatum* Steven; Asparagaceae: *Asparagus tenuifolius* Lam.; Cyperaceae: *Carex acutiformis* Ehrh., *C. divulsa* Stokes, *Pycnus flavescens* (L.) Rchb.; Dioscoreaceae: *Tamus communis* L.; Iridaceae: *Crocus chrysanthus* (Herb.) Herb., *C. flavus* Weston, *C. pallasii* Goldb., *Iris graminea* L., *I. pseudacorus* L.; Liliaceae: *Colchicum autumnale* L., *Convallaria majalis* L., *Fritillaria pontica* Wahlenb., *Ornithogalum sibthorpii* Greuter, *O. umbellatum* L., *Scilla bifolia* L., *Polygonatum multiflorum* (L.) All., *P. odoratum* (Mill.) Druce; Poaceae: *Alopecurus geniculatus* L., *Anthoxanthum odoratum* L., *Arrhenatherum elatius* (L.) J. Presl & C. Presl, *Brachypodium sylvaticum* (Huds.) P. Beauv., *Bromus mollis* L., *B. sterilis* L., *Cynodon dactylon* (L.) Pers., *Cynosurus cristatus* L., *Dactylis glomerata* L., *Elymus repens* (L.) Gould, *Festuca pratensis* Huds., *Hordeum murinum* L., *Lolium perenne* L., *Melica ciliata* L., *Poa annua* L., *P. trivialis* L.; Smilacaceae: *Smilax excelsa* L.

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Magnoliopsida

Aceraceae: *Acer campestre* L., *A. negundo* L., *A. tataricum* L.; Apiaceae: *Chaerophyllum temulentum* L., *Conium maculatum* L., *Daucus carota* L., *Heracleum sibiricum* L., *Myrrhoides nodosa* (L.) Cannon, *Torilis japonica* (Houtt.) DC.; Araliaceae: *Hedera helix* L.; Aristolochiaceae: *Aristolochia clematitis* L.; Asclepiadaceae: *Periploca graeca* L., *Vincetoxicum hirundinaria* Medic.; Asteraceae: *Achillea millefolium* L., *Anthemis arvensis* L., *A. cotula* L., *Arctium lappa* L., *Artemisia vulgaris* L., *Bellis sylvestris* Cirillo, *Carduus acanthoides* L., *Carlina vulgaris* L., *Centaurea solstitialis* L., *Chamomilla recutita* (L.) Rauschert, *Cichorium intybus* L., *Cirsium arvense* (L.) Scop., *C. creticum* (Lam.) d'Urv., *C. vulgare* (Savi) Ten., *Crepis setosa* Haller f., *Lactuca serriola* L., *Lapsana communis* L., *Matricaria trichophylla* (Boiss.) Boiss., *Taraxacum officinale* F. H. Wigg., *Tragopogon pratensis* L.; Boraginaceae: *Buglossoides purpureoerulea* (L.) I. M. Johnst., *Lithospermum officinale* L., *Myosotis ramosissima* Rochel; Brassicaceae: *Alliaria petiolata* (M. Bieb.) Cavara & Grande, *Arabis sagittata* (Bertol.) DC., *Capsella bursa-pastoris* (L.) Medik., *Cardaria draba* (L.) Desv., *Erophila verna* (L.) Chevall., *Rorippa prolifera* (Heuff.) Neilr., *Thlaspi arvense* L.; Caesalpiniaceae: *Gleditsia triacanthos* L.; Campanulaceae: *Campanula sparsa* Friv.; Cannabaceae: *Humulus lupulus* L.; Caprifoliaceae: *Sambucus ebulus* L., *S. nigra* L.; Caryophyllaceae: *Myosoton aquaticum* (L.) Moench, *Silene latifolia* Poir., *Stellaria media* (L.) Cirillo; Celastraceae: *Euonymus europeus* 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. stricta* L., *Mercurialis ovata* Sternb. & Hoppe; Fabaceae: *Amorpha fruticosa* L., *Astragalus glycyphyllos* L., *Galega officinalis* L., *Lathyrus hirsutus* L., *L. pratensis* L., *L. sylvestris* L., *Robinia pseudoacacia* L., *Trifolium pratense* L., *T. purpureum* Loisel., *Vicia cracca* L., *V. grandiflora* Scop., *V. tenuifolia* Roth, *V. tetrasperma* (L.) Schreb., *V. villosa* subsp. *varia* (Host) Corb., *V. villosa* Roth subsp. *villosa*; Fagaceae: *Quercus robur* L. subsp. *pedunculiflora* (K. Koch) Menitsky, *Q. robur* L. subsp. *robur* L.; Fumariaceae: *Corydalis solida* (L.) Clairv.; Geraniaceae: *Geranium pyrenaicum* Burm. f.; Hypericaceae: *Hypericum hirsutum* L., *H. perforatum* L.; Juglandaceae: *Juglans regia* L.; Lamiaceae: *Ajuga reptans* L., *Ballota nigra* L., *Glechoma hederacea* L., *Lamium maculatum* (L.) L., *L. purpureum* L.,

Melissa officinalis L., *Mentha aquatica* L., *M. pulegium* L., *Prunella vulgaris* L., *Salvia virgata* Jacq., *Scutellaria altissima* L., *Stachys germanica* L.; Lythraceae: *Lythrum salicaria* L.; Malvaceae: *Althaea officinalis* L., *Malva sylvestris* L.; Oleaceae: *Fraxinus angustifolia* subsp. *oxycarpa* (Willd.) Franco & Rocha Afonso, *F. ornus* L., *Ligustrum vulgare* L.; Papaveraceae: *Chelidonium majus* L., *Papaver rhoeas* L.; Plantaginaceae: *Plantago lanceolata* L., *P. major* L., *P. media* L.; Polygonaceae: *Persicaria hydropiper* (L.) Opiz, *Rumex conglomeratus* Murray, *R. crispus* L.; Primulaceae: *Lysimachia nummularia* L.; Ranunculaceae: *Anemone ranunculoides* L., *Clematis vitalba* L., *C. viticella* L., *Consolida regalis* S. F. Gray, *Ficaria verna* Huds., *Ranunculus acris* L., *R. constantinopolitanus* (DC.) D'Urv., *R. repens* L.; Rhamnaceae: *Paliurus spinachrist* Mill.; Rosaceae: *Agrimonia eupatoria* L., *Crataegus monogyna* Jacq., *Geum urbanum* L., *Malus sylvestris* (L.) Mill., *Potentilla argentea* L., *Prunus cerasifera* Ehrh., *P. spinosa* L., *Pyrus communis* subsp. *pyraster* (L.) Ehrh., *Rosa canina* L., *Rubus caesius* L.; Rubiaceae: *Cruciata laevipes* Opiz, *Galium aparine* L.; Salicaceae: *Populus alba* L., *P. nigra* L., *Salix alba* L., *S. fragilis* L.; Scrophulariaceae: *Verbascum blattaria* L., *Veronica anagalis-aquatica* L., *V. hederifolia* L., *V. triloba* (Opiz) Wiesb.; Solanaceae: *Solanum dulcamara* L., *S. nigrum* L.; Ulmaceae: *Ulmus laevis* Pall., *U. minor* Mill.; Urticaceae: *Urtica dioica* L.; Verbenaceae: *Verbena officinalis* L.; Violaceae: *Viola jordanii* Hanry, *V. odorata* L.; Zygophyllaceae: *Tribulus terrestris* L.

The most species-rich families in the reserve are: Asteraceae – 20 species and subspecies, Poaceae – 16 species and subspecies, Fabaceae – 15 species and subspecies, Lamiaceae – 12 species and subspecies, Rosaceae – 10 species and subspecies, Ranunculaceae and Liliaceae – 8 species and subspecies each, Brassicaceae – 7 species and subspecies, etc. The genera with the highest number of species are: *Vicia* – 9 species, *Lathyrus* and *Veronica* – 5 species, *Acer*, *Carex* and *Trifolium* – 4 species.

The distribution of taxa according to their biological types shows that the perennial herbaceous species have the most significant presence – 99 or 54.94% of all the plants, followed by the annual ones – 31 species (16.57%), trees – 17 species (9.09%), shrubs – 13 species (6.95%), annual- and biennial ones – 12 species (6.41%). The remaining species belong to the transient biological types (Table 2).

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Table 2. Distribution of higher plants from R “Gorna Topchiya” according to their biological types.

Biological type	Number of taxa	% of the plants in R “Gorna Topchiya”
tree	17	9.09
tree-shrub	2	1.06
shrub-tree	4	2.13
shrub	13	6.95
perennial	99	52.94
biennial-perennial	2	1.06
biennial	6	3.20
annual-perennial	1	0.53
annual-perennial	12	6.41
annual	31	16.57
Total	187	100

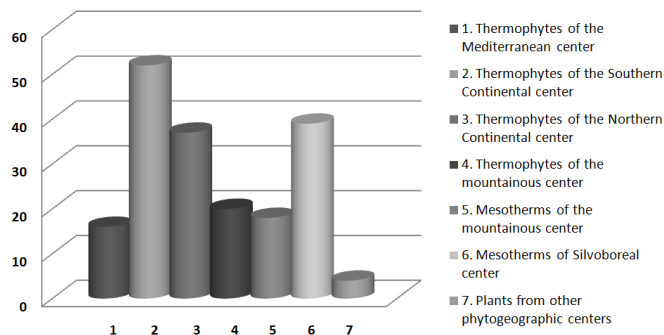
According to the biological spectrum of the studied species (Table 3), most are hemicryptophytes (H) – 68 species or 36.36% of the total number of taxa in the reserve, followed by phanerophytes (Ph)– 34 species (18.18%), cryptophytes (Cr) and therophytes (Th) – 31 species each (16.57%), therophytes to hemicryptophytes (Th-H) – 13 species (6.95%), hemicryptophytes to therophytes (H-Th) – 8 species (4.27%) and chamephytes (Ch) which are only 2 species (1.06%).

Table 3. Biological spectrum of higher plants from R “Gorna Topchiya”.

Biological form by Raunkiaer (1934)	Number of taxa	% of the plants in R “Gorna Topchiya”
Phanerophytes (Ph)	34	18.18
Chamephytes (Ch)	2	1.06
Hemicryptophytes (H)	68	36.36
Cryptophytes (Cr)	31	16.57
Therophytes (Th)	31	16.57
Therophytes to hemicryptophytes (Th-H)	13	6.95
Hemicryptophytes to therophytes (H-Th)	8	4.27
Total	187	100

According to their mobility the analyzed plants are distributed as follows: the fixed species are 65 (34.8%), the moving ones with secondary broadened areas are 44 species (23.5%) and the species that have appeared by secondary displacement – 78 plants (41.7%) (Stefanov, 1943).

The distribution of higher plants in phytogeographic centers according to the classification of Stefanov (1943) shows that the greatest part – 27.56% are thermophytes from the Southern Continental Center, followed by thermophytes from the Northern Continental Center – 19.61%, mesotherms of Silvo-boreal Center – 20.67%, thermophytes and mesotherms from the Mountainous Center are 10.60 % and 9.54% respectively, thermophytes from Mediterranean Centre – 8.48%, which means that despite the good conditions for a presumable invasion of Mediterranean species, the mountain ranges of Sakar Mountains and Dervenski heights are sufficiently strong barriers to the higher temperatures typical for the Mediterranean region. The plants from other phytogeographic centers – 2.12% (Figure 1) are least.

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

Analyzing higher plants by floral elements, distributed according to the classification of Walter, shows that geoelements with European component – 105 species, or 55.65%, as among them most are Euro-Asian (*Eur-As*) – 42 species (22.36%), Euro Mediterranean (*Eur-Med*) – 31 species (16.43 %), Euro Siberian (*Eur-Sib*) and European (*Eur*) with 12 species each (6.36 %). Second is the group of species with Mediterranean component – 70 species, or 39.13 %, among them most are Euro Mediterranean (*Eur-Med*) – with 31 species (16.43%), sub-Mediterranean (*subMed*) – with 18 species (9.54%), Mediterranean (*Med*) are 6 species (3.18%), Pontic-Mediterranean (*Pont-Med*) are 7 species (3.71%). Cosmopolitan (*Kos*) – 13 species, and boreal (*Boreal*) are 20 species, respectively, etc. (Table 4).

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 72 taxa flowered, or 73.7 % of all the plants. Among them, most species flowered

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in May-August – 22 species, May-July – 20 species, May-June – 16 species, June-September – 9 species (Table 5).

Table 4. Distribution of higher plants from R “GornaTopchiya” by floral elements according to the adapted classification of Walter (Asyov & Petrova, 2006).

Floral elements by Walter (2012)	Number of taxa	% of the plants in R “Gorna Topchiya”
<i>Adv</i>	4	2.12
<i>Bal</i>	1	0.53
<i>Bal-Anat</i>	2	1.06
<i>Bal-Dac</i>	1	0.53
<i>Boreal</i>	14	7.42
<i>Eur</i>	12	6.36
<i>Eur-As</i>	42	22.26
<i>Eur-Med</i>	31	16.43
<i>Eur-Med-As</i>	2	1.06
<i>Eur-Pont</i>	1	0.53
<i>Eur-OT</i>	1	0.53
<i>Eur-Sib</i>	12	6.36
<i>Eur-subMed</i>	4	2.12
<i>Kos</i>	13	6.95
<i>Med</i>	6	3.18
<i>Med-As</i>	4	2.12
<i>Pont</i>	3	1.59
<i>Pont-Med</i>	7	3.71
<i>Pont-OT</i>	1	0.53
<i>Pont-subMed</i>	2	1.06
<i>subBoreal</i>	6	3.18
<i>subMed</i>	18	9.54
Total	187	100

Among the flora of the reserve mezophytes dominate, represented by 128 species (67.84%), followed by hygrophytes – 21 species (11.13 %), hygromezophytes – 19 species (10.07 %) and mezohygrophytes – 10 species (5.30 %). 9 species can be related to xeromezophytes (4.77 %) (Table 6).

According to their relation to heat the species are divided into only 2 groups. Thermophytes go to the bigger group with 130 species (68.90 %), and the remaining – 57 species (31.10 %) refer to the group of mesotherms (Table 7). The dominance of thermophilic species is directly related to the influence of the Mediterranean climate, penetrating along the river Tundzha (Galabov *et al.*, 1982).

Table 5. Distribution of plants from R “Gorna Topchiya” according to their period of flowering.

Flowering period, months	Number of flowering species	% of the plants in R “Gorna Topchiya”
I-XII	1	0.53
I-IV	1	0.53
II-III	2	1.06
II-IV	3	1.59
II-V	2	1.06
III-IV	8	4.27
III-V	5	2.65
III-VIII	1	0.53
IV-V	17	9.01
IV-VI	13	6.89
IV-VII	3	1.59
IV-VIII	2	1.06
IV-IX	3	1.59
IV-X	1	0.53
V	2	1.06
V-VI	16	8.48
V-VII	20	10.60
V-VIII	22	11.66
V-IX	9	4.77
V-X	3	1.59
VI-VII	5	2.65
VI-VIII	20	10.60
VI-IX	16	8.48
VI-X	2	1.06
VII-VIII	1	0.53
VII-IX	5	2.65
VII-X	1	0.53
VIII-X	1	0.53
IX-X	1	0.53
IX-XI	1	0.53
Total	187	100

Table 6. Distribution of higher plants from R “Gorna Topchiya” according to their relation to water.

Ecological groups	Number of taxa	% of the plants in R “Gorna Topchiya”
Hydrophytes	0	0.00
Hygrophytes	21	11.13
Hygromezophytes	19	10.07
Mezohygrophytes	10	5.30
Mezophytes	128	67.84
Xeromezophytes	9	4.77
Xerophytes	0	0.00
Total	187	100

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Table 7. Distribution of higher plants from R “Gorna Topchiya” according to their relation to the thermal regime.

Ecological groups	Number of taxa	% of the plants in R “Gorna Topchiya”
Microtherms	0	0.00
Mesotherms	57	31.1
Thermophytes	130	68.9
Total	187	100

The analysis of higher plants distribution in terms of the light factor shows prevalence of heliophytes that are more than half of the species – 110 (58.8%), followed by the groups of hemi-scyophytes with 45 species and scyophytes represented with 32 species (Table 8).

Table 8. Distribution of higher plants from R “Gorna Topchiya” according to their relation to light.

Ecological groups	Number of taxa	% of the plants in R “Gorna Topchiya”
Heliophytes	110	58.8
Hemi-scyophytes	45	24.1
Scyophytes	32	17.1
Total	187	100

Conservational species

Three species 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 enlisted in Annex 4 of the Bulgarian Biodiversity Act (2002).

Fritillaria pontica Wahlenb. included in Annex 3 of the Bulgarian Biodiversity Act.

Galanthus elwesii Hooker f. included with the endangered category (*Endangered*) in “Red Book of Bulgaria, Volume 1 Plants and fungi” (Peev, 2012), in Appendix 2 of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and Annex 3 of the Bulgarian Biodiversity Act.

On the basis of literature analysis of publications about medicinal plants from 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), it was found that in R “Gorna Topchiya” there are 132 species of medicinal plants from 115 genera and 51 families, which represents 70.5% of the species, 81.5% of the genera and 94.4% of the families in the protected area. These plants represent 17.7% of the species included in Appendix 1 of the Law on Medicinal Plants (2000, 2006).

Conclusion

The study on the higher flora in R “Gorna Topchiya”, conducted in the period 2010–2012, showed that there are 187 species of vascular plants from 101 genera and 56 families. Among these plants most are the perennial herbaceous plants, hemicryptophytes, the species of European and Mediterranean origin, thermophytes, mezophytes 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 result in changes in the floristic composition, even within a 10-year period. However, a considerable gene-fund of valuable plants is protected in the R “Gorna Topchiya” to be used in folk and official medicine.

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