ECOLOGIA BALKANICA
2019, Vol. 11, Issue 2 December 2019 pp. 181-191

Analysis of Anthropophitic Flora on the Territory of Lozenska Mountain, Bulgaria

Plamen Glogov[1], Dolja Pavlova[2], Mira Georgieva[1], Vania Kachova[1]*

1 - Forest Research Institute – Bulgarian Academy of Sciences,
Bulvd. Kliment Ohridski 132. Sofia 1756 BULGARIA
2 - University of Sofia, Faculty of Biology, Department of Botany,
Bulvd. Dragan Tzankov 8, Sofia 1164 BULGARIA
[*]Corresponding author: pglogov@abv.bg

Abstract. The aim of the study is to analyze the taxonomical structure, origin and distribution of the anthropophytic element on the territory of Lozenska Mts. and to assess the degree of synanthropization of the flora. The study was carried out in the period 2016-2018. During the field studies the transect method was applied for collection and identification of the plant material. In view of possible comparisons and calculations of the synanthropic indice the surveyed area was divided into 4 sub-regions. On the territory of the Lozenska Mts. 274 species and 8 subspecies from 196 genera and 57 families were found. The anthropophytes are predominantly therophytes. In phytogeographical terms the character of the anthropophytic flora can be described as European-Asiatic with a strong boreal and less sub-mediterranean influence. Four species of nature conservation status were identified among the anthropophytes. The antropophytes of Lozenska Mts. are 33.3% of its vascular flora and almost twice of the same group of plants in the flora of Bulgaria (14,0%). The north-eastern part of the mountain is most affected by the synanthropic processes and less affected is the north-western part. For the period 1961-2018 the percentage of the anthropophytes in the surveyed area is increased by 7.2%, while the participation of the autochthonous species is decreased by 3.8%. The high values of calculated indices of synanthropization show the intensification of this process on the territory of the mountain.

Key words: synanthropization, anthropophytes, autochthonous flora, ecological groups, Lozenska Mts.

Introduction

The Lozenska Mountain is a part of the Floristic Region Western Sredna Gora with a height of 1195 m and an approximate area of 90 m^2. About 14.3% of its territory enter into NATURA 2000 areas. With its proximity to the capital, the mountain is a valuable site from a commercial and recreational point of view. At the same time, the negative human impacts associated with unregulated felling, grazing and others contributing to the erosion processes and droughts are a major cause of the increased processes of xerophytisation and degradation of plant communities which was registered more than 50 years ago in the first large-scale mountain vegetation study by GANCHEV (1961). In spite of the constant and high anthropogenic pressure, the study of the impact and spread of anthropophytes on the

territory of the Lozenska Mountain, the risk of synanthropization and the reduction of autochthonous species in its floristic complex has not been carried out until now. Collecting and updating of the information on these species is important for the genesis of its local flora and for the control and management of ecosystems (PETROVA & VLADIMIROV, 2001).

The aims of the present study are:

1. Analysis of the diversity of anthropogenic elements, their distribution and origin on the territory of the Lozenska Mountain;

2. An assessment of the degree of synanthropization of its flora.

Material and Methods

Lozenska mountain is part of Sredna gora floristic region. It is situated in Southwest Bulgaria close to Sofia city and covers 80 sq.km area. The highest elevation mountain rises at 1190 m a.s.l. (Popov Del Peak). Variety of rocks are revealed on the slopes of the mountain: sandstone mainly on the norhtern slopes and metamorphyc rocks on the southern slopes. Limestones and dolomites form a part of the ridge of the mountain peak of Bachul, Rakovica mound, Lalina mogila and Polovrak. The predominant soil types in the mountain are Chromis Cambisols and Humic Cambisols. The climate is characterized by relatively mild winters, low annual temperature amplitudes and two periods of maximum rainfall over the year. The average annual temperature is 9.3 ° C and the annual precipitation is 590.7 mm.

The survey was conducted in the period 2016 - 2018. During the field studies, the transect method for species identification was used. Based upon the fieldwork experience in the previous floristic investigation of the Lozenska Mountain (GLOGOV & DELKOV, 2016) and after the preliminary observation of the whole territory during the present study 19 transects (averaged from 3,6 to 4,8 km each) were set up (Fig. 1) are selected to encompass a maximum area and representative areas of habitat diversity. The terrains in the height range of 600 m to 1190 m a. s. l. were inventoried. Various habitats have been investigated - forests of different vegetation types and stages of succession, wet meadows, places around streams, river banks, villas zones as well as areas affected by anthropogenic activity.

The principles and the methodical approach of the present research and analysis follow the generally accepted practice of floristic studies in foreign and Bulgarian literary sources (KAMELIN, 1973; TOLMACHOV, 1986; ĆWIKLIŃSKI, 1970; WOJCIKOWSKA & MOYSIYENKO, 2008; PAVLOVA & GEORGIEVA, 2015; *etc.*). The taxonomic nomenclature and determination of plant taxon follow KOJUHAROV (1992); DELIPAVLOV & CHESHMEZHDIEV (2003) and "Flora of Bulgaria" - Vol. I-XI. (1963-2012). Life forms follow the classification of RAUNKIAER (1934). Floristic elements are according ASYOV & PETROVA (2012). Anthropophytes list follows STEFANOV & KITANOV (1962), PETROVA & VLADIMIROV (2001), etc. The conservation status of species is in line with Directive 92/43/EEC (EC, 1992), CITES (2009), BDA (2007), Red Book of Bulgaria (PEEV, 2015), IUCN, Red List of Bulgarian Vascular Plants (PETROVA & VLADIMIROV, 2009). Ecological groups are according PAVLOV (1998). Invasive alien species follow PETROVA *et al*. (2013).

In view of possible comparisons and calculations of the synanthropization indexes, the studied area is divided into subareas considering the geomorphological characterization of the mountain and the physico-geographic distribution of two parts - north and south-east (IVANOV *et al*., 1969). Due to the greater area of the northern part, the difference in slope exposure and the soil specificity, the northern part is conventionally divided into three sub-areas with approximately the same area as the main boundary passes along the ridge of the mountain (Fig. 2). The fourth subarea corresponds to the southeastern part according

to the division of IVANOV *et al*., (1969). These 4 subareas in the present study will be named as follows: Part I (northwestern subarea); Part II (northeastern subarea); Part III (southwestern subarea); Part IV (southeastern subarea) (Fig. 1).

The floristic synanthropization indexes (S1) are calculated using the formula by WYSOCKI & SIKORSKI (2002):

$$S1 = (Ap + A)/C \cdot 100, \%$$

where: Ap - number of apophytes;
A - number of anthropophytes;
C - total number of species in individual plots (or the entire territory of the mountain).

Results

Taxonomical structure

As a result of the study, 274 species and 8 subspecies of 196 genera and 57 families were established (Table 1). They represent 48.7% of the anthropophytes in the flora of Bulgaria - 563 species (PETROVA & VLADIMIROV, 2001). The relation number of autochthonous species: number of apophytes: number of anthropophytes in 1961 (GANCHEV, 1961) was 43.0: 30.9: 26.1, and in 2018, it is: 39.2: 27.5: 33.3. The most anthropophytes (76.6%) from their total number on the territory of the mountain are registered in its Southwestern part, and the smallest number (47.8%) is found in its Northeastern part. At the same time, the highest percentage of the flora of each part of the mountain is the anthropophytes in its Northeastern part (37%) and the lowest those in the Northwest (31.7%). 66.4% of the anthropophytes are present in all parts, 8% in only three of the parts and 4.7% in only two of the parts.

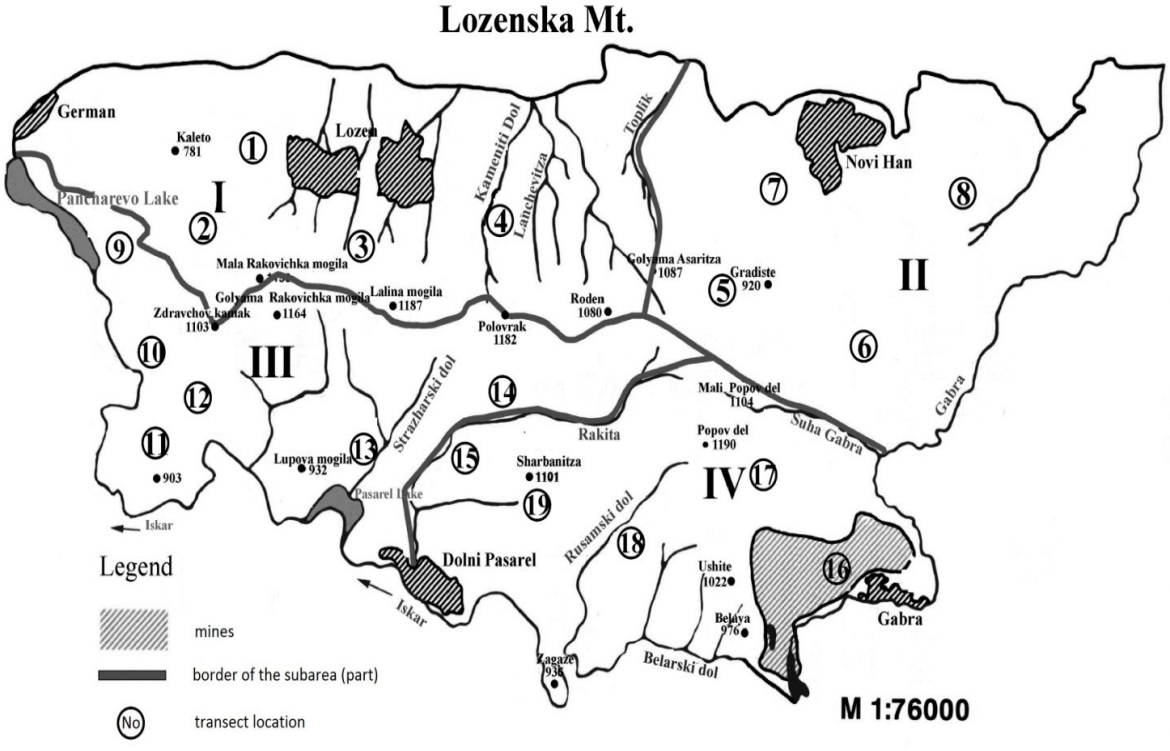

Fig. 1. Map of Lozenska Mts. with regions and transects.

Table 1 Taxonomic structure of anthropophyte flora of the Lozenska Mountain.

Area	Taxonomic range	Lycopodiophyta		Equisetophyta		Polypodiophyta		Pinophyta		Magnoliophyta				Total	
										Liliopsida		Magnoliopsida		Anthrophytes (% of the entire flora of the mountain and total number anthrophytes)	
		Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
Part 1	fam.	0	0	1	2	1	2	0	0	5	11	40	85	47	82.5
	gen.	0	0	1	1	1	1	0	0	16	12	115	87	133	67.9
	sp.	0	0	1	1	1	1	0	0	20	12	150	87	172	62.8
Part 2	fam.	0	0	0	0	1	3	0	0	3	8.1	33	89	37	64.9
	gen.	0	0	0	0	1	1	0	0	11	11	91	88	103	52.6
	sp.	0	0	0	0	1	1	0	0	16	12	105	80	131	47.8
Part 3	fam.	0	0	1	2	1	2	1	0	4	8.2	45	92	49	86.1
	gen.	0	0	1	1	1	1	1	0	16	10	139	88.1	158	80.6
	sp.	0	0	1	1	1	1	1	0	23	11	184	88.3	209	76.3
Part 4	fam.	0	0	1	2	1	2	1	0	4	8.9	38	84	45	78.9
	gen.	0	0	1	1	1	1	1	0	15	12	111	86	129	65.8
	sp.	0	0	2	1	1	1	1	0	21	12	146	85	171	62.4
Lozenska mountain 2018	fam.	0	0	1	2	1	2	1	1.8	5	7	49	54	57	62.6
	gen.	0	0	1	1	1	1	1	0.5	21	11	172	88	196	48.3
	sp.	0	0	2	1	1	1	1	0.7	30	11	240	88	274	33.3
Lozenska mountain 1961	fam.	0	0	1	3	1	3	0	0	4	11	30	83	36	50.7
	gen.	0	0	1	1	1	1	0	0	13	13	86	85	101	34.1
	sp.	0	0	2	1	1	1	0	0	23	15	128	83	154	26.1

Seven of the richest anthropophyte families determined on the territory of the mountain (*Asteraceae, Poaceae, Fabaceae, Brassicaceae, Chenopodiaceae, Caryophyllaceae and Scrophulariaceae*) match with the list of leading families from territory of all country (PETROVA & VLADIMIROV, 2001). The most numerous are families *Asteraceae* (42 species), *Fabaceae* (25 species) and *Poaceae* (20 species), and the most riches are genera: *Vicia* (9 species), *Geranium* (6 species), *Bromus* (6 species) and *Veronica* (5 species) (Table 2).

Biological spectrum

The distribution of the two largest groups in biological spectrum shows generally weak prevailing of therophytes above hemicriptophytes. In comparison with 1961 geophytes have decreased in half, and phanerophytes have increased with 77% because of introducing of exotes (Fig. 2).

Distribution and origin

In phytogeographical terms (Table 3), the highest percentage is the Eurasian (29.2%) and the European species (24.1%), followed by the boreal (16.1%). In the period 1961-2018, the number of most of the floristic elements increased proportionally, with the exception of the Sub-Mediterranean, which declined by 41% and the Adventive species, which increased almost 8 times. Among anthropophytes are established two Balkan

endemics (*Dianthus corymbosus* Boiss. and *Scabiosa triniifolia* Friv.) and 3 sub-endemics (*Orlaya grandiflora* (L.) Hoffm., *Verbascum blattaria* L. and *Verbascum chaixii* subsp. *austriacum* (Roem. & Schult.) Hayek.

Table 2. List of the richest with anthropophytes genera on the territory of the Lozenska Mountain.

Family	Territory of the Lozenska mountain			
	2018		1961	
	Number species	Number genera	Number species	Number genera
Asteraceae	42	35	22	13
Fabaceae	25	10	19	8
Poaceae	20	15	12	9
Brassicaceae	17	16	6	6
Scrophulariaceae	16	7	9	6
Caryophyllaceae	14	12	10	7
Lamiaceae	12	9	6	6
Boraginaceae	11	10	5	4
Apiaceae	10	9	7	6
Ranunculaceae	7	5	4	4

Relict anthropophyte flora is presented by 8 species (*Hedera helix* L., *Lonicera xylosteum* L., *Equisetum palustre* L., *Pteridium aquilinum* (L.) Kuhn, *Juglans regia* L., *Rumex acetosa* L., *Salix alba* L. и *Salix fragilis* L.), tertiary relicts, most of which are distributed in the Southwestern part of the mountain.

Ecological groups

The distribution of ecological groups in terms of light- factor shows a prevalent presence of over 75% of heliophyte species in each of the mountain parts. The participation of the sciophytes in the anthropophytic element is negligible (less than 2%).

With respect to the other main factor - soil humidity (Fig. 4), anthropophytes with highest presence in all parts (with prevailing participation above 50%) are the mesophytes, following by mesoxerophytes (over 20%) and xeromesophytes (over 15%). The lowest percentage (below 2%) are the representatives of over-moistened and aquatic habitats. The strongest change for the period 1961-2018 is observed in xerophytes, whose participation did decrease with 47%.

Conservation status

Among anthropophytes on the territory of Lozenska Mountain are determined 4 species with conservation (environmental-protective) status as 1 of them - *Geranium bohemicum* L. is included in Red list of Bulgarian vascular plants with category „endangered“, 2 species (*Bupleurum rotundifolium* L., *Smyrnium perfoliatum* L. are included in Annex 4 of the Low of biodiversity (ЗБР?) and one species *Opuntia humifusa* (Raf.)Raf is in the list of CITES (2009). Habitats of these species been established only in the two southern parts of the mountain.

Ivasive alien species (IAS)

IAS constitute 9,9% (27 species) from the anthropophytes of Lozenska Mountain (Table 5) and 44,3% from IAS in the flora of Bulgaria (Petrova *et al.*, 2013). In supplement, on the territory of the mountain are found habitats of 4 potentially IAS - *Opuntia tortispina* Engelm., *Opuntia fragilis* Nutt., *Impatiense baulfourii* Hook.f. и *Lupinus polyphylus* Lindl. Seven from the established IAS: *Ailanthus altissima*, *Acer negundo*, *Robinia pseudoacacia*, *Amorpha fruticosa*, *Opuntia humifusa*, *Bidens frondosus* and *Fallopia* × *bohemica* are strongly aggressive and represent the biggest threat to biodiversity, nature and humans (Pyšek *et al.*, 2009; Petrova *et al.*, 2013). Predominates the percentage of deliberately introduced species (Petrova *et al.* 2013) invasive alien species (64,5 %) above unintentialy introduced (38,7%). Their average presence in separate parts of the mountain is 56,5%, as the biggest presented IAS there is in Part 1 1 (87,1 %), and the lowest – in Part 2 (25,8%). Dominant IAS (their quantitative participation in in communities is above 50%) are 14 (45,2%) from species: *Amaranthus hybridus* L., *Amaranthus retroflexus* L, *Elodea canadensis* Michx., *Erigeron annuus* (L.) Pers., *Erigeron canadensis* (L.) Cronquist, *Fallopia X bohemica* (Chrtek&Chrtkova) J.P. Balley, *Impatiense glandulifera* Royle, *Oenothera biennis* L., *Opuntia humifusa* (Raf.) Raf., *Robinia pseudoaccacia* L.,

Solidago gigantea Ait, *Sorghum halepense* (L.) Pers., *Impatiense baulfourii* Hook.f., *Lupinus polyphylus* Lindl.

Indices of anthropogenic changes of vascular flora

The comparison of indexes of synanthropization shows the highest anthropophytes impact in Northeastern part (67,5%) and the lowest – in Northwestern part (61,8%) of the mountain (Table 6).

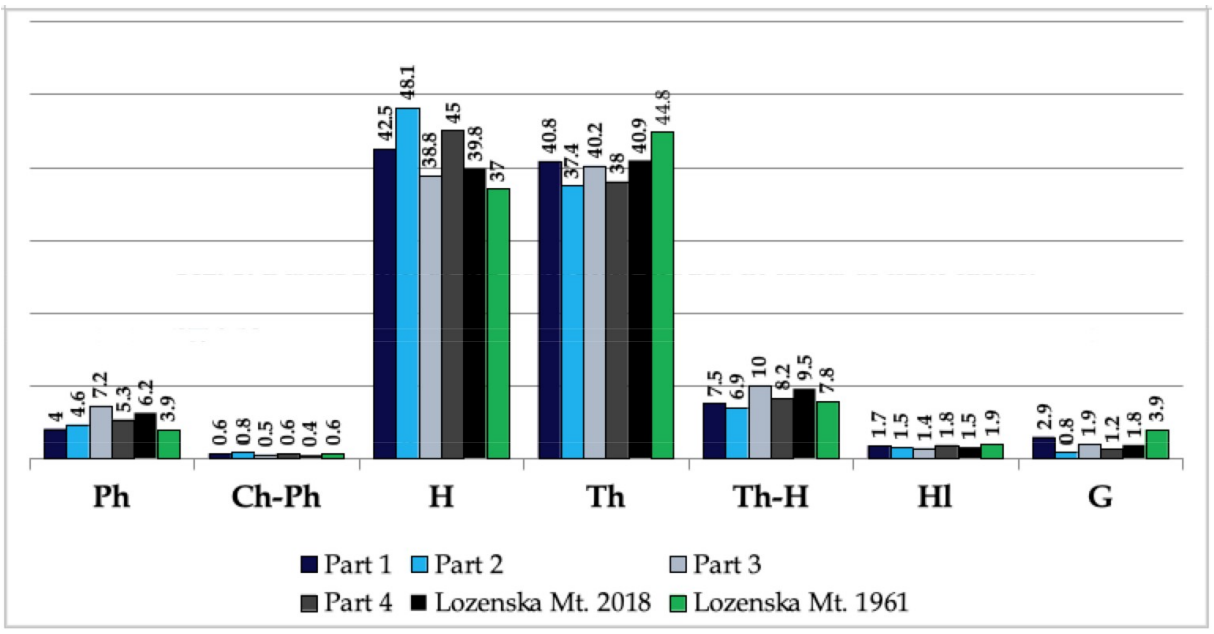

Fig. 2. Biological spectrum of the anthropophytes on the territory of the Lozenska Mountain.

Table 3. Distribution of anthropophytes on the territory of Lozenska Mountain by floral elements.

Type floral element	**Part 1**	**Part 2**	**Part 3**	**Part 4**	**Lozenska mountain 2018**	**Lozenska mountain 1961**
	%	%	%	%	%	%
1. European	23.8	22.9	24.4	24.6	24.1	24.2
2. Euroasian	29.6	29.8	30.1	31.0	29.2	24.7
3. Sub-Mediterranean	4.7	6.1	6.7	5.3	6.9	11.7
4. Mediterranean	4.1	2.3	1.9	3.5	4	3.8
5. Pontic	5.8	6.1	6.2	4.7	5.1	5
6. Boreal	16.9	14.5	15.8	15.2	16.1	17.5
7. Alpine	0.6	0	0.5	0	0.4	1.3
8. Balkan Subendemic	1.2	0.8	1.0	0.6	1.1	1.9
9. Endemic	0.6	0.8	1	1.2	0.7	1.9
10. Cosmopolitan	9.3	13.7	7.7	10.5	7.7	6.5
11. Adventive	3.5	3.1	4.8	3.5	4.7	0.6
Total	100	100	100	100	100	100

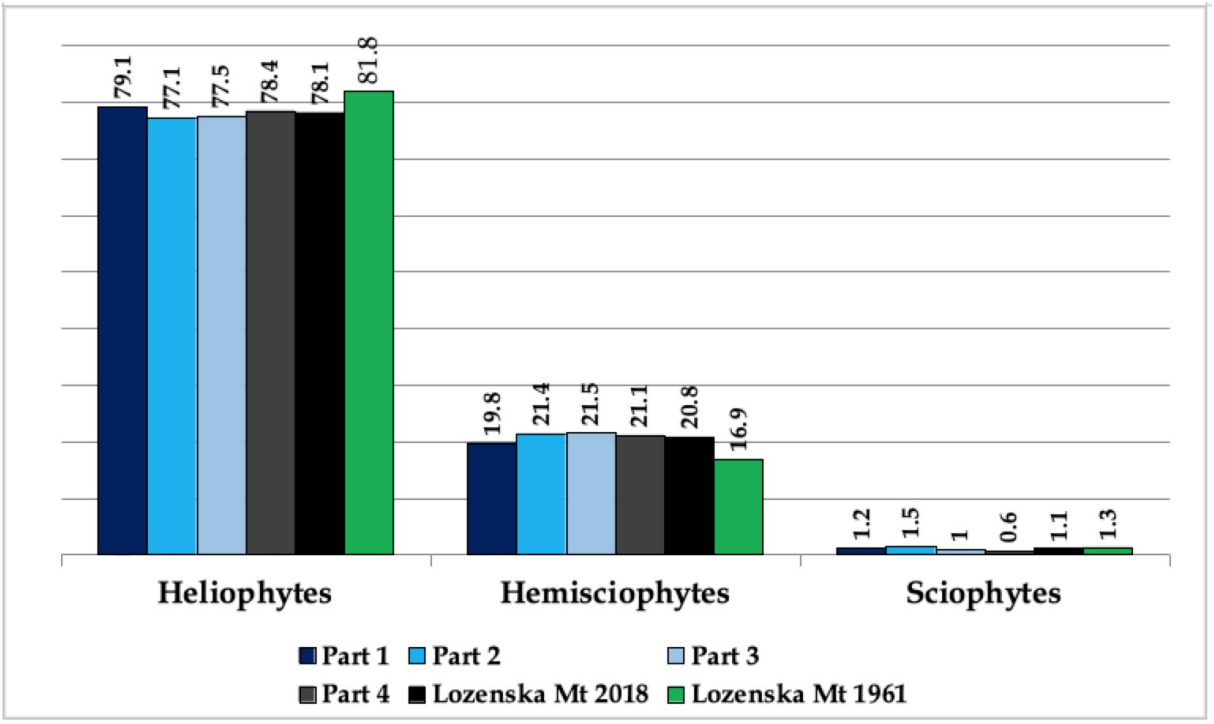

Fig. 3. Distribution of the ecological groups in terms of light-factor.

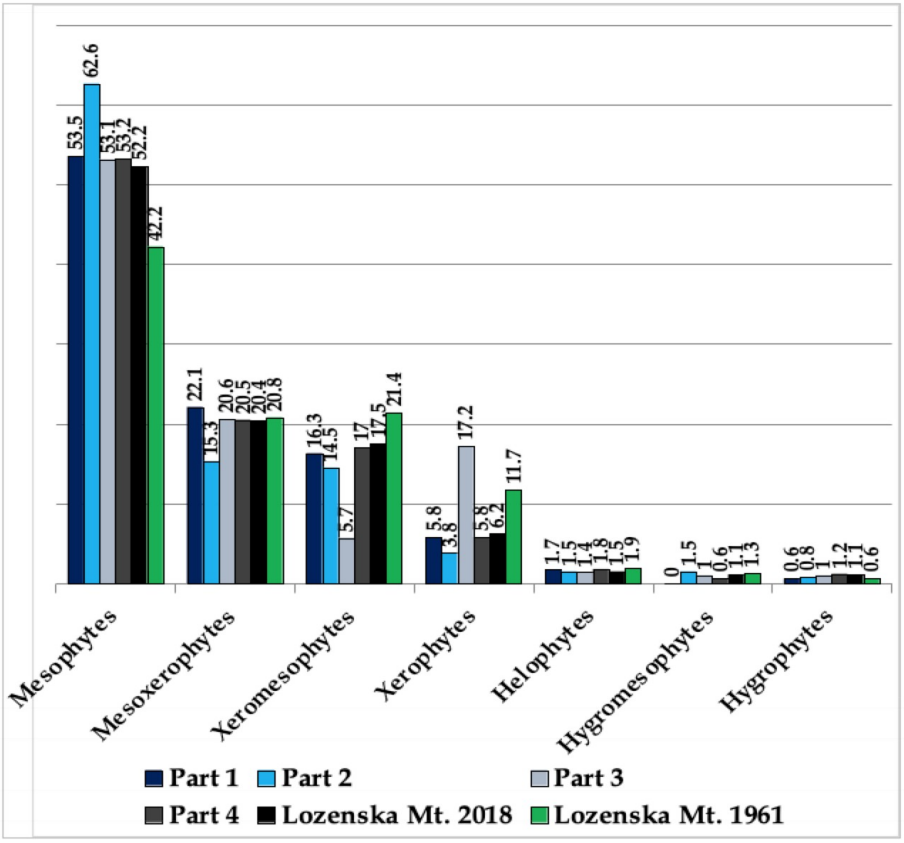

Fig. 4. Distribution of ecological groups in terms of soil moisture.

Table 4. Distribution of the anthopophytes with conservation status.

Species	Category of endangerment	Part 1	Part 2	Part 3	Part 4
Opuntia humifusa (Raf.)Raf	CITES	V			
Geranium bohemicum L.	Endangered /EN A4c according to IUCN and Red list			V	
Bupleurum rotundifolium L.	BDA (Annex 4)	V		V	
Smyrnium perfoliatum L.	BDA (Annex 4)			V	

Table 5. Distribution of invasive alien species on the territory of Lozenska Mountain.

Species	Part 1	Part 2	Part 3	Part 4
1. *Acer negundo* L.	V		V	V
2. *Ailanthus altissima* Swingle	V		V	
3. *Amaranthus hybridus* L.	V	V	V	V
4. *Amaranthus retroflexus* L.	V	V	V	V
5. *Amorpha fruticosa* L.	V		V	
6. *Bidens frondosus* L.				V
7. *Buddleja davidii* Franch.	V			
8. *Chenopodium ambrosioides* L.	V			
9. *Datura stramonium* L.	V		V	
10. *Elodea canadensis* Michx.				V
11. *Erigeron annuus* (L.) Pers.	V	V	V	V
12. *Erigeron canadensis* (L.) Cronquist	V	V	V	V
13. *Fallopia X bohemica* (Chrtek&Chrtkova) J.P. Balley		V	V	
14. *Gleditsia triacanthos* L.	V			
15. *Helianthus tuberosus* L.	V			
16. *Impatiense glandulifera* Royle	V		V	
17. *Koelreuteria paniculata* Laxm.	V			
18. *Laburnum anagyroides* Medik.	V			
19. *Oenothera biennis* L.	V		V	
20. *Opuntia humifusa* (Raf.) Raf.	V			
21. *Oxalis corniculata* L.	V			
22. *Parthenocissus quinquefolia* (L.) Planch.	V			
23. *Robinia pseudoaccacia* L.	V	V	V	V
24. *Solidago gigantea* Ait.			V	
25. *Sorghum halepense* (L.) Pers.	V	V		V
26. *Xanthium italicum* Moretti	V	V	V	V
27. *Xanthium spinosum* L.	V		V	
28. *Opuntia fragilis* Nutt.	V			
29. *Impatiense baulfouri*i Hook.f.	V			
30. *Lupinus polyphylus* Lindl.	V		V	
31. *Opuntia tortispina* Engelm.	V			

Table 6. Distribution of synanthropization groups and indexes of synanthropization.

Group	Part 1	Part 2	Part 3	Part 4	Lozenska Mountain 2018	Lozenska Mountain 1961
Anthropophytes	172	131	209	171	274	154
Apophytes	163	108	167	156	227	182
Total number species	542	354	599	496	823	589
Index of synanthropization	61.8%	67.5%	62.8%	65.9%	60.9%	57.0%

It is observed an increase with 3,9 % of the total index of synanthropizatin (S1) of the flora during the 2017 (S1=60,9%) in comparison with established in 1961 (S1=57,0%).

Discussion

Data on the increased participation of the anthropophytes and the decrease in the share of autochthonous species in the last 50 years are evidence of gradual anthropophytisation of the mountain. This process is due to a certain extent, to the biological characteristics of anthropophytes and, above all, to their mobility or their ability to disperse rapidly in all directions and to retain themselves in a variety of conditions of existence, due to their high vegetative and seminal production, the high germination of their seeds preserved for a long time, as well as the conveniences that have their diasporas for rapid disperse at a greater distance from different transport agents. The high percentage of therophytes is a common phenomenon for the anthropophyte element of Bulgaria. According to STEFANOV & KITANOV (1962) the representatives of this group of plants have the ability to spread at great speed. The authors note that out of the group of anthropophytes the number of annual plants in Bulgaria is comparatively limited, which means that humans is the main factor for the distribution of annual anthropophytes and the creation of conditions for their accommodation and the retention of their new habitats. The presence of high rates of hemicryptophytes can be explained by their prevalence in the biological spectrum of our flora as well as by the strategy of spreading of a large part of them associated with a variety of vegetative propagation conveniences.

Due to their wide spread throughout the country, their migration routes are difficult to understand and their origins in our country are varied. The predominance of species with European participation among the anthropophytes corresponds to the established by GLOGOV & DELKOV (2016) distribution of the floral elements for the whole flora of the mountain. typical for Lozenska Mountain as well as for other Bulgarian mountains is typical formation of anthropophyte communities at places where animals are raised, for example the species *Verbascum lychnitis* L. is accompanied by *Thymus* species, *Trifolium repens* L., *Agrostis capillaris* L., *Chenopodium bonus - henricus* L., *Pastinaca hirsuta Pancic* and others.

The phytogeographic analysis of anthropophytes shows their relationship to the climate change. The de Martonne aridity index calculated on a base of the average annual temperature and the annual precipitation is 30,6. According to the de Marton Classification Scheme, at such an IDM value, the area under study belongs to a humid climat type. (MITKOV & TOPLIYSKI, 2019). That explains the high presence of European and Boreal species related to the Mountain phytogeographic center (STEFANOV, 1943). On the other hand, the prevailing percentage of Eurasian species is

an indicator of steppe climate-influenced xerophytic processes, whose varieties can be found in territories adjacent to the study area (MITKOV & TOPLIYSKI, 2019). The two precipitation maximums recorded on the territory of the Lozenska mountain are a sign of Mediterranean influence, as evidenced by the notable participation of Mediterranean and sub-Mediterranean species.

With regard to the distribution of the anthropophytes in the separated parts of the mountainous territory, it should be noted that among them predominates therophytes in Part 2 and Part 4. In these parts the process of ruderalization is most enhanced. A share of Part 4 covered by the open-cast quarries of mine "Chukurovo" is strongly anthropogenic and is a prerequisite for the invasive settlement of ruderal vegetation with the participation of *Urtica dioica* L., *Datura stramonium* L., *Solanum nigrum* L., *Hyoscyamus niger* L., *Sambucus ebulus* L., *Amaranthus retroflexus* L., species of the genus *Chaenopodium*, *Cirsium*, etc. The other reason for high percentage of anthropophytes is the deserted and non-tillage agricultural lands agricultural lands, which covered larger areas of the territory of these two parts of the mountain.

The analysis of the distribution of populations of IAS on the territory of the mountain shows their predominant presence in the areas around rivers with constant water regime - Iskar, Rakita and Gabra, and on the lands of the village of Dolni Lozen and Chukurovo mine. For the most part, these species form populations that enter as asectators in the composition of the plant communities. Considering that IAS are mentioned as the second most important reason for the extinction of species after habitat destruction (PETROVA *et al.*, 2013), there is a special interest in the ways of their entering the mountain. The high percentage of IAS in the western part of the Lozenska Mountains are considered to be related to the tourist flow and the existence of villa areas and settlements, where after cultivation of species for different purposes (mostly as ornamental plants) they "go out" and "get wild". The proximity of the Iskar River should also be considered as the main road for the penetration and distribution in the mountain of many species, both invasive and synantropic, evidenced by their high concentration in the western part of the mountain.

The influence of both factors- climatic and anthropogenic on the distribution of anthropophytes on the Lozenska Mountain is complex. Their weight varying according to the distance of time. In the short and local terms, the human factor has a stronger influence, as evidenced by the presence of a significant number of Invasive alien species. But their naturalization, as well as the high percentage of Eurasian and Mediterranean species, are an indicator of gradual and irreversible long-term climate change.

Conclusion

Antropophytes of Lozenska Mountain occupy 33.3% of its vascular flora, which is almost twice the percentage of the same group of plants in the flora of Bulgaria (14%). This fact and the high values of the indexes of synanthropization show the intensification of this process on the territory of the mountain. For the period 1961-2018. the percentage share of anthropophytes in the area surveyed increased by 7.2%, while the participation of autochthonous species decreased by 3.8%. The Northeastern part of the mountain is most strongly influenced by the processes of synanthropization, and the weakest influenced part is the Northwestern part of the mountain. The predominant life forms among the anthropophytes of the Lozenska Mountains is the therophytes, and in phytogeographical terms of view the character of the anthropophytes flora of the mountain can be described as European-Asian with a strong Boreal and less Sub-Mediterranean influence.

References

ASYOV B., A. PETROVA. 2012. *Conspectus of the Bulgarian vascular flora. Distribution maps and floristic elements.* 4 Edition., Sofia, Bulg., Biodiversity Fund. 490 p.

BDA. 2007. Biological Diversity Act (Act on Amending and Supplementing the Biological Diversity Act). 2007. – *State Gazette,* 94/16.11.2007: 2-44 (In Bulgarian).

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). 2009. Appendices. Available at: [cites.org].

ĆWIKLIŃSKI E. 1970. Flora synantropijna Szczecina. - In: *The synthropic flora of Szczecin Volume 33 of Monographiae botanicae*. Publisher, Państwowe Wydawn. Naukowe. 102 p.

DELIPAVLOV D., I. CHESHMEDZHIEV. 2003. [*Guide to the plants in Bulgaria*]. Plovdiv. Agricultural Univ. Publ. House, 582 p. (In Bulgarian).

EC. 1992. Council Directive 92/43/EEC of 21 May 1992 on the Conservation of natural Habitats and of Wild Fauna and Flora. - *Official Journal*, L206: 7-50.

GANCHEV S. 1961. [*Vegetation of the Lozenska planina and specifics in its development.*] Publ. House BAN, Sofia, 193 p. (In Bulgarian).

GLOGOV P., A. DELKOV. 2016. Results from investigation of vascular flora on the therritory of Lozen mountain. - *Forest Science,* 1-2: 6-46. (In Bulgarian).

IVANOV IL., M. GEORGIEV, P. PETROV, E. BLAGOEV. 1969. [*Geomorphological characterization of the territories of Sofia and Pernik districts in connection with the analysis and economic assessment of natural conditions and resources*], *ICPS Report. Fund of the LOPS Department at the GGF of Sofia University, "Kliment Ohridski"*. 171 p. (In Bulgarian).

KAMELIN P.B. 1973. [*Florogenetic analysis of natural flora upper Middle Asia*]. Leningrad. Publ. House "Nauka". 355 p. (In Russian).

KOZHUHAROV S.(Ed.) 1992. [*Field Guide to the Vascular Plants in Bulgaria*]. Naouka & Izkoustvo, Sofia. 787 p. (In Bulgarian).

MITKOV S., D. TOPLIYSKI. 2019. [Steppe climate variants in Bulgaria]. - *Annual of Sofia University "St. Kliment Ohridski",* 2(111): 37-46. (In Bulgarian).

PAVLOV D. 1998. [*Ecological basis of forest topology in Bulgaria*]. Sofia. Forest University; pp. 96-245. (In Bulgarian).

PAVLOVA D., E. GEORGIEVA. 2015. *Spontaneous flora of the Rila Monastery (Bulgaria).* - *Biotechnology & Biotechnological Equipment,* 29(Sup1: Bioscience – Development and New Opportunities): 8-19. [DOI].

PEEV D. 2015. Red Data Book of the Republic of Bulgaria, Vol. 1 – In: Peev D. (Eds): *Plants and Fungi*. Sofia. Peev D. (Eds). BAN & MOSW. Sofia. Available at: [e-ecodb.bas.bg].

PETROVA A., V. VLADIMIROV. 2009. Red List of Bulgarian vascular plants. - *Phytologia Balcanica*, 15(1): 63-94.

PETROVA A., V. VLADIMIROV. 2001. [Anthropophyte flora of Bulgaria]. - In: Temniskova D., Eds): *Proceedings of Sixth National Conference of Botany*. Sofia: University Press "St. Kl. Ohridski" pp. 77-82. (In Bulgarian).

PETROVA A., V. VLADIMIROV, V. GEORGIEV. 2013. *Invasive Alien Species of Vascular Plants in Bulgaria*. Sofia. IBER – BAS. 320 p.

PYŠEK P., P.W. LAMBDON, M. ARIANOUTSOU, I. KUHN, J. PINO, M. WINTER. 2009. Alien vascular plants of Europe. - In: *DAISIE handbook of Alien species in Europe*. Springer, Dordrecht, pp. 43-61.

RAUNKIAER C. 1934. *The Life Forms of Plants and Statistical Plant Geography.* Oxford University Press, London. 632 p.

STEFANOV B. 1943. [*Phytogeographic elements in Bulgaria]*. Knipegraf. Sofia. 509 p. (In Bulgarian).

STEFANOV B., B. KITANOV. 1962. [*Cultivated plants and cultivated vegetation in Bulgaria]*. Sofia. Publishing House Bulgarian Academy of Sciences. 275 p. (In Bulgarian).

TOLMACHEV A. 1986. [*Methods of comparative floristic and problems florogenesis*]. Novosibirsk. Nauka, 196 p. (In Russian).

WOJCIKOWSKA B., I. MOYSIYENKO. 2008. *The synanthropic flora of kurgans within three steppe zones in southern Ukraine*. Biodiv. Res. Conserv. pp. 11-12.

WYSOCKI C., P. SIKORSKI. 2002. *Phytosociology Opplied.* Warszaw. SGGW Press, 449 p.

Received: 21.05.2019
Accepted: 20.08.2019

Union of Scientists in Bulgaria – Plovdiv
University of Plovdiv Publishing House