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Comparative analysis of the myriapod fauna (Diplopoda, Chilopoda) of the Shumen Plateau and the Madara Plateau (Northeastern Bulgaria)

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Abstract: *At present, the inventory lists of the Myriapoda of many geographical areas in Bulgaria and the comparative analyzes of the similarity between such local faunas are scarce or completely missing. The present paper presents the results of the comparative analysis of α- and β-diversity of the myriapoda communities in natural habitats in two regions in Northeastern Bulgaria – the Shumen Plateau and the Madara Plateau. The compared habitats in these plateaus have similar geographical, soil and climatic conditions, and similar species composition of plant formations. The analysis of the structure of the myriapoda communities included estimation of species diversity by determining the Shannon-Wiever index (H') and the Berger-Parker index (d). The degree of similarity between the species composition of the communities was analyzed by the Czekanowski-Dice-Sörensen, Jaccard, Bray-Curtis, Horn, Morisita-Horn indices and the corrected Chao-Sörensen and Chao-Jaccard indices. The species diversity of the millipede community in the Shumen Plateau is much greater than that of the Madara Plateau, while the diversity of the centipede communities in the two plateaus does not differ significantly. In both classes the greatest species diversity is registered in deciduous and mixed deciduous-coniferous forests. Chao-Sörensen and Chao-Jaccard indices of similarity for the myriapod communities in these habitats are the highest, approaching 1, in contrast to the other sites where the registered species composition of the centipedes is smaller and the degree of similarity is about 0.6.*

Keywords: Biodiversity, Diplopoda, Chilopoda, Chao-Sörensen, Chao-Jaccard

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Introduction

The decades-long deterioration of the quality of the environment, the pollution of its components and climate change cause the destruction of key natural habitats and the extinction of many species [1]. The global reduction of biodiversity is one of the greatest challenges facing humanity, which necessitates finding new approaches and practices for the conservation of natural complexes. Functioning of ecosystems is closely related to their taxonomic composition and the abundance of species, as well as the contribution of each taxonomic ensemble to the substance cycle and energy flow [2]. Millipedesare a key group of soil detritophagous that have a significant impact on the mineralization of dead organic matter, since they regulate the composition and abundance of soil fauna. Therefore, the study of the diversity and composition of their communities is of great importance. We are well aware that the assessment of one taxonomic group cannot give a clear picture of the overall change in the community, since the dynamics of biodiversity in one taxonomic ensemble is not necessarily related to its change in other taxa [3-8]. However, a better understanding of the factors influencing α- and β-diversity will allow us to predict the role of the respective taxonomic group in maintaining the structure and function of the ecosystem, especially in changing environmental and climatic conditions.

The residual plateaus in the northeastern part of the Danube Plain proved very suitable for assessing the compositional differences in the communities of different taxa. The plateaus are part of the Moesian Plate, have a common origin and are characterized by similar physical, geographic and soil-climatic conditions. A comparative analysis of the composition and diversity of the myriapod communities will reveal millipedes' ability to settle and migrate, and the possibilities for exchange of species between communities. The aim of this study is to make a comparative analysis of the α- and β-diversity of the myriapoda communities in natural habitats of two residual plateaus in Northeastern Bulgaria, and to assess the degree of similarity of the millipede and centipede communities in both study regions.

Materials and Methods

The analysis is based on data from the studies on the Myriapoda of the Shumen Plateau ($43^0 15' 52$ N, $26^0 54' 0$ E) and the Madara Plateau ($43^0 15' 25$ N, $27^0 21' 7$ E), located 12 km from each other. The two plateaus are separated by the town of Shumen which is located east of the Shumen plateau and west of the Madara plateau. The Shumen Plateau is part of the Shumen Plateau Nature Park, and the Madara Plateau is part of the NATURA 2000 ecological network within the boundaries of the Provadia-Royak Plateau Protected Area, BG0002038 for the protection of wild birds and the Provadia-Royak Plateau Protected Area, BG0000104 for the protection of natural habitats and of wild flora and fauna. Both plateaus provide essential ecosystem amenities for the local community: Shumen plateau is used throughout the year for recreation and logging,

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and a significant part of the Madara plateau are agrocenoses used for growing crops such as *Triticum vulgaris*, *Hordeum vulgare*, *Secale cereale.*

The taxonomic composition, zoogeographical affiliation, ecological characteristics and habitat distribution of myriapod communities in the two plateaus were discussed in detail by the authors of the presentarticle in their previous publications [9-11]. The material for the present study was collected from five study sites on the Shumen Plateau (RI-RV) and from five sites on the Madara Plateau (MP1-MP5). The sites reflect themain habitats in the two plateaus, which are characterized by the same soil type and similar dominant species in their plant community:

RI, MP5 - Mixed deciduous forest: *Fagus sylvatica moesiaca, Fagus sylvatica, Carpinus betulus, Quercus dalechampii, Quercus frainetto, Quercus cerris, Tilia tomentosa, Pyrus communis, Acer campestre;* **RII, MP4** - Mixed deciduous-coniferous forest: *F. silvatica, C. betulus, Q. cerris, Betula pendula, Pinus nigra, Pinus sylvestris*; **RIII, MP3** - Deciduous hornbeam forest: *C. betulus,Carpinus orientalis*, *Quercus petraea*, *Q. cerris*; **RIV, MP1** - Coniferous forest: *P. nigra;* **RV, MP2** - Open meadow: *Chrysopogongryllus, Festuca valesiaca, Dichanthium ischaemum, Syringa vulgaris, Paliurus spina-christi* and *Prunus spinosa.*

The main soil type in the work sites in both areas were chernozems, the most widespread of which are leached (degraded) soils (Luvisols, LV). The dominant soil subtype in the work sites located in the forest habitats were the ordinary leached soils (Haplic, LVh). By mechanical composition they are heavy sandy-clay soils with high density and relatively low humus content. The work sites in the open meadows - RV and MP2 were covered with light leached soils (Albic, LVa) [12-13].

The material was collected in the period May 2007 - April 2009 from the Shumen Plateau and in the period January 2012 - December 2013 from the Madara Plateau. The sampling is performed monthly by using Barber traps, 10 in each work site. The traps are plastic containers with an opening whose diameter is 9 cm. Their capacity is 500 ml and they are half filled with 50% solution of ethylene glycol and 3-4 ml of formalin. They are covered with plastic lids, and positioned 2-3 cm off the ground surface.

Species diversity of myriapoda communities was assessed using the Shannon-Wiever (H') and Berger-Parker (d) indices with the PAST program (PAleontologicalSTatistics Version 1.94b). The degree of similarity in the species composition of the communities was analyzed by the Sörensen, Jaccard, Horn, Morisita-Horn, Bray-Curtis indices and the corrected Chao-Sörensen and Chao-Jaccard indices, using the SpadeR program by Anne Chao [14], which can be found athttp://chao.stat.nthu.edu.tw/wordpress/software_download/.

The Jaccard and Sörensen indices are based solely on data on the occurrence of species (presence-absence), ie. the number of species shared by the two communities and the number of species unique to each, irrespective of their numbers. Jaccard calculates unique (unshared) species as a ratio of the total number of

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species recorded in both communities, while Sörensen attaches twice as much importance to shared species [15]. Therefore, the similarity of Sörensen is closely related to that of Jaccard and always has higher values than it. These indices, however, strongly depend on the sample size.

The Bray-Curtis, Horn, and Morisita-Horn indices, in contrast to those of Jaccard and Sörensen, include species abundance in both communities [16]. They are special cases of a family of biodiversity indices, known as Hill numbers (q), which are effective species numbers, or an indicator of the degree of occurrence of species [17, 18]. The value of q is a parameter that determines the sensitivity of the index to species with high or low representativeness: at q = 1 (Horn and Bray-Curtis indices) all species in the sample are presented proportionally and their value depends on the number and abundance of all species in the sample; at q<1 (Jaccard and Sörensen indices) the weight of rare species increases, and at q>1 (Morisita-Horn index) dominant species increase their importance.

All indices listed so far do not take into account the species that are most likely shared between the two communities but are not present in the samples. Chao et al. [13] combine the indices based on absence of species and the indices based on relative abundance or biomass, and thus adjust the Jaccard and Sörensen indices. In our opinion, the indices based on the abundance of Jaccard-Chao and Sörensen-Chao are the best estimate of the general faunal similarity between the communities and were the refore used in the study.

Results

A total of 32 species of millipedes from both classes are registered in the ten work sites on the Shumen Plateau and Madara Plateau - 13 species of the Diplopoda class, belonging to 4 families and 19 species of the Chilopoda class, representatives of 7 families. The total species richness is 12 and 11 species of diplopods, and 18 and 12 species of chilopods in the Shumen and the Madara Plateau respectively. The largest number of diplopod species registered in the Shumen Plateau is found in the coniferous forest, the mixed deciduous-coniferous forest and the deciduous forest of *Fagus sylvatica*, while in the Madara Plateau they are in the mixed deciduous-coniferous forest (Table 1).

The smallest number of diplopod species - 4 and 5 species respectively, were registered in the deciduous forest of *Carpinus orientalis* in the Shumen Plateau and on the open meadow of the Madara Plateau. The most common species of diplopods are *Leptoiulus trilineatus* in the Shumen Plateau and *Polydesmus complanatus* in the Madara Plateau. Despite the approximately equal number of species and the very similar species composition, a number of representatives of the class are found in only one of the studied areas. For example, the species *Polydesmus denticulatus* and *Megaphyllum unilineatum* were registered only in the Shumen Plateau, whereas the diplopod *Glomeris balcanica* was not found in it during this study. It was registered only in the Madara Plateau.

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Table 1. Species composition of Myriapoda: Diplopoda and number of specimens at work sites, collected in pitfall traps in natural habitats of Shumen Plateau (RI-RV) and Madara Plateau (PM1-PM5)

№	Species	Species code	Zoogeographical category	Number of specimens at work sites									
	Diplopoda			**RI**	**MP5**	**RII**	**MP4**	**RIII**	**MP3**	**RIV**	**MP1**	**RV**	**MP2**
1	*Glomeris hexasticha* Brandt, 1833	Ghex	CEU	2	94	28	35	0	68	27	2	0	12
2	*Glomeris balcanica* Verhoeff, 1906	Gbal	BK	0	0	0	0	0	1	0	6	0	24
3	*Polydesmus complanatus* (Linnaeus, 1761)	Pcom	CEU	19	0	15	466	0	0	5	0	0	0
4	*Polydesmus denticulatus* C.L. Koch, 1847	Pden	EU	2	0	2	0	0	0	0	0	0	0
5	*Polydesmus renschi* Schubart, 1934	Pren	CPBK	0	0	0	6	6	0	0	2	0	0
6	*Anamastigona bilselii* (Verhoeff, 1940)	Abil	BK	18	0	7	3	0	0	1	0	0	0
7	*Leptoiulus trilineatus* (C.L. Koch, 1847)	Ltri	EEU	495	30	202	4	70	13	62	15	84	18
8	*Cylindroiulus boleti* (C.L. Koch, 1847)	Cbol	EEU	6	46	68	114	20	10	186	100	4	4
9	*Megaphyllum bosniense* (Verhoeff, 1897)	Mbos	BK	116	151	63	49	178	26	5	14	12	6
10	*Megaphyllum lictor* (Attems,1904)	Mlic	BK	0	1	0	1	0	4	1	0	4	0
11	*Megaphyllum transsylvanicum* (Verhoeff, 1897)	Mtrans	EEU	0	208	1	62	0	1	118	0	3	0
12	*Megaphyllum unilineatum* (C.L. Koch, 1838)	Muni	EEU	0	0	0	0	0	0	1	0	0	0
13	*Pachyiulus hungaricus* (Karsch, 1881)	Phun	CPBK	6	0	0	26	0	0	0	0	0	0
	Total number of specimens			**664**	**530**	**386**	**766**	**274**	**123**	**406**	**139**	**107**	**64**
	Total number of species			**8**	**6**	**8**	**10**	**4**	**7**	**9**	**6**	**5**	**5**

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Table 2. Species composition of Myriapoda: Chilopoda and number of specimens at work sites, collected in pitfall traps in natural habitats of Shumen Plateau (RI-RV) and Madara Plateau (PM1-PM5)

№	Species	Species code	Zoogeographical category	Number of specimens at work sites									
	Chiplopoda			**RI**	**MP5**	**RII**	**MP4**	**RIII**	**MP3**	**RIV**	**MP1**	**RV**	**MP2**
1	*Eupolybothrus* (*Mesobothrus*) *transsylvanicus* (Latzel, 1882)	Etrans	CPBK	0	0	0	0	0	0	1	0	0	0
2	*Lithobius* (*Lithobius*) *forficatus* (Linnaeus, 1758)	Lfor	EU	20	0	2	2	0	0	7	0	3	0
3	*Lithobius* (*Lithobius*) *lucifugus* L. Koch, 1862	Lluc	CEU	0	0	2	1	1	0	0	0	0	0
4	*Lithobius* (*Lithobius*) *mutabilis* L. Koch, 1862	Lmuta	CEU	37	0	11	36	0	0	0	0	0	0
5	*Lithobius* (*Lithobius*) *muticus* C.L. Koch, 1847	Lmuti	CEU	1	0	10	1	1	4	3	4	21	3
6	*Lithobius* (*Lithobius*) *nigripalpis* L. Koch, 1867	Lnig	EME	89	4	101	12	35	2	105	21	157	2
7	*Lithobius* (*Lithobius*) *parietum* Verhoeff, 1899	Lpar	CPBK	0	0	0	0	0	0	0	0	1	0
8	*Lithobius* (*Lithobius*) *schuleri* Verhoeff, 1925	Lsch	CEU	0	0	2	0	0	0	1	0	0	0
9	*Lithobius* (*Monotarsobius*) *crassipes* L. Koch, 1862	Lcras	ESI	0	0	1	1	0	0	0	0	0	0
10	*Lithobius* (*Sigibius*) *beroni* Negrea, 1965	Lber	BK	1	0	0	0	0	0	1	0	0	0
11	*Scolopendra cingulata* Latreille, 1829	Scin	MED	0	0	0	0	0	0	0	0	3	0
12	*Cryptops anomalans* Newport, 1844	Cano	EU	22	3	23	1	26	0	11	1	17	1
13	*Cryptops parisi* Brölemann, 1920	Cpar	CEU	3	0	0	0	0	0	0	0	0	0
14	*Shendyla carniolensis* Verhoeff, 1902	Scar	CEU	0	0	0	0	0	0	5	0	0	0
15	*Clinopodes flavidus* C.L. Koch, 1847	Cfla	EMT	2	0	5	1	2	1	2	1	4	1
16	*Stenotaenia linearis* (C.L. Koch, 1835)	Slin	EU	0	1	0	0	0	0	2	0	0	1
17	*Henia illyrica* (Meinert, 1870)	Hill	EEU	0	0	0	0	0	0	2	1	0	0
18	*Strigamia crassipes* (C.L. Koch, 1835)	Scras	EU	3	1	3	1	2	0	0	0	0	0
19	*Pleurolithobius patriarchalis* (Berlese, 1894)	Ppatr	EME	0	134	0	93	0	10	0	0	0	0
	Total number of specimens			**178**	**143**	**160**	**149**	**67**	**17**	**140**	**28**	**206**	**8**
	Total number of species			**9**	**5**	**10**	**10**	**6**	**4**	**11**	**5**	**7**	**5**

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19 species of chilopods were registered in the studied habitats in both plateaus. The largest number of species (11) was found in the coniferous forest of the Shumen Plateau and in the mixed deciduous-coniferous forests in both plateaus (10 species each). The chilopods *Lithobius nigripalpis* in the Shumen Plateau and *Pleurolithobius patriarchalis* in the Madara Plateau were found in the largest quantities and they dominated in the chilopod communities (Table 2). Seven species of chilopods: *Eupolybothrus transsylvanicus*, *Lithobius parietum*, *Lithobius schuleri*, *Lithobius beroni*, *Scolopendra cingulata*, *Cryptops parisi* and *Shendyla carniolensis* were absent in the Madara Plateau and were only found in the Shumen Plateau.

The presence of the above-mentioned species of diplopods and chilopods in only one of the studied plateaus and their absence in the other may be due to the difficult migration of the species within the town of Shumen, which separates the two studied areas. This interferes with the exchange of species between the two plateaus.

In addition, the habitats of the Madara Plateau are highly fragmented by the local agrocenoses and are most probably disturbed as a result of plant protection substances use.

Although the species richness of the Shumen Plateau and the Madara Plateau are approximately the same, the compositions of species in them are different, depending on the ecological affiliation and specialization of the respective species.

Discussion

α-diversity of myriapoda communities

The number of millipedes registered in the two regions did not differ significantly, hence the Shannon-Wiever index for both plates had similar values. It was slightly higher for the Diplopoda community in the Madara Plateau (1.85) compared to that of the millipedes from the Shumen Plateau (1.46). The millipedes community of the Madara Plateau consisted of species with relatively high numbers. Five of the species had more than 200 individuals, which indicated a high degree of dominance and a low degree of community equality (Berger-Parker index = 0,5). In the millipedes community of the Shumen Plateau, the species with more than 200 individuals were only 3, and the Berger-Parker index was low (0,29), which indicates a higher degree of community leveling (Fig. 1 A).

The α-diversity of the centipedes communities in the two plateaus did not differ significantly. The Berger-Parker index had approximately the same values (0,65 for the Madara Plateau and 0,69 for the Shumen Plateau), which is an indicator of a high degree of equality of communities in both regions and is a result of the low or medium number of most species in both communities. Only the species *Pleurolithobius*

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patriarchalis in the Madara Plateau and *Lithobius nigripalpis* in the Shumen Plateau are highly numerous and dominate over the others (Fig. 1 B).

This is in complete agreement with the results reported by Magurran et al. [19], about the stability of α-diversity established during a 5-year study on the diversity of fish, benthic invertebrates and diatoms in Trinidad. These results support the argument that community regulation - the stability of α-diversity over time - is a common feature of ecosystems.

A)



B)

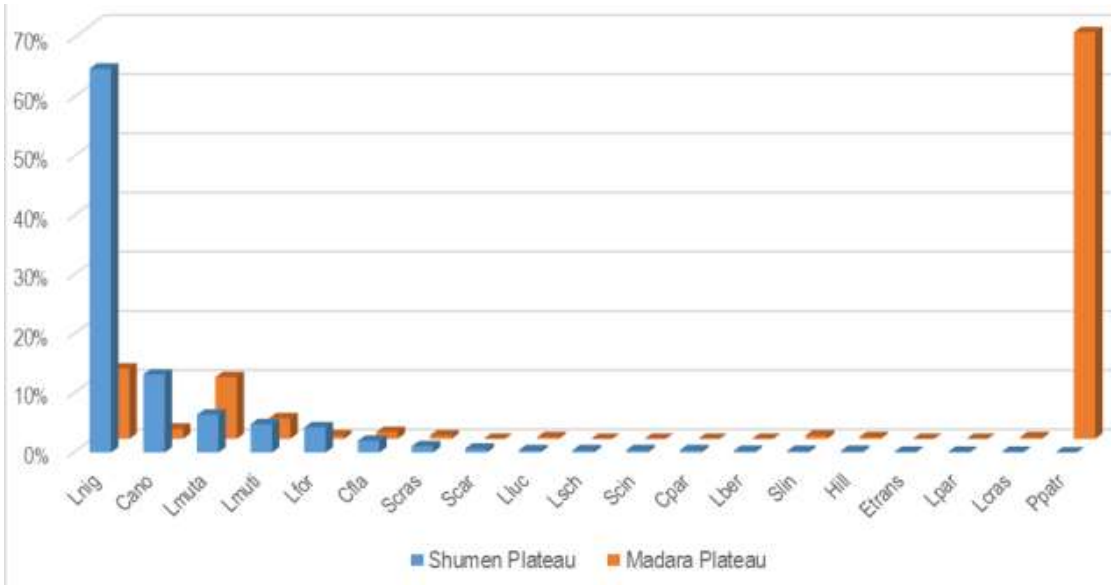


Fig. 1. Species composition and ratio of the species Diplopoda - A) and Chilopoda - B) on the Shumen Plateau and the Madara Plateau

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Beta-diversity of myriapoda communities

Differences /similarities in the composition of communities is one of the main and most noticeable characteristics by which different ecosystems can be distinguished. Significant differences were observed when comparing the faunal similarity of the myriapoda communities in different habitats of the Shumen Plateau and the Madara Plateau.

The indices based on the abundance Sörensen-Chao, which were used for measuring the faunal similarity between the millipedes and centipedes communities in different work sites in the Shumen and the Madara Plateau, vary between 0.97 and 0.57 for the millipedes communities, and from 0.90 to 0.43 in centipedes communities (Table 3).

The greatest abundance and almost complete similarity of myriapoda communities in both classes is observed in mixed deciduous-coniferous forests, where in millipedes communities, for example, the value of the Jaccard-Chao (0.95) and Sörensen-Chao (0.97) indices are almost equal to one.

Table 3. Faunal similarity of myriapod communities in the work sites of the Shumen Plateau and the Madara Plateau, expressed by the abundance indices of Jaccard-Chao and Sörensen-Chao: A) Diplopoda, B) Chilopoda

A) Diplopoda

	Jaccard-Chao				Sorensen-Chao			
	Estimate	St. Error	95%Lower	95%Upper	Estimate	St. Error	95%Lower	95%Upper
RII-MP4	0.9522	0.1461	0.6658	1.2386	0.9755	0.1042	0.7713	1.1797
RIV-MP1	0.6618	0.0186	0.6253	0.6983	0.7965	0.0136	0.7698	0.8232
RI-MP5	0.5801	0.0937	0.3964	0.7638	0.7343	0.0844	0.5689	0.8997
RV-MP2	0.4245	0.0826	0.2626	0.5864	0.5960	0.0841	0.4312	0.7608
RIII-MP3	0.3949	0.0508	0.2953	0.4945	0.5662	0.0525	0.4633	0.6691

B) Chilopoda

	Jaccard-Chao				Sorensen-Chao			
	Estimate	St. Error	95%Lower	95%Upper	Estimate	St. Error	95%Lower	95%Upper
RII-MP4	0.8182	0.0901	0.6416	0.9948	0.9000	0.1066	0.6911	1.1089
RV-MP2	0.5000	0.1779	0.1513	0.8487	0.6667	0.1788	0.3163	1.0171
RIV-MP1	0.4545	0.1130	0.2330	0.6760	0.6250	0.1309	0.3684	0.8816
RIII-MP3	0.4286	0.1220	0.1895	0.6677	0.6000	0.1323	0.3407	0.8593
RI-MP5	0.2727	0.0460	0.1825	0.3629	0.4286	0.0656	0.3000	0.5572

The great diversity of plant species in the phytocenosis of mixed deciduous-coniferous forests creates an abundance of microhabitats with different conditions. There are no homogeneous habitats in nature, and

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what at first glance seems to be a homogeneous environment for the organisms living in it, especially for not very mobile species such as Myriapoda, may turn out to be a mosaic of completely inappropriate or perfectly habitable places. In addition, spatial and temporal gradients of abiotic factors or available resources exist in most microhabitats. Therefore, the richer the phytocenosis in a given habitat, the more diverse microhabitats are available in it. The reduction of the differences between individual sites in terms of species composition of the phytocenosis leads to homogenization of the myriapoda communities and to their almost complete conformity. Similar homogenization has been observed previously in other organism groups, such as plants [20], insects [21, 22], and birds [23].

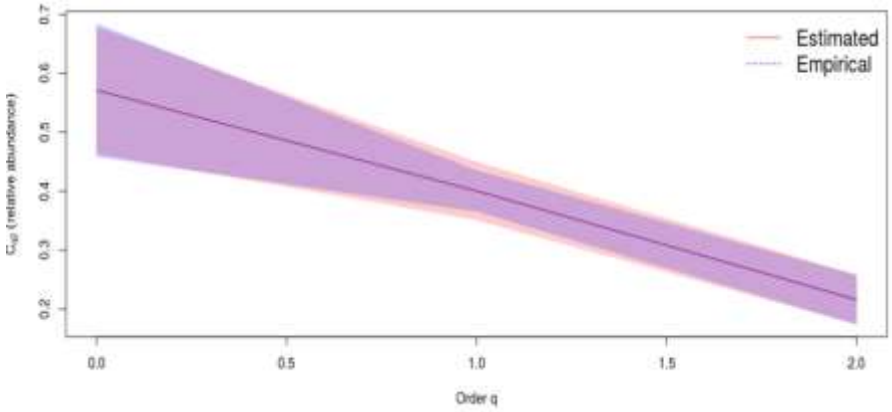
This great similarity in the composition of myriapoda communities in these work sites is a result ofthe presence of a relatively highnumber of shared species. For example, the great similarity of centipedes communities in mixed deciduous-coniferous forests (RII-MP4), among which there are 9 shared species, can be seen in the high values of the Jaccard-Chao and Sörensen-Chao indices (0.82 and 0.90 respectively), while in mixed deciduous forest communities (RI-MP5), in which there are only 3 shared species, the two indices have much lower values (Jaccard-Chao - 0.27 and Sörensen-Chao - 0.43), which points to a low degree of similarity of the centipedes communities in them (Table 3).

The similarity indices for the other work sites are comparable in value and show similarities close to 0.5 for the adjusted Jaccard-Chao index and about 0.65 for the Sörensen-Chao index in millipedes communities and 0.4 - 0.55 for centipedes communities, respectively. The lowest degree of similarity is observed between centipedes communities in mixed deciduous forests and millipedes communities in hornbeam forests.

Different approaches were used for comparing the general faunal similarity of the two classes (Diplopoda / Chilopoda) in the two studied areas (Table 4, Fig. 2 and Table 5, Fig. 3).

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A)



B)

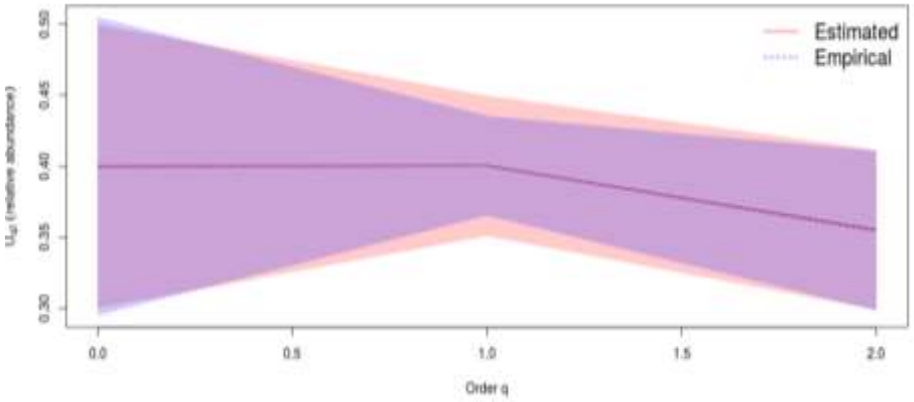


Fig. 2. Relationship between the relative abundance of species and the values of different similarity indices when comparing millipede communities of the Shumen Plateau and Madara Plateau A) based on Sorensen, B) based on Jaccard

Table 4. General faunal similarity of millipedes community of the Shumen Plateau and the Madara Plateau

(1) BASIC DATA INFORMATION:

The loaded set includes abundance/incidence data from 2 communities and a total of 10 species.

Samples size in Community 1	n1 = 1837
Samples size in Community 2	n2 = 1622
Number of observed species in Community 1	D1 = 12
Number of observed species in Community 2	D2 11
Number of observed shared species in two communities	D12 = 10
Number of bootstrap replications for s.e. estimate	10

Some statistics: f[11]= 0 ; f[1+]= 0 ; f[+1]= 0 ; f[2+]= 1 ; f[+2]= 0 ; f[22]= 0

(2) ESTIMATED SIMILARITY INDICES:

	Estimate	s.e.	95%Lower	95%Upper
(a) Classic richness-based similarity				
C02 (q=0, Sorensen)	0.8696	0.0317	0.8075	0.9317
U02 (q=0, Jaccard)	0.7692	0.0526	0.6661	0.8723
(b) Measures for comparing species relative abundances				
C12=U12 (q=1, Horn)	0.6868	0.0077	0.6717	0.7018
C22 (q=2, Morisita-Horn)	0.4117	0.0219	0.3687	0.4548
Chao Jaccard-abundance	0.9783	0.0014	0.9756	0.9810
Chao Sorensen-abundance	0.9890	0.0007	0.9876	0.9904
(c) Measures for comparing size-weighted species relative abundances				
Horn size-weighted (q=1)	0.6872	0.0092	0.6692	0.7052
(d) Measures for comparing species absolute abundances				
C12=U12 (q=1, Horn)	0.6853	0.0092	0.6673	0.7033
C22 (Morisita-Horn)	0.3954	0.0095	0.3768	0.4140
Bray-Curtis	0.4845	0.0092	0.4665	0.5026

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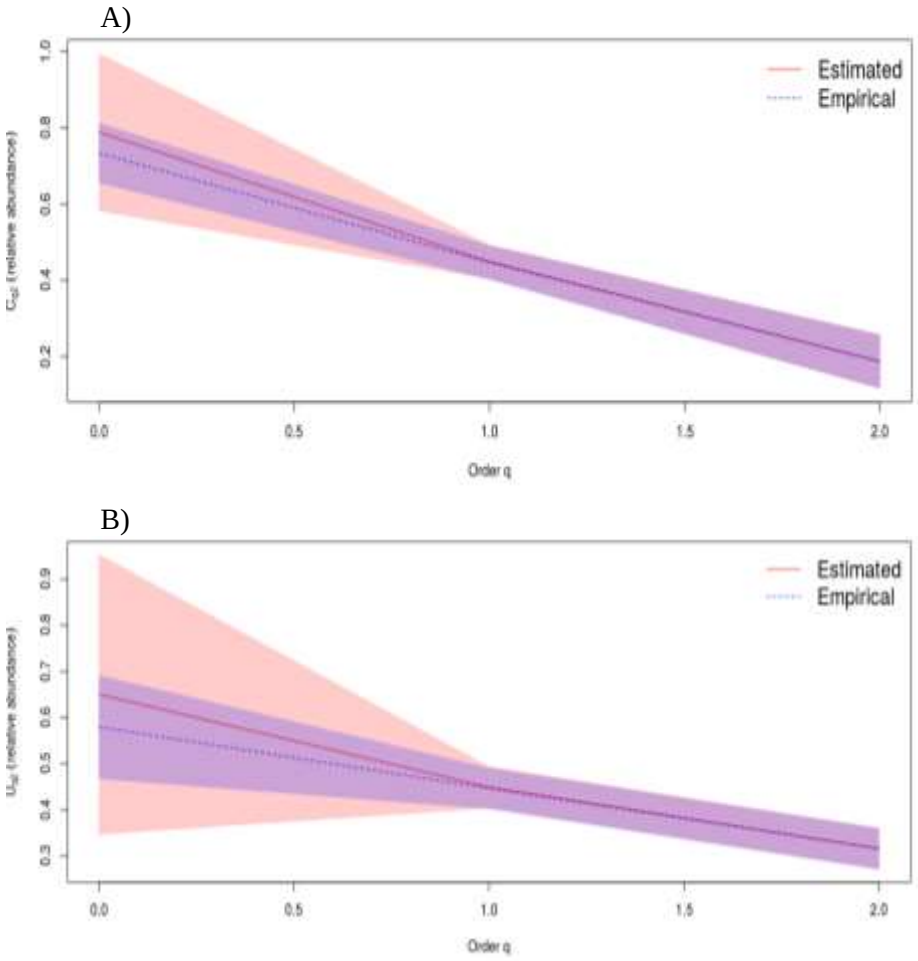


Fig. 3. Relationship between the relative abundance of species and the values of different similarity indices when comparing centipede communities of the Shumen Plateau and Madara Plateau: A) based on Sorensen, B) based on Jaccard

Table 5. General faunal similarity of centipedes community of the Shumen Plateau and the Madara Plateau

(1) BASIC DATA INFORMATION:

The loaded set includes abundance/incidence data from 2 communities and a total of 19 species.

Samples size in Community 1	n1 = 751
Samples size in Community 2	n2 = 345
Number of observed species in Community 1	D1 = 18
Number of observed species in Community 2	D2 = 12
Number of observed shared species in two communities	D12 = 11
Number of bootstrap replications for s.e. estimate	10

(2) ESTIMATED SIMILARITY INDICES:

	Estimate	s.e.	95%Lower	95%Upper
(a) Classic richness-based similarity				
C02 (q=0, Sorensen)	0.7877	0.1055	0.5809	0.9945
U02 (q=0, Jaccard)	0.6497	0.1551	0.3457	0.9537
(b) Measures for comparing species relative abundances				
C12=U12 (q=1, Horn)	0.4482	0.0232	0.4028	0.4937
C22 (q=2, Morisita-Horn)	0.1872	0.0364	0.1159	0.2584
U22 (q=2, Regional overlap)	0.3153	0.0229	0.2705	0.3602
Chao Jaccard-abundance	0.3118	0.0276	0.2577	0.3659
Chao Sorensen-abundance	0.4753	0.0132	0.4494	0.5012
(c) Measures for comparing size-weighted species relative abundances				
Horn size-weighted (q=1)	0.4155	0.0227	0.3709	0.4600
(d) Measures for comparing species absolute abundances				
C12=U12 (q=1, Horn)	0.3733	0.0227	0.3288	0.4179
C22 (q=2, Morisita-Horn)	0.1475	0.0338	0.0812	0.2137
U22 (q=2, Regional overlap)	0.2570	0.0302	0.1979	0.3161
Bray-Curtis	0.1986	0.0847	0.0325	0.3646

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Using the Horn and Bray-Curtis indices, in which all species in the sample are represented proportionally (q = 1) and their value depends on the number and quantity of all species in the sample, we obtained significant differences in the β-diversity of the two classes. Due to the significantly higher number of registered specimensin millipedes communities (3459 millipedes), the values of the Horn index - 0.68 and the Bray-Curtis index - 0.48 were higher than those in the Chilopoda communities of (0.37 and 0.20, respectively), which had significantly lower number (1096 centipedes).

The Morisita-Horn index (q = 2) attaches great importance to the dominant species, which in the centipede communities of in both plateaus was only one, as a result of which its value - 0.15 was lower than that in the millipede community - 0.39, in which there were more dominant species (Table 4, Fig. 2 and Table 5, Fig. 3).

At q = 0 (Sörensen and Jaccard indices) the weight of rare species increases and since their number in millipedes and centipedes communities was almost equal, the values of both indices were very close - 0.87 of Sörensen and 0.77 of Jaccard for millipeda community and 0.79 and 0.65 respectively for .

All similarity indices used so far do not take into account important community parameters. Therefore, the Jaccard-Chao and Sörensen-Chao-based indices, which combine data on the absence, relative abundance of species in the compared communities, are the best assessor of β-diversity and similarity between them. According to the Sörensen-Chao index, the millipedes communities in the two studied surveys had almost complete similarity and the value of the index was almost equal to one - 0.99. The habitat distribution of millipedes which are trophically related to the type of plant formation in a given area, was probably the reason for this homogenization of the community in the Shumen and Madara Plateaus. The communities of predatory differed significantly in the two regions studied - the value of the Sörensen-Chao index was 0.47.

The present research, devoted to the study of the similarity of myriapoda communities in two residual plateaus of Northeastern Bulgaria, was conducted to meet the need to quantify α- and β-diversity as the most important indicator for the functioning and stability of ecosystems. The results revealed that the composition and habitat distribution of Myriapoda, millipedes in particular, very much depends on the richness of the phytocenosis in the respective area. Species-rich and biomass-rich plant communities create an abundance of micro-habitats and ecological niches occupied by a large number of species which occur in high numbers of individuals. This creates a stable α-diversity, which is preserved over time and ensures the sustainability of the ecosystem.

Similarity of the faunal complexes in different geographical regions also depends on the physiographic and biocoenotic parameters of the environment. However, when these parameters are relatively identical, the most important factor for species composition, biomass and importance of each species in the communities is anthropogenic activity.

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