ECOLOGIA BALKANICA
2020, Vol. 12, Issue 2 December 2020 pp. 187-196

Study on the Distribution of Climbing Plants (Climbers) on the Territory of the Danube Island Aydemir, Bulgaria

Plamen S. Glogov[1*], Georgi Hinkov Ivanov[1], Mira L. Georgieva[1], Vania G. Kachova[1], Alexandru L. Ciuvat[2], Cristian I. Anghelus[2]

1 - Forest Research Institute – Bulgarian Academy of Sciences,
132 Kliment Ohridski Blvd, Sofia, BULGARIA
2 - National Institute for Research and Development in Forestry "Marin Dracea",
Bulevardul Eroilor nr. 128, Voluntari, Ilfov, Brashov, ROMANIA
[*]Corresponding author: pglogov@abv.bg

Abstract. The purpose of the present study is to describe the diversity, distribution and participation of the climbing plants (woody and herbaceous climbers) in the different plant communities in natural habitats of the Danube island Aydemir which is part of NATURA 2000 and to investigate their participation in the succesional processes. The methodology includes setting up Permanent Sample Plots (PSP) in different parts of the island with natural and semi-natural vegetation. The composition, cover abundance and occurrence of all the plant species in the PSP and their affiliation to a specific habitat type of NATURA 2000 were determined, as well as some soil properties as a major part of natural conditions giving specificity of plant composition. During the study, 36 species of vascular plants were identified belonging to 33 genera and 26 families from *Magnoliophyta* division - 41,4% of all the species and 66,7% of the vines are diagnostic for habitat 91EO Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae). The study shows that the distribution and diversity of climbers on the territory of Aydemir island, are mainly determined by vertical structure and age of forest communities and the high species richness in them. Among the climbers found on the island, the invasive alien species *Sicyos angulatus* has the strongest influence on the condition of natural habitats, and represents a real threat to their diversity.

Key words: Danube island, invasive alien species, lianas, climbers, NATURA 2000.

Introduction

Climbing plants (woody lianas and vines like *Periploca graeca* and *Vitis sylvestris*) and annual and perennial climbers (herbaceous climbers like *Humulus lupulus* and *Sicyos angulatus*) play an increasingly important role in forest regeneration, species diversity and ecosystem level processes such as transpiration and carbon sequestration (Schnitzer & Bongers, 2002). In world's scale and especially in the tropics, lianas influence forest dynamics by increasing the size of treefall gaps, and thereby increasing tree turnover rate (Phillips & Gentry, 1994). According to Tang et al. (2012) lianas are considered structural parasites, having a negative impact on the forests such as the reduction of aboveground biomass of trees (Laurance et al., 2014). The low occurrence of lianas in temperate regions has been ascribed to frequent low winter temperatures that may

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

cause freezing-induced embolisms in lianas' long vessel systems and lead to unrecoverable damage (Tang et al., 2012). The regular and active forest management (Addo-Fordjour et al., 2012), and indirect role of fishing and trampling also affects the climbers' abundance.

Climbers are principal physiognomic components of some specific European habitats such as riparian and longoze forests (91EO, 91FO). In Bulgaria, part of the places where these habitats and the natural processes in them can be observed are the Danube Islands, most of which are currently difficult to access and relatively poorly visited due to natural conditions (periodic flooding) and prohibition regimes related to border control and biodiversity conservation measures.

The flora and vegetation of the Danube islands has been subject of numerous studies (Yordanov & Kochev, 1981; Hinkov et al., 2006; Tzonev, 2005; 2007; 2008; Pedashenko et al., 2012) some of which date from the first half of the last century (Petkov, 1940; Stoyanov, 1947, 1948). Many of these publications are focused on climbers as part of the local floristic composition of the study areas, but the inter-storey vegetation on the Danube Islands has not been the subject of an independent study to date.

The purpose of the present study is to describe the diversity, distribution and participation of climbers in the different plant communities of the Aydemir island which is a part of NATURA 2000 and to investigate their role in the succession processes. Some major characteristics of soils also have been done.

Material and Methods

The research activities took place on the territory of the Danube island Aydemir, in natural habitats of riparian vegetation, where investigations were made on the presence of vines (including invasive alien and local species) in the phytocoenoses. Aydemir Island (also named Chayka) the largest island in the Chayka archipelago, has been designated as a Community Important Area (SCI), code BG0000534 by Commission Decision (CD, 2009) and a protected area under Directive 92/43/EEC for the conservation of natural habitats and wild fauna and flora with the Council of Ministers' decision No122 of March 2, 2007 (State Gazette, 2007).

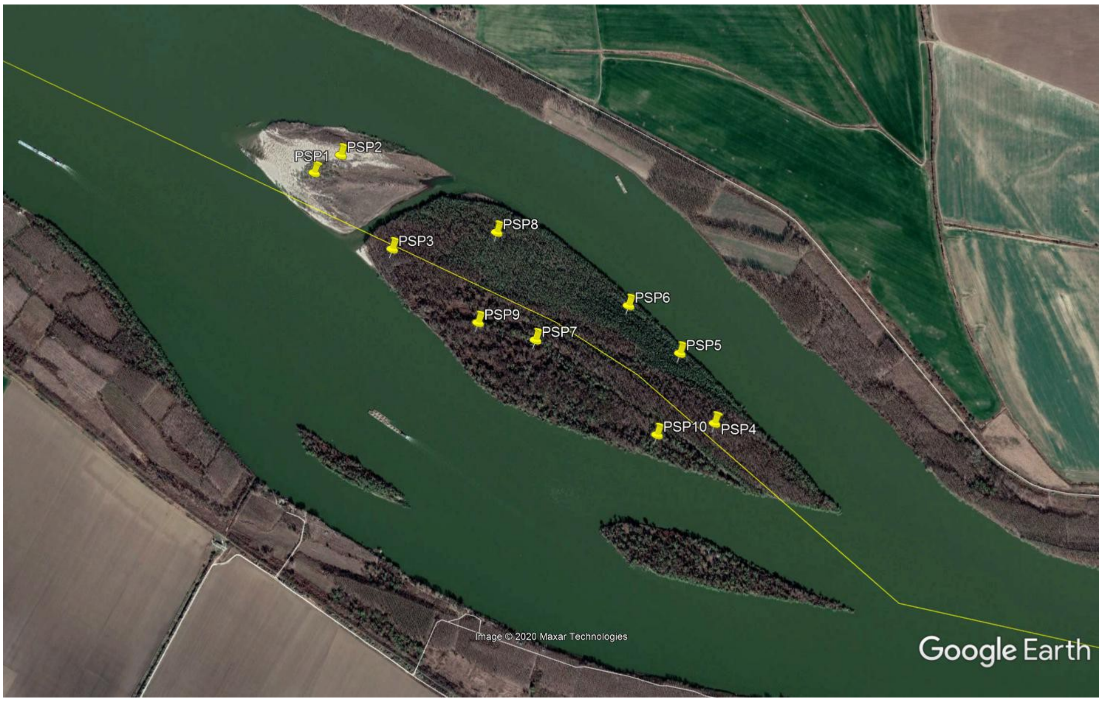

Fig. 1. PSP locations on Aydemir (Chayka) island.

The island of Aydemir has an area of 77 ha on department 5 "a" (SFE Silistra, 2011). The main habitat classes are Bogs, Marshes, Water fringed vegetation, Fens and Broad-leaved deciduous woodland. Other characteristic habitat type are floodplain broad-leaved forests of *Salix alba* L., *S. triandra* L., with *Populus nigra* L., *P. alba* L., *P. canescens* Sm., *Populus x canadensis, Ulmus laevis* Pall., *Morus nigra* L., *Fraxinus pennsylvanica* Marschal, *Fr. americana* L., and *Acer negundo* L. The following habitats listed in Annex 1 to Directive 92/43/EEC are identified on the territory of the island: Habitat 3130 – Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or *Isoëto-Nanojuncetea* with an area of 2,52 ha; 3150 - Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation (0,1 ha); 3270 - Rivers with muddy banks with *Chenopodion rubri* p.p. and *Bidention* p.p. vegetation (5,82 ha) and 91EO - Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*) (86,35 ha) (NATURA 2000 - Standard data form, 2020).

The study was conducted in October 2019. It is part of the project "Invasive alien plant species in protected areas of the Danube Islands on the territory of Bulgaria and Romania" funded under the bilateral science cooperation program between Romania and Bulgaria.

The methodology includes setting up Permanent Sample Plots (PSP) with a size for one plot of 500 sq. m in different parts of the island with homogenous vegetation (Hinkov et. al., 2020). The geographical coordinates of the plot centre were registered using GPS devices (Garmin GPSMAP64s) and marked with paint on the nearest tree. All trees, shrubs and herbaceous plants present within the PSP boundary were inventoried. The cover abundance/abundance of species was established at PSP level in % using the Braun-Blanquet (1964) scale (Table 1).

The composition and the cover abundance of all plant species in the PSP and their diagnostic role to a specific habitat type of NATURA 2000 were presented. The species occurrence was calculated as a ratio between the number of PSP in which one species was found and the total PSP number (Pavlov, 1998). The constancy (in scores from I to V) of each species was derived from the occurrence (Table 2).

Table 1. Braun-Blanquet scale of cover abundance.

Braun-Blanquet scale	Range of cover
R	< 5%; very few individuals
+	< 5%; few individuals
1	< 5%; numerous individuals
2	6-25%
3	26-50%
4	51-75%
5	76-100%

Table 2. Calculation of species constancy by Zielonka (2004).

Constancy	Occurrence (%)
I	0-20
II	21-40
III	41-60
IV	61-80
V	81-100

The cover abundance and constancy of each species were presented individually in five phytocenotic layers (Pavlov, 1998): A1, A2, B, C and D. For the purposes of this study the first two layers of trees A1 and A2 are united in one common layer - A, and the tall grass layer (C) and short grass and mosses layer (D) are united in the layer C.

The characteristic species for the habitats of Annex 1 to Directive 92/43/EEC are according to Kavrakova et al. (2005). The taxonomic nomenclature and the determination of plant taxa is by Kozhuharov (1992) and Delipavlov & Cheshmedzhiev (2003). Invasive alien species (IAS) have been identified according to Petrova et al. (2013), Drescher & Bohdan (2016), Invasive Species Compendium (CABI, 2020), Global invasive species database (ISGG, 2020) and their nomenclature is given according to The Plant List (2013) database. The soil analyses were made according Donov et al. (1974).

Some main soil characteristics were determined such as pH – potentiometrically by pH-meter "Placitronic, MV 88" according ISO 10390, 2002; mechanical composition (texture) by titration method, with HCl treatment, and total carbon (C%) and humus (%) by the Thurin method and total nitrogen (N%) by the Keldal method – all of methods described by Donov et al. (1974).

Results

During the study 10 Permanent Sample Plots were set up and 36 species of vascular plants belonging to 33 genera and 26 families from one division - *Magnoliophyta* (Table 3) were identified.

The ratio between the number of species of the classes *Liliopsida* and *Magnoliopsia* is respectively 6 and 30. The species richest families are *Asteraceae* (4 species), and *Poaceae* (6 species). Trees and shrubs sum up 13 species, and herbs a total of 23 species. The climbers are represented with 6 species - 4 herbaceous climbers (*Calystegia sepium*, *Humulus lupulus, Sicyos angulatus*, *Tamus communis*) *and 2 woody climbers* (*Periploca graeca*, *Vitis sylvestris*).

Two of the PSPs are set up in monodominant plantations of hybrid poplars (*Populus x canadensis* Moench) and 4 PSPs are in plantations of hybrid willows (*Salix* × *rubens*). The rest of the PSPs are situated in mixed plantations of *Populus x canadensis*, *Salix* × *rubens*, *Ulmus laevis* and *Fraxinus pennsylvanica*. The total cover of the tree layer in the PSP's is between 35 and 80%, on shrub layer - between 0 and 95% and on the herb layer - between 0 and 70%.

The highest number of species (26 species or 52% of the total floristic composition of the all PSPs) was found in PSP 5, and the lowest - 14 species (28%) - in PSP 10. The richest diversity (over 50%) of all vines was found in 2 sample plots (or 20% of all PSPs) - PSP 5 (4 species, 66,4%) and PSP 7 (3 species, 49,8%). Climbers were not registered in PSPs 1, 2 and 9 (30% of all PSPs). Their participation in the rest of the PSPs is between 16,6 and 33,2% (1 or 2 species). Species cover abundance and constancy in the sample plots is highlighted in Table 3.

Of the all species (41,4%) and 66,7% of the climbers are diagnostic for habitat 91EO Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*).

The variety of vines is higher in the PSPs set up in the primary forests dominated by *Populus nigra, Salix* × *rubens and Ulmus leavis* (3-5 species) than in the secondary communities of *Fraxinus pennsylvanica* (1-2 species).

Eleven species or 30,6% of the PSPs floristic composition are IAS. The largest number of IAS is found in PSPs 1 and 2 (5 species), and the least is in PSP 8 (1 species). One of them (S*icyos angulatus*) is climber (Fig. 2). This species has the highest constancy and cover abundance in the PSPs.

Table 3. Species cover abundance and constancy in the sample plots.

Species, Layer (A, B,C)	Family	No of PSP and species cover abundance (%)										Con-stan-cy	Species diagnos-tic for Natura 2000 Habitats	IAS
		1	2	3	4	5	6	7	8	9	10			
Total cover abundance (%) of Layer A		35	45	70	65	55	60	70	60	80	55			
Total cover abundance (%) of Layer B		18	20	75	15	55	10	15	95	30	5			
Total cover abundance (%) of Layer C		60	70	35	25	70	45	10	20	5	20			
Acer negundo L. *(A)*	Aceraceae										3	I		V

Acer negundo L. *(B)*	Aceraceae									1		I		V
Acer negundo L. *(C)*	Aceraceae				1					1		II		V
Agrostis capillaris L. *(C)*	Poaceae	2	1									I		
Amorpha fruticosa L. *(B)*	Fabaceae			2		4	2	2				III	91EO	V
Amorpha fruticosa L. *(C)*	Fabaceae			2	2	3	2	2				III	91EO	V
Aristolochia clematitis L.	Aristolo-chiaceae								+			I		
Bidens frondosa L.	Asteraceae					2	2					II	3270	V
Calystegia sepium (L.) R.Br.	Convol-vulaceae							+				I	91EO	
Chenopodium glaucum L.	Chenopo-diaceae		1									I	3270	
Cirsium arvense Scop.	Asteraceae					r						I	91EO	
Digitaria sanguinalis (L.) Scop.	Poaceae	2	1									II		V
Echinochloa crus-galli (L.) Beauv	Poaceae	1	2									II	3270	
Erigeron annuus (L.) Pers.	Asteraceae	2	1	1		+	+				1	IV	91EO	V
Fraxinus pennsylvanica Marshall *(A)*	Oleaceae				4							I		V
Fraxinus pennsylvanica Marshall *(B)*	Oleaceae			2	2						1	II		V
Fraxinus pennsylvanica Marshall *(C)*	Oleaceae		1	2	2			1		3		II		V
Galium album Mill.	Rubiaceae						+					I		
Humulus lupulus L. *(B)*	Cannaba-ceae							+				I	91EO	
Lycopus europaeus L.	Lamiaceae					r	r					II	91EO	
Morus nigra L. *(A)*	Moraceae									3		I		
Morus nigra L. *(B)*	Moraceae			2		1		2		1	1	III	91EO	
Morus nigra L. *(C)*	Moraceae				+					1	+	II		
Myosotis palustris L.	Boragina-ceae						r					I		
Panicum capillare L.	Poaceae	1	2									II		V
Periploca graeca L. *(C)*	Apocyna-ceae				+	1	+	1			1	III	91EO	
Persicaria maculosa Gray	Polygona-ceae					+						I		
Phalaris arundinacea L.	Poaceae	2										I		
Polygonum persicaria L.	Polygona-ceae					+						I		
Polypogon viridis (Gouan) Breistr.	Poaceae	2	1									II		
Populus x canadensis Moench *(A)*	Salicaceae	3	2	4	2							III	91EO	
Populus x canadensis Moench *(B)*	Salicaceae	2	2									II	91EO	
Populus x canadensis Moench *(C)*	Salicaceae	1	1	1								II	91EO	
Populus nigra L. *(A)*	Salicaceae							3		4		II	91EO	

Portulaca oleracea L.	Portulaca-ceae	+	1									II	3130	
Rubus caesius var. *agrestis* Weihe & Nees	Rosaceae			2				1				II	91EO	
Salix × rubens Schrank *A)*	Salicaceae		3		2	4	4		4		3	III	91EO	
Salix × rubens Schrank *(B)*	Salicaceae		1									II	91EO	
Sicyos angulatus L. *(B)*	Cucurbita-ceae					2	3		5			II		V
Sicyos angulatus L. *(C)*	Cucurbita-ceae								3			I		V
Solanum nigrum L.	Solanaceae					2					1	II		
Stellaria nemorum L.	Cario-phyllaceae						+		+			II	91EO	
Tamarix ramosissima Ledeb. *(B)*	Tamari-caceae	2	2									II		V
Tamus communis L.	Diosco-reaeceae			1		1						II		
Urtica dioica L.	Urticaceae								+			I		
Ulmus laevis Pall. *(A)*	Ulmaceae							3		1	1	II		
Ulmus laevis Pall.*(B)*	Ulmaceae			3				2		1		II		
Ulmus laevis Pall.*(C)*	Ulmaceae							1	+	1		I		
Vitis sylvestris C.C.Gmel. *(B)*	Vitaceae			1		1					1	II	91EO	
Vitis sylvestris C.C.Gmel. *(C)*	Vitaceae			1		1						II	91EO	
Xanthium italicum Moretti	Asteraceae	2	3									II	3270	V

Fig. 2. Invasive potential of the alien species *Sicyos angulatus* (Photo: G. Hinkov).

Another point of investigation is characteristic of natural habitat conditions. Among them the soils conditions are this characteristic that has a major role in determined specificity of plant diversity and abundance of plant species. All soils of Aydemir are *Alluvial Fluvisols* and have similar characteristics. They have neutral to slightly alkali reaction (pH 6,96 – 7,37). The organic carbon in PSP 1 is with lowest value (0,9%), but in the rest plots the content of organic carbon is normal (~ 2%). The value of nitrogen follows the trends of organic carbon values, and varied among average values 0,15-0,20%. Detailed characteristics of soils of Aydemir island is given by Kachova (2020).

Discussions

The highest variety of climbers is in PSP 5, where the cover abundance of the tree and shrub layers is around the average (55%), and the herbaceous layer is high (70%). The soils of this plot have not special characteristics - normal content of carbon (2,88%), and slightly alkali reaction (7,37). The highest species diversity was also found in the same PSP. This corresponds to the finding by Nabe-Nielsen (2001) that the density of climbers increased with the density of small trees and the areas with high tree-saplings had a high diversity of lianas.

The lack of understory, poor species composition and low grass cover abundance is associated with increased participation of the invasive alien species *Sicyos angulatus* (Star cucumber). This species is the most competitive not only compared with the rest of the herbaceous climbers and lianas but for all other plant species in the PSPs. Its occurrence in Danube island Belene was recorded 15 years ago by Tzonev (2005) who predicted the expansion of its distribution in Bulgaria. The Star-cucumber populations form dense monodominant sinusia on all layers, being favoured by seasonal flooding and rapid growth thanks to the species strong environmental adaptability.

The relationship between the diversity of climbers and primary vegetation, confirms at this stage the findings of Roeder et al. (2010) that species richness and the proportion of climbers decreased with the increase in distance from the primary forest. According to Campbell et al. (2015) lianas preferentially impact certain ecological "guilds" of tree species such as late – successional / climax species.

The absence of climbers in some of the sample plots could also be explained by the presence in the herbaceous layer of a large number of cereals (including invasive alien species) such as *Agrostis capillaris, Phalaris arundinacea, Digitaria sanguinalis, P. capillare* etc.

The species diversity and abundance of climbers on the territory of Aydemir island are close to those of other Danube islands such are Belene (Stoyanov, 1947), Cama and Barzina (Mică) island (Schneider-Binder, 2009). The results confirm important role of climbers for the biodiversity of the forests (Schnitzer & Bongers, 2002). The intercrown connections provided by them are of great importance to animals that can't fly or glide long distances and also increase the likelihood of trees pulling down their neighbours when they fall (Putz, 2012). All the climbers contain active substances as follows: *Calystegia sepium* - glycosides, tannins, resins (Konstandi, 2020 – pers. com.), *Humulus lupulus* - alfa-acids, terpenes, flavonoides (Killeen et al., 2017), *Sicyos angulatus* - flavonoid glycosides and sterols (An et al., 2019)., *Tamus communis* - polyphenols and flavonoids (Shaheen et al., 2009) „*Vitis sylvestris* - (tannins and *Periploca graeca* - steroids, terpenoids, phenylpropanoids, flavonoids, quinines (Mingjin at al., 2019). Some of them are edible such as *Vitis syvestris*, other are toxic (*Periploca graeca).*

Conclusions

The study shows that the distribution and diversity of climbers on the territory of Aydemir island depend to some extent on the well-defined and balanced structure of forest communities and their rich biodiversity.

Among the climbers found on the island, the invasive alien species *Sicyos angulatus* has the strongest influence on the condition of natural habitats and represent a real threat to their diversity.

The remaining IAS registered on the island pose an indirect threat to the climbers, as well as to the entire habitat 91EO, causing appearance of secondary communities and reducing its natural floristic diversity.

Acknowledgment

The publication was made with the financial assistance of a project for bilateral cooperation between Bulgarian Academy of Sciences and the Romanian Academy of Sciences.

References

Addo-Fordjour, P., R. Zakaria & A. Mansor. (2012). Impacts of forest management on liana abundance and liana–tree relationships in a tropical forest in Malaysia and implications for conservation. *International Journal of Biodiversity Science, Ecosystem Services & Management, 9*(1), 1-8. doi: 10.1080/21513732.2012.714798.

An, J.P., L. Dang, T. Ha, H. Pham, B. Lee, C. Lee & W. Oh. (2019). Flavone glycosides from *Sicyos angulatus* and their inhibitory effects on hepatic lipid accumulation. *Phytochemistry, 157,* 53-63. doi: 10.1016/j.phytochem.2018.10.013.

Braun-Blanquet, J. (1964). *Pflanzensociologie: Grundzuge der Vegetationskunde.* III Auflage. Vienna, Austria: Springer.

Campbell, M., W. Laurance & A. Magrach. (2015). Ecological effects of lianas in fragmented forests. *Ecology of Liana, 29,* 443-450. doi: 10.1002/9781118392409.ch29.

CABI. (2020). *Invasive Species Compendium*, Retrieved from: cabi.org/isc.

CD. 2009. Commission decision of 12 December 2008 adopting, in accordance with Council Directive 92/43/EEC, a second updated list of sites of Community importance in the Continental Biogeographical Region. *Official Journal of the European Union of 13.02.2009.* Retrieved from natura2000.moew.government.bg.

Delipavlov, D. & Cheshmedzhiev I. (2003). *Guidebook to the plants in Bulgaria.* Plovdiv, Bulgaria: Publ. House Agricultural Univ. 582 p. (in Bulgarian)

Donov, V., Yorova K. & Gencheva S. (1974). *Guide to Soil Research*. Sofia, Bulgaria: Forest University. 205 p. (In Bulgarian).

Drescher, A. & Bohdan P. (2016). *Fraxinus pennsylvanica* – an invasive tree species in middle Europe: Case studies from the Danube basin. *Contribuții Botanice – 2016*, LI, 55-69.

Hinkov, G., Zlatanov T., & Stoyanov N. (2006). Regeneration potential of stands dominated by *Quercus robur* L. in Vardim islands. *Analele ICAS, 49*(1), 55–65.

Hinkov, G., Glogov, P., Kachova, V. Georgieva, M., Cristian, A. & Ciuvat A. (2020). Methological approach for monitoring investigation of riparian forests on Danube islands. *Silva Balcanica, 21*(2), 53-69.

ISGG. (2020). Global invasive species database, Retrieved from iucngisd.org.

Kachova, V. 2020. Characteristics of *Alluvial Fluvisols* from islands of Low Danube (Aydemir and Vetren). *Ecologia Balkanica, 12*(2): 121-129.

Kavrakova, V., Dimova D., Dimitrov D., Tzonev R. & Belev T. (Eds.). (2005). *Manual for identification of habitats of European conservation significance*. Sofia, ISBN 954-9433-03-X, 128 p. (In Bulgarian).

Killeen, D., Watkins, O., Sansom, C., Andersen, D., Gordon, K. & Perry, N. (2017). *Fast sampling, analyses and chemometrics for plant breeding: bitter acids, xanthohumol and terpenes in lupulin glands of hops (Humulus lupulus)*. *Phytochemical Analysis, 28,* 50-57. doi: 10.1002/pca.2642.

Kozhuharov, S. (Ed.). (1992). *Guide book to the higher Plants in Bulgaria*. Sofia, Bulgaria: Nauka i Izkustvo. 787 p. (In Bulgarian).

Laurance, W., Andrade A., Magrach A., Camargo J., Valsko J., Campbell M., Fearnside P., Edwards W., Lovejoy Th. & Laurance S. (2014). Long-term changes in liana abundance and forest dynamics in undisturbed Amazonian forests. *Ecology, 95*, 1604–1611.

Mingjin, H. M, S. Shen, C. Luo & Yan Ren 2019. Genus *Periploca* (Apocynaceae): *A Review of Its Classification, Phytochemistry, Biological Activities and Toxicology. Molecules, 24*(15), 2749. doi: 10.3390/molecules24152749.

Nabe-Nielsen, J. (2001). Diversity and distribution of lianas in a Neotropical rain forest, Yasuní National Park, Ecuador. *Journal of Tropical Ecology*, *17*(01), 1–19.

NATURA 2000 - standard data form. (2020). Retrieved from natura2000.moew.government.bg (In Bulgarian).

Pavlov, D. (1998). *Phytocoenologia*. Sofia, Bulgaria: Martilen. 191 p. (In Bulgarian).

Pedashenko, H., Apostolova, V., & Vassilev, K. (2012). *Amorpha fruticosa* invasibility of different habitats in lower Danube. *Phytologia Balcanica, 18*(3), 285-291.

Petkov, N. (1940). Danubian Islands. *Lesovadska мisal, 9*(6), 424-435. (In Bulgarian).

Petrova, A., Vladimirov V. & Georgiev V. (2013). *Invasive alien species of vascular plants in Bulgaria*. Sofia, Bulgaria: IBER – BAS. 317 p. (In Bulgarian).

Phillips, O. & Gentry A. (1994). Increasing turnover through time in tropical forests. *Science, 263,* 954–958.

Putz, F. (2012). Vine Ecology. *Ecology. Info 24.* Retrived from ecology.info

Roeder, M., Hölscher D. & Ferraz I. D. K. (2010). Liana regeneration in secondary and primary forests of Central Amazonia. *Plant Ecology & Diversity*, 3, 165–74.

Schneider-Binder, E. (2009). Floodplain forests along the Lower Danube. *Transylvanian Review of Systematical and Ecological Research, 8:* 113-113.

Schnitzer, S. & Bongers F. (2002). The ecology of lianas and their role in forests. *Trends in ecology and evolution, 17,* 223-230. doi: 10.1016/S0169-5347(02)02491-6.

Shaheen, F., L. Ali, S. Ali, N. Erdemoglu, & B. Sener. 2009. Antioxidant flavonoids from *Tamus communis* ssp. Cretica. *Chemistry of Natural Compounds, 45(*3), 346-349.

State Gazette. (2007), March 9, 21. (In Bulgarian)

SFE (State Forest Entreprise) Silistra. 2011. *Forest management plan*. Agrolesproekt EOOD.

Stoyanov, N. (1947). The Herbaceous Vegetation of the Island Belene. *Gorsko stopanstvo (Sofia), 3, 21-28; 39-46; 196-197.* (In Bulgarian).

Stoyanov, N. 1948. *The vegetation of the Danube Islands near Bulgaria and its economic utilization.* Sofia, Bulgaria: Publishing House Bulg. Acad. Sci. 187 p. (In Bulgarian).

Tang, Y., Kitching R., & Cao M. (2012). Lianas as structural parasites: a re-evaluation. *Chinese science bulletin, 57*(4), 307-312 doi: 10.1007/s11434-011-4690-x.

The Plant List. (2013). Version 1.1. Retrieved from theplantlist.org

Tzonev, R. (2005). *Sicyos angulatus* (Cucurbitaceae): a new adventive species for the flora of Bulgaria. *Phytologia Balcanica, 11*(1), 67–68.

Tzonev, R. (2007). *Eclipta prostrata* (Asteraceae): a new alien species for the Bulgarian flora. *Phytologia Balcanica, 13*(1), 79-80.

Tzonev, R. (2008). Changes in the Vegetation on the Territory of three Protected Areas along the Danube River. *Plant* *ecology, Vegetation and habitat diversity,* 323-333.

Yordanov, D. & Kochev H. (1981). *Vegetation of reservoirs in Bulgaria.* Sofia, Bulgaria: BAS, 183 p. (In Bulgarian).

Zielonka, T. (2004). The herb and dwarf shrub colonization of decaying logs in subalpine forest in the Polish Tatra Mountains. *Plant Ecology, 172(1),* 63-72. doi: 10.1023/B:VEGE.0000026037. 03716.fc.

Received: 22.07.2020
Accepted: 15.12.2020