

Biodiversity of Relict Vascular Plants in Bulgaria

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Abstract: *Climate changes observed in the last years pose a serious threat to biodiversity. Similar climatic changes, nevertheless, have occurred many times in our planet's history. Relict plants that survived after experiencing climate change can give us information about the past and the future of species. The rich biodiversity in the countries of Southern Europe, including Bulgaria, is shaped by a large number of relict plants. To date, the biodiversity of relict plants in Bulgaria has not been systematically described and remains somewhat unknown. Our aim is to systematize available information and present biodiversity of relict vascular plants in Bulgaria. Using a critical approach, we discovered 346 species of 207 genera and 81 families of relict origin. This number accounts for 8.74% of the natural flora of Bulgaria and 8.43% of the total flora of Bulgaria (which includes foreign species). We divided relict plants into two groups: tertiary relicts (183 species) and quaternary relicts (163 species). The quaternary relicts we divided into 3 groups: glacial relicts (143 species), interglacial relicts (13 species) and postglacial relicts (7 species). Among the relicts with the largest number are perennial herbaceous plants, followed by shrubs and trees. 144 relict species have conservation status.*

Keywords: *relict, vascular plants, tertiary, quaternary, glacial, interglacial, postglacial*

1. INTRODUCTION

One problem of a global scale today is the loss of species and the rapid impoverishment of ecosystems. Paleontology has sufficient evidence that the extinction of species and even of large taxonomic groups has occurred throughout the history of our Earth. However, we should not remain calm in the face of the facts. In the geological past, these processes were caused by natural changes in the landscape, the atmosphere, and the climate. Today, a large number of species is endangered by the expansion of human activity. While current and past changes are comparable in their scale, the speed of the changes that take place accelerates. The solution of this problem should be found in the joint efforts of experts from all fields of human knowledge and the economy. One way for biologists to effectively contribute to solving the problem is by focusing their research on relicts. To this end, it is important for us to study the origin, the history and the current condition of relicts.

The term "relict" was introduced to Biology (in particular to Zoology) by Lovén [1] to explain findings of marine-type mysid crustaceans in freshwater lakes. The ecological and geographical criteria of recent relicts were analyzed in detail by Birshstein [2]. According to this author, those taxa that have remained almost unchanged in time (or are characterized by a delayed rate of evolution) are considered relict taxa. Vulf [3] defines "relict species" as remnants of more or less ancient flora, which occupied a relict area. The relict area is a remnant of a larger area, which was formed under specific conditions in the past different from those of other areas. In this sense, the term "relict species" is a historical-geographical concept, associated with the historical range of the species. The age of the relicts is determined by the time when the species has become a part of the flora composition.

The origin and distribution of relicts can often be linked to past changes in their environment, in particular climate changes. Therefore, they can be called "climate relicts". The status of a species as climate relict is usually determined on biogeographical basis, using current geographical distribution and attachment to specific habitats. Most often climate relicts were separated into three groups: 1. Tertiary relicts that withdrew with the onset of drier and cooler climatic conditions during the late Tertiary and early Quaternary; 2. Glacial relicts that are more widely distributed during Quaternary cold stages and have experienced significant range contractions since the LGM; 3. Postglacial relicts that have survived to this day in regions with warmer climates, such as in the early Holocene [4].

In this article, we will use the categorization of relict species into three groups as suggested by Hampe & Jump [4] and most widely used in botanical literature. On this basis, we will divide the plant relicts into two main groups: tertiary relicts and quaternary relicts. We will then divide quaternary relicts into 3 groups: glacial, interglacial and postglacial. We believe that this division most accurately reflects the origin of the relicts according to geological and related climate change.

In order to understand this categorization, we will provide a brief overview of the climate in the Cenozoic era, the time, in which these relict species originated. It is believed that the Cenozoic era began after the extinction of the dinosaurs before ca. 65.5 million years and continues to this day. Cenozoic (Neozoic, Cainozoic) era is divided into three periods: Paleogene (with three epochs: Paleocene, Eocene and Oligocene), Neogene (with two epochs: Miocene and Pliocene) and Quaternary (with two epochs: Pleistocene and Holocene). The first two periods in the past have been designated as Tertiary, a term that is still used in biogeography. During Paleogene and Neogene temperatures and the CO₂ content were higher than those today. The climate was warm and humid. During these periods, there was a gradual cooling, which culminated in the third period, the Quaternary (Fig. 1) [5].

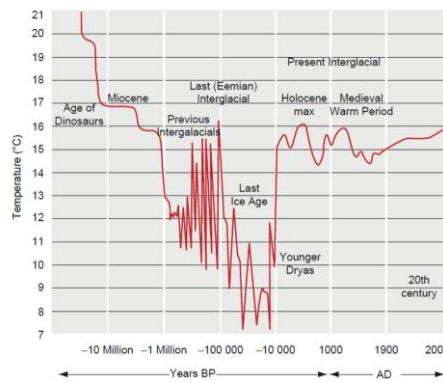


Fig1. Temperature changes over the past 10 million years [5]

In the Pleistocene occurred several ice ages and they totaled six for Europe. During the ice ages, large areas of Northern Europe and many mountain regions of Central and South Eurasia were covered with ice (Fig. 2). In the Last Glacial Maximum (LGM), many parts of Northern and Western Europe located south of the ice sheets and glaciers were covered with permafrost. Southern European peninsulas (such as the Iberian, the Italian and the Balkan) are considered glacial refuges for many species [6]. Between the ice ages occurred periods of warming, which are identified as interglacial periods. These interglacial periods occur over a period of about 100,000 years, and had duration of about 15,000 to 20,000 years. The Last Glacial Maximum occurred before ca. 20,000 years. The transition between the LGM and the current interglacial period has been dramatic. Ice sheets began to retire before ca. 15,000 years as a result of severe sudden warming, called Bolling warm period. This event did not last long and before ca. 12,500 years, the climate suddenly reverted back to glacial temperatures. The last cold snap is called Younger Dryas. The post-glacial warm period began about 11,550 years ago with the glacier retreat from the moraines in Central Scandinavia. With it, Holocene started, the youngest period of the Earth’s history [5].

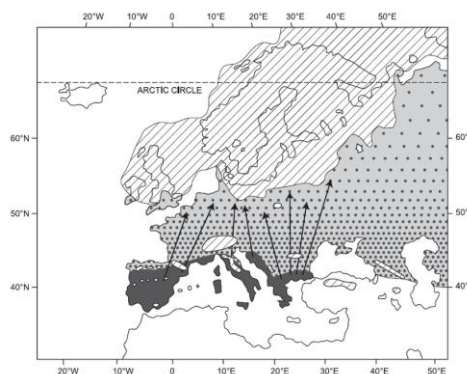


Fig2. Map of Europe in the Pleistocene: the striped areas designate spaces covered with ice; areas in light gray have deep-frozen soil; areas in dark gray are refuges of glacial relicts; the dots on a light gray background show a gradient of refuges of glacial relicts in north-south direction; the arrows show northerner locations of refuges for more species than usually considered [6]

The aim of our study is to summarize available information about the biodiversity of relict vascular plants that occur on the territory of Bulgaria. Bulgaria is a relatively small country with an area of 110 994 km², located on the Balkan Peninsula in Southeastern Europe (Fig. 3). As mentioned above, the Balkan Peninsula was one of the refuges for many species during the glacial periods. At this time, the botanical literature in Bulgaria lacks a publication that contains a list of relict vascular plants and their distribution in different groups. Our goal is to fill this gap. A detailed list of relict plants is needed not only for the purposes of ecology and environmental protection; it will be particularly useful in floristic studies, in conservation biology and in biogeography.



Fig3. Geographical position of Bulgaria

2. MATERIALS AND METHODS

Information on individual relict vascular plants can be found in some of the most important botanical publications in Bulgaria: Flora of PR Bulgaria, Vol. 1–7 [7], Flora of PR Bulgaria, Vol. 8–9 [8], Red Data Book of PR Bulgaria, Vol. 1. Plants [9], Biodiversity of Vascular Plants in Bulgaria [10], Red Data Book of Republic of Bulgaria, Vol. 1. Plants and Fungi [11], Red Data Book of Republic of Bulgaria, Vol. 3. Natural Habitats [12], Important Plant Areas in Bulgaria [13] and in plans for management of the protected areas in Bulgaria [14, 15]. A number of other publications by Bulgarian authors also include data on relict vascular plants in Bulgaria [16, 17, 18, 19, 20, 21, 22]. This information may be supplemented by publications by authors from neighboring countries [23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50]. The names of the families Angiosperm plants are according Angiosperm Phylogeny Group III [51].

3. RESULTS AND DISCUSSION

Based on the information from all sources and our critical selection, we have prepared a list of relict vascular plants that occur on the territory of the Republic of Bulgaria (in Appendix). In this list, we have not included cosmopolitan species that other authors cited as relicts. According to the above-mentioned definition of relict species, we are convinced that cosmopolitan species should not be counted in this group.

Relict vascular plants in the Bulgarian flora are 346 species from 207 genera and 81 families. This number accounts for 8.74% of the natural flora of Bulgaria and 8.43% of the total flora of Bulgaria (which includes foreign species). We divided relict plants into two groups: tertiary relicts (183 species) and quaternary relicts (163 species). The quaternary relicts are divided into 3 groups: glacial relicts (143 species), interglacial relicts (13 species) and postglacial relicts (7 species).

The families with the highest number of relict species in the Bulgarian flora are: Asteraceae, Fabaceae (19 species), Salicaceae (18 species), Rosaceae (16 species), Cyperaceae, Ericaceae (14 species), Primulaceae (12 species), Campanulaceae, Caryophyllaceae, Saxifragaceae (11 species). The genera with the largest number of relict species are: *Salix* L. (14 species), *Carex* L. (10 species), *Saxifraga* L. (9 species), *Acer* L., *Astragalus* L. (7 species), *Campanula* L., *Gentiana* L., *Pinus* L., *Quercus* L. (6 species).

Among the relict species with the largest number, are perennial herbaceous plants, followed by shrubs and trees (Table 1).

Table1. *Distribution of relict species by biological type*

Biological type	Tertiary relicts	Quaternary relicts		
		Glacial	Interglacial	Postglacial
Annual herbaceous plant	5	1	–	–
Annual or biannual herbaceous plant	1	1	–	–
Biannual herbaceous plant	2	–	–	–
Perennial herbaceous plant	70	123	12	6
Shrub	44	15	1	1
Shrub or tree	23	3	–	–
Tree	38	–	–	–

The distribution of relict species according to their floristic elements, results in the following: Among the tertiary relicts (Fig. 4), most species have sub-Mediterranean origin (22 species), Euro-Asian origin (20 species) and Balkan origin (20 species). Among the quaternary glacial relicts (Fig. 5), approximately 1/3 of the species have Boreal origin (45 species). The Arctic-Alpine species (17 species) and Alpine-Carpathian-Balkan species (14 species) are a relatively large number.

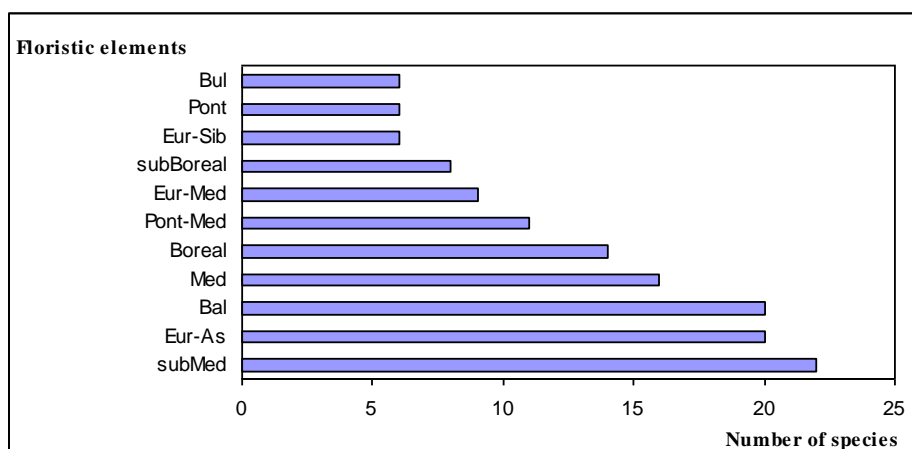


Fig4. *Distribution of tertiary relicts by floristic elements*
(Only floristic elements represented by 5 or more species are included)

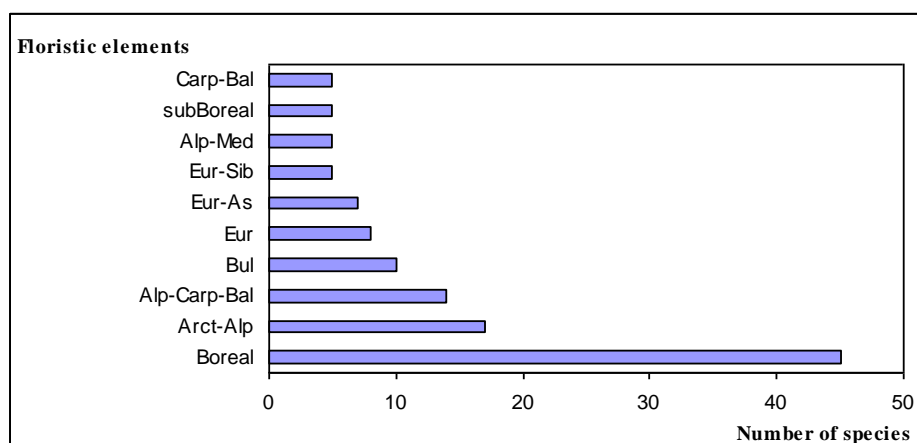


Fig5. *Distribution of quaternary glacial relicts by floristic elements*
(Only floristic elements represented by 5 or more species are included)

144 relict species have conservation status: 77 species of tertiary relicts, 59 species of quaternary glacial relicts, 6 species of quaternary interglacial relicts and 2 species of postglacial relicts (in Appendix).

4. CONCLUSION

As a result of our study we found a significant number of relict species of vascular plants in the flora of Bulgaria. The list of relicts who we prepared, divided into groups, systematize available data. It will be useful in floristic studies, in conservation biology and in biogeography.

APPENDIX

List of Relict Vascular Plants in Bulgaria

Legend

• **Biological Type**

a – annual herbaceous plant; a-b – annual or biennial herbaceous plant; b – biennial herbaceous plant; p – perennial herbaceous plant; sh – shrub; sh-t – shrub or tree; t – tree

• **Conservation Status**

Bern Convention [52]: BC1 – Appendix 1; Convention on International Trade in Endangered Species of Wild Fauna and Flora [53]: CITES; Directive 92/43/EEC [54]: DA2 – Annex II, DA4 – Annex IV, DA5 – Annex V; Red Data Book of Republic of Bulgaria. Vol.1. Plants and Fungi [11]: CR – Critically endangered, EN – Endangered, EX – Extinct, RE – Regionally extinct, VU – Vulnerable; Biodiversity Act of Republic of Bulgaria [55]: BA2 – Annex 2, BA2a – Annex 2a, BA3 – Annex 3, BA4 – Annex 4.

• **Floristic Element**

Alp – Alpine; Anat – Anatolian; Ap – Apenninian; Arct – Arctic; As – Asiatic; Bal – Balkan; Boreal – Boreal; Bul – Bulgarian; Carp – Carpathian; Cauc – Caucasus; Dac – Dacian; Eur – European; Eux – Euxinian; Med – Mediterranean; OT – Oriental-Turanian; Pont – Pontic; Sib – Siberian; Prefixes: sub – sub; N – North; S – South; E – East; W – West; C – Central.

Table2. Tertiary relicts

No	Species name	Family	Biological type	Conservation status	Floristic element
1	<i>Abies alba</i> Mill.	Pinaceae	t		Boreal
2	<i>Abies borisii-regis</i> Mattf.	Pinaceae	t		Bal
3	<i>Acer campestre</i> L.	Sapindaceae	sh-t		Eur-OT
4	<i>Acer heldreichii</i> Orph. ex Boiss.	Sapindaceae	t	VU	Bal
5	<i>Acer hyrcanum</i> Fisch. & C. A. Mey	Sapindaceae	t		subMed
6	<i>Acer monspessulanum</i> L.	Sapindaceae	t		subMed
7	<i>Acer platanoides</i> L.	Sapindaceae	t		subMed
8	<i>Acer pseudoplatanus</i> L.	Sapindaceae	t		Eur-Med
9	<i>Acer tataricum</i> L.	Sapindaceae	sh-t		subMed
10	<i>Adiantum capillus-veneris</i> L.	Adiantaceae	p	CR, BA3	subBoreal
11	<i>Aesculus hippocastanum</i> L.	Sapindaceae	t	EN, BA3	Bal
12	<i>Aethionema arabicum</i> (L.) Andr. ex DC.	Brassicaceae	a	CR, BA3	subMed
13	<i>Alnus glutinosa</i> (L.) Gaertn.	Betulaceae	t		Med-Cas
14	<i>Alnus incana</i> (L.) Moench	Betulaceae	t		subMed
15	<i>Anthemis argyrophylla</i> (Halácsy & Georgiev) Velen.	Asteraceae	p	CR, BA3	Bul
16	<i>Arbutus andrachne</i> L.	Ericaceae	sh	CR, BA3	Med
17	<i>Arbutus unedo</i> L.	Ericaceae	sh	CR, BA3	subMed-As
18	<i>Arctostaphylos uva-ursi</i> (L.) Spreng.	Ericaceae	sh		Boreal
19	<i>Asarum europaeum</i> L.	Aristolochiaceae	p		Eur-Sib
20	<i>Asperula suberosa</i> Sibth. & Sm.	Rubiaceae	p	CR, BA3	Bal
21	<i>Astracantha aitensis</i> (Ivan.) Podl.	Fabaceae	sh	BC1, EN, BA3	Bul
22	<i>Astracantha thracica</i> (Griseb.) Podlech	Fabaceae	sh	VU, BA3	Bal
23	<i>Astragalus physocalyx</i> Fisch.	Fabaceae	sh	BC1, CR, BA3	Bal-Anat
24	<i>Astragalus wilmottianus</i> Stoj.	Fabaceae	p	EN, BA3	Bal
25	<i>Asyneuma limonifolium</i> (L.) Janch.	Campanulaceae	p		Ap-Bal
26	<i>Azolla filiculoides</i> Lam.	Salviniaceae	a		Boreal
27	<i>Berberis vulgaris</i> L.	Berberidaceae	sh		Eur-Med
28	<i>Betula pendula</i> Roth	Betulaceae	t		Eur-Sib
29	<i>Blechnum spicant</i> (L.) Sm.	Blechnaceae	p		Boreal

30	<i>Butomus umbellatus</i> L.	Butomaceae	p		Eur-As
31	<i>Caldesia parnassifolia</i> (L.) Parl.	Alismataceae	p	BC1, DA2, RE, BA2, BA3	Eur-As
32	<i>Calluna vulgaris</i> (L.) Hull	Ericaceae	sh	BA3	subBoreal
33	<i>Campanula lanata</i> Friv.	Campanulaceae	b	BC1, VU, BA3	Bal
34	<i>Campanula lingulata</i> Waldst. & Kit.	Campanulaceae	p		Ap-Bal
35	<i>Campanula versicolor</i> Andrews	Campanulaceae	p	EN, BA3	EMed
36	<i>Cardamine glauca</i> Spreng. ex DC.	Brassicaceae	a		subMed
37	<i>Cardamine graeca</i> L.	Brassicaceae	a-b		Med
38	<i>Carpinus betulus</i> L.	Betulaceae	t		Eur-subMed
39	<i>Carpinus orientalis</i> Mill.	Betulaceae	sh-t		subMed
40	<i>Castanea sativa</i> L.	Fagaceae	t	EN	Med
41	<i>Celtis australis</i> L.	Ulmaceae	t		Med
42	<i>Celtis plachoniana</i> K.I. Chr.	Ulmaceae	sh-t	EN	Med
43	<i>Centaurea calocephala</i> Willd.	Asteraceae	p	CR	Pont
44	<i>Centaurea calvescens</i> Pančić	Asteraceae	b		subMed
45	<i>Centaurea jankae</i> D. Brandza	Asteraceae	p	BC1, DA2, EN, BA2, BA3	Bal
46	<i>Centaurea trinervia</i> Steven ex Willd.	Asteraceae	p	CR	Pont
47	<i>Centaurea wagenitziana</i> Bancheva & Kit Tan	Asteraceae	p	CR, BA3	Bal
48	<i>Centranthus kellereri</i> (Stoj., Stef. & T. Georg.) Stoj. & Stef.	Caprifoliaceae	p	BC1, CR, BA3	Bul
49	<i>Ceratophyllum submersum</i> L.	Ceratophyllaceae	p		Eur-As
50	<i>Cercis siliquastrum</i> L.	Fabaceae	sh-t		Med-OT
51	<i>Cicer montbretii</i> Jaub. & Spach	Fabaceae	p	EN, BA3	Bal-Anat
52	<i>Cistus salviiifolius</i> L.	Cistaceae	sh	EN, BA3	Eur-As
53	<i>Clematis vitalba</i> L.	Ranunculaceae	p		Eur
54	<i>Colutea arborescens</i> L.	Fabaceae	sh		subMed
55	<i>Comandra elegans</i> (Rochel ex Rchb.) Rchb. f.	Santalaceae	sh		Bal-Dac-Anat
56	<i>Corylus avellana</i> L.	Betulaceae	sh		Med-CAs
57	<i>Corylus colurna</i> L.	Betulaceae	t		Pont-CAs
58	<i>Cotinus coggygria</i> Scop.	Anacardiaceae	sh		Med-As
59	<i>Crataegus pentagyna</i> Waldst. & Kit.	Rosaceae	sh		subMed
60	<i>Cyclamen coum</i> Mill.	Primulaceae	p	BC1, CITES, BA3	Pont-Med
61	<i>Cypripedium calceolus</i> L.	Orchidaceae	p	BC1, CITES, DA2, CR, BA2, BA3	Eur-As
62	<i>Daphne kosanini</i> (Stoj.) Stoj.	Thymelaeceae	sh		subMed
63	<i>Daphne laureola</i> L.	Thymelaeceae	sh	EN, BA3	subMed
64	<i>Daphne mezereum</i> L.	Thymelaeceae	sh		Eur-Sib
65	<i>Daphne pontica</i> L.	Thymelaeceae	sh	EN, BA3	Pont
66	<i>Dictamnus albus</i> L.	Rutaceae	p		Eur-As
67	<i>Edraianthus graminifolius</i> (L.) DC.	Campanulaceae	p		Bal-Ap
68	<i>Edraianthus serbicus</i> (A. Kern.) Petrovič	Campanulaceae	p	EN, BA3	Bal
69	<i>Ephedra distachya</i> L.	Ephedraceae	sh	BA3	Pont-Med
70	<i>Epimedium pubigerum</i> (DC.) Morren & Decne	Berberidaceae	p	BA3	Bal-Anat
71	<i>Eranthis bulgaricus</i> (Stef.) Stef.	Ranunculaceae	p	CR, BA3	Bul
72	<i>Erica arborea</i> L.	Ericaceae	sh	BA3	Pont-Med
73	<i>Erythronium dens-canis</i> L.	Liliaceae	p		Med
74	<i>Fagus orientalis</i> Lipsky	Fagaceae	t		SEux
75	<i>Fraxinus excelsior</i> L.	Oleaceae	t		Eur-Med

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76	<i>Fraxinus ornus</i> L.	Oleaceae	t		subMed
77	<i>Galium procurrens</i> Ehrend.	Rubiaceae	p	CR, BA3	Bal
78	<i>Galium rhodopeum</i> Velen.	Rubiaceae	p	BC1, EN, BA3	Bal
79	<i>Gentiana frigida</i> Haenke	Gentianaceae	p	EN, BA3	Alp-Bal
80	<i>Gentiana lutea</i> L.	Gentianaceae	p	DA5, EN, BA3	Eur
81	<i>Goodyera repens</i> (L.) R. Br.	Orchidaceae	p	CITES, EN, BA3	Boreal
82	<i>Gypsophila tekirae</i> Stef.	Caryophyllaceae	p	CR, BA3	Bul
83	<i>Haberlea rhodopensis</i> Friv.	Gesneriaceae	p	BC1, BA3	Bal
84	<i>Hedera helix</i> L.	Araliaceae	sh		Eur-As
85	<i>Herminium monorchis</i> (L.) R. Br.	Orchidaceae	p	CITES, RE, BA3	Eur-As
86	<i>Hippuris vulgaris</i> L.	Plantaginaceae	p	CR, BA3	Boreal
87	<i>Hottonia palustris</i> L.	Primulaceae	p	RE, BA3	Boreal
88	<i>Hydrocharis morsus-ranae</i> L.	Hydrocharitaceae	p		Eur-As
89	<i>Hypericum androsaemum</i> L.	Hypericaceae	sh	EN, BA3	Eur-OT
90	<i>Hypericum calycinum</i> L.	Hypericaceae	sh	EN, BA3	Pont-Med
91	<i>Hypericum setiferum</i> Stef.	Hypericaceae	p	EX, BA3	Bul
92	<i>Ilex aquifolium</i> L.	Aquifoliaceae	sh-t	EN, BA3	subMed
93	<i>Ilex colchica</i> Pojark.	Aquifoliaceae	sh	EN, BA3	Pont
94	<i>Isopyrum thalictroides</i> L.	Ranunculaceae	p		Eur
95	<i>Jasminum fruticans</i> L.	Oleaceae	sh		Pont-CAs
96	<i>Juglans regia</i> L.	Juglandaceae	t		Eur-As
97	<i>Juniperus communis</i> L.	Cupressaceae	sh-t		subBoreal
98	<i>Juniperus excelsa</i> M. Bieb.	Cupressaceae	sh-t	BA3	Med-OT
99	<i>Juniperus oxycedrus</i> L.	Cupressaceae	sh-t		Eur-Med
100	<i>Juniperus sabina</i> L.	Cupressaceae	sh	EN, BA3	Pont-Sib
101	<i>Lathraea rhodopaea</i> Dingler	Scrophulariaceae	p	BA3	Bal
102	<i>Lathyrus aureus</i> (Steven) D. Brândză	Fabaceae	p		Eux
103	<i>Laurocerasus officinalis</i> Roem.	Rosaceae	sh-t		Eux
104	<i>Leersia oryzoides</i> (L.) Sw.	Poaceae	p		subBoreal
105	<i>Limodorum abortivum</i> (L.) Sw.	Orchidaceae	p	CITES, BA3	Med
106	<i>Lonicera etrusca</i> Santi	Caprifoliaceae	sh		Med
107	<i>Lycopus europaeus</i> L.	Lamiaceae	p		Eur-As
108	<i>Mespilus germanica</i> L.	Rosaceae	sh-t		Pont-Med
109	<i>Micromeria cristata</i> (Hampe) Griseb	Lamiaceae	p		Bal-Anat
110	<i>Oenanthe aquatica</i> (L.) Poir.	Apiaceae	p		Eur-Sib
111	<i>Ostrya carpinifolia</i> Scop.	Betulaceae	sh-t		subMed
112	<i>Paeonia mascula</i> (L.) Mill.	Paeniaceae	p	EN, BA3	Pont-Med
113	<i>Paliurus spina-christi</i> Mill.	Rhamnaceae	sh		Eur-As
114	<i>Pancratium maritimum</i> L.	Amaryllidaceae	p	EN, BA3	Pont-Med
115	<i>Periploca graeca</i> L.	Apocynaceae	sh		Pont-Med
116	<i>Phillyrea latifolia</i> L.	Oleaceae	sh-t		Med
117	<i>Picea abies</i> (L.) Karst.	Pinaceae	t		Boreal
118	<i>Pinus brutia</i> Ten.	Pinaceae	t	CR, BA3	Med
119	<i>Pinus heldreichii</i> Christ.	Pinaceae	t		Ap-Bal
120	<i>Pinus nigra</i> J.F. Arnold	Pinaceae	t		subMed
121	<i>Pinus peuce</i> Griseb.	Pinaceae	t		Bal
122	<i>Pinus sylvestris</i> L.	Pinaceae	t		subBoreal
123	<i>Pistacia terebinthus</i> L.	Anacardiaceae	sh-t		Pont-Med
124	<i>Platanus orientalis</i> L.	Platanaceae	t		Med
125	<i>Populus alba</i> L.	Salicaceae	t		Eur-As
126	<i>Populus canescens</i> (Aiton) Sm.	Salicaceae	t		Eur-Med
127	<i>Populus nigra</i> L.	Salicaceae	t		Eur-As
128	<i>Populus tremula</i> L.	Salicaceae	t		subBoreal
129	<i>Potentilla palustris</i> (L.) Scop.	Rosaceae	sh	BA3	Boreal
130	<i>Primula vulgaris</i> subsp. <i>rubra</i> (Sm.) Arcang.	Primulaceae	p	BA4	Bal-Eux

131	<i>Prunus fruticosa</i> Pall.	Rosaceae	sh		Eur-Sib
132	<i>Pyracantha coccinea</i> M.J. Roemer	Rosaceae	sh		Pont-Med
133	<i>Quercus cerris</i> L.	Fagaceae	t		Eur-subMed
134	<i>Quercus coccifera</i> L.	Fagaceae	sh-t	EN, BA3	Med
135	<i>Quercus dalechampii</i> Ten.	Fagaceae	t		subMed
136	<i>Quercus hartwissiana</i> Steven	Fagaceae	t	BA2a	Pont-Eux
137	<i>Quercus pubescens</i> Willd.	Fagaceae	sh-t		Eur-subMed
138	<i>Quercus trojana</i> Webb	Fagaceae	t	BA3	Ap-Bal-Anat
139	<i>Ramonda serbica</i> Pančić	Gesneriaceae	p	BC1, DA4, EN, BA3	Bal
140	<i>Ranunculus lingua</i> L.	Ranunculaceae	p		Eur-As
141	<i>Rhododendron ponticum</i> L.	Ericaceae	sh	BA3	Eux
142	<i>Rhus coriaria</i> L.	Anacardiaceae	sh-t		Med-As
143	<i>Rhynchosorys elephas</i> (L.) Griseb.	Orobanchaceae	p	BA3	subMed
144	<i>Rumex acetosa</i> L.	Polygonaceae	p		Boreal
145	<i>Ruscus aculeatus</i> L.	Asparagaceae	p	DA5, BA4	SPont
146	<i>Ruscus hypoglossum</i> L.	Asparagaceae	p	BA4	Pont
147	<i>Ruta graveolens</i> L.	Rutaceae	p	EN, BA3	Pont-Med
148	<i>Salix alba</i> L.	Salicaceae	t		Eur-As
149	<i>Salix caprea</i> L.	Salicaceae	sh-t	BA4	subBoreal
150	<i>Salix cinerea</i> L.	Salicaceae	sh		Eur-As
151	<i>Salix fragilis</i> L.	Salicaceae	t		Eur-As
152	<i>Salix purpurea</i> L.	Salicaceae	sh		Eur-Med- CAs
153	<i>Salix silesiaca</i> Willd.	Salicaceae	sh-t		Carp-Bal
154	<i>Salix triandra</i> L.	Salicaceae	sh-t		subBoreal
155	<i>Salvinia natans</i> (L.) All.	Salviniaceae	a	BC1, BA3	Boreal
156	<i>Sambucus racemosa</i> L.	Caprifoliaceae	sh		Boreal
157	<i>Sanicula europaea</i> L.	Apiaceae	p		Eur-Sib
158	<i>Scorzonera lanata</i> M. Bieb.	Asteraceae	p		Med
159	<i>Serapias vomeracea</i> (Burm.) Briq.	Orchidaceae	p	CITES, EN, BA3	Med
160	<i>Silene asterias</i> Griseb.	Caryophyllaceae	p		Bal
161	<i>Silene larchenfeldiana</i> Baumg.	Caryophyllaceae	p		Carp-Bal
162	<i>Silene waldsteinii</i> Griseb.	Caryophyllaceae	p		Bal
163	<i>Smilax excelsa</i> L.	Smilacaceae	sh		subMed
164	<i>Sorbus aria</i> (L.) Crantz	Rosaceae	sh-t		Eur
165	<i>Staphylea pinnata</i> L.	Staphyleaceae	sh-t		Eur-Med
166	<i>Stratiotes aloides</i> L.	Hydrocharitaceae	p	CR, BA3	Eur-Sib
167	<i>Syringa vulgaris</i> L.	Oleaceae	sh		Carp-Bal
168	<i>Tamus communis</i> L.	Dioscoreaceae	p		subMed
169	<i>Taraxacum bithynicum</i> DC.	Asteraceae	p	EN	Med
170	<i>Taxus baccata</i> L.	Taxaceae	sh-t	EN, BA3	Eur-NAm
171	<i>Trachelium rumelianum</i> Hampe	Campanulaceae	p	VU, BA3	Bal
172	<i>Trachystemon orientalis</i> (L.) D. Don	Boraginaceae	p		SEux
173	<i>Trapa natans</i> L.	Lythraceae	p	BC1, EN, BA3	Eur-As
174	<i>Turgeniopsis foeniculacea</i> (Fenzl) Boiss.	Apiaceae	a	CR, BA3	Med
175	<i>Ulmus laevis</i> Pall.	Ulmaceae	t		Eur-Med
176	<i>Ulmus minor</i> Mill.	Ulmaceae	t		Eur-Med
177	<i>Vaccinium arctostaphylos</i> L.	Ericaceae	sh	BC1, EN, BA3	Pont
178	<i>Vaccinium myrtillus</i> L.	Ericaceae	sh		Boreal
179	<i>Vaccinium uliginosum</i> L.	Ericaceae	sh		Boreal
180	<i>Veronica turrilliana</i> Stoj. & Stef.	Scrophulariaceae	p	BC1, EN, BA3	Bal
181	<i>Viburnum lantana</i> L.	Caprifoliaceae	sh		Eur-Med
182	<i>Viscum album</i> L.	Loranthaceae	sh		Eur-As
183	<i>Vitis sylvestris</i> C. C. Gmel.	Vitaceae	sh		subMed

Table3. Quaternary glacial relicts

No	Species name	Family	Biological type	Conser-vation status	Floristic element
1	<i>Adenostyles alliariae</i> (Gouan) A. Kern.	Asteraceae	p		Alp-Carp-Bal
2	<i>Alyssum orbelicum</i> Ančev & Uzunov	Brassicaceae	p	CR, BA3	Bul
3	<i>Alyssum pirinicum</i> (Stoj. & Acht.) Ančev	Brassicaceae	p	EN, BA3	Bul
4	<i>Androsace villosa</i> L.	Primulaceae	p		Arct-Alp
5	<i>Anemone narcissiflora</i> L.	Ranunculaceae	p	BA3	Boreal
6	<i>Antennaria dioica</i> (L.) Gaerth.	Asteraceae	p		Arct-Alp
7	<i>Arabis alpina</i> L.	Brassicaceae	p		Arct-Alp
8	<i>Arabis ferdinandi-coburgii</i> Kellerer & Sünd.	Brassicaceae	p	EN, BA3	Bul
9	<i>Arenaria biflora</i> L.	Caryophyllaceae	p		Alp-Carp-Bal
10	<i>Arenaria ciliata</i> L.	Caryophyllaceae	p	EN, BA3	Alp
11	<i>Arenaria pirinica</i> Stoj.	Caryophyllaceae	p	EN, BA3	Bul
12	<i>Armeria alpina</i> (DC.) Willd.	Plumbaginaceae	p		Alp-Carp-Bal
13	<i>Artemisia chamaemelifolia</i> Vill.	Asteraceae	sh	CR, BA3	Alp-Cauc
14	<i>Artemisia eriantha</i> Ten.	Asteraceae	p	DA5, EN, BA3	Carp-Bal
15	<i>Aster alpinus</i> L.	Asteraceae	p		Arct-Alp
16	<i>Astragalus alopecurus</i> Pall.	Fabaceae	p	BC1, DA2, CR, BA3	Alp
17	<i>Astragalus australis</i> (L.) Lam.	Fabaceae	p		Eur-As
18	<i>Bartsia alpina</i> L.	Orobanchaceae	p		Boreal
19	<i>Bistorta major</i> S. Gray	Polygonaceae	p		Eur-As
20	<i>Bistorta vivipara</i> (L.) S. Gray	Polygonaceae	p		Boreal
21	<i>Campanula alpina</i> Jacq.	Campanulaceae	p		Alp-Carp
22	<i>Campanula cochlearifolia</i> Lam.	Campanulaceae	p	EN	Alp-Carp
23	<i>Campanula rotundifolia</i> L.	Campanulaceae	p		Boreal
24	<i>Carex appropinquata</i> A. Schumach.	Cyperaceae	p		Eur-Sib
25	<i>Carex atrata</i> L.	Cyperaceae	p		Eur
26	<i>Carex ericetorum</i> Pollich	Cyperaceae	p		Eur-Sib
27	<i>Carex curvula</i> All.	Cyperaceae	p		Alp-Med
28	<i>Carex flava</i> L.	Cyperaceae	p		Boreal
29	<i>Carex limosa</i> L.	Cyperaceae	p	EN, BA2a	Boreal
30	<i>Carex parviflora</i> Host	Cyperaceae	p		Alp
31	<i>Carex pirinensis</i> Acht.	Cyperaceae	p	BA2a	Bul
32	<i>Carex rostrata</i> Stokes	Cyperaceae	p		Boreal
33	<i>Carex rupestris</i> All.	Cyperaceae	p	BA2a	Boreal
34	<i>Cerastium alpinum</i> L.	Caryophyllaceae	p		Arct-Alp
35	<i>Cortusa matthioli</i> L.	Primulaceae	p	BA3	Arct-Alp
36	<i>Diphasiastrum alpinum</i> (L.) Holub.	Lycopodiaceae	p	DA5, BA3	Boreal
37	<i>Draba siliquosa</i> M. Bieb.	Brassicaceae	p	EN	Alp-Carp
38	<i>Drosera rotundifolia</i> L.	Droseraceae	p	BA3	Boreal
39	<i>Dryas octopetala</i> L.	Rosaceae	sh		Boreal
40	<i>Empetrum nigrum</i> subsp. <i>hermaphroditum</i> (Hagerup) Böcher.	Ericaceae	sh	EN, BA3	Boreal
41	<i>Epilobium alsinifolium</i> Vill.	Onagraceae	p		Eur
42	<i>Epilobium anagallidifolium</i> Lam.	Onagraceae	p		Boreal
43	<i>Epilobium palustre</i> L.	Onagraceae	p		subBoreal
44	<i>Equisetum fluviatile</i> L.	Equisetaceae	p		Boreal
45	<i>Eriophorum gracile</i> Koch ex Roth	Cyperaceae	p		Boreal
46	<i>Eriophorum vaginatum</i> L.	Cyperaceae	p		Eur-As
47	<i>Festuca violacea</i> Ser. ex Gaudin	Poaceae	p		Boreal
48	<i>Galanthus nivalis</i> L.	Amaryllidaceae	p	CITES, DA5, EN, BA3	Eur
49	<i>Galium boreale</i> L.	Rubiaceae	p		Boreal
50	<i>Gentiana acaulis</i> L.	Gentianaceae	p	CR, BA3	Eur

51	<i>Gentiana asclepiadea</i> L.	Gentianaceae	p		Eur
52	<i>Gentiana nivalis</i> L.	Gentianaceae	a	EN	Boreal
53	<i>Gentiana verna</i> L.	Gentianaceae	p		Eur-As
54	<i>Gentianella bulgarica</i> (Velen.) Holub	Gentianaceae	a-b		Pont
55	<i>Geum montanum</i> L.	Rosaceae	p		Alp-Carp-Bal
56	<i>Geum reptans</i> L.	Rosaceae	p		Alp-Carp-Bal
57	<i>Gymnadenia conopsea</i> (L.) R. Br.	Orchidaceae	p	CITES	Eur-As
58	<i>Hieracium villosum</i> Jacq.	Asteraceae	p	EN	Alp-As-Bal
59	<i>Homogyne alpina</i> (L.) Cass.	Asteraceae	p		Alp-Carp-Bal
60	<i>Isoetes lacustris</i> L.	Isoetaceae	p	EN, BA3	Boreal
61	<i>Juncus alpinus</i> Vill.	Juncaceae	p		Eur-NAm
62	<i>Juncus trifidus</i> L.	Juncaceae	p		Boreal
63	<i>Juncus triglumis</i> L.	Juncaceae	p	CR, BA3	Arct-Alp
64	<i>Juniperus sibirica</i> Burgsd.	Cupressaceae	sh		Boreal
65	<i>Kobresia myosuroides</i> (Vill.) Fiori	Cyperaceae	p	EN, BA2a	Arct-Alp
66	<i>Laserpitium archangelica</i> Wulfen	Apiaceae	p	CR, BA3	Carp-Bal
67	<i>Ligularia sibirica</i> (L.) Cass.	Asteraceae	p	BC1, DA2, CR, BA2, BA3	Eur-Sib
68	<i>Listera cordata</i> (L.) R. Br.	Orchidaceae	p	CITES, BA3	Boreal
69	<i>Lloydia serotina</i> (L.) Rchb.	Liliaceae	p	EN, BA3	Boreal
70	<i>Luzula italica</i> Parl.	Juncaceae	p		subBoreal
71	<i>Lysimachia thyrsoiflora</i> L.	Primulaceae	p	BA3	subBoreal
72	<i>Menyanthes trifoliata</i> L.	Menyanthaceae	p	EN, BA3	Boreal
73	<i>Meum athamanticum</i> Jacq.	Apiaceae	p		Alp-Carp-Bal
74	<i>Minuartia verna</i> (L.) Hiern	Caryophyllaceae	p		subBoreal
75	<i>Myricaria germanica</i> (L.) Desv.	Tamaricaceae	sh	CR, BA3	Eur-WAs
76	<i>Nigritella nigra</i> (L.) Rchb. f.	Orchidaceae	p	CITES	Eur
77	<i>Omalothea norvegica</i> (Gunn.) Schultz-Bip. & F. Schultz	Asteraceae	p		Boreal
78	<i>Omalothea supina</i> (L.) DC.	Asteraceae	p		Boreal
79	<i>Oxyria digyna</i> (L.) Hill.	Polygonaceae	p		Arct-Alp
80	<i>Oxytropis campestris</i> (L.) DC.	Fabaceae	p		Boreal
81	<i>Oxytropis kozhuharovii</i> D. Pavlova, D. Dimitrov & M. Nikolova	Fabaceae	p	CR, BA2a	Bul
82	<i>Oxytropis urumovii</i> Jav.	Fabaceae	p	VU, BA2a	Bul
83	<i>Papaver degenii</i> (Urum. & Jav.) Kuzmanov	Papaveraceae	p	VU, BA3	Bul
84	<i>Parnassia palustris</i> L.	Saxifragaceae	p		subBoreal
85	<i>Pedicularis oederi</i> Vahl	Scrophulariaceae	p	EN	Arct-Alp
86	<i>Pedicularis orthantha</i> Griseb.	Scrophulariaceae	p		Bal
87	<i>Pedicularis verticillata</i> L.	Scrophulariaceae	p		Boreal
88	<i>Phleum alpinum</i> L.	Poaceae	p		Arct-Alp
89	<i>Phyteuma confusum</i> A. Kern.	Campanulaceae	p		Alp-Carp-Bal
90	<i>Pinus mugo</i> Turra	Pinaceae	sh-t		Alp-Carp-Bal
91	<i>Pleuropterypyrum undulatum</i> (Raf.) Á. Löve & D. Löve	Polygonaceae	p		Eur-As
92	<i>Poa alpina</i> L.	Poaceae	p		Boreal
93	<i>Poa laxa</i> Haenke	Poaceae	p		Alp-Med
94	<i>Poa media</i> Schur	Poaceae	p		Carp-Bal
95	<i>Polygonum viviparum</i> L.	Polygonaceae	p		Boreal
96	<i>Potamogeton alpinus</i> Balb.	Potamogetonaceae	p		Boreal
97	<i>Potentilla crantzii</i> (Crantz) Beck ex Fritsch	Rosaceae	p		Arct-Alp
98	<i>Potentilla fruticosa</i> L.	Rosaceae	sh	BA3	Boreal
99	<i>Primula deorum</i> Velen.	Primulaceae	p	BC1, VU, BA3	Bul
100	<i>Primula farinosa</i> L.	Primulaceae	p		Eur
101	<i>Primula halleri</i> J. F. Gmel.	Primulaceae	p	BA3	Alp-Carp-Bal
102	<i>Primula minima</i> L.	Primulaceae	p		Alp-Carp-Bal
103	<i>Pseudorchis albida</i> (L.) A. Löve & D. Löve	Orchidaceae	p	CITES	Arct-Alp

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104	<i>Pyrola chlorantha</i> Sw.	Ericaceae	p		Boreal
105	<i>Ranunculus crenatus</i> Waldst. & Kit.	Ranunculaceae	p		Alp-Carp-Bal
106	<i>Rheum rhaponticum</i> L.	Polygonaceae	p	BC1, CR, BA3	Bul
107	<i>Rhodiola rosea</i> L.	Crassulaceae	p	CR, BA3	Boreal
108	<i>Rhododendron myrtifolium</i> Schott & Kotschy	Ericaceae	sh	EN, BA3	Carp-Bal
109	<i>Ribes nigrum</i> L.	Saxifragaceae	sh	CR, BA3	Arct-Alp
110	<i>Sagina saginoides</i> (L.) Karst.	Caryophyllaceae	p		Boreal
111	<i>Salix appendiculata</i> L.	Salicaceae	sh-t		Alp-Bal
112	<i>Salix herbacea</i> L.	Salicaceae	sh		Boreal
113	<i>Salix lapponum</i> L.	Salicaceae	sh		Eur-Sib
114	<i>Salix pentandra</i> L.	Salicaceae	sh-t	CR, BA3	Eur-Sib
115	<i>Salix reticulata</i> L.	Salicaceae	sh		Arct-Alp
116	<i>Salix retusa</i> L.	Salicaceae	sh	EN, BA3	Alp
117	<i>Salix waldsteiniana</i> Willd.	Salicaceae	sh		Alp-Carp-Bal
118	<i>Saxifraga aizoides</i> L.	Saxifragaceae	p	EN, BA3	Boreal
119	<i>Saxifraga androsacea</i> L.	Saxifragaceae	p	BA3	Eur-Sib
120	<i>Saxifraga bryoides</i> L.	Saxifragaceae	p		Alp-Med
121	<i>Saxifraga carpatica</i> Sternb.	Saxifragaceae	p		Carp-Bal
122	<i>Saxifraga ferdinandi-coburgi</i> Kellerer & Sünd.	Saxifragaceae	p		Bal
123	<i>Saxifraga oppositifolia</i> L.	Saxifragaceae	p		Arct-Alp
124	<i>Saxifraga paniculata</i> Mill.	Saxifragaceae	p		Eur-Am
125	<i>Saxifraga retusa</i> Gouan	Saxifragaceae	p	BA3	Alp-Ap-Carp-Bal
126	<i>Saxifraga stellaris</i> L.	Saxifragaceae	p		Boreal
127	<i>Selaginella selaginoides</i> (L.) P. Beauv. ex Mart. & Schrank	Selaginellaceae	p		Boreal
128	<i>Sibbaldia procumbens</i> L.	Rosaceae	p	EN	Boreal
129	<i>Silene acaulis</i> L.	Caryophyllaceae	p		Arct-Alp
130	<i>Soldanella pusilla</i> Baumg.	Primulaceae	p		Alp-Carp-Bal
131	<i>Soldanella rhodopaea</i> F. K. Mey	Primulaceae	p		Bal
132	<i>Spiraea salicifolia</i> L.	Rosaceae	sh	CR, BA3	Boreal
133	<i>Swertia perennis</i> L.	Gentianaceae	p	EN	Eur
134	<i>Swertia punctata</i> Baumg.	Gentianaceae	p	CR, BA3	Carp-Bal-Cauc
135	<i>Tozzia carpatica</i> Woloszack	Scrophulariaceae	p	DA2, VU, BA2, BA3	Alp-Med
136	<i>Trichophorum caespitosum</i> (L.) Hartm.	Cyperaceae	p		Boreal
137	<i>Trollius europaeus</i> L.	Ranunculaceae	p	BA3	Boreal
138	<i>Vaccinium vitis-idaea</i> L.	Ericaceae	sh		Boreal
139	<i>Veratrum lobelianum</i> Bernh.	Melanthiaceae	p		Eur-As
140	<i>Veronica alpina</i> L.	Scrophulariaceae	p		Eur-Jap-Ch
141	<i>Veronica bellidioides</i> L.	Scrophulariaceae	p		Alp-Med
142	<i>Viola biflora</i> L.	Violaceae	p		Boreal
143	<i>Viola palustris</i> L.	Violaceae	p	CR, BA3	Eur-NAM

Table 4. Quaternary interglacial relicts

No	Species name	Family	Biological type	Conser-vation status	Floristic element
1	<i>Adonis vernalis</i> L.	Ranunculaceae	p	CITES	Eur-Sib
2	<i>Amygdalus nana</i> L.	Rosaceae	sh		Eur-As
3	<i>Asparagus tenuifolius</i> Lam.	Asparagaceae	p	BA4	Pont-Med
4	<i>Aster oleifolius</i> (Lam.) Wagenitz	Asteraceae	p		Pont-Sib
5	<i>Astragalus austriacus</i> L.	Fabaceae	p		subMed
6	<i>Astragalus pubiflorus</i> DC.	Fabaceae	p	BA3	subMed
7	<i>Cachrys alpina</i> M. Bieb.	Apiaceae	p	BA3	Pont
8	<i>Hyacinthella leucophaea</i> (Koch) Schur	Asparagaceae	p		Pont-Med
9	<i>Iris pumila</i> L.	Iridaceae	p		subMed
10	<i>Morina persica</i> L.	Caprifoliaceae	p	BA3	Med-OT

11	<i>Paeonia tenuifolia</i> L.	Paeoniaceae	p	BC1, EN, BA3	subMed
12	<i>Prunus fruticosa</i> Pall.	Rosaceae	sh		Eur-Sib
13	<i>Ranunculus illyricus</i> L.	Ranunculaceae	p		Eur-subMed
14	<i>Sternbergia colchiciflora</i> Waldst. & Kit.	Amaryllidaceae	p		Eur-Pont

Table 5. Quaternary postglacial relicts

No	Species name	Family	Biological type	Conser-vation status	Floristic element
1	<i>Lathyrus pancicii</i> (Jurišić) Adamović	Fabaceae	p	CR, BA2a	Bal
2	<i>Lathyrus pannonicus</i> (Jacq.) Garcke	Fabaceae	p		subMed-Sib
3	<i>Linum flavum</i> L.	Linaceae	p		subMed
4	<i>Oxytropis pilosa</i> (L.) DC.	Fabaceae	p		Eur-CAs
5	<i>Plantago maxima</i> Juss. ex Jacq.	Plantaginaceae	p	BA3	Eur-As
6	<i>Rubus saxatilis</i> L.	Rosaceae	sh		Eur-As
7	<i>Viola ambigua</i> Waldst. & Kit.	Violaceae	p		Eur-Sib

REFERENCES

- [1] Lovén S. L., Om nagra i Vettern och Venern funna Crustaceer, Öfvers. K. Vetensk. Akad. Förhandl., Stockholm, pp. 285–314 (1862) (in Swedish).
- [2] Birshstein Y. A., The term "relic" in biology, Zoologicheski Zhurnal 26(4), 313–330 (1947) (in Russian).
- [3] Vulf E. V., The concept of "relict" in botanical geography, Materials on the history of flora and vegetation of USSR, Moscow, Leningrad, pp. 28–56 (1941) (in Russian).
- [4] Hampe A. and Jump A. S., Climate Relicts: Past, Present, Future, Annual Review of Ecology, Evolution and Systematics 42, 313–333 (2011).
- [5] Habel J. C. and Assmann T. (Eds.), Relict species: Phylogeography and Conservation Biology, Springer-Verlag, Berlin, Heidelberg, p. 442 (2010).
- [6] Bhagwat S. A. and Willis K. J., Species persistence in northerly glacial refugia of Europe: a matter of chance or biogeographical traits? Journal of Biogeography 35, 464–482 (2008).
- [7] Yordanov D. (Main ed.), Flora of PR Bulgaria, Vol. 1–7, Publishing House of BAS, Sofia (1963–1979) (in Bulgarian).
- [8] Velchev V. (Ed.), Flora of PR Bulgaria, Vol. 8–9, Publishing House of BAS, Sofia (1982–1989) (in Bulgarian).
- [9] Velchev V. (Ed.), Red Data Book of PR Bulgaria, Vol. 1, Plants, Publishing House of BAS, Sofia, p. 447 (1984) (in Bulgarian).
- [10] Peev D., Kozuharov St., Anchev M., Petrova A., Ivanova D. and Tzoneva S., Biodiversity of Vascular Plants in Bulgaria, In: Curt Meine (Ed.), Bulgaria's Biological Diversity: Conservation Status and Needs Assessment, Volumes I and II, Washington, D.C., Biodiversity Support Program (1998).
- [11] Peev D. (Main ed.), Red Data Book of Republic of Bulgaria. Vol. 1. Plants and Fungi, IBER – BAS & MEW, Sofia, p. 888 (2011) (in Bulgarian).
- [12] Biserkov V. (Main ed.), Red Data Book of Republic of Bulgaria, Vol. 3. Natural habitats, IBER – BAS & MEW, Sofia, p. 458 (2011) (in Bulgarian).
- [13] Peev D., Petrova A., Apostolova I. and Asyov B. (Eds.), Important Plant Areas in Bulgaria, PENSOFT, Sofia–Moscow, p. 469 (2012) (in Bulgarian).
- [14] Peev D., National park Rila. Management plan 2001–2010, Adopted by Resolution №522 of Council of Ministers on 04.07.2001, Sofia, p. 337 (2001) (in Bulgarian).
- [15] Asyov B., Goranova V. and Stoykov D., Flora and fungal diversity of Vrachanski Balkan Natural Park, In: Management plan of Vrachanski Balkan Natural Park, Adopted by Resolution №570 of Council of Ministers on 14.10.2011, Agrolesproject Ltd., Sofia, p. 477 (2011) (in Bulgarian).
- [16] Bozhilova E., Koeva Y. and Tonkov S., Systematics of vascular plants, St. Kliment Ohridski Univ. Publ., Sofia, p. 320 (1992) (in Bulgarian).
- [17] Gruev B. and Kuzmanov B., General biogeography, St. Kliment Ohridski Univ. Publ., Sofia, p. 498 (1994) (in Bulgarian).

- [18] Petrova A., A contribution to the flora of East Bulgaria, *Phytologia Balcanica* 10(2–3), 201–205 (2004).
- [19] Tzonev R. and Karakiev T., *Plantago maxima* (Plantaginaceae): a relict species new for the Bulgarian flora, *Phytologia Balcanica* 13(3), 347–350 (2007).
- [20] Uzunova S. and Uzunov S., The plants in Strandzha Natural Park, State Forestry Agency, Directorate of Strandzha Natural Park, p. 215 (2008) (in Bulgarian).
- [21] Bozukov V. S. and Tsenov B. V., Catalogue of the Cenozoic plants of Bulgaria (Eocene to Pliocene). Addendum and Corrigendum, *Phytologia Balcanica* 18(3), 237–261 (2012).
- [22] Tashev A. N., Conservation importance of the dendroflora of the Pirin Mountain (Bulgaria), *Phytodiversity of Eastern Europe* 8(4), 4–13 (2014).
- [23] Domin K., Some Remarks on the Genesis of the Flora of Southern Slovakia, *Berichte der Schweizerischen Botanischen Gesellschaft* 46, 545–555 (1936).
- [24] Panetsos C. P., Natural hybridization between *Pinus halepensis* and *Pinus brutia* in Greece, *Silvae Genetica* 24(5–6), 163–168 (1975).
- [25] Fésűs I., Interaction Between Agriculture and Environment in Hungary, IUCN, Information Press, Oxford, p. 113 (1992).
- [26] Schlee M., Grimm G., Göker M., Sauer W. and Hemleben V., Molecular and phytosociological insight into postglacial relicts *Lathyrus pannonicus* and *Oxytropis pilosa* In: Habel J. (Ed.), *Phytogeography and Conservation of Postglacial Relicts*, Book of Abstracts, Luxembourg, pp. 31–32 (1997).
- [27] Bajzáth J., Plant macrofossils from Hungarian Pleistocene III. Palaeobotanical study in Győrújfalú, Western Hungary, *Annals Historico-Naturalis Musei Nationalis Hungarici* 90, 17–26 (1998).
- [28] Denk T., Frotzler N. and Davitashvili N., Vegetational patterns and distribution of relict taxa in humid temperate forests and wetlands of Georgia (Transcaucasia), *Biological Journal of the Linnean Society* 72, 287–332 (2001).
- [29] Galdean N., Needs assessment report for the Natural Park Iron Gates, Regional environmental center for Central and Eastern Europe local office Bucharest, Romania, p. 56 (2002).
- [30] Boža P., Anačkov G., Igić R., Vukov D. and Polić D., Flora “Rimskog šanca” (Vojvodina, Srbija), 8th Symposium on the flora of Southeastern Serbia and Neighbouring Regions, Niš, 20–24.06.2005, Abstracts, p. 55 (2005).
- [31] Demeter L., Pásztohy Z., Csörgő A.-M. and Cărauş I., Terrace ponds in the Ciuc Basin: a preliminary characterization, *Universitatea din Bacău, Studii și Cercetări, Biologie* 10, 19–23 (2005).
- [32] Thompson J. D., *Plant Evolution in the Mediterranean*, Oxford University Press, p. 293 (2005).
- [33] Andonovski V. and Pop-Stojanov D., Feasibility Study for the establishment of the National Park in the Macedonian side of Shara Mountain, Balkan Foundation for Sustainable Development, Skopje, p. 23 (2006).
- [34] Drescher A., Prots B. and Yena A. V., Notes on Crimean Flora (botanical excursion on the Crimean peninsula), *FRITSCHIANA, Veröffentlichungen aus dem Institut für Pflanzenwissenschaften, Bereich Systematische Botanik und Geobotanik, der Karl-Franzens-Universität Graz*, p. 71 (2007).
- [35] Lukash O., Distribution, cenotic characteristic and protection of habitats of plants of the Bern Convention in East Polesye, *Thaiszia–Journal of Botany Košice* 17, 33–58 (2007).
- [36] Nikolić L., Stojanov S. and Randelović N., The endemic and relict plants species in the valley of the River Pčinja, In: Trumić, M. (ed.), *Proceedings Ecological Truth, Serbia*, pp. 34–39 (2007).
- [37] Obratov-Petkovic D., Popovic I. and Dajic-Stevanovic Z., Diversity of the vascular flora of Mt. Zlata (Southwest Serbia), *EurAsian Journal of BioSciences* 5, 35–47 (2007).
- [38] Avramović D., Nikolić L., Zlatković B. and Randelović N., The proposal of rare plant species of the valley of river Pčinja nominated for protection, *Proceedings from 3 Congress of Ecologist of Macedonia with international participation and marking the 80-Anniversary of Prof. dr Ljupčo Grupče’s life and 60 years active scientific work*, Macedonian Ecological Society, Skopje, pp. 182–186 (2008).

- [39] Rakaj M., Floristic and chorological news from North Albania, *Botanica Serbica* 33(2), 177–183 (2009).
- [40] Stevanović V., Vukojičić S., Šinžar-Sekulić J., Lazarević M., Tomović G. and Tan K., Distribution and diversity of Arctic-Alpine species in the Balkans, *Plant Systematics and Evolution* 283(3–4), 219–235 (2009).
- [41] Jakšić P. and Momirović M., Contribution to understanding the origin and the genesis of the Nišava riverside valley fauna, *Biologica Nyssana* 1(1–2), 123–130 (2010).
- [42] Oprea A., Goia I., Tănase C. and Sîrbu C., Assessment of species composition: endemics, relicts and red-listed plants (tracheophytae, bryophytae and fungi) in forest natural habitats of Romania, *Contribuții Botanice XLV*, pp. 13–24 (2010).
- [43] Stanković M., Rarely, threatened and relict species in flora NPA “Zasavica”, 10th Symposium on the Flora of Southeastern Serbia and Neighbouring regions, Vlasina, 17–20 June 2010, Abstracts, pp. 66–67 (2010).
- [44] Murvanidze M., Mumladze L., Arabuli T. and Kvavadze E., Landscape distribution of oribatid mites (Acari, Oribatida) in Kolkheti National Park (Georgia, Caucasus), In: Moraes, G. J., H. Proctor (eds), *Acarology XIII: Proceedings of the International Congress, Zoosymposia* 6, 221–233 (2011).
- [45] Bank P., Bemmerlein-Lux F., Gagica I. and Hajredini E., Sustainable Development Atlas, Framework for a comprehensive and balanced rural development for the Municipality of Dragash / Dragaš Kosovo, Volume V: Data, Dragaš, Kosovo, p. 97 (2012).
- [46] Kaplan Z., Flora and Phytogeography of the Czech Republic, *Preslia* 84, 505–573 (2012).
- [47] Oprea A. and Sîrbu C., The vascular flora of Rarău Massif (Eastern Carpathians, Romania). Note I, *Memoirs of the Scientific Sections of the Romanian Academy*, Vol. XXXV, pp. 55–84 (2012).
- [48] Horatu P. E., Study on ecotourism development in transboundary region of Djerdap National Park and Porțile de Fier Nature Park in frame of Workpackage no. 6 of the Bioregio Carpathians Project, Final report, p. 110 (2014).
- [49] Valeriu-Ioan V., Contributions to the study of flora in the Orăștie River BASIN (Central-Western Romania), *Analele Universității din Oradea, Fascicula Protecția Mediului*, Vol. XXII, pp. 103–110 (2014).
- [50] Velitzelos D., Bouchal J. M. and Denk T., Review of the Cenozoic floras and vegetation of Greece, *Review of Palaeobotany and Palynology* 204, 56–117 (2014).
- [51] Angiosperm Phylogeny Group, An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III, *Botanical Journal of the Linnean Society* 161(2), 105–121 (2009).
- [52] Bern Convention, Convention on the Conservation of European Wildlife and Natural Habitats, Appendix I, 2002, <http://conventions.coe.int/Treaty/FR/Treaties/Html/104-1.htm> (accessed 30 December 2015).
- [53] Convention on International Trade in Endangered Species of Wild Fauna and Flora, Appendix II, 2009, <http://www.cites.org/eng/app/appendices.shtml> (accessed 30 December 2015).
- [54] Directive 92/43/EEC, Council Directive 92/43/EEC of 21 May 1992 on the Conservation of Natural Habitats and of Wild Fauna and Flora, Appendix II, OJ L 206, 22.07.1992.
- [55] Biodiversity Act of Republic of Bulgaria, State Gazette number 77, 9 August 2002, pp. 9–42. Last amended in State Gazette number 27, 15 March 2013 (in Bulgarian).

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