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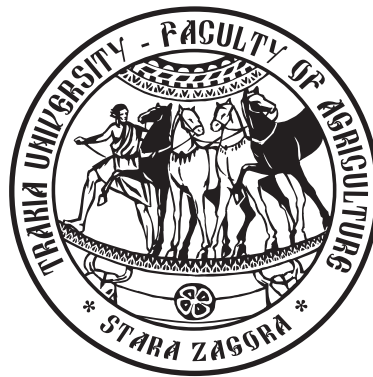
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Ecological analysis of the flora in the 'Chinarite' protected area - Rodopi municipality, Bulgaria

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Abstract. The aim of the present study was to make an ecological analysis of the floristic composition in the protected area 'Chinarite' Rodopi municipality, Bulgaria in terms of its biological spectrum, biological types and phytogeographic elements and an assessment of the anthropogenic effect on it. In studied protected area were identified 147 species of vascular plants, of them 8 species included in the Red List of Threatened Species of the International Union for Conservation of Nature (IUCN). 73 medicinal species, 55 nectariferous plants and 10 tertiary relicts were recorded. The anthropogenic impact on the protected area is obvious and it has affected to the greatest degree the species composition of vascular plants, which encompasses a large number of weeds - 28 species, ruderals - 29 species, alien - 5 species and invasive - 6 species.

Keywords: *Platanus orientalis* L., protected area, conservation value, medicinal species, nectariferous plants

Introduction

The protected area 'Chinarite' is situated in the territory of the village of Belashtitsa, Rodopi municipality, Plovdiv region, Central South Bulgaria. It is located at an altitude of 286 m at the border between the Upper Thracian Lowland and the very foothills of the mountain. It is a part of the geographical area 'Rodopska Yaka' at the northern foothill of 'Chernaliitsa' ridge of the Western Rhodopes. The protected area is spread on 11 309 da. According to the classification of Velchev (2002), vegetation in the studied area belongs to the Mediterranean type, the European deciduous forest area, Macedonia and Thrace province, the Upper Thracian Lowland region, Plovdiv district.

Biogeographical classification of Bulgarian vegetation (Asenov, 2006) attributes the protected area to the Upper Thracian biogeographical region. The author notes that there are Oriental plane forests in that region, growing along the right tributaries of the Maritsa River, at the foot of the Rhodope Mountains.

In the 'Guidelines for identifying habitats of European importance in Bulgaria' (2008) the *P. orientalis* forests (PAL.CLASS.: 44.711) are defined mainly as riparian, dominated by *P. orientalis*, belonging to *Platanion orientalis* alliance.

As a Mediterranean representative, spreading in the region of Central European deciduous forests with the riparian communities, the plane trees commonly form monodominant phytocenoses.

The aim of the present study was to make an ecological analysis of the floristic composition in the protected area 'Chinarite' and an assessment of the anthropogenic effect on it.

Material and methods

The biological spectrum of the life-forms of the studied flora was classified according to Raunkiaer (1937) and Gorishina (1979).

'Synopsis of Higher Flora of Bulgaria' (Assyov and Petrova, 2012) was used for determining the chorology and floral elements.

'Red Book of the Republic of Bulgaria' (Peev, 2011); Biological Diversity Act of the Republic of Bulgaria (2002); 'Red List of Bulgarian vascular plants' (Petrova and Vladimirov, 2009); the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 1975); List of Rare Threatened and Endemic Plants in Europe (Lubenova et al., 1983); IUCN: Red List of Threatened Species (2015) and Bern Convention (1979) were used as reference books and documents for identifying the species with conservation value.

The plants with healing power were identified in accordance with the Law of medical plants in Bulgaria (2000).

Nectariferous plants were determined according to Tashev and Pancheva (2009).

The invasive species were identified according to the 'List of the Worst Invasive Alien Species Threatening Biological Diversity in Europe' (2007).

Results and discussion

Biological Types

In the flora of the protected area 'Chinarite' were found 128 species of grassy plants, i.e. 88.3% of the identified taxa. Out of the six biological groups of grassy plants, the largest share is occupied by the perennial species (65.6%), followed by the annual (22.6%), annual or biennial (7.8%) and biennial species (2%). Trees and shrubs are 6.9% and 2% of the total number of species, respectively (Figure 1). No species belonging to the group of semi-shrubs were found in the studied area.

The high percentage of perennial plants is a typical characteristic of forest communities (Lubenova et al., 1983; Radoukova, 2008a).

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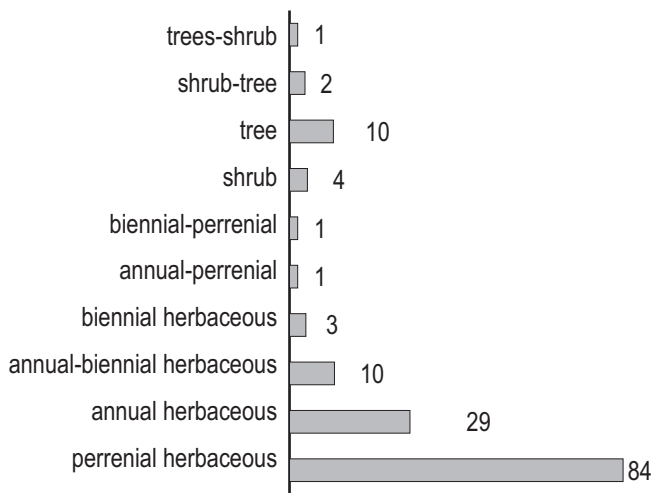


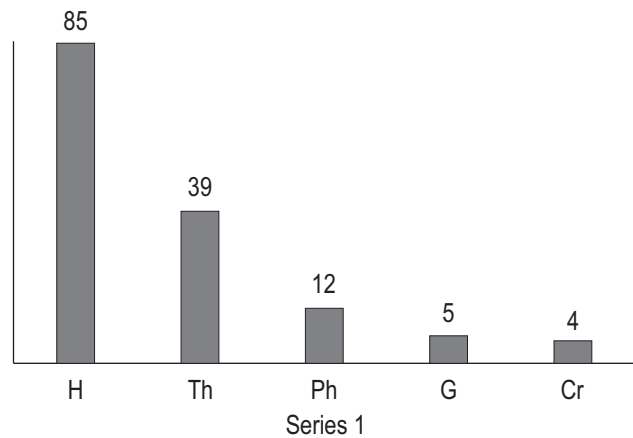
Figure 1. The distribution of the plants by biological types in protected area 'Chinarite', Rodopi Municipality, Bulgaria

The families in the studied area, richest in species, are dominated by perennial grassy species, followed by annual grassy species: *Poaceae* (13 perennial and 9 annual species), *Asteraceae* (11 perennial and 9 annual), The families in the studied area, richest in species, are dominated by perennial grassy species, followed by annual grassy species: *Poaceae* (13 perennial and 9 annual species), *Asteraceae* (11 perennial and 9 annual), *Lamiaceae* (10 perennial and one annual or biennial). Trees and shrubs belong to 17 genera and 14 families.

Transient biological types (annual-perennial, biennial-perennial, tree-shrub) are represented by one species and shrub-tree – by two species.

Biological Spectrum

The predominant life-form in the biological spectrum of the studied area is that of hemicryptophytes – 58.6% of the total number of plants, followed by therophytes – 26.9% and phanerophytes – 8.2% (Figure 2). According to Raunkiaer (1934) such distribution is called a 'climate of hemicryptophytes' which is typical of the temperate and cold zones.



*H - Hemicryptophyta; Th - Therophyta; Ph - Phanerophyta; G - Geophyta; Cr - Criophyta

Figure 2. Biological spectrum of the protected area 'Chinarite', Rodopi Municipality, Bulgaria.

Comparing the biological spectra of the protected area 'Chinarite' (Table 1) and of Bulgaria as a whole (Bondev, 1991), show that they are close and are typical of the temperate continental flora.

Table 1. Comparison of the biological spectrum of the protected area "Chinarite" and Bulgaria

Live forms %	Ph	H	Cr	Th
Protected area "Chinarite"	8.2	58.6	6.2	26.9
Bulgaria	11.61	55.27	6	27

* Ph - Phanerophyta; H - Hemicryptophyta; Cr - Criophyta; Th - Therophyta

Phytogeographical Analysis

A wide diversity of flora elements is found in the phytogeographical spectrum of the protected area 'Chinarite', which is due to the special geographical location of the territory and the landscape characteristics (Figure 3). The predominant phytogeographical element is Eurasian (22.8%), which indicates

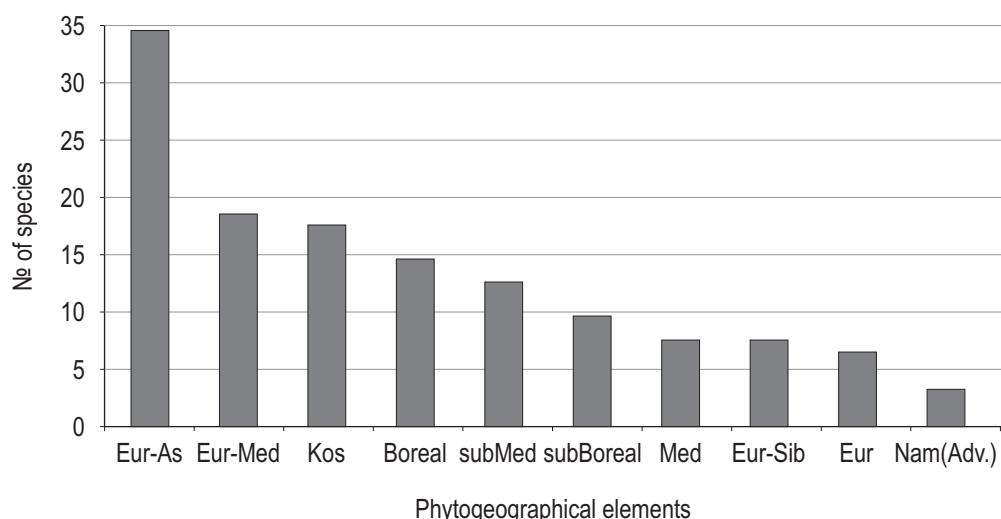


Figure 3. Basic phytogeographical elements in flora of protected area "Chinarite", Rodopi Municipality, Bulgaria

Appendix 1. Medicinal and nectariferous plants in protected area "Chinarite"

N	Taxon	Medicinal	Nectariferous	N	Taxon	Medicinal	Nectariferous
1	<i>Acer pseudoplatanus</i> L.		+	46	<i>Lythrum salicaria</i> L.	+	+
2	<i>Agrimonia eupatoria</i> L.	+		47	<i>Malva sylvestris</i> L.	+	+
3	<i>Alliaria petiolata</i> (M.Bieb.) Cavara&Grande	+		48	<i>Marrubium vulgare</i> L.		+
4	<i>Allium scorodoprasum</i> L.	+		49	<i>Medicago sativa</i> L.		+
5	<i>Anemone ranunculoides</i> L.	+	+	50	<i>Melilotus alba</i> Medic.	+	+
6	<i>Anthriscus sylvestris</i> (L.) Hoffm.		+	51	<i>Melissa officinalis</i> L.	+	+
7	<i>Aristolochia clematitis</i> L.	+		52	<i>Mentha longifolia</i> (L.) Huds.	+	+
8	<i>Artemisia vulgaris</i> L.	+		53	<i>Onopordum acanthium</i> L.	+	+
9	<i>Arum maculatum</i> L.	+		54	<i>Origanum vulgare</i> L.	+	+
10	<i>Aegopodium podagraria</i> L.		+	55	<i>Paliurus spina-christi</i> Mill.	+	+
11	<i>Ballota nigra</i> L.	+	+	56	<i>Parietaria officinalis</i> L.	+	
12	<i>Bellis perennis</i> L.	+	+	57	<i>Persicaria lapathifolia</i> (L.) Gray		+
13	<i>Berteroa incana</i> (L.) DC		+	58	<i>Petasites albus</i> Gaerth.	+	+
14	<i>Campanula glomerata</i> L.		+	59	<i>Plantago lanceolata</i> L.	+	+
15	<i>Cannabis sativa</i> L.	+		60	<i>Plantago major</i> L.	+	
16	<i>Capsella bursa-pastoris</i> (L.) Medik	+	+	61	<i>Plumbago europaea</i> L.	+	
17	<i>Cardaria draba</i> (L.) Desv.		+	62	<i>Potentilla argentea</i> L.	+	+
18	<i>Carthamus lanatus</i> L.	+		63	<i>Potentilla reptans</i> L.	+	
19	<i>Celtis australis</i> L.	+		64	<i>Prunella vulgaris</i> L.	+	+
20	<i>Centaurea solstitialis</i> L.	+		65	<i>Prunus cerasifera</i> Ehrh.		+
21	<i>Chaerophyllum temulentum</i> L.	+		66	<i>Ranunculus ficaria</i> L.	+	+
22	<i>Chelidonium majus</i> L.	+		67	<i>Robinia pseudoacacia</i> L.		+
23	<i>Cichorium intybus</i> L.	+	+	68	<i>Rubus caesius</i> L.	+	+
24	<i>Cirsium arvense</i> (L.) Scop.		+	69	<i>Salix alba</i> L.	+	+
25	<i>Clematis vitalba</i> L.	+	+	70	<i>Salix fragilis</i> L.		+
26	<i>Clinopodium vulgare</i> L.	+	+	71	<i>Salvia sclarea</i> L.	+	+
27	<i>Convolvulus arvensis</i> L.	+	+	72	<i>Sambucus ebulus</i> L.	+	+
28	<i>Cornus mas</i> L.	+	+	73	<i>Sambucus nigra</i> L.	+	+
29	<i>Corylus avellana</i> L.	+	+	74	<i>Sanguisorba officinalis</i> L.	+	
30	<i>Equisetum arvense</i> L.	+		75	<i>Solanum nigrum</i> L.	+	+
31	<i>Eryngium campestre</i> L.	+	+	76	<i>Stellaria media</i> (L.) Vill.	+	+
32	<i>Euphorbia cyparissias</i> L.	+		77	<i>Taraxacum officinale</i> F.H.Wigg	+	+
33	<i>Fraxinus oxycarpa</i> Willd.	+	+	78	<i>Teucrium chamaedrys</i> L.	+	+
34	<i>Fumaria officinalis</i> L.	+		79	<i>Thamus communis</i> L.	+	
35	<i>Galium aparine</i> L.	+		80	<i>Thlaspi arvense</i> L.	+	
36	<i>Geranium pyrenaicum</i> Burm.f.	+		81	<i>Tordylium maximum</i> L.	+	
37	<i>Geranium robertianum</i> L.	+		82	<i>Torilis nodosa</i> (L.) Gaertn.	+	
38	<i>Geum urbanum</i> L.	+		83	<i>Tussilago farfara</i> L.	+	+
39	<i>Hedera helix</i> L.	+		84	<i>Ulmus laevis</i> Pall.		+
40	<i>Hypericum perforatum</i> L.	+	+	85	<i>Verbena officinalis</i> L.	+	+
41	<i>Juglans regia</i> L.		+	86	<i>Veronica anagallis-aquatica</i> L.	+	
42	<i>Juncus inflexus</i> L.	+	+	87	<i>Vinca herbacea</i> Waldst&Kit	+	+
43	<i>Lactuca serriola</i> L.	+		88	<i>Xanthium strumarium</i> L.	+	
44	<i>Lamium purpureum</i> L.	+	+		Total	73	55
45	<i>Leonurus cardiaca</i> L.	+	+				

that the flora is typical of the transitional continental climate of the region and it is consistent with the major trends of the spread of the flora of South Bulgaria. The European-Mediterranean elements also occupy a significant share (12.4%), as well as the cosmopolitan species (11.7%).

According to Bondev (1991) the most widely spread species in Bulgarian flora are the Eurasian (31.5%) and the European (21.34%), followed by the European-North American (9.25%), cosmopolitan or almost cosmopolitan (5.34%), Mediterranean (about 4%) and less represented are species with another distribution.

Conservation Value of the Studied Flora

Plants with conservation value, the endemic and relict species are among the most specific and often the most vulnerable groups of plants (Gusev et al., 2004; Radoukova, 2008b). Still, at a regional level in Bulgaria, there is a great lack of information about the spread and the population status of species from those three groups (Zahariev and Behchet, 2014; Lacheva and Radoukova, 2014).

Checking the conservation value of the plant species found in the studied area in the major legal documents shows that there are 8 species included in the Red List of Threatened Plants of the International Union for Conservation of Nature /IUCN/ (*Carex*

Appendix 2. Distribution of the taxon in dependence with the Anthropogenic Impact on the Protected Area 'Chinarite'

N	Taxon	Weed	Ruderal	Alien	Invasive
1	<i>Artemisia vulgaris</i> L.		+		
2	<i>Aristolochia clematitis</i> L.	+			
3	<i>Ballota nigra</i> L.		+		
4	<i>Bromus sterilis</i> L.		+		
5	<i>Camelina rumelica</i> Velen.	+			
6	<i>Cannabis sativa</i> L.			+	
7	<i>Capsella bursa-pastoris</i> (L.) Medic.	+	+		
8	<i>Cardamine hirsuta</i> L.	+			
9	<i>Carthamus lanatus</i> L.		+		
10	<i>Cichorium intybus</i> L.	+	+		
11	<i>Cirsium arvense</i> (L.) Scop.	+	+		
12	<i>Convolvulus arvensis</i> L.	+			
13	<i>Conyza canadensis</i> (L.) Cronquist	+	+	+	+
14	<i>Cynodon dactylon</i> (L.) Pers.	+	+		
15	<i>Dactylis glomerata</i> L.		+		
16	<i>Echinochloa crusgalli</i> (L.) P.Beauv.			+	+
17	<i>Equisetum arvense</i> L.	+			
18	<i>Erigeron annuus</i> (L.) Pers.			+	+
19	<i>Fumaria officinalis</i> L.	+			
20	<i>Galium aparine</i> L.	+	+		
21	<i>Hedera helix</i> L.		+		
22	<i>Lactuca serriola</i> L.	+			
23	<i>Lamium purpureum</i> L.	+			
24	<i>Lythrum salicaria</i> L.		+		
25	<i>Malva sylvestris</i> L.	+	+		
26	<i>Medicago sativa</i> L.			+	
27	<i>Onopordum acanthium</i> L.		+		
28	<i>Parietaria officinalis</i> L.		+		
29	<i>Persicaria lapathifolia</i> (L.) Gray	+	+		
30	<i>Poa bulbosa</i> L.	+	+		
31	<i>Robinia pseudoacacia</i> L.			+	+
32	<i>Rubus caesius</i> L.		+		
33	<i>Rumex crispus</i> L.		+		
34	<i>Rumex pulcher</i> L.	+			
35	<i>Sambucus ebulus</i> L.	+	+		
36	<i>Setaria verticillata</i> (L.) P.Beauv.	+			
37	<i>Setaria viridis</i> P.Beauv.	+			
38	<i>Sherardia arvensis</i> L.	+			
39	<i>Solanum nigrum</i> L.		+		
40	<i>Sorghum halepense</i> (L.) Pers.	+			
41	<i>Stellaria media</i> (L.) Vill.	+	+		
42	<i>Taraxacum officinale</i> F.H.Wigg.		+		
43	<i>Thlaspi arvense</i> L.	+	+		
44	<i>Tragopogon dubius</i> Scop.		+		
45	<i>Urtica dioica</i> L.	+	+		
46	<i>Verbascum sinuatum</i> L.		+		
47	<i>Veronica hederifolia</i> L.	+			
48	<i>Veronica verna</i> L.	+			
49	<i>Xanthium italicum</i> Moretti		+	+	+
50	<i>Xanthium strumarium</i> L.			+	+
	Total	28	29	8	6

distans L., *Carex remota* L., *Galium palustre* L., *Juncus inflexus* L., *Lythrum salicaria* L., *Mentha longifolia* L. Huds., *Platanus orientalis* L., *Salix alba* L.), all of them with an exception of *P. orientalis* (which is of Lower Risk) are in category Least Concern.

Endemic plants were not identified in the studied area, but there are 10 tertiary relicts: *Acer pseudoplatanus* L., *Hedera helix* L., *Corylus avellana* L., *Platanus orientalis* L., *Clematis vitalba* L., *Salix*

alba L., *Salix fragilis* L., *Rumex crispus* L., *Celtis australis* L., *Ulmus laevis* Pall. They represent 6.8% of the total number of species in the protected area 'Chinarite', which indicates the original character of the studied flora.

Medicinal and nectariferous species

73 medicinal plant species or 49.6% of the total number of

species in the protected area 'Chinarite' are established. The nectariferous species are 55 or approximately 43% of the total number of species and 71.4% of the established medicinal plants in the investigated area (Appendix 1).

Out of the identified medicinal taxa 8 have conservation value (4 are in IUSN and 4 are endemic). With the exception of *J. inflexus*, those species assign also to a category of nectariferous species, to which are include also four of the relict species – *A. pseudoplatanus*, *S. fragilis*, *C. australis* and *U. laevis*.

Assessment of the Anthropogenic Impact on the Protected Area

The protected area 'Chinarite' is subject to an increased anthropogenic pressure because of its close proximity to private properties located around its borders. A chapel and a place for recreation and picnics have been constructed in the territory of the protected area. During the site visits we found that private vehicles entered and the human activities directly or indirectly affected the flora of the studied area. Disposal of household and industrial waste on a small area of the territory was also established, which contradicts all the legislative documents and has an extremely negative impact on plant diversity.

Sheep and cattle are grazing mainly along the borders, but also within the protected area and, though small in number, the animals have an impact on the more sensitive elements of the flora components by trampling and grazing.

There are neither permanent nor temporary guards in the protected area.

The established human activities and the strongly clumped canopy of the plane forest are the most likely reason for the availability of a large number of weed species (28 species) and ruderals (29 species) in the protected area, which represent 29.3% of the total number of identified species (Appendix 2).

Eight alien species were found in the flora of the protected area 'Chinarite'. The invasive species in the protected area are six, one of which *Robinia pseudoacacia* L. being included in the List of most dangerous invasive alien species, threatened biodiversity of Europe (2007). This represents 4.1% of all the species identified in the studied area and 12% of the total number of invasive species in Bulgaria.

The relatively large number of anthropophytes and apophytes is an indicator of the direct anthropogenic impact on the studied area.

The typical apophytes identified in the present study are: *Artemisia vulgaris* L., *Bellis perennis* L., *Cardaria draba* (L.) Desv., *Chelidonium majus* L., *Cynodon dactylon* (L.) Pers., *Sambucus nigra* L., *Urtica dioica* L., etc. The typical anthropophytes are: *Arum maculatum* L., *Aristolochia clematidis* L., *Capsella bursa-pastoris* (L.) Medik., *Carthamus lanatus* L., *Centaurea solstitialis* L., *Cichorium intybus* L., *Cirsium arvense* (L.) Scop., *Convolvulus arvensis* L., *Erigeron annuus* (L.) Pers., *Ficus carica* L., *Galium aparine* L., *Geum urbanum* L., *Hypericum perforatum* L., *Malva sylvestris* L., *Marrubium vulgare* L., *Morus nigra* L., *Parietaria officinalis* L., *Plantago major* L., *Prunus cerasifera* Ehrh., *Rubus caesius* L., *Setaria viridis* P.Beauv., *Stellaria media* (L.) Vill. *Solanum nigrum* L., *Sonchus oleraceus* L., *Tordylium maximum* L., *Tragopogon dubius* Scop, etc.

Similar data about the strong anthropogenic impact on the plane tree communities located close to settlements are mentioned in the 'Guidelines for Identifying Habitats of European Importance in Bulgaria', according to which ruderal species, such as *Urtica dioica* L., *Sambucus ebulus* L., *Parietaria officinalis* L., *Xanthium strumarium* L., *Arctium lappa* L., *Poa bulbosa* L., etc., are very often

dominating in the herbaceous layer.

Conclusion

Hemicryptophytes and therophytes dominate in the biological spectrum of the protected area 'Chinarite', characterizing the studied flora as moderate continental with a pronounced Mediterranean character. The Eurasian, European-Mediterranean, cosmopolitan, boreal and sub-Mediterranean floristic elements are the major part of the species composition of the studied area. The inventory conducted for the assessment of the conservation value of the flora showed that there are 8 species included in the Red List of Threatened Species (IUCN) and 10 tertiary relicts. *P. orientalis* is the species with the highest conservation value, included in IUCN, in the Red Book of Bulgaria (2011) and in the Biological Diversity Act of the Republic of Bulgaria (2002). The anthropogenic impact on the protected area is obvious and it has affected to the greatest degree the species composition of vascular plants, in which there is a large number of weeds, ruderals, alien and invasive species.

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Reviews

- Problems and achievements of cotton (*Gossypium Hirsutum* L.) weeds control** 179
T. Barakova, G. Delchev
- Achievements and problems in the weed control in grain sorghum (*Sorghum Bicolor* Moench.)** 185
G. Delchev, M. Georgiev

Genetics and Breeding

- Parthenogenetic responsiveness of sunflower hybrid combinations with expressed tolerance to herbicides** 190
M. Drumeva, P. Yankov
- In vitro propagation of oil-bearing rose (*Rosa damascena* Mill.)** 194
V. Badzhelova

Nutrition and Physiology

- Variation in the chemical composition and physical characteristics of grain from winter barley varieties** 198
B. Dyulgerova, N. Dyulgerov, D. Dimova
- Haematological and serum biochemical indices of broiler chickens fed raw sickle pod (*Senna obtusifolia*) seed meal** 203
C. Augustine, I.D. Kwari, J.U. Igwebuike, S.B. Adamu
- Prey size selectivity of pikeperch (*Sander Lucioperca* L.) fed with topmouth gudgeon (*Pseudorasbora Parva* Temminck & Schlegel)** 209
M. Gevezova-Kazakova, M. Yankova, T. Hubenova, A. Zaikov, G. Rusenov
- Influence of organic nitrogen amendment, containing amino acids on the cellulase and xylanase, produced by *Trichoderma* spp. isolates** 213
D. Draganova, I. Valcheva, Y. Kuzmanova, M. Naydenov

Production Systems

- Justification of a method for determining the moment for switching on the level one signaling of filled grain harvester hoppers** 218
G. Tihanov, B. Kolev, K. Trendafilov, N. Delchev, Y. Stoyanov
- Mathematical approaches for assessment and classification of the European Union member states based on the average yield of vegetables for the period 1961-2014** 223
N. Keranova

Present status of *Zymoseptoria tritici* (*Mycosphaella graminicola* /Fuckel/ Schroter) of the wheat cultures in the Republic of Macedonia 227

I. Karov, E. Arsov

Agriculture and Environment

Influence of basic agrotechnical activities on the productivity and yield of *Triticum monococcum* L. 230

S. Stamatov, K. Uzundzhalieva, E. Valchinova, G. Desheva, P. Chavdarov, B. Kyosev, T. Cholakov, R. Ruseva, N. Velcheva

Avifauna abundance and diversity in Jos wildlife park, Nigeria 234

B.T. Kwaga, D. Iliya, A. Ali, D. Khobe

Ecological analysis of the flora in the 'Chinarite' protected area - Rodopi municipality, Bulgaria 240

L. Dospatliev, M. Lacheva

Product Quality and Safety

Food emulsions with amidated pectin from celery (*Apium graveolens* var. *rapaceum* D. C.) tubers 246

Iv. Petrova, N. Petkova, M. Ognyanov, Ap. Simitchiev, M. Todorova, P. Denev

Sensory and instrumental texture analysis of Bulgarian commercial pates 251

M. Tonchev, T. Atanasov, A. Todorova, Ts. Atanasova, N. Shtrankova, M. Momchilova G. Zsivanovits

Short Communication

Influence of elevated platform (wire-mesh or wooden) in the cage on domestic rabbit (*Oryctolagus cuniculus*) activity 257

S. Peeva, E. Raichev, D. Georgiev, A. Stefanov

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