NORTH-WESTERN JOURNAL OF ZOOLOGY 14 (1): 1-12
Article No.: e171101

http://biozoojournals.ro/nwjz/index.html

Ground beetles (Coleoptera: Carabidae) in grasslands: Model for assessment of the species diversity and ecosystem condition in Bulgaria

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Received: 13. March 2017 / Accepted: 20. May 2017 / Available online: 29. July 2017 / Printed: June 2018

Abstract. The study presents a survey of the species composition of ground beetles occurring in the five major subtypes of grassland ecosystems, distributed on the territory of Bulgaria (dry, mesic, wet, alpine-subalpine and inland salt grasslands). A total of 329 species of 71 genera were identified. The qualitative analysis of the carabids' species composition confirmed the potentially crucial significance of humidity for the distribution of carabids. This parameter occurred as the first axis on the ordination graph. The other important factor appears to be the soil conditions, which was the second axis. The analysis of the life forms of the ground beetles occurring in grasslands showed a predominance of the zoophages (181 species; 55%) over the mixophytophages (148 species; 45%). After summarizing all available information, a model of the distribution of the species in the ecosystem subtypes, altitudes and regions was prepared. On the basis of the arithmetical average number of the common species from all altitude belts was developed a 5-scale system for assessment of the species richness of ground beetles and the conditions in the five subtypes of grassland ecosystems.

Key words: Carabidae, ground beetles, grassland, assessment, ecosystem condition, Bulgaria.

Introduction

Grasslands are areas dominated by grasses and forbs, and have few or no trees. Seasonal drought, occasional fires and grazing by large mammals all prevent woody shrubs and trees from becoming established. Less than eight percent of all grasslands worldwide are protected. Temperate grasslands have the lowest protection of any biome on earth, at less than one percent (Defenders of Wildlife 2017).

Grassland ecosystems include open biotopes, which to a large extent depend on human management. Fixed low-intensity activities (e.g. regular mowing of hay or regulated grazing) may lead to formation of biologically valuable open ecosystems. These semi-natural meadows, pastures, etc. support populations of a number of target species, some of which are completely dependent on a given type of habitat.

Invertebrates have multifaceted impacts on the environments they inhabit, existing in a variety of ecological niches and functional differentiations. They exist in the particular conditions of the habitat, while at the same time they also influence and transform it. When a sufficient amount of information about species composition, taxonomic and ecological structure of the invertebrate fauna in the herbaceous ecosystems is collected, then more explicit assessments and deductions about the state of the studied territories could be done, and precise conclusions on the ecosystem services that they can offer could be specified.

The representatives of the family Carabidae are extremely various, well represented among the arthropod soil fauna (Gobbi & Fontaneto 2008) and important for the ecological research (Sakine 2006). Thanks to their varied ecological role (predators, scavengers, prey, partially phytophages), their study on an ecosystem level has a great scientific and practical importance (Dehelean et al. 2012).

Ground beetles are very useful for describing the changes in the habitats, since they appear in almost all terrestrial biotopes and exhibit remarkable trends in populational-dynamic direction (Rainio & Niemelä 2003, Pearce & Venier 2006).

The main objective of this work was to study species composition of the ground beetles occurring in the five major subtypes of grassland ecosystems, distributed on the territory of Bulgaria, and to prepare a model for their assessment.

Material and Methods

Methodology and analysis of the data

The collection of the basic information includes several steps:

Step 1: Overview of the available literary sources (scientific publications, catalogs), containing a summarised regional works for the Bulgarian carabid fauna and individual notes that give information about the species composition and single records of carabids. Data from personal observations, collections and field studies were also used.

Step 2: Detailed analysis of the ecological requirements of the species and assigning each species to lists for the corresponding subtypes of grassland ecosystems (some of the species could be found in more than one subtype, and eurybionts inhabit all subtypes of ecosystems).

Step 3: Preparation of a list of the ground beetles, occurring in the different types of grasslands in Bulgaria.

The development of the model for assessment of the condition of the different subtypes of grassland ecosystems also includes several stages:

Step 4: Apportion of the species in relation to the altitude at which they are present.

Step 5: Preparation of the model of distribution of the species by the ecosystem subtypes, altitudes and regions, on the basis of the summarised available information.

Step 6: Development of a 5-scale system for assessment of the status of the different subtypes of grass ecosystems. As a step to develop the valuations of the various ranks and as a limit for a very bad condition (1st rank), one-fifth of the arithmetic average number of species from all altitude ranges, established for each ecosystem subtype, was used.

Categorization of the species in respect of their life forms was made according to the classification of Sharova (1981). Systematics follows Kryzhanovskij et al. (1995).

For the mathematical processing of the data the software products CANOCO 4.5 (Ter Braak & Šmilauer 2002) and PRIMER 6 (Clarke & Gorley 2005) were used.

Table 1. Typology of the grassland ecosystems and descriptions of the subtypes (Level 3) in Bulgaria.

Level			Description	Nomenclature
1	2	3		
Terrestrial	Grasslands	Dry grasslands	Dry lands dominated by grass or herbs mostly with low productivity but high species richness. They could be open or closed, arid, floristically rich, steppe-like, typically with species of genus *Stipa* and *Festuca*. In Bulgaria within this group are included also communities dominated by *Dichantium ischaemum*, *Chrysopogon gryllus* and *Poa bulbosa*. They are often semi-natural in term of origin, developed on places of thermophilous oak forests.	EUNIS: E1; Bondev (1991): 129, 130; Directive 92/43: 6210, 6220, 6240, 6250, 6260, 62C0, 62A0
		Mesic grasslands	Lowland and montane mesotrophic and eutrophic pastures and hay meadows. They are generally more productive than dry grasslands. The soils are moistened by underground or surface water supplied by slope runoff. Species richness is generally high.	EUNIS: E2; Bondev (1991): 26, 44, 73, 74, 148; Directive 92/43: 6410, 6420, 6440, 6510, 6520
		Seasonally wet and wet grasslands	Grasslands of occasionally flooded river banks, of depressions where rain water collects. Very typical are humid meadows rich in clover (*Trifolium* spp.) and other legumes, mostly developed above the lowlands but below the montane level.	EUNIS: E3; Bondev (1991): 148; Directive 92/43: 6420, 6430, 6440, 6510
		Alpine and subalpine grasslands	Primary and secondary grass or sedge dominated communities of the alpine and subalpine levels. Part of these grasslands form dense, closed, chionophilous grasslands of acid substrates at the 1800–2500 m of high mountains. These grasslands are usually submitted to pasture regimes. Particular group are alpine and subalpine grasslands of base-rich soils. Habitats with sparse vegetation on stony serpentine soils in the mountains occupy small area.	EUNIS: E4; Bondev (1991): 1, 2, 8, 9; Directive 92/43: 6150, 6170, 6230, 62D0
		Inland salt grasslands	Salt steppe-like habitats and their associated salt-tolerant herbaceous communities and other sub-halophyte plant communities. Dominant species are *Puccinelia convoluta*, *Puccinelia distans*, *Camphorosma monspeliaca*, *Camphorosma annua*, *Crypsis aculeata*, *Elymus elongatus*, *Artemisia santonicum*, etc.	EUNIS: E6; Bondev (1991): 146; Directive 92/43: 1340, 1530

General typology of grassland ecosystems

"Grassland ecosystems" are usually considered as a natural or mostly seminatural vegetation type. They are part of farm holdings (pastures, meadows, hedges, ridges, field margins, buffer strips, uncultivated land, etc.). Grasslands include the lands used for production of natural resources for animal consumption as food, for production of fiber or for livestock services. The "grassland ecosystems" include dynamic associations of different species forming pastures or meadows, livestock, other fauna, soils, water, and the atmosphere.

The used typology of "Grassland ecosystems" corresponds with the ecosystem classification of MAES (Maes et al. 2013), combined with the European Nature Information System (EUNIS) habitat classification types. The MAES ecosystem typology on Level 2 follows closely the EUNIS Level 1. The third level of the MAES typology corresponds therefore to the EUNIS level 2. The EUNIS level 2 is the base for the assessment approach. A selection of EUNIS classification on level 2 is proposed for detailed typology as level 3 for target ecosystem type. A total of 5 grassland types were selected. They correspond to levels "E1", "E2", "E3", "E4" and "E6" from EUNIS group "E". Descriptions and relations to other classification systems of proposed subtypes are presented in Table 1.

Results

The data collected during the survey indicate a fairly rich set of ground beetles (Coleoptera: Carabidae), which can be found in the different grassland ecosystems. These are 329 species from 71 genera, which represents 44% of the species and 57% of the genera included in the full list of carabid species of Bulgaria (Guéorguiev & Teofilova in prep.).

Appendix 1 contains a check-list of all species with information about the life form which they refer to, and their presence in the given subtype of grass ecosystem. Individual codes used in the mathematical analysis for all species are also given.

Dry grassland ecosystems are spread throughout the territory of the country. Large complexes of them are situated in northeastern Bulgaria, and smaller ones are found in southeastern and southwestern Bulgaria. In the rest of the country they occupy smaller areas and have a scattered distribution. For this ecosystem subtype a species composition of 174 carabid species was established.

Mesophilous and mesohygrophilous grass ecosystems occur mainly at the fringes of rivers. These include also various lowland and low mountainous meadows and pastures of altitudes to about 1600 m a.s.l. For this ecosystem subtype are characteristic 180 species of ground beetles.

Seasonally wet and wet grasslands are common in the lowland parts of the country, on the flooded banks of the rivers or in geomorphological depressions where the rain waters are collected. In this subtype of ecosystems were found 111 species.

Alpine and subalpine grassland ecosystems are distributed in the mountains above 1800 m, where a zonal herbaceous vegetation of arcto-alpine type is developed. Carabid communities are highly specific and include 95 species.

Inland salt grasslands develop on plain territories with salty soils. In Bulgaria large areas of halophyte vegetation occur in the southeastern parts of the country, in the area between Sliven, Karnobat and Yambol; they also occupy small areas in northern Bulgaria, along the river of Studena. The carabid complex in this subtype of ecosystems also consists of a specific set of species and includes 60 typical halophilous and halotolerant species.

The dendrogram for splitting by the similarity on the basis of the qualitative (species) composition of the ecosystems (Fig. 1) shows the differentiation of humid and salt ecosystems in a separate group with a relatively low level of similarity. In the second group, with an average level of similarity, mesophilous and arid grassland ecosystems are separated, which are quite similar in species composition. Alpine and subalpine grasslands are characterized by a distinctive species composition, including mostly typical mountain species, and they separate as an individual group with a very

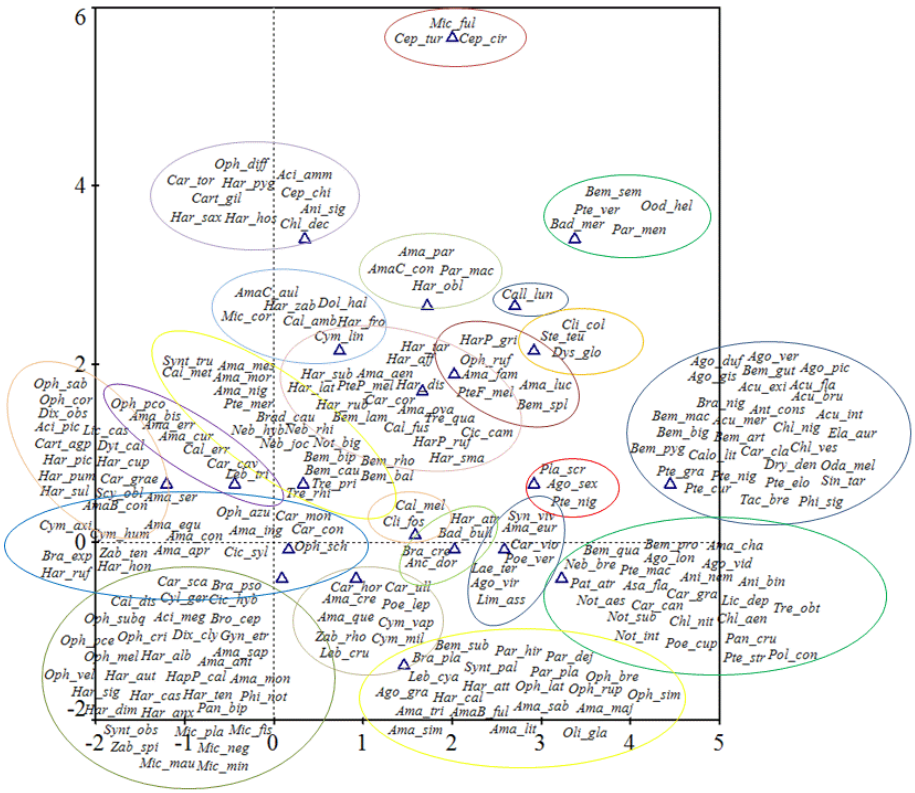

Figure 3. Qualitative DCA analysis of the carabid species, inhabiting the five types of grass ecosystems.

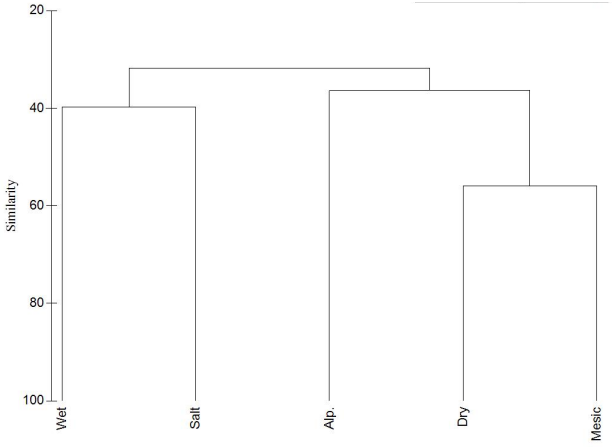

Figure 1. Brey-Curtis Similarity dendrogram based on the species richness.

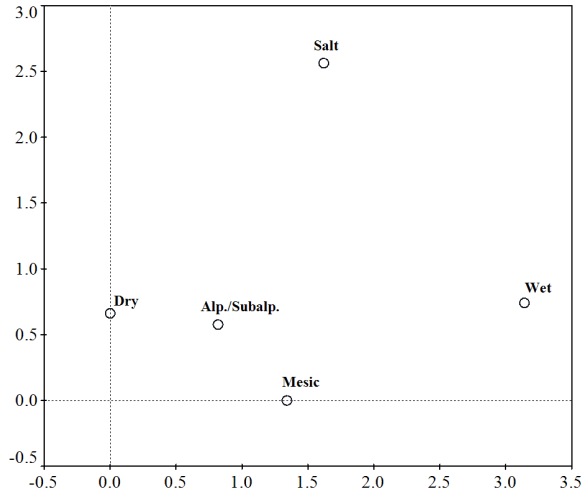

Figure 2. Qualitative DCA analysis of the five types of grass ecosystems.

low level of similarity to the other subtypes of ecosystems.

The gradient analysis of the individual subtypes of grassland ecosystems based on their carabid species composition, confirms the potentially crucial role of humidity for the distribution of ground beetles. In this study humidity occurs as a first axis on the ordination graph (Fig. 2). The figure shows that according to their regime of humidity alpine and subalpine ecosystems occupy an intermediate position between the dry and the mesic subtypes, and salt ecosystems have rather mesophilous conditions of humidity. As a second axis of distribution the soil conditions may be adopted. In this case it can be argued that dry, alpine and wet ecosystems are characterized by a specificity of the soil substrate, while in the salt ecosystems soil conditions are quite extreme.

In the ordination of the species (Fig. 3) similar patterns are observed as in the distribution of the subtypes of ecosystems along the two axes; the same two gradients have the greatest impact. From left to right the species are arranged according to their humidity requirements – from xerophilous to hygrophilous. In vertical direction species are arranged from mesophilous (*Harpalus attenuatus*, *Lebia cyanocephala*, *Parophonus dejeani*), through halotolerant (*Acinopus ammophilus*, *Chlaenius decipiens*, *Harpalus hospes*, *Harpalus pygmaeus*, *Ophonus diffinis*) to halobiont (*Cephalota circumdata*, *Cephalota turcica*, *Microlestes fulvibasis*).

The shaping of the individual groups of species is based on the stenotopy of the species, i.e. depending on whether the species are attached to one particular type of ecosystem or may be found in more than one type. In the lower left

corner of the graph are located mesoxerophilous species from open habitats in the lowland and lower mountain belts (*Carabus scabriusculus*, *Cylindera germanica*, *Gynandromorphus etruscus*, *Harpalus autumnalis*, *Microlestes minutulus*, *Zabrus spinipes*, etc.). Above them are the mesoxerophils which are found also in the higher parts of the mountains (*Amara ingenua*, *Brachinus explodens*, *Carabus montivagus*, *Cicindela sylvicola*, *Calosoma auropunctatum*, *Harpalus rufipalpis*, *Ophonus schaubergerianus*, etc.). Immediately above them are positioned the typical xerophilous species from open habitats (*Amara reflexicollis*, *Calathus longicollis*, *Harpalus sulphuripes*, *Harpalus servus*, *Licinus cassideus*, *Ophonus cordatus*, *Scybalicus oblongiusculus*, etc.). On their right, along the humidity gradient, are located the typical high-mountain species (*Amara morio*, *Amara nigricornis*, *Bradycellus caucasicus*, *Bembidion rhodopense*, *Leistus parvicollis*, *Nebria rhilensis*, *Syntomus truncatellus*).

At the bottom right of the graph are positioned the mesohygrophilous and hygrophilous species, as on the far right side are the most closely connected with the water species: many species of the genera *Acupalpus*, *Agonum*, *Bembidion*, *Chlaenius*, *Notiophilus*, some *Pterostichus* species.

In the center of the graph as a rule are placed the unpretentious eurybiont species (*Amara aenea*, *Bembidion lampros*, *Carabus coriaceus*, *Cicindela campestris*, *Harpalus affinis*, *Harpalus rufipes*, *Trechus quadristriatus*, etc.), and around them are positioned the polytopic species, occurring in more than two types of ecosystems (*Agonum viridicupreum*, *Amara lucida*, *Bembidion splendidum*, *Brachinus crepitans*, *Calathus melanocephalus*, *Callistus lunatus*, *Carabus convexus*, *Clivina fossor*, *Cymindis lineata*, *Microlestes corticalis*, *Ophonus rufibarbis*, *Poecilus versicolor*, *Pterostichus melas*, *Zabrus tenebrioides*, etc.).

The analysis of the life forms of the ground beetles occurring in the grassland ecosystems shows a predominance of the zoophages (181 species; 55%) over mixophytophages (148 species; 45%). There are 19 life forms of ground beetles – 13 zoophagous and 6 mixophytophagous.

The largest share of the species belongs to the harpaloid geohortobionts from Class Mixophytophagous, followed by the surface & litter-dwelling stratobionts from Class Zoophagous (Fig. 4).

The similarity between the five subtypes of grasslands ecosystems, calculated on the basis of the life forms of the species found in the given subtype (Fig. 5), shows a different pattern from the distribution according to the species composition. With very high similarity into a separate group are dry and mesic ecosystems. This is probably due to a greater resemblance in the environmental conditions in these two subtypes of ecosystems. In both ecosystem subtypes the highest rate of the harpaloid geohortobionts (respectively 32% for the dry and 26% for the mesic) was established, followed by the mixophytophagous stratohortobionts (respectively 16% and 15%). The zoophagous litter & crevice-dwelling stratobionts (respectively 13% and 12%) and the litter-dwelling stratobionts (respectively 8% and 9%) also have a large share in both subtypes.

The alpine and salt ecosystems were united with a high level of similarity. They are also characterized by the strongest presence of the harpaloid geohortobionts (respectively 27% for the alpine and 33% for the salt). Relatively large for both ecosystems is the share of the surface & litter-dwelling

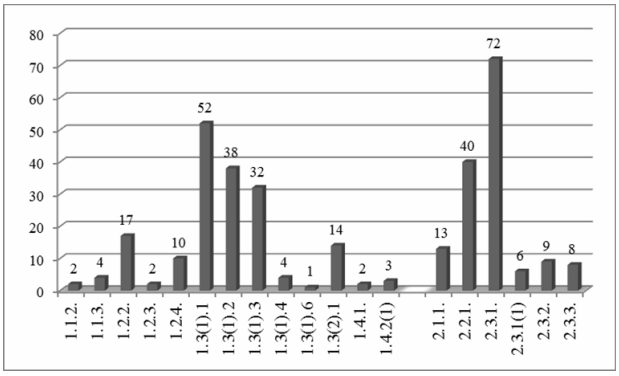

Figure 4. Number of species in the different life forms of the ground beetles from grassland ecosystems in Bulgaria.

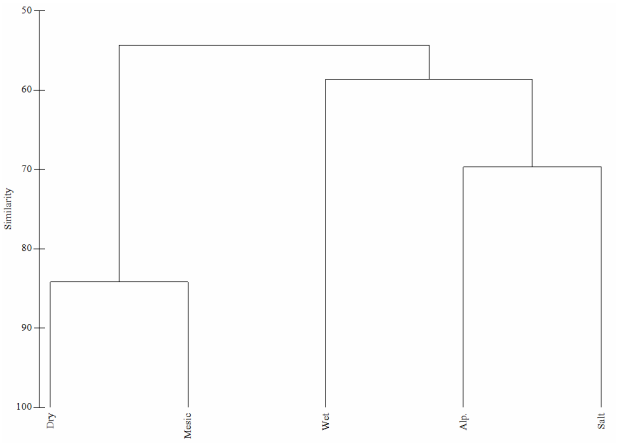

Figure 5. Brey-Curtis Similarity dendrogram based on the life forms of the ground beetles from the different types of grassland ecosystems.

stratobionts (respectively 13% and 15%). Many of the species in the alpine and subalpine ecosystems pertain to the litter-dwelling stratobionts (21%), while in the salt ecosystems the same constitute 10%.

The wetland ecosystems separate in a detached group on an average level of similarity. There is a very high presence of the surface & litter-dwelling stratobionts in them (34% of all species inhabiting seasonally wet and wet grasslands refer to this life form). With a smaller proportion are the harpaloid geohortobionts (14%), litter-dwelling stratobionts (12%) and litter & soil-dwelling digging stratobionts (11%).

To the harpaloid geohortobionts belong *Anisodactylus*, *Scybalicus*, *Pangus*, most of the *Amara* and *Harpalus* species that are dependent on the vegetation cover and in principle inhabit open territories with low and moderate levels of humidity and drained soils. This explains their low presence in the wet ecosystems.

Stratohortobionts are *Gynandromorphus*, *Parophonus*, *Ophonus*, some *Amara*, subgenera *Cephalophonus* and *Semiophonus*, which are also typical of the open areas, but are sensitive to extreme environmental conditions, and therefore are rarely found at high altitudes and on saline or waterlogged soils. It is similar for the zoophagous litter & crevice-dwelling stratobionts (*Masoreus*, *Philorhizus*, *Syntomus*, *Microlestes*, *Cymindis*, *Brachinus*), whose distribution depends mostly on the soil substrate.

For the litter-dwelling stratobionts, which live hidden in

Table 3. Model scheme for assessment of the species richness of the ground beetles and the condition in the five subtypes of grassland ecosystems in Bulgaria, developed on the basis of the number of common species.

Grassland ecosystem subtype	Rank: 1 Very bad	Rank: 2 Bad	Rank: 3 Moderate	Rank: 4 Good	Rank: 5 Very good
Dry	≤ 19	20–39	40–59	60–79	≥ 80
Mesic	≤ 25	26–50	51–75	76–100	≥ 100
Wet	≤ 18	19–36	37–54	55–72	≥ 72
Alpine/Subalpine	≤ 6	7–12	13–18	19–24	≥ 24
Salt	≤ 8	9–16	17–24	25–32	≥ 33

the substrate (*Leistus*, *Nebria*, *Trechus*, *Patrobus*, *Stomis*, *Calathus*, *Synuchus*, *Olisthopus*, *Badister*, subgenus *Europhilus*), the presence of vegetal litter is more important than humidity conditions and soil type, so they are found in all types of ecosystems.

Surface & litter-dwelling stratobionts are most of the *Bembidion* and *Agonum* species, *Notiophilus*, *Platynus*, *Anchomenus*, *Panagaeus*, *Chlaenius*, *Oodes*, *Licinus*, *Polystichus*, which are litter-dwelling species living also in the epigeic layers; they are not highly sensitive to the extreme fluctuations of the soil and humidity regimes.

To the litter & soil-dwelling digging stratobionts relate most of the *Poecilus* and *Pterostichus* species, which hunt on the surface of the soil, and in order to hide, they actively dig in the ground or litter. The high percentage of these forms in the wet ecosystems is due to their pronounced hygrophily.

The species richness or species composition of the fauna is a major parameter of the structure of the communities and it is an obligatory element in the ecological surveys. In turn, community structure is best expressed through the different ecological groups. The predators are a mandatory component of every ecosystem, and the assessment of the status and trends of their communities and populations brings information about the total productivity and condition of the ecosystems.

In the present study as a model for the assessment of the species richness of predatory invertebrates the ground beetles are used. This group of animals includes pronounced predators and is characterized by extremely high abundance, wide variety of species and proven ecological significance; they also serve as indicators about the state of the ecosystems and the environment. Furthermore, it is precisely for this group of animals the available data are sufficiently complete and reliable, at least within the borders of Bulgaria.

The parameter of the species diversity is applicable for all five subtypes of grass ecosystems. The 5-scale system for assessment of the ecosystems condition is composed on the basis of the relatively mass and common species which are not limited to a specific part of the territory of the country. Rare species that are difficult to find in the field are also not included.

Table 2 presents the number of established common species occurring in the different altitudinal zones of the country. Dry and mesic ecosystems in Bulgaria occupy territories up to about 1600 m a. s. l., wet and salt grasslands are located in the lowland parts of the country, and alpine and subalpine subtype occur above 1700–1800 m. The distribution of the number of species in the separate altitudinal ranges was done with respect to these regularities.

On the basis of the arithmetical average number of species from all altitudinal belts the 5-scale system was devel

Table 2. Altitudinal distribution of the number of species of ground beetles in the five subtypes of grassland ecosystems.

Altitude	Grassland subtype				
m a.s.l.	Dry	Mesic	Wet	Alp.	Salt
0–200	113	145	89		33
200–400	123	154	92		30
400–600	122	157	91		30
> 600			89		29
600–800	114	148			
800–1000	113	143			
1000–1200	89	115			
1200–1400	78	103			
1400–1600	69	91			
> 1600	49	65			
1700–1800				79	
1800–2000				74	
2000–2200				57	
2200–2400				42	
2400–2600				18	
2600–2800				7	
> 2800				7	
Average:	97	125	90	30	41

oped for assessment of the ground beetles species richness and the condition in the five subtypes of grassland ecosystems (Table 3).

Discussion

For the grassland ecosystems in Bulgaria very rich carabid fauna was established consisting of 329 species, most of them typically living in open biotopes and rarely found in other types of habitats. A small proportion of the species are polytopic or eurytopic. According to Nietupski et al. (2015) grasslands, especially those excluded from agricultural use, may harbor precious and rare Carabidae fauna, and they should be subject to close monitoring.

The results of the study show that in relation to the species composition, carabid communities of the dry and mesic grass ecosystems are the most related. Those of the alpine-subalpine ecosystems are characterized by a particuliar species composition, including mostly typical mountain species and differing from communities in the other types of ecosystems.

The qualitative analysis of the carabids' species composition confirmed the potentially crucial role of the humidity and the soil conditions for the distribution of ground beetles, which in the ordination graph appeared respectively as the first and the second axis. Soil type, moisture and vegetation cover are noted as the most important factors determining the distribution of the ground beetles (e.g. Brygadyrenko 2015, Brygadyrenko 2016, Teofilova & Kodzhabashev 2015), along with the different land use and the presence of forests

in the surrounding of the habitats (Nietupski et al. 2015).

The established life forms of the grassland ground beetles are characterized by a predominance of the zoophages (55%) over the mixophytophages (45%) with a ratio between these two classes reflecting the closeness of the grass ecosystems in Bulgaria to the meadow-like steppes of the forest-steppe zone of Eurasia (Sharova 1981).

The similarity between the five subtypes of grassland ecosystems, calculated on the basis of the life forms of the carabids, shows very high similarity between the dry and mesic ecosystems. The specificity in the environmental conditions (primarily soil and humidity regimes) determines the separation of wet ecosystems in an independent group including species with pronounced hygrophily.

Mathematical processing of the data shows that the grouping of the ecosystems according to their taxonomic structure is distinguishing by the grouping according to the ecological structure (using the life forms).

The 5-scale model for the assessment of the species richness of the ground beetles in the five grassland ecosystem subtypes represents an innovation in the ecological analyses. The model reflects the total productivity and condition of ecosystems and offers a 5-scale valuation with ranks varying from "very bad" to "very good" condition.

Acknowledgments. The present study was carried out thanks to the financial aid and in parallel with the implementation of the Project Д-33-90/03.09.2015 Assessment and mapping of GRASSLAND ecosystems condition and their services in Bulgaria (IBER-GRASS), and Project BiodivERsA-FACCE2014-47 SusTaining AgriCultural ChAnge Through ecological engineering and Optimal use of natural resources (STACCATO).

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Appendix 1. List of Carabidae species that could be found in Bulgarian grasslands.

№	Species	Life form	Grassland subtypes					Code
			Dry	Mesic	Wet	Alp.	Salt	
	Tribe Cicindellini							
1.	*Cylindera (Cylindera) germanica* Linnaeus, 1758	1.2.4	+	+				Cyl_ger
2.	*Cephalota (Taenidia) elegans* (Fischer von Waldheim, 1823)	1.2.4	+					Cep_ele
3.	*Cephalota (Taenidia) circumdata* (Dejean, 1822)	1.2.4					+	Cep_cir
4.	*Cephalota (Taenidia) chiloleuca* Fisher-Waldheim, 1820	1.2.4	+				+	Cep_chi
5.	*Cephalota (Cephalota) turcica* (Schaum, 1859)	1.2.4					+	Cep_tur
6.	*Calomera littoralis* (Fabricius, 1787)	1.2.4			+			Calo_lit
7.	*Cicindela (Cicindela) hybrida* Linnaeus, 1758	1.2.4	+	+				Cic_hyb
8.	*Cicindela (Cicindela) sylvicola* Latreille et Dejean, 1822	1.2.4	+	+		+		Cic_syl
9.	*Cicindela (Cicindela) soluta* Latreille et Dejean, 1822	1.2.4	+					Cic_sol
10.	*Cicindela (Cicindela) campestris* Linnaeus, 1758	1.2.4	+	+	+	+	+	Cic_cam
	Tribe Nebriini							
11.	*Leistus (Pogonophorus) parvicollis* Chaudoir, 1869	1.3(1).2				+		Lei_par
12.	*Leistus (Leistus) ferrugineus* (Linnaeus, 1758)	1.3(1).2		+				Lei_fer
13.	*Nebria (Nebria) brevicollis* (Fabricius, 1792)	1.3(1).2		+	+			Neb_bre
14.	*Nebria (Eunebria) jockischi* Sturm, 1815	1.3(1).2				+		Neb_joc
15.	*Nebria (Alpaeonebria) rhilensis* J. Frivaldszky, 1879	1.3(1).2				+		Neb_rhi
16.	*Nebria (Alpaeus) hybrida* Rottenberg, 1874	1.3(1).2				+		Neb_hyb
17.	*Nebria (Tyrrhenia) eugeniae* K. Daniel, 1903	1.3(1).2				+		Neb_eug
	Tribe Notiophilini							
18.	*Notiophilus aestuans* Motschulsky, 1864	1.3(1).1		+	+			Not_aes
19.	*Notiophilus interstitialis* Reitter, 1889	1.3(1).1		+	+			Not_int
20.	*Notiophilus laticollis* Chaudoir, 1850	1.3(1).1	+					Not_lat
21.	*Notiophilus biguttatus* (Fabricius, 1779)	1.3(1).1				+		Not_big
22.	*Notiophilus substriatus* C. R. Waterhouse, 1833	1.3(1).1		+	+			Not_sub
23.	*Notiophilus aquaticus* (Linnaeus, 1758)	1.3(1).1	+	+	+	+	+	Not_aqu
24.	*Notiophilus germinyi* Fauvel, 1863	1.3(1).1	+					Not_ger
	Tribe Carabini							
25.	*Calosoma (Campatita) auropunctatum* (Herbst, 1784)	1.2.2	+			+		Cal_aur
26.	*Calosoma (Caminara) denticolle* Gebler, 1833	1.2.2	+					Cal_den
27.	*Carabus (Eucarabus) ullrichi* Germar, 1824	1.2.2		+		+		Car_ull
28.	*Carabus (Tachypus) cancellatus* Illiger, 1798	1.2.2		+	+			Car_can
29.	*Carabus (Carabus) granulatus* Linnaeus, 1758	1.2.2		+	+			Car_gra
30.	*Carabus (Trachycarabus) scabriusculus* Olivier, 1795	1.2.2	+	+				Car_sca
31.	*Carabus (Limnocarabus) clathratus* Linnaeus, 1761	1.2.2			+			Car_cla
32.	*Carabus (Archicarabus) montivagus* Palliardi, 1825	1.2.2	+	+		+		Car_mon
33.	*Carabus (Tomocarabus) convexus* Fabricius, 1775	1.2.2	+	+		+		Car_con
34.	*Carabus (Pachystus) graecus* Dejean, 1826	1.2.2	+					Car_grae
35.	*Carabus (Pachystus) hungaricus* Fabricius, 1801	1.2.2	+					Car_hun
36.	*Carabus (Pachystus) cavernosus* Frivaldszky, 1835	1.2.2	+			+		Car_cav
37.	*Carabus (Oreocarabus) hortensis* Linnaeus, 1758	1.2.2		+		+		Car_hor
38.	*Carabus (Chaetocarabus) intricatus* Linnaeus, 1761	1.2.2				+		Car_int
39.	*Carabus (Megodontus) violaceus* Linnaeus, 1758	1.2.2		+	+	+		Car_vio
40.	*Carabus (Lamprostus) torosus* Frivaldszky, 1835	1.2.2	+				+	Car_tor
41.	*Carabus (Procrustes) coriaceus* Linnaeus, 1758	1.2.2	+	+	+	+	+	Car_cor
	Tribe Elaphrini							
42.	*Elaphrus (Elaphroterus) aureus* P. W. J. Müller, 1821	1.2.3			+			Ela_aur
	Tribe Clivinini							
43.	*Clivina (Clivina) fossor* (Linnaeus, 1758)	1.4.2(1)	+	+	+	+		Cli_fos
44.	*Clivina (Clivina) collaris* (Herbst, 1784)	1.4.2(1)		+	+		+	Cli_col
	Tribe Dyschiriini							
45.	*Dyschiriodes (Eudyschirius) globosus* Herbst, 1784	1.4.2(1)		+	+		+	Dys_glo
	Tribe Broscini							
46.	*Broscus cephalotes* (Linnaeus, 1785)	1.4.1.	+	+				Bro_cep
47.	*Broscus nobilis* (Dejean, 1828)	1.4.1.	+					Bro_nob
	Tribe Trechini							
48.	*Blemus discus* (Fabricius, 1792)	1.3(1).2		+	+			Ble_dis
49.	*Trechus (Trechus) quadristriatus* (Schrank, 1781)	1.3(1).2	+	+	+	+	+	Tre_qua
50.	*Trechus (Trechus) austriacus* Dejean, 1831	1.3(1).2	+	+	+	+	+	Tre_aus
51.	*Trechus (Trechus) obtusus* Erichson, 1837	1.3(1).2		+	+			Tre_obt
52.	*Trechus (Trechus) kobingeri* Apfelbeck, 1902	1.3(1).2				+		Tre_kob
53.	*Trechus (Trechus) rhilensis* Kaufmann, 1884	1.3(1).2				+		Tre_rhi
54.	*Trechus (Trechus) gulickai* Löbl, 1967	1.3(1).2				+		Tre_gul
55.	*Trechus (Trechus) demircapicus* P. Moravec, 1986	1.3(1).2				+		Tre_dem
56.	*Trechus (Trechus) orphaeus* Pawlowski, 1973	1.3(1).2				+		Tre_orp

№	Species	Life form	Grassland subtypes					Code
			Dry	Mesic	Wet	Alp.	Salt	
57.	*Trechus (Trechus) rambouseki* Breit, 1909	1.3(1).2				+		Tre_ram
58.	*Trechus (Trechus) priapus* K. Daniel, 1902	1.3(1).2				+		Tre_pri
59.	*Trechus (Trechus) pirinicus* Pawlowski, 1972	1.3(1).2				+		Tre_pir
	Tribe Tachyini							
60.	*Tachys (Polyderis) brevicornis* Chaudoir, 1846	1.3(1).4			+			Tac_bre
	Tribe Bembidiini							
61.	*Asaphidion flavipes* (Linnaeus, 1761)	1.2.3		+	+			Asa_fla
62.	*Bembidion (Chlorodium) splendidum* Sturm, 1825	1.3(1).1	+	+	+		+	Bem_spl
63.	*Bembidion (Chlorodium) pygmaeum* (Fabricius, 1792)	1.3(1).1			+			Bem_pyg
64.	*Bembidion (Metallina) lampros* (Herbst, 1784)	1.3(1).1	+	+	+	+	+	Bem_lam
65.	*Bembidion (Metallina) properans* (Stephens, 1828)	1.3(1).1		+	+			Bem_pro
66.	*Bembidion (Notaphus) semipunctatum* (Donovan, 1806)	1.3(1).1			+		+	Bem_sem
67.	*Bembidion (Eupetodromus) starkii* Schaum, 1860	1.3(1).1			+			Bem_sta
68.	*Bembidion (Philochthus) biguttatum* (Fabricius, 1779)	1.3(1).1			+			Bem_big
69.	*Bembidion (Philochthus) guttula* (Fabricius, 1792)	1.3(1).1			+			Bem_gut
70.	*Bembidion (Trepanes) articulatum* (Panzer, 1796)	1.3(1).1			+			Bem_art
71.	*Bembidion (Trepanes) maculatum* Dejean, 1831	1.3(1).1			+			Bem_mac
72.	*Bembidion (Diplocampa) fumigatum* (Duftschmid, 1812)	1.3(1).1			+		+	Bem_fum
73.	*Bembidion (Bembidion) quadrimaculatum* (Linnaeus, 1761)	1.3(1).1		+	+			Bem_qua
74.	*Bembidion (Nepha) caucasicum* (Motschulsky, 1844)	1.3(1).1				+		Bem_cau
75.	*Bembidion (Bembidionetolitzkya) rhodopense* Apfelbeck, 1902	1.3(1).1				+		Bem_rho
76.	*Bembidion (Peryphus) subcostatum* (Motschulsky, 1850)	1.3(1).1		+				Bem_sub
77.	*Bembidion (Ocyturanes) balcanicum* Apfelbeck, 1899	1.3(1).1				+		Bem_bal
78.	*Bembidion (Testedium) bipunctatum* (Linnaeus, 1761)	1.3(1).1				+		Bem_bip
79.	*Sinechostictus (Sinechostictus) tarsicus* (Peyron, 1858)	1.3(1).1			+			Sin_tar
	Tribe Patrobini							
80.	*Patrobus atrorufus* (Ström, 1768)	1.3(1).2		+	+			Pat_atr
	Tribe Pterostichini							
81.	*Stomis (Stomis) pumicatus* (Panzer, 1796)	1.3(1).2			+			Sto_pum
82.	*Xenion ignitum* (Kraatz, 1875)	1.3(1).4				+		Xen_ign
83.	*Poecilus (Poecilus) sericeus* Fischer von Waldheim, 1824	1.3(2).1		+	+			Poe_ser
84.	*Poecilus (Poecilus) cupreus* (Linnaeus, 1758)	1.3(2).1		+	+			Poe_cup
85.	*Poecilus (Poecilus) lepidus* (Leske, 1785)	1.3(2).1		+		+		Poe_lep
86.	*Poecilus (Poecilus) versicolor* (Sturm, 1824)	1.3(2).1		+	+	+		Poe_ver
87.	*Pterostichus (Platysma) niger* (Schaller, 1783)	1.3(2).1			+	+		Pte_nig
88.	*Pterostichus (Argutor) cursor* (Dejean, 1828)	1.3(2).1			+			Pte_cur
89.	*Pterostichus (Argutor) vernalis* (Panzer, 1796)	1.3(2).1			+		+	Pte_ver
90.	*Pterostichus (Adelosia) macer* (Marsham, 1802)	1.3(2).1		+	+			Pte_mac
91.	*Pterostichus (Pseudomaseus) nigrita* (Paykull, 1790)	1.3(2).1			+			Pte_nigr
92.	*Pterostichus (Pseudomaseus) gracilis* (Dejean, 1828)	1.3(2).1			+			Pte_gra
93.	*Pterostichus (Phonias) strenuus* (Panzer, 1797)	1.3(1).1		+	+			Pte_str
94.	*Pterostichus (Melanius) elongatus* (Duftschmid, 1812)	1.3(2).1			+			Pte_elo
95.	*Pterostichus (Petrophilus) melanarius* (Illiger, 1798)	1.3(2).1	+	+	+	+	+	PteP_mel
96.	*Pterostichus (Feronidius) melas* (Creutzer, 1799)	1.3(2).1	+	+	+		+	PteF_mel
97.	*Pterostichus (Pterostichus) merklii* J. Frivaldszky, 1879	1.3(2).1				+		Pte_mer
	Tribe Sphodrini							
98.	*Calathus (Calathus) distinguendus* Chaudoir, 1846	1.3(1).2	+	+				Cal_dis
99.	*Calathus (Calathus) fuscipes* (Goeze, 1777)	1.3(1).2	+	+	+	+	+	Cal_fus
100.	*Calathus (Calathus) longicollis* Motschulsky, 1865	1.3(1).2	+					Cal_lon
101.	*Calathus (Neocalathus) ambiguus* (Paykull, 1790)	1.3(1).2	+	+			+	Cal_amb
102.	*Calathus (Neocalathus) erratus* C. R. Sahlberg, 1827	1.3(1).2	+			+		Cal_err
103.	*Calathus (Neocalathus) melanocephalus* (Linnaeus, 1758)	1.3(1).2	+	+	+	+		Cal_mel
104.	*Calathus (Neocalathus) metallicus* Dejean, 1828	1.3(1).2				+		Cal_met
105.	*Calathus (Neocalathus) mollis* (Marsham, 1802)	1.3(1).2	+					Cal_mol
106.	*Calathus (Neocalathus) cinctus* (Motschulsky, 1850)	1.3(1).2	+	+				Cal_cin
107.	*Dolichus halensis* (Schaller, 1783)	1.3(1).2	+	+			+	Dol_hal
108.	*Laemostenus (Pristonychus) terricola* (Herbst, 1784)	1.3(1).6		+	+	+		Lae_ter
109.	*Synuchus (Synuchus) vivalis* Illiger, 1798	1.3(1).2		+	+	+		Syn_viv
	Tribe Agonini							
110.	*Agonum (Platynomicrus) gracilipes* (Duftschmid, 1812)	1.3(1).1		+				Ago_gra
111.	*Agonum (Agonum) gisellae* Csiki, 1931	1.3(1).1			+			Ago_gis
112.	*Agonum (Olisares) longicorne* Chaudoir, 1846	1.3(1).1		+	+			Ago_lon
113.	*Agonum (Olisares) duftschmidi* J. Schmidt, 1994	1.3(1).1			+			Ago_duf
114.	*Agonum (Olisares) sexpunctatum* (Linnaeus, 1758)	1.3(1).1			+	+		Ago_sex
115.	*Agonum (Olisares) viduum* (Panzer, 1796)	1.3(1).1		+	+			Ago_vid
116.	*Agonum (Olisares) viridicupreum* (Goeze, 1777)	1.3(1).1		+	+	+		Ago_vir

№	Species	Life form	Grassland subtypes					Code
			Dry	Mesic	Wet	Alp.	Salt	
117.	*Agonum (Olisares) versutum* Sturm, 1824	1.3(1).1			+			Ago_ver
118.	*Agonum (Europhilus) piceum* (Linnaeus, 1758)	1.3(1).2			+			Ago_pic
119.	*Limodromus assimilis* (Paykull, 1790)	1.3(1).1		+	+	+		Lim_ass
120.	*Platynus (Batenus) scrobiculatus* (Fabricius, 1801)	1.3(1).1			+	+		Pla_scr
121.	*Anchomenus (Anchomenus) dorsalis* (Pontoppidan, 1763)	1.3(1).1	+	+	+			Anc_dor
122.	*Olisthopus rotundatus* (Paykull, 1790)	1.3(1).2	+					Oli_rot
123.	*Olisthopus fuscatus* Dejean, 1828	1.3(1).2	+					Oli_fus
124.	*Olisthopus glabricollis* (Germar, 1817)	1.3(1).2		+				Oli_gla
	Tribe Zabrini							
125.	*Amara (Zezea) chaudoiri* Schaum,1858	2.3.1.		+	+			Ama_cha
126.	*Amara (Zezea) reflexicollis* Motschulsky,1844	2.2.1.	+					Ama_ref
127.	*Amara (Zezea) tricuspidata* Dejean, 1831	2.2.1		+				Ama_tri
128.	*Amara (Zezea) fulvipes* (Audinet-Serville, 1821)	2.2.1.	+					AmaZ_ful
129.	*Amara (Zezea) plebeja* (Gyllenhal, 1810)	2.2.1		+				Ama_ple
130.	*Amara (Amara) aenea* (De Geer, 1774)	2.3.1	+	+	+	+	+	Ama_aen
131.	*Amara (Amara) anthobia* Villa, 1833	2.1.1	+	+				Ama_ant
132.	*Amara (Amara) convexior* Stephens, 1828	2.3.1	+	+		+		Ama_con
133.	*Amara (Amara) eurynota* (Panzer, 1796)	2.3.1		+	+	+		Ama_eur
134.	*Amara (Amara) communis* (Panzer, 1797)	2.3.1	+	+				Ama_com
135.	*Amara (Amara) familiaris* (Duftschmid, 1812)	2.1.1	+	+	+		+	Ama_fam
136.	*Amara (Amara) lucida* (Duftschmid, 1812)	2.3.1	+	+	+		+	Ama_luc
137.	*Amara (Amara) ovata* (Fabricius, 1792)	2.3.1	+	+	+	+	+	Ama_ova
138.	*Amara (Amara) saphyrea* Dejean, 1828	2.2.1	+	+				Ama_sap
139.	*Amara (Amara) similata* (Gyllenhal, 1810)	2.3.1		+				Ama_sim
140.	*Amara (Amara) montivaga* Sturm, 1825	2.3.1	+	+				Ama_mon
141.	*Amara (Amara) morio* Ménétriés, 1832	2.3.1				+		Ama_mor
142.	*Amara (Amara) nigricornis* Thompson, 1857	2.3.1				+		Ama_nig
143.	*Amara (Amara) curta* Dejean, 1828	2.3.1	+			+		Ama_cur
144.	*Amara (Amara) tibialis* (Paykull, 1798)	2.3.1	+			+		Ama_tib
145.	*Amara (Amara) littorea* C. C. Thomson, 1857	2.3.1		+				Ama_lit
146.	*Amara (Celia) bifrons* (Gyllenhal, 1810)	2.3.1	+			+		Ama_bif
147.	*Amara (Celia) praetermissa* C.R. Sahlberg, 1827	2.3.1	+	+				Ama_pra
148.	*Amara (Celia) sabulosa* Serville, 1821	2.3.1		+				Ama_sab
149.	*Amara (Celia) sollicita* Pantél, 1888	2.3.1	+	+				Ama_sol
150.	*Amara (Celia) arenaria* (Putzeys, 1865)	2.3.1	+					Ama_are
151.	*Amara (Amarocelia) erratica* (Duftschmid, 1812)	2.3.1	+			+		Ama_err
152.	*Amara (Xenocelia) fusca* Dejean, 1828	2.3.1	+					Ama_fus
153.	*Amara (Xenocelia) ingenua* (Duftschmid, 1812)	2.3.1	+	+		+		Ama_ing
154.	*Amara (Xenocelia) bischoffi* Jedlička, 1946	2.3.1.	+			+		Ama_bis
155.	*Amara (Xenocelia) cursitans* C. Zimmermann, 1832	2.3.1	+			+		AmaX_cur
156.	*Amara (Xenocelia) messae* Baliani, 1924	2.3.1				+		Ama_mes
157.	*Amara (Paracelia) quenseli* (Schönherr, 1806)	2.3.1		+		+		Ama_que
158.	*Amara (Paracelia) serdicana* Apfelbeck, 1904	2.3.1.	+					Ama_ser
159.	*Amara (Bradytus) apricaria* (Paykull, 1790)	2.3.1(1)	+	+		+		Ama_apr
160.	*Amara (Bradytus) consularis* (Duftschmid, 1812)	2.3.1(1)	+					AmaB_con
161.	*Amara (Bradytus) crenata* Dejean, 1828	2.3.1(1)		+		+		Ama_cre
162.	*Amara (Bradytus) fulva* (O. Müller, 1776)	2.3.1(1)		+				AmaB_ful
163.	*Amara (Bradytus) majuscula* (Chaudoir, 1850)	2.3.1(1)		+				Ama_maj
164.	*Amara (Amathitis) parvicollis* Gebler, 1833	2.3.1(1)		+			+	Ama_par
165.	*Amara (Percosia) equestris* (Duftschmid, 1812)	2.3.1	+	+		+		Ama_equ
166.	*Amara (Curtonotus) aulica* (Panzer, 1797)	2.3.1	+	+			+	AmaC_aul
167.	*Amara (Curtonotus) convexiuscula* (Marsham, 1802)	2.3.1		+			+	AmaC_con
168.	*Zabrus (Zabrus) tenebrioides* (Goeze, 1777)	2.3.2	+	+		+		Zab_ten
169.	*Zabrus (Pelor) spinipes* (Fabricius, 1798)	2.3.2	+	+				Zab_spi
170.	*Zabrus (Pelor) rhodopensis* Apfelbeck, 1904	2.3.2		+		+		Zab_rho
	Tribe Harpalini							
171.	*Anisodactylus (Anisodactylus) binotatus* (Fabricius, 1787)	2.3.1		+	+			Ani_bin
172.	*Anisodactylus (Anisodactylus) pueli* Schauberger, 1933	2.3.1	+	+				Ani_pue
173.	*Anisodactylus (Anisodactylus) nemorivagus* (Duftschmidt, 1812)	2.3.1		+	+			Ani_nem
174.	*Anisodactylus (Pseudanisodactylus) signatus* (Panzer, 1796)	2.3.1	+				+	Ani_sig
175.	*Anisodactylus (Hexatrichus) poeciloides* (Stephens, 1828)	2.3.1		+			+	Ani_poe
176.	*Scybalicus oblongiusculus* (Dejean, 1829)	2.3.1.	+					Scy_obl
177.	*Gynandromorphus etruscus* (Quensel en Schönherr, 1806)	2.2.1.	+	+				Gyn_etr
178.	*Bradycellus (Bradycellus) caucasicus* (Chaudoir, 1846)	2.1.1.				+		Brad_cau
179.	*Bradycellus (Bradycellus) harpalinus* (Audinet-Serville, 1821)	2.1.1.		+				Brad_har
180.	*Stenolophus (Stenolophus) teutonus* (Schrank, 1781)	2.1.1		+	+		+	Ste_teu

№	Species	Life form	Grassland subtypes					Code
			Dry	Mesic	Wet	Alp.	Salt	
181.	*Acupalpus (Ancylostria) interstitialis* Reitter, 1884	2.1.1.			+			Acu_int
182.	*Acupalpus (Acupalpus) brunnipes* (Sturm, 1825)	2.1.1			+			Acu_bru
183.	*Acupalpus (Acupalpus) flavicollis* (Sturm, 1825)	2.1.1			+			Acu_fla
184.	*Acupalpus (Acupalpus) meridianus* (Linnaeus, 1761)	2.1.1.			+			Acu_mer
185.	*Acupalpus (Acupalpus) exiguus* Dejean, 1829	2.1.1.			+			Acu_exi
186.	*Anthracus consputus* (Duftschmid, 1812)	2.1.1.			+			Ant_con
187.	*Parophonus (Parophonus) maculicornis* (Duftschmid, 1812)	2.2.1		+			+	Par_mac
188.	*Parophonus (Parophonus) dejeani* (Csiki, 1932)	2.2.1		+				Par_dej
189.	*Parophonus (Parophonus) planicollis* (Dejean, 1829)	2.2.1		+				Par_pla
190.	*Parophonus (Parophonus) laeviceps* (Ménétriés, 1832)	2.2.1		+				Par_lae
191.	*Parophonus (Parophonus) mendax* (Rossi, 1790)	2.2.1			+		+	Par_men
192.	*Parophonus (Ophonomimus) hirsutulus* (Dejean, 1829)	2.1.1.		+				Par_hir
193.	*Harpalus (Cephalophonus) cephalotes* Fabricius et Laboulbene, 1854	2.2.1.	+	+				Har_cep
194.	*Harpalus (Semiophonus) signaticornis* (Duftschmid, 1812)	2.2.1	+	+				Har_sig
195.	*Harpalus (Pseudophonus) rufipes* (Degeer, 1774)	2.1.1	+	+	+	+	+	HarP_ruf
196.	*Harpalus (Pseudophonus) griseus* (Panzer, 1797)	2.3.1	+	+	+		+	HarP_gri
197.	*Harpalus (Pseudophonus) calceatus* (Duftschmid, 1812)	2.3.1	+	+				HarP_cal
198.	*Harpalus (Cryptophonus) tenebrosus* Dejean, 1829	2.3.1	+	+				Har_ten
199.	*Harpalus (Harpalus) rufipalpis* Sturm, 1818	2.3.1	+	+		+		Har_ruf
200.	*Harpalus (Harpalus) honestus* (Duftschmid, 1812)	2.3.1	+	+		+		Har_hon
201.	*Harpalus (Harpalus) sulphuripes* Germar, 1824	2.3.1	+					Har_sul
202.	*Harpalus (Harpalus) rubripes* (Duftschmid, 1812)	2.3.1	+	+	+	+	+	Har_rub
203.	*Harpalus (Harpalus) attenuatus* Stephens, 1828	2.3.1		+				Har_att
204.	*Harpalus (Harpalus) atratus* Latreille, 1804	2.3.1	+	+	+			Har_atr
205.	*Harpalus (Harpalus) serripes* (Quensel, 1806)	2.3.1	+	+		+		Har_ser
206.	*Harpalus (Harpalus) pumilus* Sturm, 1818	2.3.1	+					Har_pum
207.	*Harpalus (Harpalus) picipennis* (Duftschmid, 1812)	2.3.1	+					Har_pic
208.	*Harpalus (Harpalus) anxius* (Duftschmid, 1812)	2.3.1	+	+				Har_anx
209.	*Harpalus (Harpalus) amplicollis* Ménétriés, 1848	2.3.1		+				Har_amp
210.	*Harpalus (Harpalus) calathoides* Motschulsky, 1844	2.3.1		+				Har_cal
211.	*Harpalus (Harpalus) servus* (Duftschmid, 1812)	2.3.1	+					Har_srv
212.	*Harpalus (Harpalus) subcylindricus* Dejean, 1829	2.3.1	+	+	+	+	+	Har_sub
213.	*Harpalus (Harpalus) zabroides* Dejean, 1829	2.3.2	+	+			+	Har_zab
214.	*Harpalus (Harpalus) froelichi* Sturm, 1818	2.3.1	+	+			+	Har_fro
215.	*Harpalus (Harpalus) hirtipes* (Panzer, 1796)	2.3.1	+					Har_hir
216.	*Harpalus (Harpalus) tardus* (Panzer, 1797)	2.3.1	+	+	+	+	+	Har_tar
217.	*Harpalus (Harpalus) albanicus* Reitter, 1900	2.3.1	+	+				Har_alb
218.	*Harpalus (Harpalus) latus* (Linnaeus, 1758)	2.3.1	+	+	+	+	+	Har_lat
219.	*Harpalus (Harpalus) smaragdinus* (Duftschmid, 1812)	2.3.1	+	+	+	+	+	Har_sma
220.	*Harpalus (Harpalus) autumnalis* (Duftschmid, 1812)	2.3.1	+	+				Har_aut
221.	*Harpalus (Harpalus) cupreus* Dejean, 1829	2.3.1	+					Har_cup
222.	*Harpalus (Harpalus) dimidiatus* (Rossi, 1790)	2.3.1	+	+				Har_dim
223.	*Harpalus (Harpalus) caspius* (Steven, 1806)	2.3.1	+	+				Har_cas
224.	*Harpalus (Harpalus) pygmaeus* Dejean, 1829	2.3.1	+				+	Har_pyg
225.	*Harpalus (Harpalus) rumelicus* Apfelbeck, 1904	2.3.1	+					Har_rum
226.	*Harpalus (Harpalus) hospes* Sturm, 1818	2.3.1	+				+	Har_hos
227.	*Harpalus (Harpalus) affinis* (Schrank, 1781)	2.3.1	+	+	+	+	+	Har_aff
228.	*Harpalus (Harpalus) distinguendus* (Duftschmid, 1812)	2.3.1	+	+	+	+	+	Har_dis
229.	*Harpalus (Harpalus) saxicola* Dejean, 1829	2.3.1	+				+	Har_sax
230.	*Harpalus (Harpalus) oblitus* Dejean, 1829	2.3.1		+			+	Har_obl
231.	*Harpalus (Harpalus) akinini* Tschitschérine, 1895	2.3.1	+					Har_aki
232.	*Ophonus (Metophonus) laticollis* Mannerheim, 1825	2.2.1		+				Oph_lat
233.	*Ophonus (Metophonus) cordatus* (Duftschmid, 1812)	2.2.1	+					Oph_cor
234.	*Ophonus (Metophonus) rupicola* (Sturm, 1818)	2.2.1.		+				Oph_rup
235.	*Ophonus (Metophonus) puncticollis* (Paykull, 1798)	2.2.1.	+			+		Oph_pco
236.	*Ophonus (Metophonus) veluchianus* (G. Muller,1931)	2.2.1.	+	+				Oph_vel
237.	*Ophonus (Metophonus) puncticeps* Stephens, 1828	2.2.1	+	+				Oph_pce
238.	*Ophonus (Metophonus) rufibarbis* (Fabricius, 1792)	2.2.1	+	+	+		+	Oph_ruf
239.	*Ophonus (Metophonus) schaubergerianus* Puel, 1937	2.2.1	+	+		+		Oph_sch
240.	*Ophonus (Metophonus) melleti* (Heer, 1837)	2.2.1	+	+				Oph_mel
241.	*Ophonus (Metophonus) subsinuatus* (Rey, 1886)	2.2.1	+					Oph_subs
242.	*Ophonus (Metophonus) gabrieleae* Wrase, 1987	2.2.1	+	+				Oph_gab
243.	*Ophonus (Metophonus) parallelus* (Dejean, 1829)	2.2.1	+	+				Oph_par
244.	*Ophonus (Metophonus) brevicollis* (Audinet-Serville, 1821)	2.2.1		+				Oph_bre
245.	*Ophonus (Hesperophonus) similis* (Dejean, 1829)	2.2.1		+				Oph_sim
256.	*Ophonus (Hesperophonus) jailensis* (Schauberger, 1926)	2.2.1	+					Oph_jai

№	Species	Life form	Grassland subtypes					Code
			Dry	Mesic	Wet	Alp.	Salt	
247.	*Ophonus (Hesperophonus) azureus* (Fabricius, 1775)	2.2.1	+	+		+		Oph_azu
248.	*Ophonus (Hesperophonus) subquadratus* (Dejean, 1829)	2.2.1	+	+				Oph_subq
249.	*Ophonus (Hesperophonus) cribricollis* Dejean, 1829	2.2.1	+	+				Oph_cri
250.	*Ophonus (Ophonus) ardosiacus* (Lutshnik, 1922)	2.2.1	+					Oph_ard
251.	*Ophonus (Ophonus) diffinis* (Dejean, 1829)	2.2.1	+				+	Oph_diff
252.	*Ophonus (Ophonus) sabulicola* (Panzer, 1796)	2.2.1	+					Oph_sab
253.	*Ophonus (Ophonus) franziniorum* Sciaky, 1987	2.2.1	+					Oph_fra
254.	*Ophonus (Ophonus) stictus* Stephens, 1828	2.2.1	+	+				Oph_sti
255.	*Ophonus (Macrophonus) oblongus* (Schaum, 1858)	2.2.1		+				Oph_obl
256.	*Ophonus (Incisophonus) incisus* (Dejean, 1829)	2.2.1	+					Oph_inc
257.	*Pangus scaritides* (Sturm, 1818)	2.3.1	+					Pang_sca
258.	*Acinopus (Acinopus) laevigatus* Ménétriés, 1832	2.3.2	+					Aci_lae
259.	*Acinopus (Acinopus) picipes* (Olivier, 1795)	2.3.2	+					Aci_pic
260.	*Acinopus (Osimus) ammophilus* Dejean, 1829	2.3.2	+				+	Aci_amm
261.	*Acinopus (Oedematicus) megacephalus* (P. Rossi, 1794)	2.3.2	+	+				Aci_meg
262.	*Graniger cordicollis* (Audinet-Serville, 1821)	2.2.1.		+				Gra_cor
263.	*Eucarterus sparsutus* (Reitter, 1898)	2.3.2.	+					Euc_spa
264.	*Oedesis caucasicus* (Dejean, 1831)	2.2.1.	+					Oed_cau
265.	*Carterus (Carterus) gilvipes* (Piochard De La Brûlerie, 1873)	2.3.3.	+				+	Cart_gil
266.	*Carterus (Carterus) rufipes* (Chaudoir, 1843)	2.3.3.	+					Cart_ruf
267.	*Carterus (Pristocarterus) angustipennis* (Chaudoir, 1852)	2.3.3.	+					Cart_agp
268.	*Carterus (Pristocarterus) angustus* (Ménétriés, 1832)	2.3.3.	+					Cart_ang
269.	*Ditomus calydonius* (P. Rossi, 1790)	2.3.3	+					Dit_cal
270.	*Dixus clypeatus* (Rossi, 1790)	2.3.3	+	+				Dix_cly
271.	*Dixus eremita* (Dejean, 1825)	2.3.3	+					Dix_ere
272.	*Dixus obscurus* (Dejean, 1825)	2.3.3	+					Dix_obs
	Tribe Panagaeini							
273.	*Panagaeus (Panagaeus) bipustulatus* (Fabricius, 1775)	1.3(1).1	+	+				Pan_bip
274.	*Panagaeus (Panagaeus) cruxmajor* (Linnaeus, 1758)	1.3(1).1		+	+			Pan_cru
	Tribe Callistini							
275.	*Callistus lunatus* (Fabricius, 1775)	1.3(1).1			+	+	+	Call_lun
276.	*Chlaenius (Dinodes) cruralis Fischer von* Waldheim, 1829	1.3(1).1	+				+	Chl_cru
277.	*Chlaenius (Dinodes) decipiens* (L. Dufour, 1820)	1.3(1).1	+				+	Chl_dec
278.	*Chlaenius (Trichochlaenius) aeneocephalus* Dejean, 1826	1.3(1).1		+	+			Chl_aen
279.	*Chlaenius (Chlaeniellus) nitidulus* (Schrank, 1781)	1.3(1).1		+	+			Chl_nit
280.	*Chlaenius (Chlaeniellus) nigricornis* (Fabricius, 1787)	1.3(1).1			+			Chl_nig
281.	*Chlaenius (Chlaeniellus) vestitus* (Paykull, 1790)	1.3(1).1			+			Chl_ves
	Tribe Oodini							
282.	*Oodes helopioides* (Fabricius, 1792)	1.3(1).1			+		+	Ood_hel
	Tribe Licinini							
283.	*Licinus (Licinus) depressus (*Paykull, 1790)	1.3(1).1		+	+			Lic_dep
284.	*Licinus (Licinus) cassideus* (Fabricius, 1792)	1.3(1).1	+					Lic_cas
285.	*Licinus (Licinus) silphoides* (P. Rossi, 1790)	1.3(1).1	+	+				Lic_sil
286.	*Badister (Badister) bullatus* (Schrank, 1798)	1.3(1).2	+	+	+			Bad_bul
287.	*Badister (Badister) meridionalis* Puel, 1925	1.3(1).2			+		+	Bad_mer
	Tribe Masoreini							
288.	*Masoreus (Masoreus) wetterhallii* (Gyllenhal, 1813)	1.3(1).3	+					Mas_wet
	Tribe Odacanthini							
289.	*Odacantha (Odacantha) melanura* (Linnaeus, 1767)	1.1.2.			+			Oda_mel
	Tribe Lebiini							
290.	*Lebia (Lamprias) cyanocephala* (Linnaeus, 1758)	1.1.3		+				Leb_cya
291.	*Lebia (Lebia) cruxminor* (Linnaeus, 1758)	1.1.3		+		+		Leb_cru
292.	*Lebia (Lebia) trimaculata* (Villers, 1789)	1.1.3	+			+		Leb_tri
293.	*Lebia (Lebia) lepida* Audouin et Brulle, 1834	1.1.3	+					Leb_lep
294.	*Philorhizus notatus* (Stephens, 1827)	1.3(1).3	+	+				Phi_not
295.	*Philorhizus sigma* (P. Rossi, 1790)	1.3(1).3			+			Phi_sig
296.	*Syntomus obscuroguttatus* (Duftschmid, 1812)	1.3(1).3	+	+				Synt_obs
297.	*Syntomus pallipes* (Dejean, 1825)	1.3(1).3		+				Synt_pal
298.	*Syntomus truncatellus* (Linnaeus, 1761)	1.3(1).3				+		Synt_tru
299.	*Microlestes corticalis* (L. Dufour, 1820)	1.3(1).3	+	+			+	Mic_cor
300.	*Microlestes fissuralis* (Reitter, 1901)	1.3(1).3	+	+				Mic_fis
301.	*Microlestes fulvibasis* Reitter, 1900	1.3(1).3					+	Mic_ful
302.	*Microlestes luctuosus* Holdhaus, 1904	1.3(1).3	+					Mic_luc
303.	*Microlestes maurus* (Sturm, 1827)	1.3(1).3	+	+				Mic_mau
304.	*Microlestes minutulus* (Goeze, 1777)	1.3(1).3	+	+				Mic_min
305.	*Microlestes negrita* (Wollaston, 1854)	1.3(1).3	+	+				Mic_neg

№	Species	Life form	Grassland subtypes					Code
			Dry	Mesic	Wet	Alp.	Salt	
306.	*Microlestes plagiatus* (Duftschmid, 1812)	1.3(1).3	+	+				Mic_pla
307.	*Microlestes apterus* Holdhaus, 1912	1.3(1).3	+					Mic_apt
308.	*Microlestes schroederi* Holdhaus, 1912	1.3(1).3	+					Mic_sch
309.	*Microlestes seladon* Holdhaus, 1912	1.3(1).3				+		Mic_sel
310.	*Cymindis (Cymindis) axillaris (Fabricius, 1794)*	1.3(1).3	+	+		+		Cym_axi
311.	*Cymindis (Cymindis) ornata* Fisher von Waldheim, 1824	1.3(1).3	+					Cym_orn
312.	*Cymindis (Cymindis) lineata* (Quensel, 1806)	1.3(1).3	+	+			+	Cym_lin
313.	*Cymindis (Cymindis) scapularis* Schaum, 1857	1.3(1).3	+					Cym_sca
314.	*Cymindis (Cymindis) humeralis* (Geoffroy in Fourcroy, 1785)	1.3(1).3	+	+		+		Cym_hum
315.	*Cymindis (Menas) miliaris* (Fabricius, 1801)	1.3(1).3		+		+		Cym_mil
316.	*Cymindis (Tarulus) vaporariorum* (Linnaeus, 1758)	1.3(1).3		+		+		Cym_vap
	Tribe Dryptini							
317.	*Drypta (Drypta) dentata* (P. Rossi, 1790)	1.1.2			+			Dry_den
	Tribe Zuphiini							
318.	*Polystichus connexus* (Geoffroy in Fourcroy, 1785)	1.3(1).1		+	+			Pol_con
319.	*Polystichus fasciolatus* (P. Rossi, 1790)	1.3(1).1		+	+			Pol_fas
320.	*Zuphium (Zuphium) araxidis* Iablokoff-Khnzorian, 1972	1.3(1).4		+	+			Zup_ara
321.	*Parazuphium (Parazuphium) chevrolati* Laporte de Castelnau, 1833	1.3(1).4			+			Parz_che
	Tribe Brachinini							
322.	*Brachinus (Brachinus) alexandri* F. Battoni, 1984	1.3(1).3	+	+				Bra_ale
323.	*Brachinus (Brachinus) berytensis* Reiche et Saulcy, 1855	1.3(1).3	+	+				Bra_ber
324.	*Brachinus (Brachinus) crepitans* (Linnaeus, 1758)	1.3(1).3	+	+	+			Bra_cre
325.	*Brachinus (Brachinus) elegans* Chaudoir, 1842	1.3(1).3		+				Bra_ele
326.	*Brachinus (Brachinus) plagiatus* Reiche, 1868	1.3(1).3		+				Bra_pla
327.	*Brachinus (Brachinus) psophia* Audinet-Serville, 1821	1.3(1).3	+	+				Bra_pso
328.	*Brachinus (Brachynidius) explodens* Duftschmid, 1812	1.3(1).3	+	+		+		Bra_exp
329.	*Brachinus* [species incertae sedis] *nigricornis* Gebler, 1829	1.3(1).3			+			Bra_nig
	Total:		174	180	111	95	60	

Explanations to the Appendix

Column № 1. Consecutive number.

Column № 2. List of the species recorded from the five types of grassland ecosystems in Bulgaria.

Column № 3. Explanation to the indexes of the life forms:

The first figure in the index shows the class of life form, the second – the subclass, the third – the life form group. In brackets after the subclass the series is shown, when it exists.

Life form class 1. Zoophagous:

Life form subclass: 1.1 – Phytobios; 1.2 – Epigeobios; 1.3 – Stratobios; 1.4 – Geobios.

Life form groups: 1.1.2 – stem-dwelling hortobionts; 1.1.3 – leaf-dwelling dendrohortobionts; 1.2.2 – large walking epigeobionts; 1.2.3 – running epigeobionts; 1.2.4 – flying epigeobionts; 1.3(1) – series crevice-dwelling stratobionts; 1.3(1).1 – surface & litter-dwelling; 1.3(1).2 – litter-dwelling; 1.3(1).3 – litter & crevice-dwelling; 1.3(1).4 – endogeobionts; 1.3(1).6 – bothrobionts; 1.3(2) – series digging stratobionts; 1.3(2).1 – litter & soil-dwelling; 1.4.1 – running & digging geobionts; 1.4.2(1) – small digging geobionts.

Life form class 2. Mixophytophagous:

Life form subclass: 2.1 – Stratobios; 2.2 – Stratohortobios; 2.3 – Geohortobios.

Life form groups: 2.1.1 – crevice-dwelling stratobionts; 2.2.1 – stratohortobionts; 2.3.1 – harpaloid geohortobionts; 2.3.1(1) – crevice-dwelling harpaloid geohortobionts; 2.3.2 – zabroid geohortobionts; 2.3.3 – dytomeoid geohortobionts.

Column № 4. Presence of the carabid species in the different types of grass ecosystems.

Column № 5. Codes for the individual species, used in the mathematical analyses.