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Bulgarian steppic vegetation – an overview

Abstract

Primary steppe grasslands in Bulgaria are distributed over a very limited area in the most north-eastern part of the country. Northern Bulgaria was covered by wooded steppe at the beginning of the Atlantic period, but by the end of this period the increasing humidity of the climate resulted in forest expansion. Recent vegetation defined as steppes is semi-natural and substitutes woodlands cleared in historical times. Communities are dominated by *Chrysopogon gryllus* and *Bothriochloa ischaemum,* which are the most typical grasses for the steppes in the country. Loess deposits in the Danube plain provide conditions for the development of species rich grasslands, some quite similar to those known in Central Europe. Significant diversity of steppe grasslands is represented by the alliances *Festucion valesiacae*, *Pimpinello-Thymion*, *Stipion lessingianae* and *Saturejion montanae*. Fragments of steppe vegetation can also be found in the south-eastern parts of the country in the Thracian lowlands. Specific features of these communities are the presence of many Mediterranean species as well as Balkan endemics, defining the vegetation as sub-Mediterranean-subcontinental steppes. Species which play an important role in the steppes are *Stipa lessingiana*, *S. capillata, Festuca valesiaca*, *Agropyron brandzae*, *Paeonia tenuifolia*, *Salvia argentea*, *S. nutans*, *Adonis vernalis*, *Artemisia austriaca*. The main threats that have emerged recently are ploughing and scrub encroachment as a result of abandonment of traditional management. The ever decreasing territories occupied by steppe grasslands are in need of conservation measures, which in Bulgaria are connected with Natura 2000 and the national system of protected areas. Steppic grasslands are fundamental for habitats 6210, 6240, 6250, 6260, 62C0 and 62A0. These habitats occupy together an area of approximately 210,000 ha. Different activities within the Natura 2000 network are envisaged to increase public awareness and support traditional agricultural practice aiming to preserve the steppes in the country.

Steppen-Vegetation in Bulgarien – ein Überblick

Zusammenfassung

Primäre Steppen sind in Bulgarien nur sehr vereinzelt im Nordosten des Landes zu finden. Das nördliche Bulgarien war zu Beginn des Atlantikums von einer Wald-Steppe bedeckt. Durch den Klimawandel am Ende dieser Periode und der damit einhergehenden Zunahme der Luftfeuchtigkeit kam es zu einer Ausbreitung der Waldflächen. Die heutigen Steppen sind halb-natürlich und ersetzen Wälder, die in historischer Zeit gerodet wurden. Die Gesellschaften werden dominiert durch Goldbart (*Chrysopogon gryllus*) und das Gewöhnliche Bartgras (*Bothriochloa ischaemum*), sie sind die typischen Vertreter der Bulgarischen Steppen. Lößablagerungen in der Donau-Ebene sind die Grundlage für die Entwicklung artenreicher Grünländer, wie sie auch in Mittel-Europa bekannt sind. Repräsentativ sind folgende Gesellschaften: *Festucion valesiacae*, *Pimpinello-Thymion*, *Stipion lessingianae* und *Saturejion montanae*. Bruchstücke der Steppenvegetation kann man auch in der Oberthrakischen Ebene im Südosten des Landes finden. Besonderes Merkmal dieser Gesellschaften ist das Vorhandensein vieler mediterraner und einheimischer Arten, welche die Vegetation als eine Submediterrane-Subkontinentale Steppe charakterisieren. Besonders wichtige Arten der Steppe sind *Stipa lessingiana*, *Stipa capillata, Festuca valesiaca*, *Agropyron brandzae*, *Paeonia tenuifolia*, *Salvia argentea*, *Salvia nutans*, *Adonis vernalis* und *Artemisia austriaca*. Die Haupt-Gefährdungen sind das Umpflügen der Flächen und das Verbuschen aufgrund der Aufgabe der traditionellen Nutzung. Die stetig abnehmenden Flächen der Steppen verdienen es, erhalten zu werden. Dies wird in Bulgarien durch Natura 2000 und durch die nationalen Schutzgebiete gesichert. Die Steppen werden repräsentiert durch die FFH-Lebensraumtypen 6210, 6240, 6250, 62C0 und 62A0, die eine Gesamtfläche ca. 210.000 ha einnehmen. Verschiedene Aktivitäten innerhalb des Natura 2000-Netzwerkes haben das Ziel, die Steppen in Bulgarien zu erhalten. So sollen unter anderem das öffentliche Bewusstsein gestärkt und die traditionelle Landnutzung gefördert werden.

1 Introduction

The Eurasian steppe extends from the Danube river delta eastwards to China. It covers thousands of square kilometers. Small scale maps of this biome do not show the steppe zone in the territory of Bulgaria. However, steppe vegetation is in fact present in the north-eastern part of the country, close to the Black Sea (Bohn et al. 2004) (Fig. 1). There are still remnants of the Pontic steppe region, which stretches along the northern shores of Black Sea and corresponds to the ancient regions of Scythia and Sarmatia. Bulgarian territory contains the most southeastern edge of the Pontic steppe.

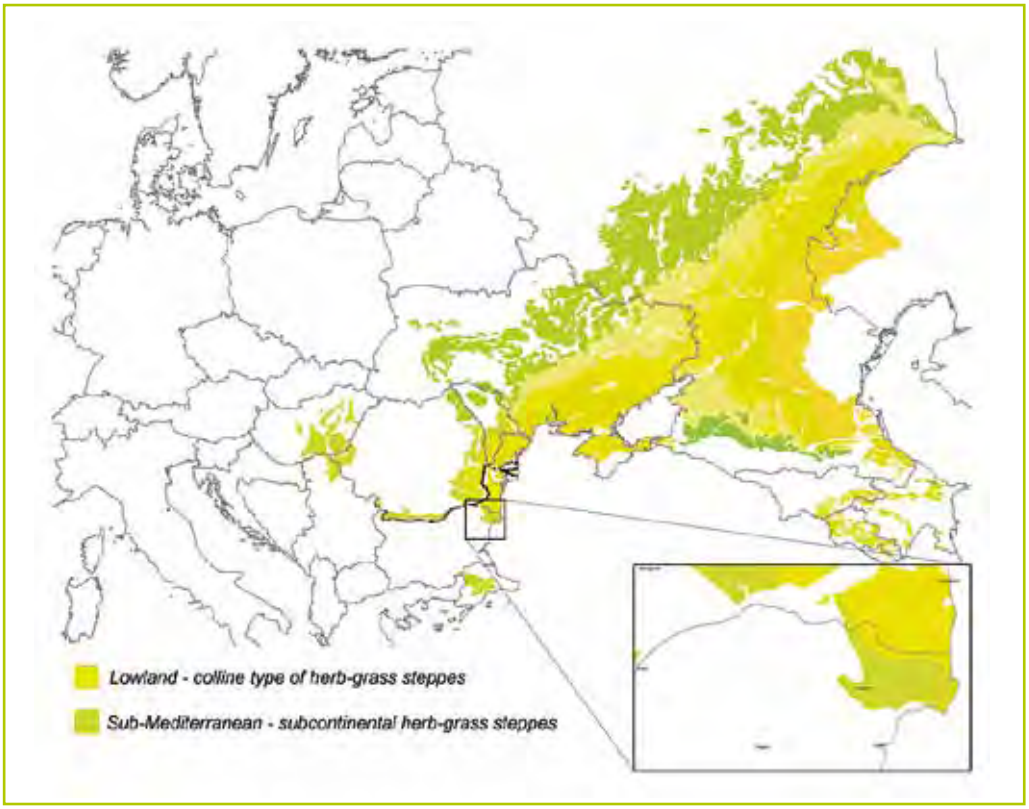

Fig. 1:
Map of steppe and forest-steppe zones in Europe according to Bohn et al. (2004). Only the north-east part of Bulgaria falls into this zone.

There are different opinions on what is steppe vegetation in Bulgarian phytosociology. One of the most widely accepted definitions is "any persistent facies of semi-open to closed grassland that is affected by a short or long drought period during the growing season" (Stefanoff 1934). This definition is too broad and includes virtually all dry grasslands. We take as typical steppe vegetation that which is dominated by grasses of genus *Stipa*, *Festuca*, *Chrysopogon*, *Koeleria*, *Agropyron* and has similar floristic composition to Pannonian and Ukrainian steppe grasslands. Such vegetation composition predominates in northern Bulgaria, along the Danube and Romanian border. Tzonev et al. (2006) reported two subtypes of typical steppes in this part of the country – meadow steppe and *Stipa-Festuca* steppe. The dry grasslands in the remaining part of the country can be assumed to be pseudo-steppes because of their transitional character between East-European steppe and sub-Mediterranean vegetation of the Balkans (Stoyanov 1925, 1941). There are several steppic species that are often present in these communities, and this has led some researchers to refer to some areas of Bulgarian dry grassland as steppe vegetation.

2 Natural settings

Bulgaria is situated between 22°21′–28°36′E and 41°14′–44°13′N. The total area of the country is 110,011.5 km^2, i.e. about 22% of the Balkan Peninsula. About two thirds of the country is mountainous. The Balkan Range crosses the country from West to East, and forms the watershed between the Danube river and the Aegean Sea. The northern Balkan Range slopes gradually slope down and form the northern Bulgarian plateau. The southern part of the country consists of irregular orography, notably the Thracian Plain and the Rhodope Mountains. Musala peak (2925m) in the Rila Mountain forms the highest point in the Balkans.

Most of the country is characterized by a continental climate. The average annual temperature ranges between 10 and 13°C. The average rainfall is about 635 mm, ranging in different parts of the country

from 450 to 1250 mm. A sub-Mediterranean climate with dry summers and mild, humid winters prevails in the valleys of southern Bulgaria (Velev 2002).
Geologically, the northern part of the country consists of the Moezian Plate, a thick sequence of sediments over the pre-Paleozoic and Paleozoic crystalline crust. The southern half is part of the Alps-Himalayan orogenetic zone and consists of a large variety of volcanic, magmatic and metamorphic rocks. Quaternary sediments of lacustrine origin also play a role in the contemporary geology (Vaptsarov & Alexiev 1977).
Bulgaria has a large variety of soil types. Lowlands are covered by fertile black and grey soils, high in humus content that are well-suited for growing cereals. The Thracian plain contains brown, loamy fertile soils while humus rich loess and chernozems (Crenozems, Phaeozems) prevail in the northern part of the country (Ninov 2002).
As a result of its geographical position, different bioclimatic influences are present in Bulgaria. The Central European one penetrates from the north and northwest and determines the presence of deciduous forests. In the south, along larger river valleys some typical Mediterranean bioclimatic impact is noticeable. The South-Euxinian influence is characteristic for the south-east and it supports the development some unique European plant communities. The Black Sea basin provides conditions for the Pontic bioclimate. The Steppic influence penetrates the northeast. These overlapping zones still further enrich the diversity of environmental conditions, and hence the vegetation diversity.

3 Origin of dry grasslands

It is well known that the Balkan Peninsula has served as a refuge for many plants in pre-historic times (e.g. Birks & Willis 2008, Médail & Diadema 2009). There is evidence that dry grasslands persist since the Miocene, linked to the warm and dry climate (Ivanov & Koleva-Rekalova 1999). These communities had a species-poor floristic composition dominated by *Chenopodiaceae* and *Asteraceae*, whereas *Caryophyllaceae, Apiaceae, Lamiaceae*, *Poaceae, Ranunculaceae* pollen was limited (Ivanov & Koleva-Rekalova 1999, Ivanov et al. 2007, Jiménez-Moreno et al. 2007). About 5 million years ago, grassland vegetation increased its distribution in Bulgaria and became rich in *Chenopodiaceae*, *Poaceae*, *Asteraceae*, *Caryophyllaceae*, *Brassicaceae, Ranunculaceae* species (Utescher et al. 2009, Ivanov et al. 2010).
At the beginning of Holocene, large areas were covered by semi-deserts (Lazarova & Bojilova 2001) due to the warm and dry climate. The herbaceous vegetation had an open structure with the prevailing species belonging to *Artemisia* and *Chenopodiaceae*. *Poaceae* were infrequent. During the next 3-4 millennia, the semi-desert transformed into steppe, and grasses gradually increased in abundance. Simultaneously, due to the climate change towards higher humidity, forest areas increased. As a result, at the beginning of the Atlantic, forest-steppe vegetation had formed. According to Jordanov (1936 p.43) "...forest-steppe is formed where within the steppe the forest has conquered certain areas but is not yet fully dominant". By the middle of the Atlantic (6000 BP), the significant humification was followed by forest expansion at the expense of grasslands. The anthropogenic influence modified the forest and steppe fluctuations since the Bronze and Iron Ages (2500-1700 BC). Forests decreased as a result of clearance and conversion into arable land. Territories not used for agriculture became secondary grasslands. We suppose that in a few scattered locations, there were "primary oases" of dry grasslands. These areas were related to shallow soils where forest vegetation was unable to develop. Steppic vegetation had its maximum distribution during Boreal phase of the Holocene (Palamarev et al. 2002).
Preserved from the ancient past and developed at the crossroads of different bioclimatic zones, Bulgarian dry grasslands are rich in biodiversity and specific features that deserve in-depth knowledge and further conservation.

4 Previous studies on dry grasslands

Steppic vegetation has been studied since the beginning of the 19th century. The early authors focused on the origin and the relation of these communities to soil types and climatic conditions (e.g. Davidoff 1914, Jordanoff 1936). There is no common opinion on the original steppe distribution in the country. Some researchers consider steppe to have existed only in northeastern Bulgaria where the vegetation is a continuation of Ukrainian and Romanian steppes (Stoyanoff 1933). Other authors adopt as primary steppes the vegetation of the countryside, as for example in the surroundings of the capital city Sofia and around the town of Bourgas (Jordanoff 1936).
Earlier studies were mostly descriptive without syntaxonomical data. There are still many gaps in the knowledge about the diversity of dry grasslands in Bulgaria. Recently, the dry grasslands and steppic vegetation has attracted increasing scientific interest due to the need for appropriate conservation

measures (Meshinev et al. 2005, Apostlova & Meshinev 2006, Tzonev et al. 2006). These studies should be continued, with an emphasis on the syntaxonomic diversity, ecology, and leading diagnostic species, aiming to develop more effective preservation measures for the future.

5 Diversity of dry grasslands

Dry grasslands in Bulgaria have a wide distribution regarding geographical position, climate and soil conditions of the country. They are formed under the strong influences of diverse climate, orography, soil types and different floristic impacts. As a result of this, Euro-Asiatic, Euro-Mediterranean, sub-Mediterranean species and hemicriptophytes dominate. Syntaxonomically, dry grasslands belong to the classes *Festuco-Brometea*, *Thero-Brachyopodietea, Helianthemetea guttati*, *Festucetea vaginatae* and *Koelerio-Corynephoretea*. *Festuco-Brometea* communities are the most widespread in the country. In southern Bulgaria, the Mediterranean vegetation is defined as *Thero-Brachypodietea* and *Helianthemetea guttati*, where cover of grasses is lower and annual species of *Trifolium*, *Logfia*, *Aegilops* and *Vulpia* increase. *Koelerio-Corynephoretea* is intrazonal vegetation, locally found on stony and eroded terrains, whereas *Festucetea vaginatae* is limited to sandy soils on the Black sea coast and along the Danube river.

Steppic and pseudosteppic vegetation in the country is related to the class *Festuco-Brometea*, which is distributed in lowlands and low mountain ranges within the oak and beech belts. *Festuco-Brometea* is represented in the country by 7 alliances – *Scabiosion ucrainicae*, *Festucion valesiacae*, *Pimpinello-Thymion*, *Stipion lessingianae*, *Saturejion montanae*, *Chrysopogono-Danthonion* and *Cirsio-Brachypodion*. According to current knowledge, we consider four of the abovementioned alliances as representing steppic vegetation: *Pimpinello-Thymion*, *Stipion lessingianae*, *Festucion valesiacae* and *Saturejion montanae*.

Remnants of real steppe vegetation are found only in the north-eastern part of the country and are classified within *Pimpinello-Thymion* and *Stipion lessingianae* (Meshinev et al. 2005, Apostolova & Meshinev 2006, Tzonev et al. 2006). They are dominated by narrow-leaf grasses and are rich in steppic species. The species composition is similar to steppic vegetation in Romania.

Pimpinello-Thymion (Fig. 2) is distributed in north-eastern Bulgaria, Romania and Ukraine (Apostolova & Meshinev 2006). According to Tzonev et al. (2006) communities of *Pimpinello-Thymion* represent petrophytic steppe vegetation. They are probably relictual and were locally distributed along the Black Sea coast and inner part of north-eastern Bulgaria during the Holocene. *Pimpinello-Thymion* is found on flat to moderately inclined carbonate terrains with shallow and frequently eroded soils. Its communities in Romania and Bulgaria have similar floristic composition. Pontic,

Fig. 2:
Community of alliance *Pimpinello-Thymion*.

Euro-Asiatic, Euro-Mediterranean and sub-Mediterranean species dominate. A lot of steppic species such as *Agropyron brandzae*, *Linum austriacum*, *Jurinea stoechadifolia*, *Koeleria brevis*, *Echinops ritro*, *Paeonia tenuifolia*, *Adonis vernalis*, *Stipa capillata* are present in the communities. They also contain some rare (*Adonis wolgensis*, *Mattiola odoratissima*, *Avena eriantha*, *Bellevalia ciliata*, etc) and endemic (*Achillea clypeolata*, *Chamaecytisus jankae*, *Satureja coerulea*, *Koeleria davidovii)* species. *Pimpinello-Thymion* communities have a rather open horizontal structure. Dominants are *Agropyron brandzae*, *Festuca valesiaca*, *Chrysopogon gryllus*, *Dichantium ischaemum*. This alliance is represented by 3 associations and 2 subassociations (Tzonev et al. 2009). This vegetation traditionally is used for grazing but with low intensity due to the limited nutrient resources.

Stipion lessingianae is locally distributed in north-eastern Bulgaria between 50 and 245 m altitude (Meshinev et al. 2005). It was found on moderately deep or shallow dry soils (Fig. 3). Basic rocks were always limestone. Steppic, Mediterranean and Euro-Asiatic species are dominants in the communities. A lot of rock outcrops form an uneven horizontal structure. Narrow-leaf grasses as *Stipa lessingiana*, *Dichantium ischaemum*, and *Festuca valesiaca* prevail. Steppic species such as *Salvia nutans*, *Adonis vernalis*, *Paeonia tenuifolia* are often present. The syntaxonomical diversity of these communities is not yet well studied in the country. *Stipion lessingianae* communities are used for grazing.

Fig. 3:
Community of alliance *Stipion lessingianae*.

Other alliances could be characterized as pseudo-steppic vegetation that contains some steppic species, but different grasses dominate together with species of genera *Thymus*, *Satureja*, *Teucrium, Trifolium,* and *Astragalus*.
Festucion valesiacae is the most widespread alliance within *Festuco-Brometea* class in Bulgaria. It develops on loess, carbonate or siliceous bedrocks, on shallow to moderately deep soils in lowlands, submontane and montane regions (Fig. 4). It may be found on flat up to moderately inclined terrains with varying expositions. Unlike the previous two alliances, the steppic species are underrepresented in *Festucion valesiacae* communities. The most common plants are *Festuca valesiaca* and *Koeleria nitidula*. A specific characteristic of *Festucion valesiacae* communities in Bulgaria is the prevalence of Euro-Asiatic (e.g. *Astragalus onobrychis*, *Poa bulbosa*, *Medicago lupulina*, *Galium verum*) and Euro-Mediterranean (e.g. *Dorycnium herbaceum*, *Lotus corniculatus*, *Filipendula vulgaris*) species. Dominants are narrow-leaf grasses as *Festuca valesiaca*, *F. rupicola*, *F. dalmatica*, *Poa angustifolia, Koeleria nitidula, Stipa capillata*, *S. eriocaulis*, *S. pennata* and *S. pulcherrima*. Balkan endemics, such as *Achillea clypeolata*, *Hypericum rumeliacum*, *Tragopogon balcanicum*,

Festuca stojanovii and *Dianthus moesiacus,* add specificity to these communities. According to Vassilev (2012) Balkan endemics make up 7–10% of the species composition. *Festucion valesiacae* communities have a more closed horizontal structure compared to *Pimpinello-Thymion* and *Stipion lessingianae*. They frequently form mosaic complexes with *Saturejion montanae* and *Chrysopogono-Danthonion calycinae*, alliances of the order *Astragalo-Potentilletalia* and vegetation of the class *Thero-Brachypodietea*. To date, 12 associations, 5 subassociations and 3 communities within *Festucion valesiacae* in Bulgaria have been described (Tzonev et al. 2009, Vassilev 2012). This vegetation is traditionally managed as pastures and rarely mown.

Fig. 4:
Community of alliance *Festucion valesiacae.*

Saturejion montanae is a Balkan endemic alliance distributed in eastern Serbia and Bulgaria. Its communities develop on shallow to moderately deep soils and on calcareous bedrocks, along rivers valleys in the lowlands, as well as in submontane and montane regions in the country. The terrains are slightly to moderately inclined and rich in skeleton (Fig. 5). This alliance is distributed in the central part of the Balkan Peninsula where steppic influence is low but the species composition contains some steppic elements such as *Festuca valesiaca*, *Festuca rupicola*, *Stipa capillata*, *Paeonia tenuifolia,* etc. *Saturejion montanae* might be assumed to be a relict vegetation type established during the last Glacial period and a preserved form of "Mediterreanean vegetation" in the inner part of the Balkans. In the Balkans, calcareous terrains are known as "Mediterranean oases" for Mediterranean vegetation (Urumov 1935), where species common in dry grasslands in the Mediterranean basin are found such as *Sideritis montana*, *Artemisia alba, Melica ciliata*, *Dichantium ischaemum*, *Rhodax canus*, *Convolvulus cantabrica*. *Saturejion montanae* is also rich in Balkan (*Hypericum rumeliacum*, *Tragopogon pterodes*, *Achillea clypeolata*, *Scabiosa triniifolia*, *Festuca stojanovii*, *Asyneuma anthericoides*, *Chamaecytisus calcareous*, *Chamaecytisus jankae)* and Bulgarian (*Verbascum urumoffii*, *Jurinea tzar-ferdinandii*, *Verbascum formanekii*, *Tulipa urimoffii)* endemics (Petrova 2006, Petrova & Vladimirov 2010). Euro-Asiatic and Euro-Mediterranean species predominate in the species composition. *Saturejion montanae* communities mostly have an open horizontal structure and are rich in biodiversity, but do not exhibit well-defined dominants. *Satureja montana* ssp. *kitaibelii*, *Festuca dalmatica*, *Festuca valesiaca, Artemisia alba*, *Dichantium ischaemum*, *Chrysopogon gryllus* are present in relatively high abundances. Unlike typical steppe communities, grasses here are accompanied with tufted chamaephytes, mostly from *Lamiaceae* (*Satureja, Thymus*, *Teucrium*) (Todorova & Tzonev 2010). *Saturejion montanae* in Bulgaria is represented by 9 associations and 3 subassociations (Vassilev 2012). These communities are similar to what is known as "rocky steppe" in the Pannonian basin in terms of ecological peculiarities. In the past, the communities have been used as pastures but nowadays they are abandoned.

Fig. 5:
Community of alliance *Saturejion montanae*.

6 Threats

The overall assessment of the state of dry grasslands in the country shows the presence of some unfavorable processes. The National Grassland Inventory (Meshinev et al. 2005) identified several groups of threatening factors which can be arranged in decreasing significance as follows: advent of forest and shrubs, ploughing, overgrazing, changes in land use, soil erosion, building and construction.

The most severe threat is traditional land use abandonment, which is linked to the dramatic drop in livestock numbers. Land abandonment is more common in the more remote areas, on steeper slopes with shallow eroded soils. The process results in shrub invasion and changes in species composition (Vassilev et al. 2011). The invasion of pastures with trees and shrubs from the native flora mainly involves species such as *Crataegus monogyna, Rosa sp., Carpinus orientalis, Paliurus spina-christii, Prunus spinosa*, *Prunus cerasifera* and *Juniperus oxycedrus*. *Ailanthus altissima* and *Eleagnus angustifolia* frequently play the role of invasive species.

Conversion of grasslands to other uses such as cereals and biofuel crops not only destroy the biodiversity of grasslands themselves but can contribute to habitat fragmentation and overall biodiversity loss. Contrary to the case of land abandonment, the grasslands that are closest to settlements are the most affected, through overgrazing, trampling and an excess of nitrogen compounds. The high seed productivity of ruderal plants enables them to increase their coverage at the expense of valuable components of dry grasslands.

Building activities and quarry establishment are among most destructive for the grasslands. They destroy the vegetation and cause irreversible changes of the habitats.

7 Conservation

The future of dry grasslands is directly bound to their use. Traditionally intended to provide fodder resources, their utilization and maintenance should be connected to livestock breeding. Adequate use of natural fodder resources presumes careful assessment and balance of extensive forms of livestock breeding.

Traditional practice has shown that the main form of protecting natural treasures is their inclusion into systems of protected areas. The development of the Bulgarian network of protected areas started in 1933. In the following decades, more than 280,000 ha of protected areas were established, which is about 3.5% of the total country area. The NATURA 2000 network in Bulgaria includes 118 Special Protection Areas (SPAs) in accordance with the Birds Directive (2009/147/EC) and 231 Sites of Community Importance (SCI) in accordance with the Habitats Directive (92/43/EEC). They cover 34.3% of the country. The presence of habitats 6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*), 6240* Sub-pannonic steppic grasslands, 6250*

Pannonic loess steppic grasslands, 62A0 Eastern sub-Mediterranean dry grasslands (*Scorzoneratalia villosae*) and 62C0 *Ponto-Sarmatic steppes (Table 1) are among the scientific criteria for site designation. These habitats are considered to represent steppe communities in the country. Most of them are concentrated in northern Bulgaria (Fig. 6). The steppe habitats are much fragmented by large areas of agricultural lands. Strict implementation of NATURA 2000 conservation measures will ensure further persistence of steppic fragments. Many areas are still preserved because of their unfavorable status for agriculture, i.e. shallow soils with rock outcrops or steep slopes. Some other activities such as wind-powered electrical generators should be established with care because their building could destroy large areas.

The Important plant areas (IPA) network was created recently, consisting of 125 sites and covering approximately 1,403,770 ha (Peev et al. 2012). A large part of the IPA network overlaps with Natura 2000, Important Bird Areas and Important Butterfly Areas. The development of the IPA network is a step forward to prioritize lands and vegetation of high conservation value.

Table 1:
National representation of steppic and pseudo-steppic habitats (according to available data for 2012).

Code	Name	Number of Natura 2000 sites with occurrences of the habitat type	Total area [ha] of the habitat type
6240	Sub-Pannonic steppic grasslands	24	11,706.37
6250	Pannonic loess steppic grasslands	34	30,172.73
62C0	Ponto-Sarmatic steppes	9	10,610.76
6210	Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*)	78	138,080.72
62A0	Eastern sub-Mediterranean dry grasslands (*Scorzoneratalia villosae*)	39	18,682.80

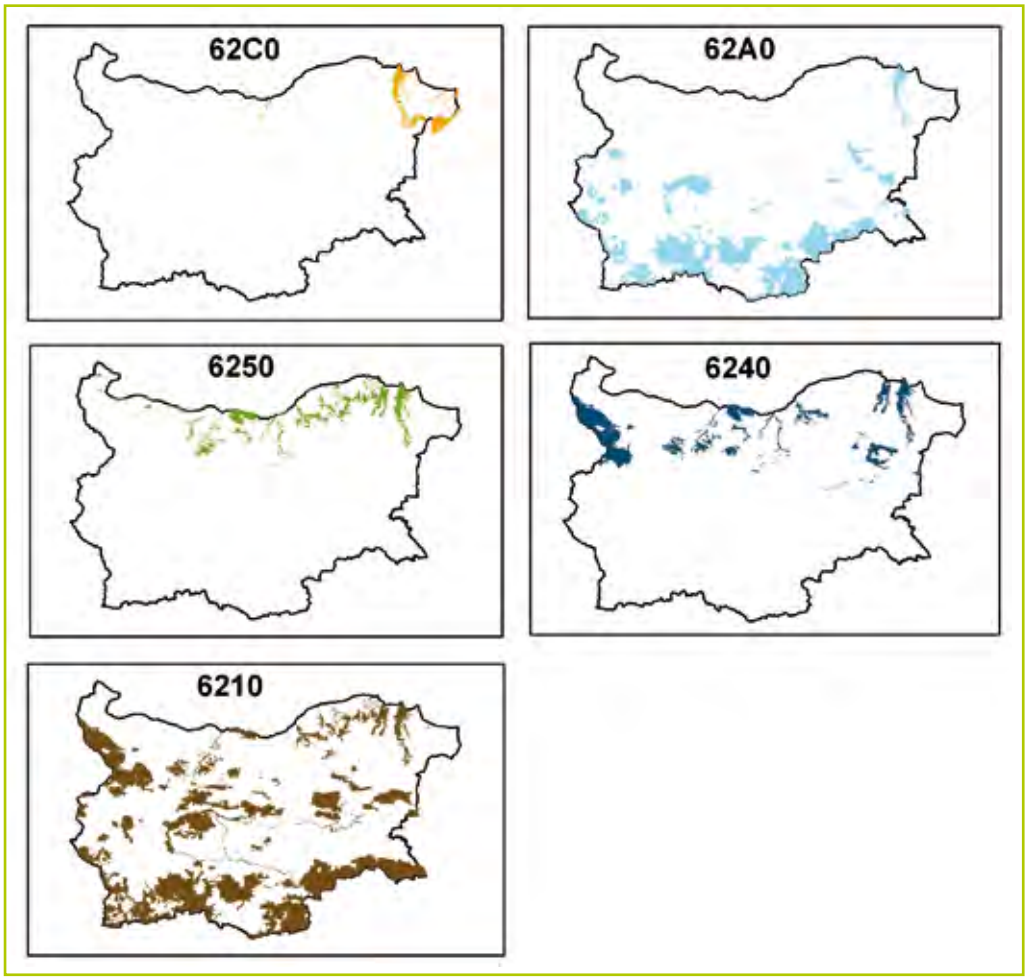

Fig. 6:
Maps showing distribution of steppic and pseudo-steppic habitats in NATURA 2000 sites.

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