Bulgarian Journal of Agricultural Science, 30 (Suppl. 1) 2024
Agricultural Academy

Mapping of grassland habitats in terms of ecological change – A case study from Svoge Municipality, Western Bulgaria

Borislav Grigorov[1*] and Kiril Vassilev[2]

[1] *Sofia University "St. Kliment Ohridski", Faculty of Geology and Geography, Bulgaria*
[2] *Institute of Biodiversity and Ecosystem Research, Department of Plant and Fungal Diversity and Resources, Bulgarian Academy of Sciences, Sofia, Bulgaria*
[*]*Corresponding author:* borislav.g.grigorov@gmail.com

Abstract

Grigorov, B. & Vassilev, K. (2024). Mapping of Grassland Habitats in Terms of Ecological Change – A Case Study from Svoge Municipality, Western Bulgaria. *Bulg. J. Agric. Sci., 30 (Supplement 1)*, 17–22

The study is focused on the research of the grassland habitats of Svoge Municipality, situated in the western parts of the country, aiming their ecology. They are incorporated in the following sites Natura 2000 sites: Iskarski Prolom-Rzhana BG0001042, Vrachanski Balkan BG0000166 and Zapadna Stara Planina and Predbalkan BG0001040, making them of a special interest for nature conservation. The total area of Svoge Municipality is 868 km^2. 134 relevés were collected during the period of 2015–2019, following the Braun-Blanquet approach and 445 field points were verified, as well. As a result, 5 grassland habitat types, included in Directive 92/43/EEC, were identified. They cover 72.38 km^2, or 8.3% of Svoge Municipality. The habitat type with the broadest distribution is 6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (*important orchid sites), while the one with the most restricted area is 6430 Hydrophilous tall herb fringe communities of plains and the montane to alpine levels.

Keywords: mapping; Natura 2000; vegetation

Introduction

The identification of habitats plays a basic role in policy making, regarding nature. When it comes to grassland territories, they are among the richest in species not only in Bulgaria, but throughout the whole Northern Hemisphere, even comparable to the tropical biome (Dengler et al., 2016). The adoption of Council 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) is a step in the right direction, regarding habitat protection. Still much has to be accomplished in order to fulfill the overall aim for their conservation. A number of authors have focused their efforts on the discussion of ecological change in grasslands and their response to it (Dukes et al., 2005; Cleland et al., 2006; Hoover et al., 2014; Borer et al., 2017; Dong et al., 2020). Habitats have to be studied at a national level and the present research is focusing on this aim. It will provide more data, despite the fact that the study is at a local level. It is in harmony with other two grassland habitat studies (Grigorov et al., 2021; 2022). The core of the author team is the same and it is in their belief that small steps lead to big leaps. Habitats provide a number of ecosystem goods and services that have been thoroughly studied in recent years (Nedkov et al., 2021; Prodanova, 2021). Házi et al. (2011), Roleček et al. (2014) and Dengler et al. (2016) have added more scientific value within their studies, including information, regarding grassland habitats throughout Europe. Grassland habitats are typical for Bulgaria and grassland vegetation in Western Bulgaria has been studied by a number of authors (Pedashenko et al., 2010; Velev et al., 2011 a, b; Vassilev et al., 2012). Grasslands in North-Eastern Bulgaria with a focus on their tradition and changes, were studied by Meshinev et al.

(2009) The Ponor Special Protection Area, a part of which is included in the present object of study, has been investigated by a number of authors (Dimitrov & Petrova, 2014; Pedashenko & Vassilev, 2014; Tzonev et al., 2014; Vassilev et al., 2014), adding more scientific data, regarding habitats. Dobrev et al. (2014) studied the effects of the Common Agricultural Policy on the Coverage of Grassland Habitats in Besaparski Ridove Special Protection Area (Natura 2000), Southern Bulgaria. Torok et al. (2017) focused their investigation on the management and threats of Eastern European grasslands, including examples from Bulgaria. Sopotlieva et al. (2018) assess the ecosystem condition of semi-grasslands outside of the Natura 2000 network, still their research provides reasonable data and Bozhkov (2022) has also contributed to habitat research.

The habitats within the territory of Svoge Municipality are protected by the ecological network of Natura 2000. They are included in the following sites: Iskarski Prolom-Rzhana BG0001042, Vrachanski Balkan BG0000166 and Zapadna Stara Planina and Predbalkan BG0001040. Grassland habitats are among the acknowledged ones by the European network of protected areas of Natura 2000. The abovementioned fact makes them of a special importance not only for our country, but for the whole continent as well. We have to ensure the long-term sustainability of the grassland habitats of Svoge Municipality and their investigation is a step in that direction. These habitats are a home to species that have designated for protection. The present study will add more scientific data for policy making aiming at preserving the favourable conservation status of grassland habitats and withstanding any disrupting human activities. Despite the cited literature, it can be deducted that grassland studies in the study area have not been a major scientific focus and this is one of the reasons for the current research.

The aim of the present study is to investigate habitats in terms of ecological change.

Materials and Methods

Svoge Municipality is located in the western part of Bulgaria. It covers a territory of around 870 km^2. The municipality has a predominantly mountainous relief, being a part of the Western Balkans. The main mountain ranges are Vrachanska Planina, Koznitsa, Murgash, Ponor, Rzhana, Golema Planina, Mala Planina. The municipality is divided by the main river artery of Iskar River. Its tributaries Iskretska River, Gabrovnitsa River, Batuliiska River are among the other main rivers. Soil diversity is at present. The following soil types are common for the studied area: *Fluvisols*, *Colluvisols, Luvisols, Cambisols, Leptosols*. The general overview of the vegetation of the study area includes communities of the classes of *Carpino-Fagetea*, *Quercetea pubescentis, Alnetea glutinosae*, *Salicetea purpureae, Crataego-Prunetea, Molinio-Arrhenatheretea, Festuco-Brometea*, *Phragmito-Magnocaricetea*, *Epilobietea angustifoliae*, *Chenopodietea* и *Polygono-Poetea annuae*.

The Braun-Blanquet approach (1965) was applied for habitat and vegetation mapping. It has successfully been used by other studies (Hukusima & Kershaw, 1988; Mirkin & Naumova, 2009; Guarino et al., 2018,) which gives the authors enough courage to apply it within their study. 134 relevés were collected during the period of 2015–2019, following the Braun-Blanquet approach and 445 field points were verified, as well. Relevés were plotted in homogenous territories of grassland phytocoenoses. All terrain vegetation mappings were carried out in square, 4×4 m vegetation plots. Later they were assigned to Directive 92/43/EEC habitats. Vegetation was classified by the application of the software products of JUICE 7.0 (Tichy, 2002) and PC-ORD (McCune & Mefford, 1999). Terrain verification points were applied to check for consistency. All acquired information was used for the generation of the habitat map. The interpretation of the habitats was accomplished, following Kavrakova et al. (2009) and the Interpretation Manual of European Union Habitats (Commission of the European Communities, 2013). Mapping was carried out with ArcGIS 10.8 in a 1:5000 scale. The map itself was created by using software tools such as the cut and merge polygons. The intersect tool was applied to overlay layers carrying forestry and habitat data. Basemap was used aiming at more detailed terrain check.

Results

Grassland habitats cover 72.38 km^2 or 8.3% of Svoge Municipality. Figure 1 displays a map of the terrain focus points and the place of the study area in Bulgaria.

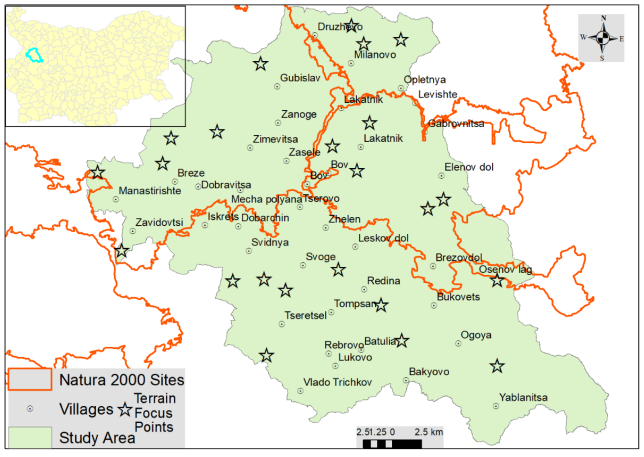

Fig. 1. Terrain focus points in Svoge Municipality

Five grassland habitat types, included in Directive 92/43/EEC, were identified (Fig. 2) and they will be presented in the following lines.

6110 *Rupicolous calcareous or basophilic grasslands of the *Alysso-Sedion albi*

Abiotic characteristic: This habitat can be discovered within 10 polygons. The smallest of them covers only 0.000073 km^2, while the largest one is taking 0.27 km^2. The overall coverage is 0.553356 km^2. The habitat type is located to the north and south of the village of Lakatnik.

Vegetation structure: Phytocoenosis are poor in species numbers and they have an open horizontal structure with total cover between 35% and 60%. Lichens and mosses are represented by *Cladonia furfuracea, Ceratodon purpureus, Ditrichium flexicaule*. The herb layer is formed by *Achillea ageratifolia, Sedum album, Sedum hispanicun*, *Alyssum minus, Arenaria serpylifolia, Sempervivum marmoreum* etc. This vegetation is regarded as transitional between the classes of *Festuco-Brometea* (all. *Saturejion montanae*) and *Sedo-Scleranthetea* (all. *Alysso alyssoidis-Sedion*).

The following threats may be outlined: Threats: invasion of grassland species, succesion, ruderalization.

6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (*important orchid sites)

Abiotic characteristic: This habitat type is represented in 275 polygons, taking up to 60.87 km^2. It is the one with the broadest distribution. It can be discovered mainly to the north and northwest. The minimum polygon area is 0.000003 km^2 and the maximum is 15.69 km^2. The habitat type is used for haymaking and as a pastureland.

Vegetation structure: The phytocoenoses are rich in species and they have semi-open to closed horizontal structure. The projected coverage is between 85% and 100%. Tussock-forming grasses prevail in plant communities. Species like *Chrysopogon gryllus, Festuca dalmatica, Dichantium ischaemum, Stipa capillata* and *Poa angustifolia* are typical. Orchid species such as *Anacamptis pyramidalis*, *Orchis morio* and *O. purpurea* are typical also for this habitat type. This vegetation belongs to the alliances of *Festucion valesiacae*, *Chrysopogono-Danthionion* and *Brachypodion pinnati* of class *Festuco-Brometea*.

Some of the major threats for this habitat type include: plant invasions, natural succession processes, leading to the development of shrubland and forest vegetation, ruderalization.

6230 * Species-rich *Nardus* grasslands, on siliceous substrates in mountain areas

Abiotic characteristic: This habitat type is represented by a total number of 34 polygons with an area of 2.11 km^2. The minimum polygon area is 0.000302 km^2 and the maximum 0.42 km^2. This habitat type has been intensively used as pastureland and has significantly declined in the last decades. It can be discovered mainly in the northwestern parts of Svoge Municipality.

Vegetation structure: The communities are moderately rich in species. Their horizontal structure is closed and the total cover is 95–100%. The dominant species is *Nardus stricta*. Taxa such as *Agrostis capillaris*, *Festuca rubra* agg., *Lerchenfeldia flexuosa*, *Chamaespartium sagittale* and *Thymus longicaulis* are also present. This vegetation is related to the alliance of *Violion caninae* (class *Nardetea strictae*) and *Potentillo ternatae-Nardion strictae* (class *Juncetea trifidi*).

Threats include the abandonment of pastures leading to succession processes, plant invasions.

6430 Hydrophilous tall herb fringe communities of plains and the montane to alpine levels

Abiotic characteristic: This habitat type is found within 30 polygons, taking up 0.12 km^2. This is the type with the most restricted territory. The smallest polygon covers 0.000446 km^2, while the largest one is 0.014 km^2. The habitat type is typical for floodplain areas with nutrient-rich soils. It is located to the south of the village of Gabrovnitsa.

Vegetation structure: The communities are poor in species. *Filipendula ulmaria* is dominating the habitats. The total cover is 80-90%. Hygrophytes, such as *Lythrum salicaria, Epilobium hirsutum* and *Mentha longifolia*, are also present. This habitat belongs to alliance *Filipendulion ulmariae,* order *Filipendulo ulmariae-Lotetalia uliginosi* and class *Molinio-Arrhenatheretea.*

Major threats are eutrophication, trampling, succession processes.

6520 Mountain hay meadows

Abiotic characteristic: This habitat type is distributed within 100 polygons and it covers a total area of 8.73 km^2. The maximum polygon's area is 4.34 km^2. This is a typical habitat type for higher altitudes and can be located in the northern and central parts of the municipality.

Vegetation structure: The communities are moderately rich in species. The structure is closed and the total cover is around 90–100%. The communities are dominated by *Agrostis capillaris, Festuca rubra agg., Arrhenatherum elatius, Cynosurus cristatus, Holcus lanatus, Trifolium alpestre, Filipendula vulgaris*. These phytocoenoses belong to the alliance of *Cynosurion cristati*, order *Arrhenatheretalia elatioris* and class *Molinio-Arrhenatheretea*.

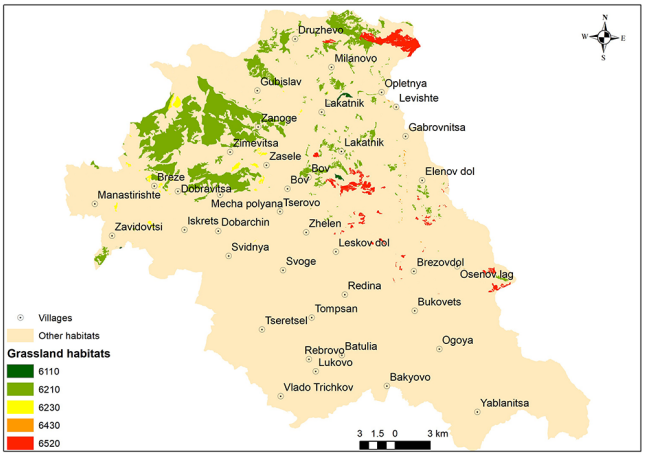

Fig. 2. Grassland habitats of Svoge Municipality

Overgrazing, grassland abandonment, leading to lack of mowing and plant invasions are among the threats for the habitat type.

Discussion

Grasslands have been under scientific focus for a long time. Ecological change occurs constantly and global experiments, such as the Nutrient Network (NutNet), study them (Borer et al., 2017). Field observations are supported by remote sensing (Cleland et al., 2006).

The present study targeted grassland habitats that are falling under the protection of Council Directive 92/43/EEC. This is the third municipality in Bulgaria, where all habitat types were studied and mapped, using the 1:5000 scale (Grigorov et al., 2021; 2022). The attempted approach in all of the previous studies was to use an administrative unit as a study area. It has both advantages and disadvantages opposing to the strictly natural approach, still among its best benefits is the possibility of decision making when a certain type of study is undertaken. The municipality is a unit that has a local government that may use the results of a certain scientific investigation for an improvement of the well-being its residents. The investigated grassland habitats in Dragoman Municipality were six, while those in Godech Municipality were 8. The situation in Svoge Municipality isn't very different from the previous studies. Grassland habitats here also have a fragmented distribution, because of the terrain characteristics and human interference. There isn't a grassland habitat type that occurs in Svoge Municipality that is not present in the other studied municipalities, telling us that the environmental conditions are similar. The habitat type of 6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (*important orchid sites) is the most widespread in the three municipalities, covering at least 50 square kilometers. This habitat type incorporates the alliances of *Festucion valesiacae*, *Chrysopogono-Danthionion* and *Brachypodion pinnati*. These xero-mesophyte and xerophyte communities are typically distributed in valleys and the lower parts of the mountains – a normal feature of the municipality's relief. The habitat type of 6430 Hydrophilous tall herb fringe communities of plains and the montane to alpine levels occurs in high water table areas, making it the type with the most restricted territorial coverage. This situation is similar in the other two municipalities. The habitat belongs to the *Filipendulion ulmariae* alliance Westhoff & Den Held 1969, order *Filipendulo ulmariae-Lotetalia uliginosi* Passarge 1975, class *Molinio-Arrhenatheretea* from syntaxonomical point of view.

It was quite common to observe habitats in Svoge Municipality that have been turned into agricultural areas, yet there are lots of abandoned agricultural areas, as well, leading to the presence of semi-natural grasslands in a formation stage. Agricultural subsidies have played and are still playing an important role for the improvement of habitat condition in the last decade. They lead to the clearance of shrubs – a common process for areas that are not mown and are left away. This brings some good news for grassland habitats of Svoge Municipality, because of the possibility for enhancement of their ability to provide ecosystem goods and services. Typical shrub species such as *Rosa* sp., *Crataegus monogyna*, *Prunus spinosa* and *Rubus* spp. invade grassland territories, leading to a deterioration of their condition. The fall of the previous political system in the country that was ruling until 1989 led to the abandonment of the habitat type of 6210, for instance. Trampling, grazing and meadow mowing are typical processes for some areas that are closer to the larger villages. They play both a positive and negative role by supporting nutrient decomposition, but erosion as well, especially in the cases of overgrazing. The illegal household disposing, the appearance of invasive species and the establishment of quarries are among the problems with grassland habitats.

Conclusion

The study investigated the occurrence of grassland habitats in Svoge Municipality, Western Bulgaria. These habitats cover over 8% of the study area. The habitat type with the broadest distribution is 6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (*important orchid sites), taking up to 60.87 km^2, while the one with the most restricted area is 6430 Hydroph-

ilous tall herb fringe communities of plains and the montane to alpine levels, covering 0.12 km^2. Grassland habitats have a fragmented distribution and are subjected to human interference. They can be discovered mainly in the northern, northwestern and central areas of Svoge Municipality. These habitats are a source for a number of ecosystem goods and services and play their important role as a carbon pool. They are used for hay making, pastoralism etc., leading to a conversion of their original state. Grassland habitats possess valuable features that have to be preserved.

The current research shows promise and may be applied as a basis for an extension of the geographical range of similar studies.

References

Borer, E., Grace, J., Harpole, W., MacDougall, A. & Seabloom, E. (2017). A decade of insights into grassland ecosystem responses to global environmental change. *Nat. Ecol. Evol., 1*, 0118. https://doi.org/10.1038/s41559-017-0118.

Bozhkov, P. (2022). Erosion regulation capacity of different habitats in Vitosha Mountain. *Phytologia Balkanica*, *28*(1), 119-126.

Braun-Blanquet, J. (1965). Plant Sociology. The Study of Plant Communities. New York & London.

Cleland, E., Chiariello, N., Loarie, S., Mooney, H. & Field, C. (2006). Diverse responses of phenology to global changes in a grassland ecosystem. *PNAS*, *103*(37), 13740-13744. www.pnas.org/cgi/doi10.1073pnas.0600815103.

Commission of the European Communities (2013). Interpretation manual of European Union habitats-EUR 28. DG Environment Nature and Biodiversity. Brussels. Commission of the European Communities. –https://ec.europa.eu/environment/nature/legislation/habitatsdirective/docs/Int_Manual_EU28.pdf [Last accessed 2/3/2023.

Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. – http://ec.europa.eu/environment/nature/legislation/habitatsdirective/index_en.htm [Last accessed 2/3/2023].

Dengler, J., Biurrun, I., Apostolova, I., Baumann, E., Becker, T., Berastegi, A., Boch, S., Cancellieri, L., Dembicz, I., Didukh, Y., Dolnik, C., Ermakov, N., Filibeck, G., Garcia Mijangos, I., Gusso del Galdo, G., Guarino, R., Janišová, M., Jaunatre, R., Jensen, K., Jeschke, M., Kącki, Z., Kozub, Ł, Kuzemko, A., Löbel, S., Pedashenko, H., Polyakova, M., Ruprecht, E., Szabó, A., Vassilev, K., Velev, N. & Weiser, F. (2016) Scale-dependent plant diversity in Palaearctic grasslands: a comparative overview. *Bull. EDGG 31*, 12-26.

Dimitrov, M. & Petrova, D. (2014). Forest Habitats in Ponor Special Protection Area (Natura 2000), Western Bulgaria: Characteristics, Status Assessment and Management Recommendations. *Acta Zoologica Bulgarica*, *Supplement 5*, 9-20.

Dobrev, V., Popgeorgiev, G. & Plachiyski, D. (2014). Effects of the Common Agricultural Policy on the Coverage of Grassland Habitats in Besaparski Ridove Special Protection Area (Natura 2000), Southern Bulgaria. *Acta Zoologica Bulgarica*, *Suppl. 5*, 147-155.

Dong, S., Shang, Z., Gao, J. & Boone, R. (2020). Enhancing sustainability of grassland ecosystems through ecological restoration and grazing management in an era of climate change on Qinghai-Tibetan Plateau. *Agriculture, Ecosystems & Environment*, 287, 106684. https://doi.org/10.1016/j.agee.2019.106684.

Dukes, J., Chiariello, N., Cleland, E., Moore, L., Shaw, M., Thayer S., Tobeck, T., Mooney, H. & Field, C. (2005). Responses of Grassland Production to Single and Multiple Global Environmental Changes. *PLoS Biol 3*(10), e319. https://doi.org/10.1371/journal.pbio.0030319.

Grigorov, B., Velev, N., Assenov, A., Nazarov, M., Gramatikov, M., Genova, B. & Vassilev, K. (2021). Grassland habitats on the territory of Dragoman Municipality (Western Bulgaria). *Flora Mediterranea*, *31*, 89-100. doi: 10.7320/FlMedit31.089.

Grigorov, B., Velev, N., Assenov, A., Tsenova, M., Nazarov, M., Genova, B. & Vassilev, K. (2022) Grassland Habitats of Community Importance on the Territory of Godech Municipality, West Bulgaria. *Ecologia Balkanica*, *14*(1), 125-135. http://web.uni-plovdiv.bg/mollov/EB/2022_vol14_iss1/125-135_eb22120.pdf.

Guarino, R., Wilner, W., Pignatti, S., Attorre, F. & Loidi, J. (2018) Spacio-temporal variations in the application of the Braun-Blanquet approach in Europe. *Phytocoenologia 48*(2), 239-250. https://doi.org/10.1127/phyto/2017/0181.

Házi, J., Bartha, S., Szentes, S., Wichmann, B. & Penksza, K. (2011). Seminatural grassland management by mowing of *Calamagrostis epigejos* in Hungary. *Pl. Biosyst., 145*, 699-707. https://doi.org/10.1080/11263504.2011.601339.

Hoover, D., Knapp, A. & Smith, M. (2014). Resistance and resilience of a grassland ecosystem to climate extremes. *Ecology*, *95*(9), 2646-2656. https://doi.org/10.1890/13-2186.1.

Hukusima, T. & Kershaw, K. (1988). The ecology of a beech forest on Mt. Sanpoiwadake, Hakusan National Park, Japan I. Braun-Blanquet, TWINSPAN and DCA Analysis. *Ecological Research, 3*(2), 89-100. https://doi.org/10.1007/BF02346932.

Kavrakova, V., Dimova, D., Dimitrov, M., Tzonev, R., Belev, T. & Rakovska, K. (eds.) (2009). Manual for Determination of Habitats with European Importance in Bulgaria. 2 ed. Sofia (Bg).

McCune, B. & Mefford, M. (1999). PC-ORD. Multivariate analysis of ecological data, ver. 4, Gleneden Beach, MjM Software Design.

Meshinev, T., Apostolova, I., Petrova, A. & Georgiev, V. (2009). Grasslands in North-Eastern Bulgaria – tradition and changes. *Grasslands in Europe*, 246-255. https://doi.org/10.1163/9789004278103_028.

Mirkin, B. & Naumova, L. (2009). Braun-Blanquet method of vegetation classification in Russia. *Journal of Biology* (*Zhurnal Obschei Biologii*), *70*(1), 66-77.

Nedkov, S., Borissova, B., Nikolova, M., Zhiyanski, M., Dimitrov, S., Mitova, R., Koulov, B., Hristova, D., Prodanova, H., Semerdzhieva, L., Dodev, Y., Ihtimanski, I. & Stoyanova, V. (2021). A methodological framework for mapping and assessment of ecosystem services provided by the natural heritage in Bulgaria. *Journal of the Bulgarian Geographical Society*, *45*,

7-18. https://doi.org/10.3897/jbgs.e78680.

Pedashenko, H., Vassilev, K. & Apostolova, I. (2010). Local occurrence of *Artemisia chamaemelifolia* Vill. in Bulgaria. *Annali di Botanica*, 1-11. doi: 10.4462/annbotrm09114.

Pedashenko, H. & Vassilev, K. (2014). Flora of Ponor SPA (Natura 2000), Western Bulgaria. *Acta zoologica bulgarica*, *Supplement 5*, 33-60.

Prodanova, H. (2021). Experimental mapping and assessment of ecosystem services based on multi-level landscape classification. *Journal of the Bulgarian Geographical Society*, *45*, 31-39. https://doi.org/10.3897/jbgs.e78692.

Roleček, J., Čornej, I. & Tokarjuk, A. (2014). Understanding the extreme species richness of semidry grasslands in east-central Europe: A comparative approach. *Preslia, 86*, 13-34.

Sopotlieva, D., Velev, N., Tsvetkova, N., Vassilev, V. & Apostolova, I. (2018). Ecosystem condition assessment of semi-natural grasslands outside the Natura 2000 network in Bulgaria, using vegetation data. *Tuexenia*, *38*, 385-404. https://doi.org/10.14471/2018.38.012.

Tichy, L. (2002). JUICE, software for vegetation classification. *J. Veg. Sc.*, *13*, 451-453.

Torok, P., Janisova, M., Kuzemko, A., Rusina, S. & Stefanozic, Z. (2017). Grasslands, their Threats and Management in Eastern Europe. Grasslands of the World, CRC Press, ISBN 9781315156125.

Tzonev, R., Gussev, C. & Popgeorgiev, G. (2014). Scrub, Grassland and Rocky Habitats in Ponor Special Protection Area (Natura 2000), Western Bulgaria: Mapping and Assessment of Conservation Status. *Acta zoologica bulgarica, Supplement 5*, 21-32.

Vassilev, K., Apostolova, I. & Pedashenko, H. (2012). *Festuco–Brometea* in Western Bulgaria with an emphasis on *Cirsio–Brachypodion pinnati*. Hacquetia, *11*, 227-248. https://doi.org/10.2478/v10028-012-0011-4.

Vassilev, K., Pedashenko, H., Velev, N. & Apostolova, I. (2014). Grassland Vegetation of Ponor Special Protection Area (Natura 2000), Western Bulgaria. *Acta zoologica bulgarica, Supplement 5*, 61-73.

Velev, N., Apostolova, I. & Fajmonová, Z. (2011a). *Cynosurus cristatus* grasslands in West Bulgaria. *Phytol*. *Balcan*., *17*(2), 221-236.

Velev, N., Apostolova, I. & Rozbrojová, Z. (2011b). Alliance *Arrhenatherion elatioris* in West Bulgaria. *Phytol. Balcan*., *17*(1), 67-78.

Received: **October, 09, 2024**; *Approved*: **October, 20, 2024;** *Published:* **December, 2024**