

PHYTOCOENOTIC DIVERSITY OF GRASSLANDS WITH *Chrysopogon gryllus* (L.) Trin. IN EURASIA

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Abstract

Chrysopogon gryllus (L.) Trin. is a species of savannoid grasses. In the Republic of Moldova, it is dominant in the xero-mesophytic grasslands of the southern steppe area (Bugeac), occurs on slopes with steppe vegetation, glades and forest edges and in the central area – on the side of forest roads, glades, as well as in xerophilous grasslands. The position of this species in the phytocoenotic classification becomes clearer if we examine its presence depending on the biogeographic regions. The analysis of the synthetic lists drawn up by different authors from the Republic of Moldova, Romania and Ukraine, countries whose territories with savannoid grasslands are part of the continental and steppe biogeographic regions, has helped us identify the species that is faithful to these communities - *Thymus pannonicus* All., which occurs in stable phytocoenoses of the ass. *Thymo (pannonici) - Chrysopogonetum grylli* Doniță et. all. 1992. In the Mediterranean, Pannonian and alpine biogeographic regions, we have shown the dependence of these grasslands on the altitude of the site. At high altitudes (the alpine zone), in areas with slightly acid soils, there are communities of the ass. *Agrostio (capilaris) - Chrysopogonetum gryllis* Kojić 1959 and ass. *Bromo (erectus) - Chrysopogonetum gryllis* Horvat 1934. The greatest phytocoenotic diversity of grasslands with *Chrysopogon gryllus* (L.) Trin. is in the Mediterranean biogeographic region. Here, at the lowest altitudes, *Chrysopogon gryllus* (L.) Trin. occurs in discrete communities with *Carex humilis*, *Schoenus nigricans*, *Teucrium capitatum*, *Bromus fibrosus*, *B. erectus*, *Globularia elongata*, *Nerium oleander*, and in areas with a little higher altitudes - *Asphodelus ramosus*. In the biogeographic regions of the Black Sea and the Anatolian plateau, it does not grow in grasslands as dominant species, but persists as a component of the grassy vegetation in sparse forests of *Quercus coccifera*, *Arbutus andrachne*, *Fantanezis phillirea*, *Olea sylvestris*, *Arbutis unedonis*, *Pinus brutia*, *Juniperus excelsa* etc. In the steppes of Anatolia (550-650 m altitude), *Chrysopogon gryllus* is a component of the grasslands with *Stipa arabica*. The syntaxonomy of the grasslands with *Chrysopogon gryllus* (L.) Trin. requires in-depth analysis based on the ecology and the habitat (heliophilous and thermophilous) of these phytocenoses, as well as the environment with *Bothriochloa ischaemum* (L.) Keng., both of which are part of the savannoid *Andropogoneta*. The necessity arises to open phytocoenotic classes of the dry grasslands *Chrysopogono-Bothriochloetea* n. n. with the meridional-latitudinal distribution to the west ord. *Chrysopogonetalia* n. n., and to the east ord. *Bothriochloetalia* n. n..

Keywords: syntaxonomy, dry grassland, biogeographic zone.

INTRODUCTION

Chrysopogon gryllus (L.) Trin. (common name - Goldbeard Grass) is a species of savannoid grasses, which occurs in dry (xeric) grasslands and has a quite large range (from the south of France to the west of the Himalayas (India), Thailand and Australia). It is remarkable that in the western areas of its range, the grasslands are represented by a single species of the genus *Chrysopogon* - *Ch. gryllus*, and in Asia (western Himalayas) apart from *Chrysopogon gryllus*, *Chrysopogon montanus*, *Ch. aciculatus*, *Ch. fulvus*, *Ch. serrulatus* also occur. In Australia, the genus *Chrysopogon* is represented by 10 species, including: *Chrysopogon gryllus* (L.) Trin. (Blake, 1944; Ganatsas et al., 2004; Joshi, et al., 1964; Neamsuvan et al., 2009; Qureshi et al., 1964; Sundriyal, 1995; Singh Vikaspal et al., 2015), in Northwest Africa, Dobignard et al., 2010, mentioned the presence of *C. gryllus*, *C. aucheri* (Boies.) Stapf., *C. plumulosus* Hochst.

Chrysopogon gryllus is a geophyte, grows about 50-180 cm tall, is dominant mainly in sunny, xerophilous, xero-mesophilous, subthermal grasslands, on chernozem soil and "brown earth" on various substrate (sand, loess, limestone, river gravel, marl, scree etc.), it forms stable, discrete communities with a specific habitat. It is mostly dependent on temperature, which ranges in the limit of the isotherm 7.5-10.5 °C

(Sburlino et al., 2013) and encompasses various biogeographic regions - continental, steppe, Pannonian, Black Sea, Anatolian, alpine, it is mostly found in the Mediterranean region at various altitudes.

Chrysopogon gryllus is a paleobotanical species with Mediterranean-Southwest Asian range, which, on the territory of the Republic of Moldova, appeared after the withdrawal of Sarmatian waters in the Middle Miocene subepoch (20-5 million years ago), growing in forest steppes with sub-Mediterranean floristic elements (Lavrenko, 1940; Gheideman, 1989).

In the Republic of Moldova, the savannoid grasslands with *Chrysopogon gryllus* occur in the Bugeac steppe, as well as in the glades of subarid forests of *Quercus pubescens* with *Cotinus coggygria* in the steppe biogeographic region as well as in glades of the mesophytic forests with *Quercus robur*, *Q. petraea* and *Fagus silvatica* (nature reserves "Codrii" and "Plaiul fagului") - the continental biogeographic region. In the Republic of Moldova, *Chrysopogon gryllus* is a plant species considered rare, because these grasslands are intensely grazed, but the current climate conditions, as well as the impact of the global warming favour an expansion within the areas with favourable soil and climate conditions, in protected areas.



Figure 1. *Chrysopogon gryllus* (L.) Trin. on a slope with steppe vegetation (Iordanovca v., Basarabeasca d.).

Having a large range and an obvious tendency toward expansion, we decided to analyse the floristic and phytocoenotic composition of the grasslands with *C. gryllus* on its large natural range. From west to east, we notice that the altitude, at which these grasslands occur, ranges from 80-100 m in the west to 2000-3000 m in the east (Himalaya Mountains in western India). In the Mediterranean Basin (North Africa, Anatolian plateau, Balkan Mountains, Eastern Alps), it is a species with compact natural range,

MATERIAL AND METHOD

In the study on the grasslands with *Chrysopogon gryllus* in the Republic of Moldova, we used the results of phytosociological studies carried out in different periods of the 20th century - Săvulescu, 1927; Zahariadi, 1932-1934 - the hills with steppe vegetation from the

occurring in productive grasslands, used as pastures, often degraded, but with different grass species, which does not clarify the situation, neither from the point of view of savannoid grasslands nor in terms of evolution, including the impact of global warming (figure 1, 2 and 3).



Figure 2. *Chrysopogon gryllus* (L.) Trin. in a grassland with steppe vegetation (Moscovei v., Cahul d.).

Southern Moldavian Plain, Nikolaeva, 1950-1955 - the glades with steppe vegetation in the forests with downy oak, Vitko, 1980-1981 - the reserve with medicinal plants from the villages Minjir, Poruceni, Seliște, Leu (Nisporeni), the edge and the glades of the mesophytic forests Kononov, 1956, as well as

herbarium specimens collected in the 21st century - from forest edges and grasslands in the forests with downy oak (Hâncești) - Vorniceni, Bucovăț, Codreanca (Strășeni), Sadova (Călărași) (Șabanova, 2012, 2014); the Nature Reserve “Ciumai” Postolache, 2017; slopes with steppe vegetation (Moscovei v., Cahul distr.) Miron *et al.* 2017; in the Bugeac Plain - Ghendov *et al.*

2015; Titica, 2017, 2018; Lebedenco village, Cahul district, Titica, 2017; Iordanovca v., Basarabeasca dist. - Titica, 2018, as well as phytocenotic studies on them, analysed by Șabanova, 2012. It is obvious that these grasslands with *Chrysopogon gryllus*, in the Republic of Moldova, tend to expand.



Figure 3. Phytocoenosis with *Chrysopogon gryllus* (L.) Trin. (Lebedenco v., Cahul d.)

The phytocenotic assessment of grasslands with *Chrysopogon gryllus* in Eurasia is not homogeneous. In the European area, the phytocenotic classification is presented according to the principle of the phytosociological school of Braun-Blanquet, 1933, 1964, that is to say, the constancy or frequency of the species is used for definition in the syntaxonomic nomenclature of the association. In the Republic of Moldova, the phytocenotic classification of dry grasslands with

Chrysopogon gryllus was carried out according to the floristic and ecological principles, delimiting the group of associations. Currently, in the communities with *Chrysopogon gryllus* as a dominant species, according to the phytocoenological classification (Braun-Blanquet, 1964) accepted by most experts in *phytocoenology*, there are various frequent species of grasses that reflect the local ecological conditions, specific to the evaluated region. The dominant species

Chrysopogon gryllus is not distributed evenly everywhere, but sometimes its range intersects with the range of *Bothriochloa ischaemum*, which has expanded in the northern hemisphere due to global warming and aridization (Lazu, 2014; Lazu et al., 2016; 2017; 2018).

In the Republic of Moldova, the grasslands with *Chrysopogon gryllus* were studied from the point of view of *phytocoenology* by Șabanova, 2012; 2014, who identified the group of associations - *Chrysopogon gryllus*, with *Festuca valesiaca*, on the basis of 17 *relevés* from the glades of forests with downy oak.

The author distinguished the second group of associations of *Chrysopogon gryllus* with *Bothriochloa ischaemum*, on the basis of the analysis of 19 *relevés*, on slopes with steppe vegetation, in areas with continental climate. These groups of associations with *Chrysopogon gryllus* cannot be analysed in more detail because the synthetic tables have not been presented. By analysing the papers on *phytocoenology*, published in the Republic of Moldova (Șabanova, 2012, 2014), concerning the communities with *Chrysopogon gryllus*, as well as the papers written by authors of the above-mentioned phytosociological studies, carried out in the evaluated locations, we have found that the faithful species of such grasslands is *Thymus marschalianus* Wild. (*T. pannonicus* All. According to Ciocârlan 1990, 1992), and this species occurs in

both biogeographic regions (continental and steppe). To elucidate the specific traits of locations and of the faithful species to *Chrysopogon gryllus*, which occurs in various biogeographic regions, we analysed the floristic composition and the abundance in the phytocenoses of the grasslands presented by authors in synthetic lists: Ukraine - Dubyna D.V. (1996); Romania - Pușcaru, Soroceanu et al., 1963; Borza, 1963; Csuros and Nidermaier, 1966; Dihoru, 1970; Ivan et al., 1993; Doniță et al., 2005; Oprea and Sârbu, 2005; Drăgulescu and Schumacher, 2006; Ștefan et al., 2007; Chifu et al., 2014; Italy - Meyer, 1975; Nimis and Fonda, 1997; Sburlino et al., 2013; Serbia - Jovanovici et al., 2017; Djodjovici et al., 2012, Djodjovici et al., 2013; Ačić et al., 2015; Croatia - Bernhardt et al., 2006; Ilijanici et al., 1972; Jasprica et al., 2007; Albania - Fanelli et al., 2015; Greece - Pirini et al., 2014; Bulgaria - Tachev et al., 2010; Pedașenco et al., 2013; Macedonia - Matevski et al., 2015 (table 1 and figure 4).

The phytocoenotic studies on the grasslands with *Chrysopogon gryllus*, carried out until now, in the Republic of Moldova, are insufficient. We determined the position of this species in the phytocoenotic classification by analysing synthetic tables based on the wide natural range presented by numerous authors, who made phytosociological assessments in various biogeographic regions. Analysing, in general, the synthetic

lists with *Chrysopogon gryllus* to which we had access, we saw the need to learn more about the chorology and the capacity of coexistence and socialization of the dominant species (*Chrysopogon gryllus* (L.) Trin.) with the local

representative – the characteristic species to the habitat or the faithful plant species, which are constant according to the concept Braun-Blanquet, 1964. The results obtained can be seen in the table 1 and figure 4.

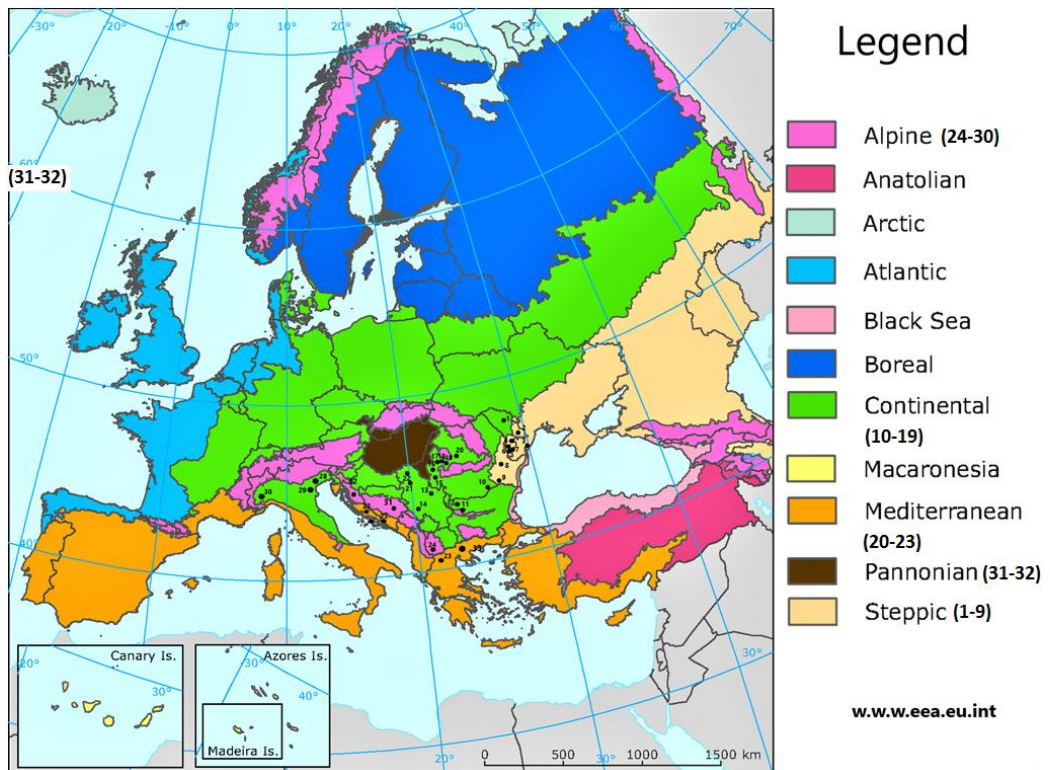


Figure 4. Distribution of phytocoenoses with dry grasslands with *Chrysopogon gryllus* (L.) Trin., in the biogeographic regions of Europe.

RESULTS AND DISCUSSION

Chrysopogon gryllus (L.) Trin., syn. *Andropogon gryllus* L., *Pollinia gryllus* Spr., in the Republic of Moldova, is a species of tussock grass, which occurs in grasslands in the southern areas of the country, particularly, in the glades of the forests of *Quercus pubescens* with *Cotinus coggygria* and in grasslands with steppe

vegetation. This relict grass species has been mentioned (Nykolaeva, 1963; Șabanova, 2012) in monographs and scientific articles as an herbaceous species that grows up to 1.5 m tall, xeromesophyte and with high fidelity to the habitat of savannoid grasslands that are located on the northern border of the natural range and which passes

through the central area of the Republic of Moldova, bordering with the Central “Codri” area.

Șabanova, 2012, 2014, described the associative character of this species, in the forests of downy oak, with the group of ass. *Chrysopogon gryllus* - *Festuca valesiaca* from the steppe biogeographic region and the group of the ass. *Chrysopogon gryllus* - *Bothriochloa ischaemum* (the continental biogeographic region). The author, on the basis of 17 relevés (in the table 1 and figure 4 N 1), has detected the presence of the group of associations *Chrysopogon gryllus* - *Festuca valesiaca* with 123 species, 103 of which are diverse. The following species are the most characteristic for these associations and are present in all the descriptions: *Thymus marchalianus*, *Galium campanulatum*, *Festuca valesiaca*, *Koeleria cristata*, *Phleum phleoides*, *Elytrigia repens*, *Elytrigia intermedia*, *Achillea pannonica*, *Securigera varia*, *Dianthus membranaceus*, *Medicago romanica*, *Teucrium chamaedrys*, *Adonis vernalis*, *Crocus reticulatus*, *Arabidopsis thaliana*, *Myosotis micrantha*, *Veronica verna*. The following species are more ordinary: *Bothriochloa ischaemum*, *Melica ciliata*, *Euphorbia stepposa*, *Galium verum*, *Helichrysum arenarium*, *Hypericum perforatum*, *Inula hirta*, *Linum austriacum*, *Jurnea mollissima*, *Otites moldavica*, *Stachys officinalis*, *Lathyrus pannonicus*, *Lathyrus pallescens*. Among Poaceae, the species with rhizomes are more abundant:

Brachypodium pinnatum, *Calamagrostis epigejos*, *Dactylis glomerata*, *Elytrigia repens*, *Elytrigia intermedia*, *Melica ciliata*, *Poa angustifolia*, *Bromus inermis*. A lower abundance is characteristic of the species of Poaceae with dense caespitose roots: *Koeleria cristata*, *Stipa capillata*, *Stipa pinnata*, *Stipa tirsia*, as well as those with spongy caespitose roots, such as: *Bothriochloa ischaemum*, *Phleum phleoides*, steppe shrubs: *Chamaecitosis austriacus*, *Thymus marschallianus*, *Caragana mollis*, semi-ephemeroids - *Adonis vernalis*, *Doronicum hungaricum*, *Lathyrus pannonicus*, *Pulsatilla grandis*, *Pulsatilla nigricans*, *Viola ambigua*, ephemeroids - *Crocus reticulatus*, *Gagea minima*, *Muscari neglectum*, ephemerals - *Myosotis micrantha*, *Veronica verna*. Constant species - *Thymus marschallianus*, *Festuca valesiaca*, *Koeleria cristata*, *Asperula cynanhica*, *Galium campanulatum*, *Galium verum*, *Eryngium campestre*, *Hypericum perforatum*, *Inula hirta*, *Medicago romanica*, *Potentilla impolita*, *Crocus reticulatus*.

In these phytocoenoses with *Chrysopogon gryllus* as dominant species, the species with characteristics of steppe plants constitute 69.9 % and the mesophytes - 23.6 %. According to ecological criteria, xeromesophytes make up 43.95 % and mesoxerophytes - 22.8 %.

The author considers this association secondary, evolving from those with *Bothriochloa ischaemum*.

Postolache Gh. (2017) mentioned the presence of *Chrysopogon gryllus* in the grasslands of the “Ciumai” Nature Reserve, as a plant that had been included in the Red Book of the Republic of Moldova (table 1, figure 4, N 2).

Miron, 2017, mentioned *Chrysopogon gryllus* as vulnerable plant, occurring in the steppe grassland, (283 ha) Moscovei village, Cahul district, where *Thymus marschalianus* was also present (table 1, figure 4, N 3).

Ghendov et al., 2015, Titica, 2017, 2018, mentioned the presence of *Chrysopogon gryllus* in the Bugeac Plain, accompanied everywhere by *Thymus marschalianus*, with varying degrees of abundance, but faithful to these communities (table 1, figure 4, N 4, 5, 6).

Dubyna et al., 1996, on the marine soils in Jebriansk (Odessa district), detected the presence of *Dauco (gutati) - Chrysopogonetum grylli* Popescu and Doltu, 1980 with 28 species, including the following diagnostic species: *Chrysopogon gryllus* (V), *Plantago lanceolata* (V), *Cynanchum acutum* (III), *Inula salicina* (V), *Dianthus bessarabicus* (III), *Apera maritima* (III), *Linum austriacum* (III). *Thymus marschalianus* (I) also occurred in this area (table 1, figure 4, N 7).

In steppe and continental grasslands of Romania, *Chrysopogon gryllus* occurs in phytocoenoses found in the south of Transylvania, Banat, Dobrogea, Central Moldavian Plateau and

Muntenia, at an altitude between 150 and 450 m. The average annual temperature, in this area, is 10.0-10.5 °C. Precipitation - 500-650 mm. Relief - plateaus and slightly inclined slopes. Soil - dark brown chernozem on loess or limestone. The sources mentioned the presence of 22 associations with *Chrysopogon gryllus* as a taxon with high degree of fidelity to the habitat, including species with a restricted range around these biogeographic zones (steppe and continental), but the species faithful to all the sites where *Chrysopogon gryllus* occurs is *Thymus pannonicus* (Doniță and Popescu, 2005).

Dihoru, 1970, mentioned the ass. *Chrysopogonetum grylli dobrogicum*, which occurred on the Babadag Plateau, whose plant communities were found on sunny, southwest-facing slopes and in glades of forests with *Quercus pubescens*.

The average coverage was 90 % (50-100 %) and the stratification consisted of 4 levels. The first layer, of 20 cm in height, included *Teucrium polium*, *Linosyris villosa*, *Alyssum hirsutum* etc., the second layer, of 30 cm - *Festuca valesiaca*; the third layer, of 60 cm - *Stipa joannis*, *Stachys transsilvanica*, *Centaurea jurneifolia*, *Orlaya grandiflora*, *Allium rotundum* etc. and the fourth - 100 cm - *Chrysopogon gryllus*, *Agropyron intermedium*, *Verbascum lanaticum*, *Salvia nutans*. *Festuca valesiaca*, *Bothriochloa ischaemum*, *Orlaya grandiflora* and *Elytrigia*

intermedia were species with particularly high abundance-dominance. Diagnostic species of the association of xerophilous plants, occurring in Dobrogea, according to the author's opinion, were the following: *Trigonella gladiata*, *Conringia austriaca*, *Lactuca viminea*, *Onobrychis gracilis*. From the synthetic list made up on the basis of 21 relevés from Dobrogea, Dihoru, 1970, distinguished phytocenoses with *Chrysopogon gryllus* in the ass. *Chryso pogonetum grylli dobrogeticum a. n.*, with a range of local species, but the species *Thymus marschalianus* (*Th. pannonicus*) (II) also occurred here and was close to the ecology of the dominant species *Chrysopogon gryllus*, and this association included the basic components of the regional association *Thymo (pannonici)-Chrysopogonetum grylli* Donița et al., 1992 (table 1, figure 4, N 8).

Ivan et al., 1993, described the *Chrysopogoneta* that occurred in Romania, which included the following companion specific floristic elements: *Festuca rupicola*, *Potentilla recta*, *Convolvulus cantabrica*, *Falcaria vulgaris*, *Cleistogenes serotina*, *Dorycnium herbaceum*, *Vinca herbacea*, *Astragalus dasyanthus*, as well as the characteristic species: *Chrysopogon gryllus* and *Thymus pannonicus*. The authors mentioned the lack of Illyrian species and the presence of numerous Pontic elements. The association *Thymo (pannonici) - Chrysopogonetum*

grylli Donița et al., 1992 is mentioned in the table 1 and figure 4, N 9.

Donița N., Popescu et al., 2005, identified the habitat of Daco-Balkan grasslands of *Chrysopogon gryllus* and *Festuca rupicola*, which are among the Mediterranean grasses of the plant association *Thymo pannonicus - Chrysopogonetum grylli* Donița et al., 1992 and occur on the Central Moldavian Plateau (Muntenia, Moldova), Babadag Plateau (Dobrogea) and Transylvanian Plateau. The altitude, in this area is about 150-450 m, the average temperature is 8-10.5 °C and the amount of precipitation - 550-650 mm. The relief consists of plateaus and slopes with slight inclination. Soils - dark brown chernozem on loess or limestone. Edifying and characteristic species - *Chrysopogon gryllus*, *Thymus pannonicus*. Other important species: *Thesium linophyllum*, *Senecio jacobea*, *Asperula cynanchica*, *Stachys recta*, *Artemisia campestris*, *Scabiosa ochroleuca*, *Adonis vernalis*, *Trifolium montanum*, *Hypericum elegans*, *H. perforatum*, *Trifolium campestre*, *Coronilla varia*. These Daco-Balkan grasslands differ from those found in Banat and western Oltenia in the presence of numerous Pontic elements and the absence of Illyrian species (table 1, figure 4, N 10).

Șabanova, 2012, mentioned that *Chrysopogon gryllus*, in the Republic of Moldova occurred at the north-eastern border of its range,

in Bucovăț, Greblești, Codreanca and Negrești, Strășeni district, and Sadova, Călărași district. Based on the analysis of 19 descriptions, the author mentioned the presence of communities of the group of associations *Chrysopogon gryllus* - *Bothriochloa ischaemum*, which consisted of 121 species, 104 of which were diverse. The coverage was 80-100 % on 100 m², and 48 species were identified in this area: *Chrysopogon gryllus* (3), *Bothriochloa ischaemum* (3), *Festuca valesiaca* (2), *Thymus marschalianus*, *Koeleria cristata*, *Asperula cynanchica*, *Galium campanulatum*, *Galium verum*, *Eryngium campestre*, *Hypericum perforatum*, *Inula hirta*, *Medicago romanica*, *Potentilla impolita*, *Potentilla recta*, *Securigera varia*, *Stachys officinalis*, *Teucrium chamaedrys*, *Crocus reticulatus*, *Stipa capillata*, *Stipa pennata*, *Bromopsis inermis*, *Dactylis glomerata*, *Elytrigia intermedia*, *Elytrigia repens*, *Melica ciliata*, *Poa angustifolia*, *Adonis vernalis*, *Doronicum hungaricum*, *Lathyrus pannonicus*, *Pulsatilla grandis*, *Pulsatilla nigricans*, *Viola ambigua*, *Gagea pusilla*, *Muscari neglectum*, *Caragana mollis*, *Chamaecytisus austriacus*, *Achillea pannonica*, *Veronica barlieri*. The species faithful to this community is *Thymus marschalianus*, which is part of the association *Thymo (pannonici) - Chrysopogonetum grylli* Donița et al., 1992 (table 1, figure 4, N 11).

Pușcaru-Soroceanu et al., 1963, characterized the distribution

of grass communities with *Chrysopogon gryllus* as dominant species, in Oltenia, southern Banat and to a lesser degree, in Transylvania. Such plant communities occur less commonly in Moldova, Muntenia and Dobrogea, where the climate is colder and drier.

They occur on plateaus and gentle slopes in hill forests with common oak, sessile oak and beech. The floristic composition is poor, and dominant species are *Chrysopogon gryllus* with *Bothriochloa ischaemum*, *Festuca valesiaca*, *Koeleria gracilis* etc.

In Oltenia and Banat, *Aira elegans*, *Sieglingia decumbens*, *Vulpia myurus* and *Haynaldia villosa* also occur. The author has mentioned some species of the family *Fabaceae*, which are quite uncommon in the studied areas – *Medicago falcata*, *Dorycnium herbaceum*, *Trifolium arvense*, *T. striatum*, *T. campestre*, *Lotus corniculatus*, *Onobrychis arenaria* etc., but the following species are more frequent: *Thymus marschallianus*, *Plantago lanceolata*, *Eryngium campestre*, *Achillea collina*, *Euphorbia cyparissias*, *Filipendula hexapetala*, *Asperula cynanchica*. There are different types of soil in the studied area – levigated chernozem, rendzina, podzol, marshy soil, alluvia, and the determining factor for the ass. *Thymo (pannonici) - Chrysopogonetum grylli* Donița et al. 1992 is the moisture in the soil and air (table 1, figure 4, N 12).

Table 1

The syntaxonomy of grasslands with *Chrysopogon gryllus* (L.) Trin., in natural habitats, according to the biogeographic regions

Biogeographic region	No. according to the map	Bibliographic source	Site	Altitude (m)	Number of relevés	Association or floristic list of the author	Diagnostic species with the frequency indicated by the author	Name of the proposed association
Steppe	1.	Șabanova, 2014	Glades in forests with <i>Quercus pubescens</i> Willd. (R. Moldova)	150-250	17	Ass. <i>Chrysopogon gryllus</i> – <i>Festuca valesiaca</i>	<i>Thymus marschallianus</i> Willd. (<i>T. pannonicus</i> All.) according to V.Ciocârlan, 1988 (V)	Ass. <i>Thymo (pannonici)</i> – <i>Chrysopogonetum grylli</i> Donița et al., 1992
	2.	Postolache, 2017	“Ciumai” Nature Reserve (R. Moldova)	45-93	-	Floristic list	<i>Thymus marschallianus</i> Willd.	- ” - ” -
	3.	Miron et al., 2017	Slope with steppe vegetation Moscovei v., Cahul distr. (R. Moldova)	75-100	-	Floristic list	<i>Thymus marschallianus</i> Willd.	- ” - ” -
	4.	Titica Gh., 2017	Plain with steppe vegetation Lebedenco v., Cahul distr. (R. Moldova)	90	-	Floristic list	<i>Thymus marschallianus</i> Willd.	- ” - ” -
	5.	Ghendov et al., 2015	Bugeac Plain, (R. Moldova)	-	-	Floristic list	<i>Thymus marschallianus</i> Willd.	- ” - ” -
Steppe	6.	Titica, 2018	Plain with steppe vegetation, Iordanovca v., Basarabeasca distr. (R. Moldova)	250	-	Floristic list	<i>Thymus marschallianus</i> Willd	Ass. <i>Thymo (pannonici)</i> – <i>Chrysopogonetum grylli</i> Donița et al., 1992
	7.	Dubyna et al., 1996	Marine sands, Jebriansk (Odessa district, Ukraine)	-	11	Ass. <i>Dauco guttati</i> – <i>Chrysopogonetum grylli</i> Popescu, Sanda, Doltu, 1980	<i>Thymus marschallianus</i> Willd	- ” - ” -

	8.	Dihoru, 1970	Babadag Plateau (Romania)	200-350	21	Ass. <i>Chrysopogon grylli dobrogicum</i> Dihoru, 1970	<i>Thymus marschallianus</i> Willd (II)	- " - " -
	9.	Ivan et al., 1993	Southern Moldova (Romania)	300-400	53	Ass. <i>Tymo (pannonici)</i> – <i>Chrysopogonetum grylli</i> Doniță N. et al., 1992	<i>Thymus pannonicus</i> All. (II)	- " - " -
Continental	10.	Doniță et al., 2005	Muntenia, Moldova, Dobrogea, Transylvania (Romania)	150-450	-	Ass. <i>Tymo (pannonici)</i> – <i>Chrysopogonetum grylli</i> Doniță N. et al., 1992	<i>Thymus pannonicus</i> All. (V)	- " - " -
	11.	Șabanova, 2012	Slopes with steppe vegetation (Strășeni, Călărași, Sadova) (R. Moldova)	250-350	19	Ass. <i>Chrysopogon gryllus</i> – <i>Bothriochloa ischaemum</i>	<i>Thymus marschallianus</i> Willd. (V)	- " - " -
Continental	12.	Pușcaru-Sorocianu, 1963	Banat (Romania)	200-300	10	Ass. <i>Chrysopogon gryllus</i>	<i>Thymus marschallianus</i> Willd. (IV)	Ass. <i>Thymo (pannonici)</i> – <i>Chrysopogonetum grylli</i> Doniță et al., 1992
	13.	Csuros and Niedermaier, 1966	Transylvanian plateau (Romania)	400-500	-	Ass. <i>Chrysopogon gryllus transilvanicum</i> Csuros, Nedem., 1966	<i>Thymus pannonicus</i> All. (IV)	- " - " -
	14.	Drăgulescu and Schumacher, 2006	Southern Transylvanian plateau (Romania)	430-525	12	Ass. <i>Chrysopogonocaricetum humilis</i> Zolyomi (1950) 1958	<i>Thymus pannonicus</i> All. (V)	- " - " -

	15.	Oprea and Sârbu, 2005	“Glodeni Hayfields” Nature Reserve, Vaslui (Romania)	-	2	Ass. <i>Thymo pannonici</i> - <i>Chrysopogonetum grylli</i> Doniță et al., 1992	<i>Thymus pannonicus</i> All. (+)	- ” - ” -
Continental	16.	Chifu et al., 2014	Transylvania, Banat, Crișana (Romania)	140-380	34	Ass. <i>Medicagini (minimae)</i> – <i>Festucetum valesiace</i> Vagner 1941 subass. <i>Chrysopogonetum grylli</i> n.n.	<i>Thymus pannonicus</i> All. (I)	Ass. <i>Thymo (pannonici)</i> – <i>Chrysopogonetum grylli</i> Doniță et al., 1992
	17.	Meyer, 1975	North-East Italy	Low altitudes		Ass. <i>Carici humilis</i> - <i>Chrysopogonetum grylli</i> - <i>fumanietosum</i> - <i>galietosum</i>	<i>Carex humilis</i> Leyss. Vest (2)	Ass. <i>Carici humulus</i> - <i>Chrysopogonetum grylli</i> Kojić i 1959
	18.	Nimis and Fonda, 1997	The highland “Friulian Plain” (NE Italy)	50-300	55	Ass. <i>Schoeno (nigricans)</i> <i>Chrysopogonetum grylli</i> Ass. <i>Chamaecytiso (purpureus)</i> – <i>Chrysopogonetum grylli</i>	<i>Schoenus nigricans</i> L. and <i>Chamaecytiso purpureus</i>	Ass. <i>Schaeno (nigricans)</i> - <i>Chrysopogonetum grylli</i> n. n. Ass. <i>Chamaecytiso (purpureus)</i> - <i>Chrysopogonetum grylli</i> n. n.
	19.	Sburlino et al., 2013	The north shore of the Adriatic Sea (Italy)	Sand dunes	18	Ass. <i>Teucrio capitati</i> – <i>Chrysopogonetum grylli</i> Sburlino et al., 2008	<i>Teucrium capitatum</i>	Ass. <i>Teucrio capitati</i> – <i>Chrysopogonetum grylli</i> Sburlino et al., 2008

Mediterranean	20.	Bernhardt <i>et al.</i> , 2006	Krk and Cres islands (Croatia)	-	17	Ass. <i>Bromo (erectus) Chrysopogonetus grylli</i> H – ic 60	<i>Bromus erectus</i> Huds. (V)	Ass. <i>Bromo (erectus) - Chrysopogonetus grylli</i> Horva 1934
	21.	Ilijanic <i>et al.</i> , 1972	West Croatia	200-220	10	Ass. <i>Globulario (elongata) - Chrysopogonetus grylli</i>	<i>Globularia elongata</i> Hagetschw. (V)	Ass. <i>Globulario (elongata) - Chrysopogonetus grylli</i> Ilijanic et al., ex Terzi
	22.	Jasprica <i>et al.</i> , 2007	The shore of the Adriatic Sea (Croatia)	84-97	5	Ass. <i>Chrysopogono grylli - Nerietum oleandri</i> Jasprica et al. 2007	<i>Nerium oleander</i> L. (V)	Ass. <i>Nerieto (oleandri) - Chrysopogonetus grylli</i> Jasprica et al. 2007
	23.	Fanelli <i>et al.</i> , 2015	The bank of Buna River (Albania)	277-484	-	Ass. <i>Asphodelo (ramosus) Chrysopogonetus grylli</i> Horvatić (1936) 1957	<i>Asphodelus ramosus</i>	Ass. <i>Asphodelo (ramosus) - Chrysopogonetus grylli</i> Horvatić (1936) 1957
Alpine	24.	Jovanovic <i>et al.</i> , 2017	Mt. Studina Serpentino, Central Balkans (Serbia)	High altitudes	13	Ass. <i>Bromo (fibrosi) - Chrysopogonetus grylli</i> Tatic 1969	<i>Bromus fibrosus</i> Hack. (<i>B. riparius</i> Rehm)	Ass. <i>Bromo (fibrosi) - Chrysopogonetus grylli</i> Tatic 1969
	25.	Ivan <i>et al.</i> , 1993	Oltenia, Transylvania (Romania)	600	21	Ass. <i>Danthonio - Chrysopogonetus grylli</i> Kojić 1959	<i>Danthonia alpina</i> Vest. Rchb. (III)	Ass. <i>Danthonio (alpina) - Chrysopogonetus grylli</i> Kojić 1959 Boscaiu (1970) 1972
	26.	Pirini <i>et al.</i> , 2014	Northern-central mountains of Greece	575-720	26	Ass. <i>Chrysopogon gryllus - Bothriochloa ischaemum</i>	<i>Teucrium capitatum</i> (69)	Ass. <i>Teucro (capitati)- Chrysopogonetus grylli</i> Sburlino et al., 2008

	27.	Pedaşenco <i>et al.</i> , 2013	North-western mountains of Bulgaria	970-1400	40	Ass. <i>Agrostio (capillari)</i> – <i>Chrysopogonetum grylli</i> Kojić 1959	<i>Agrostis capillaris</i> L. (<i>A. tenuis</i> Sibth.) according to V. Ciocârlan 1988 (V)	<i>Agrostio (capillari)</i> – <i>Chrysopogonetum grylli</i> Kojić 1959
	28.	Djordjevic <i>et al.</i> , 2012	Mt. Maljen (West Serbia)	510	-	Ass. <i>Chrysopogonetum grylli</i> Gajić 1954	<i>Agrostis capillaris</i> L. (V)	- ” - ” -
	29.	Tashev <i>et al.</i> , 2010	Stara Planina (Bulgaria)	755	-	Com. <i>Chrysopogon gryllus</i>	<i>Bromus erectus</i> Huds.	Ass. <i>Bromo (erectus)</i> - <i>Chrysopogonetum grylli</i> Horvatić 1934
	30.	Matevski <i>et al.</i> , 2015	South-western areas of Macedonia	704 (540-1300)	12	Ass. <i>Petrorragio (haynaldianae)</i> - <i>Chrysopogonetum grylli</i> Motevski et al., 2015	<i>Petrorragia haynaldianae</i> (+)	Ass. <i>Petrorragio (haynaldianae)</i> - <i>Chrysopogonetum grylli</i> Motevski et al., 2015, Kojić 1959
Pannonian	31.	Acic <i>et al.</i> , 2015	Northern-central areas of the Balkan Peninsula (Serbia, Kosovo)	600-1400	-	Ass. <i>Chrysopogonetum (grylli) serbicum</i> Ass. <i>Chrysopogonetum pannonicum</i> Stjep.-vest	<i>Agrostis capillaris</i> Leyss (cl. 8-9)	<i>Agrostio (capillari)</i> – <i>Chrysopogonetum grylli</i> Kojić 1959
	32.	Djordjevic <i>et al.</i> , 2013	South Banat, Delibato sands (Serbia)	-	-	Ass. <i>Chrysopogonetum pannonicum</i> Stjep.-vest	<i>Carex humilis</i> Leyss. Vest (2)	Ass. <i>Carici humulus</i> - <i>Chrysopogonetum grylli</i> Kojić 1959

Csuros and Niedermaier, 1966, presented a monographic study on the distribution of the species *Chrysopogon gryllus*, which was considered by the authors as a Paleo-Mediterranean-Southwest Asian plant. The ecology of this dominant plant implies that the pH should be slightly acid-neutral to slightly alkaline, and the analysis of the soil, on which this species grows, shows a decrease in the soil pH at the upper level (between 6.7 and 7.73 at 2-10 cm), as compared with the lower one (20-30 cm), by 1.3-1.73 units - the ecological limit at which the soil pH ranges from slightly acid to alkaline, which shows that the limit of the range of these phytocoenoses is determined by the acid pH of the soil and not by heat or moisture - ass. *Thymo (pannonici) - Chrysopogonetum grylli* Donița et al. 1992 (table 1, figure 4, N 13).

Drăgulescu and Schumacher, 2006, have analysed the grasslands of southern Transylvania (430-525 m altitude), attributed by them to the ass. *Chrysopogono-Caricetum humilis* Zolyomi (1950) 1958, where there are such differential species as *Dorycnium herbaceum*, *Thymus pannonicus*, *Salvia transsilvanica*, *Dianthus carthusianorum*, *Carex humilis*, *Jurnea mollis* ssp. *transilvanica* and *Astragalus austriacus*. The authors note that the *Chrysopogoneta*, in Romania, are affected by the habitat conditions specific to the given area, which are characterized by the presence of the

ecological subtypes represented by xerophilous, xero-mesophilous, meso-xerophilous and even mesophilous plant communities. However, they are reflected in the types of habitats by the presence of plant species indicating habitat conditions. In Romania, there are over 22 phytosociological units with *Chrysopogon gryllus*, and all of them include the species *Thymus pannonicus* and match the habitat and the ass. *Thymo (pannonici) - Chrysopogonetum grylli* Donița et al. 1992 (table 1, figure 4, N 14).

Oprea and Sârbu, 2005, studying the flora and vegetation of the "Glodeni Hayfields" Nature Reserve, Vaslui (Romania), discovered the presence of phytocoenoses of the ass. *Thymeto pannonicus - Chrysopogonetum grylli* Donița et al., 1992 all. *Festucion valesiaca* Klika 1931, ord. *Festucetalia valesiaca* Br.-Bl. et Tx. ex Br.-Bl. 1949, Cl. *Festuco-Brometea* Br.-Bl. et Tx. în Br.-Bl. 1949. It is noteworthy that the abundance of *Festuca valesiaca* makes up 1-2 units, which is by 3-4 units lower than the abundance of *Chrysopogon gryllus* (table 1, figure 4, N 15).

Chifu et al., 2014, mentioned the communities with *Chrysopogon gryllus* as sub-association included in the ass. *Medicagini minimae - Festucetum valesiaca* Wagner 1941. The sub-association was characterised as thermophilic and included the differential species *Chrysopogon gryllus* (IV) and *Dasyphyrum*

villosum (I). The author delimited this sub-association after analysing 34 relevés focused on areas located at 140-380 m altitude and, at the same time, it reflected a more mesophilic character of the vegetation within the described association, and *Thymus pannonicus* Aqll., in the synthetic table, has the frequency - 1. We consider the presence of the phytocoenoses of the ass. *Thymo (pannonici) - Chrysopogonetum grylli* Donița et al. 1992 (table 1, figure 4, N 16).

Meyer, 1975, in his doctoral thesis, analysed the dry grasslands with *Chrysopogon gryllus* in north-eastern Italy, where he identified the ass. *Carici humulus - Chrysopogonetum grylli*, subass. *Fumanetosum* with the variants - *Diplachne serotina* and *tipicum*, as well as subass. *galietosum* with the variants *tipicum*, *Leontodon teneciflorus*, *Vinca minor*, al. *Bromion* and *Orno-Ostrion*. The author noted that such communities are also found in Yugoslavia, Hungary and Romania, at low altitudes (table 1, figure 4, N 17).

Nemis et al., 1997, carried out the phytogeographic analysis of the steppe-like vegetation on the hills of the north-eastern Italy with the altitude 50-300 m, where he identified 6 phytogeographic groups with features relevant to the Balkan-Illyrian and the east alpine regions. 1. 34 % include endemic, sub-endemic, Illyrian-Balkan and NW sub-Mediterranean; 2. South-European - sub-Mediterranean - 18.8%; 3. Larger European range - 16.6 %; 4. Eastern Pontic - 7.6 %; 5.

South Eurasian - 10.5 %; 6. North Eurasian - 12.5 %. In the given area, by cluster analysis, the presence of two associations was determined - *Schoeno (nigricans) - Chrysopogonetum grylli* n. n. and ass. *Chamaecytiso (purpureus) Chrysopogonetum grylli* n. n. (table 1, figure 4, N 18).

Sburlino, 2013, studied the phytocoenotic diversity on the north coast of the Adriatic Sea – the grass communities on the slopes of sand dunes, as well as those occurring in the more humid areas found between them. The authors identified the presence of the ass. *Teucrio capitati - Chrysopogonetum grylli* Sburlino et al., 2008, communities of oligotrophic grasses of the northern forest steppe, found between the isotherms 7.5-10.5 °C (table 1, figure 4, N 19).

In the continental biogeographic area, at altitudes of up to 1090 m, in the glades of the Carpathian forests of Crivilui-Buzău (Romania), Ștefan et al., 2007, mentioned the ass. *Taraxaco (serotini) - Bothriochloetum* Burduja et al., 1956, where *Chrysopogon gryllus* occurred, but had low abundance.

Imbrea et al., 2008, mentioned that, on the on the rocky areas of “Cheile Globului” Nature Reserve (Mehedinți) in the south-west of Romania, in forest phytocoenoses of the ass. *Carpino orientalis - Quercetum cerris* Klika 1938, *Chrysopogon gryllus* (I) and *Thymus pannonicus* All. (III) occurred at altitudes of 100-200 m.

Lyubenova *et al.*, 2011, mentioned the presence of *Chrysopogon gryllus* on the Danubian Plain (Bulgaria) with *Cotino-Quercetum cerridis*. Altitude - 300-1000 m.

Sopotleva and A postolova 2014, determined the presence of *Chrysopogon gryllus* in the transition zone between two biogeographic regions - Euro-Asiatic steppe and Mediterranean sclerophytic vegetation. The average altitude in this area is 111-356 m. Here, the species *Chrysopogon gryllus* is part of the ass. *Chrysopogonetum grylli* (Bulgaria).

Feoli *et al.*, 1980, analysed the abandoned grasslands of the Karst region (Italy), with *Quercus pubescens*, *Q. petraea*, *Fraxinus ornus*, *Ostrya carpinifolia*, *Juniperus communis* and *Cotinus coggygria*, where the populations of *Chrysopogon gryllus* were recovering. The authors found that some mesophytes had disappeared from that area and were replaced by xerophytes.

Lonati *et al.*, 2010, studied the syntaxonomy and synecology of the communities with *Erica cinerea* L. in the Alps (north-western Italy). At 480-670 m altitude, the edaphic group *Chrysopogon gryllus* with characteristic grasses of cl. *Festuco-Brometea* occurs and is surrounded by Mediterranean forests (*Quercus pubescens*, *Q. petraea*, *Castanea sativa*, *Fraxinus ornus*, *Erica cinerea*).

Kabas *et al.*, 2013, described the grasslands found on rocky

serpentines, located between Mt. Vujan and Ilijak hill (Serbia), dominated by *Stipa novakii*. *Chrysopogon gryllus* occurs in the areas with the ass. *Stipetum novakii* a. n. (327-360 m altitude, pH 5.5-8), where the climate is humid and warm (t = 10.8 °C). These areas are surrounded by forests with *Quercus cerris*, *Q. pubescens*, *Cotinus coggygria* etc.

In the continental and steppe bioregions, *Chrysopogon gryllus*, at low altitudes, grows in grass communities, as a dominant species, but in the zone of thermophilic alpine forests, it is a species with low abundance, since it prefers areas with more light, such as glades or sparse forest vegetation.

Bernhardt *et al.*, 2006, in their study on the xerophytic grasslands on the NE Adriatic islands Cres and Krk (Croatia), mentioned the presence of plant communities of the ass. *Bromo (erectus) – Chrysopogonetum grylli* H-ic 60, on neutral to alkaline soil, in the humid habitat of the all. *Scorzonerion villosae* H-ic 49; ord. *Scorzonero – Chrysopogonetalia grylli* H-ic 60; Cl. *Festuco-Brometea* (table 1, figure 4, N 20).

Ilijanic *et al.*, 1972, described the grasslands containing *Chrysopogon gryllus*, in the western areas of Croatia, where there are dry grasslands of the Cl. *Festuco-Brometea* ass. *Globulario (elongata) – Chrysopogonetum grylli*, with a floristic composition of sub-Mediterranean type. The given region, with grassy vegetation dominated by *Chrysopogon gryllus*,

is found at an altitude of 200-220 m. The soil is brown at the uppermost horizon, but becomes red or lightly yellow at deeper profiles, at about 40 cm (table 1, figure 4, N 21).

Jasprica *et al.*, 2007, on the Adriatic coast, indicated the presence of grass communities of the ass. *Chrysopogono grylli* – *Nirietum oleandri* Jasprica *et al.*, 2007, all. *Rubus ulmifoli* – *Nerion oleandri*, ord. *Tamaricetalia*, cl. *Nerio-Tamaricetea* (Braun-Blanquet *et Bolos* 1957). These communities are characterized as resistant to long periods of drought and include components of the ord. *Quercetalia ilicis* and *Scorzonero-Chrysopogonetalia*. According to the authors, they occur all along the Mediterranean coastline (table 1, figure 4, N 22).

Fanelli *et al.*, 2015, carried out a research on the vegetation of the Buna River-Velipoja Protected Landscape (Albania). On carbonate substrate, there are perennial grasses specific to the Mediterranean region. The author indicated the presence of communities of the ass. *Asphodelo (ramosus)* – *Chrysopogonetum grylli* Horvatić (1936) 1957, described in Dalmatia by Horvatić in 1958 and 1963, and then – in Albania (at 83-152 m and 277-484 m altitude), as well as in the sparse forests of *Quercus trojana*. There are no *Chrysopogoneta* in areas with Mediterranean climate, where the grasslands consist mainly of *Stipa bromoides*. The authors indicated the association *Asphodelo - Chrysopogonetum grylli* Horvatić

(1936) 1958, all. *Chrysopogono-Saturejion* Horvat & Horvatić in Horvatić 1934, ord. *Scorzonero - Chrysopogonetalia* Horvatić & Horvat in Horvatić 1963, cl. *Festuco-Brometea* Br.-Bl. *et Tuxen ex Klika et Horvatić* 1963 (table 1, figure 4, N 23).

Koci *et al.*, 2017, studied the flora and vegetation of the southwest part of Vlora Bay (Albania), which was represented mainly by three families being respectively Poaceae - 28 species, Asteraceae - 16 species and Fabaceae - 13 species, the Mediterranean elements predominated - 49%. On cliffs, there are forests of *Quercus pubescens*, *Q. ilex* with the herbaceous layer consisting mostly of *Chrysopogon gryllus*, *Dactylis glomerata* and *Asparagus acutifolius*. The woody layer of forests, in the studied area, is dominated by *Cupressus sempervirens* (90- 95 %).

Zupančič *et al.*, 1987, analyzed the relief of Slovenia from phytogeographic point of view and mentioned the presence of grasslands with *Chrysopogon gryllus* in the pre-alpine zone, where sub-Mediterranean elements predominated (*Sesleria autumnalis*, *Ruscus aculeatus*, *Chrysopogon gryllus*, *Luzula nivea*) in *Ostrya - Fagetum* forests.

Pipenbaher *et al.*, 2008, studied the sub-Mediterranean Illyrian grass vegetation of (Slovenia) in two totally different sites - with limestone and flysch substrates. In this area, they

identified the ass. *Danthonia (alpinae)* - *Scorzonetum villosae*. *Chrysopogon gryllus* is a component of the grass vegetation in the sites with lighter substrate and has a higher frequency. The soil pH, in such areas, is neutral to slightly acid; the average temperature is 8-12 °C.

Čarni, 2003, mentioned that, on the Adriatic coastline, in the north-west of Croatia (264-504 m altitude), at the edge of forests of *Quercus pubescens* with *Cotinus coggygria*, there were grass communities with *Chrysopogon gryllus* of the ass. *Knautio illyricae* – *Melampyretum carstinise* as. nova.

Karmiris et al., 2010, studied the diet of animals living in Mediterranean shrublands. At 360-520 m altitude, in central Macedonia, Greece, nearly 50 % of the area is covered by scattered kermes oak (*Quercus coccifera*) stands, and the herbaceous layer is dominated by *Chrysopogon gryllus* and *Dichanthium ischaemum*. Such species as *Festuca valesiaca*, *Cynodon dactylon*, *Bromus tectorum*, *Anthoxanthum odoratum*, *Dactylis glomerata* also occur in this area. The Fabaceae family is represented by *Trifolium stellatum*, *Medicago polymorpha*, *Trifolium arvense*, *T. campestre*, *Vicia cracea*. Other species – *Malva sylvestris*, *Cichorium intybus*, *Sanguisorba minor*, *Capsella bursa-pastoris*, *Leontodon hispidus*, *Taraxacum officinale*, *Sonchus oleraceus*.

Ganatsas et al., 2004, described some areas, in Greece,

planted with *Pinus halepensis* and *P. pinea* (200-300 m altitude). The soil, at these sites, is shallow, eroded, covered mostly by forest vegetation - *Quercus coccifera* and *Q. pubescens*, the herbaceous layer is dominated by *Chrysopogon gryllus*.

In the Mediterranean biogeographic region, *Chrysopogon gryllus* is present as a dominant species in grassy phytocenoses, forming communities with diverse local species of xeric grasslands.

Maestre and Cortina, 2002, mentioned the spatial distribution of the components of the Mediterranean semi-arid steppe vegetation with *Stipa tenacissima* L. - as dominant species and *Brachipodium retusum* (Pers.) P. Beauv. - co-dominant species, which represent 73 % of the total perennial vegetation cover. The steppes of the south-eastern Spain do not include such grass species as *Chrysopogon gryllus* and *Bothriochloa ischaemum* (altitude - 460 m, temperature - 15.8 °C, precipitation - 388 mm), because they are found at the south-western boundary of the xeromesophytic grasslands.

Jovanovici Sl. et al. 2017 (Serbia) demonstrated the distribution of the grass communities with *Chrysopogon gryllus* on limestone serpentines in the Balkan Mountains, at high altitudes, where they identified grassland vegetation of the ass. *Bromo (fibrosi)* – *Chrysopogonetum grylli* Tatici 1969 (table 1, figure 4, N 24).

Ivan *et al.*, 1993, based on relevés sampled in the area of the Transylvanian Plateau (Romania), at the altitude of 600 m, emphasized the specific floral composition of grasslands with *Chrysopogon gryllus*, accompanied by *Danthonia alpina* (III) - an oligotrophic xeromezophytic grass species, which grows on slightly acid soil. Other species that occur in this area: *Festuca valesiaca* (IV), *Asperula cynanchica* (II), *Achillea setacea* (II), *Trifolium montanum* (IV), *Teucrium montanum* (III), *Eryngium campestre* (III), *Teucrium chamaedrys* (III), *Filipendula vulgaris* (III), *Salvia pratensis* (IV), *Euphorbia cyparissias* (III), *Sanguisorba minor* (II), *Dianthus carthusianorum* (IV), *Trifolium campestre* (III), *Prunella laciniata* (III), *Thymus globarescens* (II), *Anthyliis vulneraria* (II), *Phleum montanum* (II) etc. The zonal component of these *Chrysopogoneta* is missing - *Thymus pannonicus*. These communities of savanoid grasses occur at the northern border of this biogeographic region and contact with the dry steppe grasslands of cl. *Festuco-Brometea*. The authors accepted to include such plant communities in the ass. *Dantonina (alpina) - Chrysopogonetum grylli* Kojić 1959; Boșcaiu (1970) 1972 (table 1, figure 4, N 25).

Pirini *et al.*, 2014, presented a study on the steppe-like grassland vegetation in the hills around the lakes of Vegoritida and Petron, in north-central Greece. Based on 245 relevés of vascular plant species,

subjected to the cluster analysis, four plant communities were distinguished in the area, namely *Artemisia campestris-Dasyphyrum villosum*, *Chrysopogon gryllus-Bothriochloa ischaemum*, *Satureja montana-Artemisia alba* and *Stipa capillata-Koeleria macrantha*. These communities were classified in cl. *Festuco-Brometea*, ord. *Astragalo-potentillietalia*. The authors consider these communities steppe-like or secondary grasslands, with some species interpreted as relicts of the Tertiary period, and the secondary grasslands as a result of degradation of forests with *Quercus trojana*. Steppe species occur in open oak woodlands or shibljak-type shrublands.

The authors also mention that low-altitude dry grasslands of north-central Greece are located near the south-eastern European margins of the vegetation class *Festuco-Brometea*. The authors concluded that the steppe-like grasslands around the Lakes of Vegoritida and Petron are clearly secondary steppe grasslands but it is rather likely that populations of steppe species have occurred continuously in deciduous woodlands and shrublands, in landscapes that “were probably never densely wooded throughout the Holocene”. *Chrysopogon gryllus* and *Bothriochloa ischaemum* are present in all clusters mentioned by the authors, and this fact suggests a close connection of these species with the Balkan (alpine and Mediterranean) habitat. After analyzing the synthetic table

presented by the authors, we highlighted the dominance of the species *Thymus sibthorpii* in the grass communities of the ass. *Chrysopogon gryllus* - *Bothriochloa ischaemum* Sbrulino et al., 2008. The authors conclude that the dry grasslands of Greece are secondary steppes, formed because of intensive grazing, in the sparse forests of *Quercus trojana* as well as in the Mediterranean forests with *Q.coccifera*, which has led to the creation of shrublands of the *shibljak* type (wooded deciduous pastureland of the subcontinental parts of the Balkans and the Black Sea area). Under postglacial and current climatic as well as land use (grazing) conditions in our area, and depending on the degree of their demand for light, steppe species may have occurred either in open oak woodlands or in various kinds of *shibljak*-type degradation stages (table 1, figure 4, N 26).

Pedashenko et al., 2013, carried out a research on the ecological diversity and syntaxonomy of the dry grasslands of NW Bulgarian Mountains. They identified, at high altitudes, on limestone substrate with alkaline pH, plant communities of the ass. *Agrostio (cappilari)* - *Chrysopogonetum grylli* Kojić 1959; all. *Chrysopogono grylli* - *Danthonion calycinae* Kojić 1959; ord. *Brachipodietalia pinnati* Korneck 1974; cl. *Festuco - Brometea* Br.-Bl. et Tx. et Klika et Hadac 1944 (table 1, figure 4, N 27).

Djordjevic et al., 2012, described communities of the ass. *Chrysopogonetum grylli* Gajić 1954; all. *Chrysopogono - Danthonion calycinae* Kojić i 1959; ord. *Festucetalia valesiaceae* Br.-Bl. et Tx. 1943, cl. *Festuco - Brometea* Br.-Bl. et Tx. 1943, found at 510-490 m altitude. The frequency of *Agrostis capillaris* - (V) (3 relevés), ass. *Agrostis (capillaris) - Chrysopogon grylli* Kojić, 1959 (table 1, figure 4, N 28).

Tashev et al., 2010, contributed to the study of habitat diversity in the Western Stara Planina Mountains (Bulgaria), where they identified the biotope of sub-Pannonian steppe with *Chrysopogon gryllus* and *Bothriochloa ischaemum*. One of the most common species for these steppes is *Bromus erectus* with ass. *Bromo (erectus)* - *Chrysopogonetum grylli* Horvatić 1934 (table 1, figure 4, N 29).

Matevski et al., 2015, studied the syntaxonomy of the rocky grasslands on carbonate bedrocks in the west and southwest of the Republic of Macedonia, where they have identified the ass. *Petrorragio haynaldianae - Chrysopogonetum grylli* n.n., in areas with the average temperature 11.2 °C and altitude from 540 m to 1300 m. *Chrysopogon gryllus* and *Bothriochloa ischaemum* occur in arid grasslands all over the Balkans (Table 1, figure 4, N 30).

Velev, 2005, analyzed the dynamics of grassland vegetation in the Lovech province (Bulgaria) over

15 years. The average altitude of the sites studied by the author is 1000-1200 m. In the areas covered mainly by forest vegetation with *Fagus sylvatica* and *Quercus cerris*, there are communities of herbaceous plants with *Agrostis capillaries*, *Pteridium aquilegium* (L.) Kechn. and *Festuca valesiaca*, which occur in large areas in the Bulgarian part of the Balkan mountain range. The phytocoenoses with *Chrysopogon gryllus* are secondary communities in the forest vegetation.

Todorova et al., 2010, mentioned that, in the Bosnek village (western Bulgaria), 20 % of the territory is covered by dry grasslands, at 830-1500 m altitude, on limestone substrate on karst rocks. In this area, the authors have identified phytocoenoses of the association *Bromo moesiaca* - *Stipetum epilosae* a.n. all. *Saturejon montanae* Horvat 1962, ord. *Festucetalia* Br.-Bl. et Tuxen 1943, cl. *Festuco-Brometea* Br.-Bl. et Tuxen 1943. *Chrysopogon gryllus* and *Bothriochloa ischaemum* occur in 5 of the 38 analyzed relevés.

In the alpine biogeographic region, there are forest belts and alpine grasslands with Mediterranean and sub-Mediterranean vegetation, where *Chrysopogon gryllus* occurs in habitats with slightly acid soils and alpine grasses - *Agrostis capillaris*, *Danthonia alpina*, *Bromus fibrosus*, *Petrorrhagia haynaldiana* etc.

Aćić et al., 2015, described the ecology, biodiversity and classification of arid grasslands in the Central Balkans (Serbia,

Kosovo), which include the north-central Balkan Peninsula (south-eastern Pannonian Plain). They are found along the Danube, Tisa, Sava, Begej and Tamiš rivers. Pannonian dry grasslands form xerophilous grassy communities at various altitudes (from low altitudes in the floodplain of rivers to mountain areas of 600-1400 m) and on various types of soil: chernozem, alkaline silicates, limestone with neutral pH, slightly acid sands, such as loess and Pleistocene sediments and deposits. The authors consider that in the Central Balkans (Serbia, Kosovo) traditional Pannonian dry grasslands are communities of cl. *Festuco-Brometea*, ord. *Festucetalia vaginatae*. By analysing the database made up of 1897 relevés with 1323 species of vascular plants, 11 clusters have been identified. *Chrysopogon gryllus* has been mentioned as dominant and constant species in the Cluster 2, on the hills in the zone of *Quercus frainetto* and *Q. cerris* forest (table 1, figure 4, N 31).

Djurđević et al., 2013, demonstrated the allelopathic effects of *Chrysopogon gryllus* L. in *Chrysopogonetum Pannonicum* Stjep.-Ves. steppe community in the region Deliblato Sands of Southern Banat (Serbia), where they detected leaching of phenolic acid and studied its impact on the germination capacity of the seeds of *Trifolium arvense* and *Poa pratense*, which had low abundance and cover in the ass. *Carici humilis-Chrysopogonetum grylli* Kojić 1959. The abundance of *Carex*

humilis is (2) (table 1, figure 4, N 32).

Szollát *et al.*, 2007, in their article on the vegetation of sandy areas of Gödi láprét, Hungary, mentioned semi-natural steppes dominated by *Bromus erectus* and grasslands dominated by *Chrysopogon gryllus*, *Brachypodium pinnatum* and *Equisetum ramosissimum*, with such abundant species as *Stipa capillata*, *Festuca rupicola*, *F. pseudovina*, *Koeleria cristata*, *Carex caryophylla*, *Dactylis glomerata* and *Centaurea sadleriana*. In the studied grasslands found in the Danubian Plain, of the Pannonian biogeographic region, *Chrysopogon gryllus* has low abundance.

Dobolyi, 2002, studied the changes that occurred in the vegetation of grasslands found on dolomite rocks in Csíki-Hegyek (Budaörs, Hungary), between 1996 and 2001. During that period, the proportion of species with sub-Mediterranean, Pontic, Balkan and Sarmatian elements increased, and the distribution of phytosociological elements of *Festucetalia valesiacae* order, *Festuco-Brometea* class, such as *Chrysopogon gryllus*, have experienced an increase in abundance.

Salamon-Albert and Lörincz, 2010, studied the vegetation of meadows, focusing on the ass. *Iriditetum sibiricae*, which contained plant communities that were specific to Hungary. The list of components of this association also included *Chrysopogon gryllus*, which was very scattered, but still

present in the communities of meadow grasses.

Hagyó, 2003, in an article on the vegetation of marsh meadows of Zákányszék (Hungary), mentioned the presence of *Chrysopogon gryllus* in ass. *Agrostio-Caricetum distantis* and ass. *Astragalo austriacae - Festucetum sulcatae*, considering them transitional types of communities, from arid to humid ones.

The analyzed meadows from the Pannonian Plain, containing *Chrysopogon gryllus*, commonly occur in meadow habitats as components of the ass. *Agrostio (alba) - Caricetum distans* and *Astragalo austriacae - Festucetum sulcatae*. The soil in this area is sandy.

The Pannonian biogeographic region comprises grasslands with *Chrysopogon gryllus*, occurring at the border with the xeric steppes from cl. *Festuco-Brometea*, thus, the analyzed lists highlight the xerophytic character of the sites with *Bromus erectus*, as well as the expansion in the meadow habitats with *Agrostis alba* or *Iris sibirica*.

The "Black Sea" biogeographic region includes the Balkan and Anatolian coasts. In this area, there are favourable conditions for the growth and expansion of the savannoid species *Chrysopogon gryllus*, which is not dominant in plant communities, but is part of the grassland and forest phytocoenoses occurring in the given region.

Tzonev *et al.*, 2005, studied the psammophytic vegetation (on

dunes) of the Bulgarian Black Sea coast, where they detected, on shifting dunes, the presence of grass communities of the ass. *Aurinio uichritziani* - *Artemisietum campestris* and ass. *Cakilo euxinae* - *Salsolietum rutenicae*, which occurred on mountain slopes in Bulgaria and Turkey and differed from those found on Dobrudzha coast and "Golden Sands" resort in the more savannoid floristic composition.

Karaer et al., 2010, presented the results of a research on the phytosociological and ecological structure of Mediterranean enclaves along the stream valleys in inner parts of Black Sea region (Turkey). At the altitude of 350-800 m, there are degraded forests of *Quercus coccifera*, *Pinus brutia*, *Arbutus andrachne*, *A. unedonis* and *Olea sylvestris*. They form forest communities with *Chrysopogon gryllus*, which occurs in the following associations: *Siderito dichotomae* - *Quercetum cocciferae*, *Cotino coggygiae* - *Arbutetum andrachnes*, *Spiraeocrenatae* - *Oleetum sylvestris*, *Paliuro spinae-christi* - *Fontanesietum philliraeoides*, *Buxo sempervirenti* - *Arbutetum unedonis*, *Quercus infectoriae* - *Pinetum brutiae*. The grasses in these forest communities are 30-40 cm tall, their coverage is about 25-40 %, slope exposure - southern or south-western. In these associations, *Chrysopogon gryllus* is in minority and its range includes areas with slightly acid forest soils, but the temperature and the amount

of light make it possible for this species to grow in the forest areas.

The Anatolian biogeographic region is a plateau with silvopastoral vegetation, which includes various altitudes favourable to forests, grasslands and forest steppes.

Korkmaz et al., 2011, in the study on the vegetation of the Kizilirmak valley (Turkey), identified the presence of steppe vegetation, and *Chrysopogon gryllus* is present everywhere in the forests of cl. *Quercetea ilicis* Br.-Bl. et de Bolos G. Vayreda 1950, where it has high frequency (V) in 10 relevés, at 300-400 m altitude. The author mentioned 10 associations containing *Chrysopogon gryllus*: 1. ass. *Spyreaeo crenatae* - *Oleetum sylvestris* Karaer et al. 2010. 2. Ass. *Buxo sempervirentis* - *Arbutetum unedonis* Karaer et al. 2010, located at 300-400 m altitude, *Chrysopogon gryllus* (h = 70 cm) has a coverage of 20 %, frequency - (I). 3. Ass. *Scutellaria pinnatifidae* - *Juniperetum excelsae* Korkmaz., Engin, Kutbay et Galcin, altitude - 350-600 m, height of *Chrysopogon gryllus* plants - 45-60 cm, coverage - 20-25 % and frequency - (II). Ass. *Cotino coggygiae* - *Pinetum brutiae* Korkmaz, Engin, Kutbay et Galciu, the frequency of *Chrysopogon gryllus* - (II), coverage - 20-25 %. h = 50-70 cm. In the Anatolian steppes, at the altitude of 550-650 m, *Chrysopogon gryllus* has high frequency, together with *Stipa arabica*. It is part of the ass. *Linario carifoliae* - *Astragaletum microcephali* Korkmaz, Angin,

Kytbay et Galcin. At the altitude of 1250-1300 m, there are no *Chrysopogon gryllus* plants in the Anatolian steppes. It is obvious that *Chrysopogon gryllus* occurs in areas with Mediterranean climate on alkaline soil on carbonate substrate.

Kaya et al., 2013, carried out a synecological and syntaxonomical research on the overgrazed steppe vegetation on Arat Mountain (Turkey). *Chrysopogon gryllus* is present in the ass. *Minuartio formosae* - *Astragaletum diphtheritae*, at 710-720 m altitude, with the frequency I, coverage - 70-75 %, on slopes with northern exposure and inclination of 15-20 °. It is part of the cl. *Astragalo-Brometea*. Therophytes predominate in these grasslands, as a result of overgrazing.

Ünal S. et al. evaluated the vegetation of the Kayseri Province, Central Anatolia (Turkey). The authors studied the steppe vegetation at 1080-2264 m, where the average temperature was 10.2 °C. The succession of grass species from these grasslands was studied. The authors determined that *Chrysopogon gryllus* was in decline, but *Festuca valesiaca*, the dominant species of xeric grasslands, was expanding.

Qureshi et al., 1964, studied the forest soils of the arid and semi-arid regions of India. They found that dry forests on red and yellow soils predominated in the arid zone (*Accacia senegal*, *Prosopis spicigera* et al.), the most common species of shrubs were *Tamarix dioica*, *Zizyphus rotundifolia* et al.,

grasses - *Chrysopogon montanus* et al. (red soil, precipitation - 500-550 mm, altitude - 305-701 m, depth of groundwater - 16-22 m).

Joshi et al., 1964, studied the grasses and sedges of certain areas in Jhunjhunu district (Rajasthan, India). The research was conducted in low-lying areas, sandy areas and hilly areas with *Chrysopogon gryllus*, which was found only in hilly areas, where it formed longitudinal belts over hilly slopes.

Sundriyal, 1995, in the study on grassland forage production and management in the western Himalaya, mentioned the presence of *Chrysopogon gryllus* as dominant species in the alpine zone (altitude > 3000 m, t < 6-10 °C, rainfall < 1000 mm; dry months - 5-6, winter snow - 6-7 months), together with *Agrostis canina*, *Dactylis glomerata*, *Koeleria cristata*, *Poa pratensis*, *Phleum alpinum*, *Danthonia jacquemontii* et al., climax species - *Rhododendron*, *Juniperus*, *Cotoneaster*, *Artemisia*, *Lonicera*, *Hippophae*. The author mentioned the presence of *Chrysopogon gryllus* in the montane zone (altitude = 2000-3000 m, t < 10 °C, rainfall < 1000 mm, winter snow - 3-4 months), climax species in forests - *Betula utilis*, *Abies pindrow*, *Taxus baccata*, *Pinus excelsa*, *Acer caesium*.

Neamsuvan et al., 2009, mentioned, for the first time, the presence of *Chrysopogon gryllus* (L.) Trin. in a new location - Vetiveria (Thailand), characterized by evergreen forest vegetation, at the altitude of 1250-1500 m with

degraded grasslands, which are often burned.

Singh *et al.*, 2015, studied the vegetation of degraded oak forests (*Quercus floribunda* and *Q. leucotriphoros*), at 1500-2350 m altitude, in the Garhwal Mountains (Himalaya). They mentioned that *Chrysopogon gryllus* occurred in unaffected forests as well as in those affected by anthropogenic disturbance.

In the Central Himalaya, *Chrysopogon gryllus* occurs in the montane zone - 2000-3000 m altitude (t = 15 °C; rainfall - 1000-2000 mm; dry months - 2-3), sub-montane - 1200-2000 m altitude (t = 15-20 °C; rainfall - 1000-2500 mm; rainy days - 100-150; dry months - 2-3) and sub-tropical zone - altitude < 1200 m (t > 20 °C; rainfall - 1000 mm; dry months - 4-5, sunny days < 100), together with *Bothriochloa pertusa*, *Cynodon dactylon*, *Arundinella*, *Phragmites* etc., climax species - *Quercus incana*, *Q. dilatata*, *Q. semecarpifolia*, *Cedrus*, *Picea*, *Pinus*, *Terminalia* etc.

In Eastern Himalaya, *Chrysopogon gryllus* occurs in the sub-montane zone - 1200-2000 m altitude (t = 15-20 °C; rainfall - 2000 mm; dry months - 3-4, humid climate) and sub-tropical - altitude < 1200 m (t - 20 °C; rainfall > 2000 mm; dry months < 4), together with *Agrostis*, *Bothriochloa*, *Festuca*, *Phalaris*, *Phleum*, *Phragmites*, *Cynodon*, *Arundinella* etc. with regional grass species, in forest vegetation - with *Quercus lamellosa*, *Magnolia*,

Rhododendron arboreum, *Terminalia* etc.

Terzi, 2015, analyzed the vegetation of the dry grasslands of ord. *Scorzonero-Chrysopogonetalia*, and modified its nomenclature, as being strictly sub-Mediterranean, of the order *Scorzonerietalia villosae*, occurring in Albania, Bosnia and Herzegovina, Bulgaria, Italy, Kosovo, Montenegro, Slovenia and Serbia. The vegetation of this order occurs in the western Balkans till the pre-alpine area. The author mentions the species of the order as meso-xerophilic, but included in cl. *Festuco-Brometea* and considers that such communities are closer to the ecological requirements of *Scorzonera villosa*, which occurs at lower altitude.

Romeo Di Pietro *et al.*, 2015, analyzed the nomenclature and the syntaxonomy of dry grasslands (steppes) in Europe. They mentioned the presence of grassy communities of all. *Chrysopogono-Danthonion* in the Balkans and attributed the west European grassland vegetation to ord. *Brometalia*, cl. *Festuco-Brometea*.

Redzic, 1999, carried out an analytical study on the syntaxonomy of grasses of Cl. *Festuco-Brometea* Br.-Bl. et Tx. 1943 from the Balkans and concluded that “they are significantly different from those in the western and central Europe, and even from those in the eastern Europe, by the presence of numerous species which belong to the Balkan, Illyrian and the southeast Europe floristic element”.

This phytocenotic class (*Festuco-Brometea*) includes so many different orders – *Scorzoneretalia villosae*, *Festucetalia valesiaca*, *Brometalia erecti* and *Astragalopotentilletalia*, with numerous phytocenotic specifications, atypical to the class of grasslands in western and central Europe. This situation emphasizes the need for further revision, according to Redzic S., of the status of the class *Festuco-Brometea*, under mainly xeric conditions, encountered at different altitudes. The author also mentions that, by syntaxonomically differentiating the xerophilous vegetation from the xeromesophilous vegetation, the floristic composition is specified by the presence of hemicryptophytes and chamaephytes with more than 35 % and of the Illyrian, Balkan and south-east European floristic elements, and attributes the grasslands with *Chrysopogon gryllus* to two orders of cl. *Festuco-Brometea*: the first one - *Scorzoneretalia villosa* Horvatic 1975, with species of Mediterranean and sub-Mediterranean grasses in meso-xeric habitats, and the second

one - *Festucetalia valesiaca* Br.-Bl. and Tx. 1943 - in xeric habitats.

Therefore, the savannoid grasslands *Chrysopogono-Bothriochloetea* n.n. comprise the range of grasses in the Mediterranean and sub-Mediterranean climate zone and the dry grasslands of the natural range of the dominant species *Bothriochloa ischaemum* and *Chrysopogon gryllus*, occurring in Europe and Asia, within the limits of the isotherm 8-10.5 °C and average amounts of precipitation of 500-1000 mm, and all that would correspond to the habitat expressed by ecological formula - $U_{1-2}Tr_{1,R}7-8T_{4,5}H_1$ (Lazu, 2014).

This hypothesis requires further vegetation inventory, more in-depth studies on the current situation of savannoid grasslands and more conclusive evidence in terms of paleobotany, plant geography and population genetics, in order to confirm the syntaxonomic position of communities with *Chrysopogon gryllus* and *Bothriochloa ischaemum*.

CONCLUSIONS

Chrysopogon gryllus, within its wide range (continental, steppe, alpine, Mediterranean and Pannonian biogeographic regions), forms discrete and stable phytocoenoses, as dominant species and is accompanied by species of local grasses, and in the biogeographic regions of the Black

Sea and Anatolia, it is an ordinary component of regional phytocoenoses.

In the present grasslands with *Chrysopogon gryllus*, occurring in the plains and glades with steppe vegetation of the forests with *Quercus pubescens* and *Cotinus coggygria* (steppe and

continental biogeographic regions), there are stable communities of the association *Thymo (pannonici) - Chrysopogonetum grylli* Doniță et al., 1992.

In the Mediterranean biogeographic region, at an altitude of 480-670 m, within the range of Mediterranean forests with *Quercus petraea*, *Q. pubescens*, *Castanea sativa*, *Fraxinus ornus*, *Erica cinerea*, with numerous shrubs - *Rosa* sp., *Corylus avellana*, *Sorbus aria*, *Juniperus communis*, *Berberis vulgaris*, *Rosa canina* etc. and grasses, such as *Chrysopogon gryllus* and *Bothriochloa ischaemum* etc., there are isolated grasslands used as pastures, and in some sectors, the trees and shrubs have degraded to extinction.

In the alpine biogeographic region (500-1500 m altitude), there are dry grasslands with *Chrysopogon gryllus* as dominant species, and in degraded forests, it occurs as an ordinary component.

In the eastern part of its range, in the Himalaya Mountains, *Chrysopogon gryllus* grows at altitudes up to 3000 m and above, where it forms monodominant

communities, and at low altitudes, it forms communities with other species of the genus *Chrysopogon*.

The grasslands with *Chrysopogon gryllus* and *Bothriochloa ischaemum* spread over a large area, compactly accompanied by a group of their faithful grasses, separating the xerophilous grasses of the cl. *Festuco-Brometea* from savannah grasslands, which are more thermophilous and more humid, reminiscent of the times when they were grazed by herds of herbivores in the savannahs of the Tertiary era.

The grassland communities with *Chrysopogon gryllus* are more common on the European continent (continental, steppe, Pannonian, Mediterranean and alpine biogeographic regions), but they are less common, or, at least, we have not found any bibliographic sources mentioning their presence in North Africa, Middle East and Southeast Asia, and the habitat of these phytocenoses is included, in terms of climate, in the isotherm 7.5-10.5 °C (Sburlino et al., 2013) and the precipitation limit > 500 mm (Sundriyal, 1995).

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