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Eco-faunistic study on the Collembola fauna in the Vasvár-Nagymákfa area (Őrség, Western Hungary)

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WINKLER, D. & TRASER, GY. N.: *Eco-faunistic study on the Collembola fauna in the Vasvár-Nagymákfa area (Őrség, Western Hungary).*
Abstract: In the course of the 6th Hungarian Biodiversity Day in 2010 the Collembola fauna was studied in the region of Vasvár-Nagymákfa in four different habitats (forests and meadows). During the survey a total of 5557 specimens belonging to 67 species were collected, 49 of them are new to the fauna of Őrség peaking now a total of 103 Collembola species in this region of Western Hungary. Two species, namely *Tetracanthella pericarpatica* Kaprus & Tsalan, 2009 and *Arrhopalites acanthophthalmus* Gisin, 1958 proved to be new to the Hungarian fauna. A particular *Pseudosinella* species (*P.* cf. *horaki*) is also described and illustrated.

Keywords: soil fauna diversity, Collembola communities, Hungarian Biodiversity Day, *Tetracanthella pericarpatica, Arrhopalites acanthophthalmus, Pseudosinella* cf. *horaki*

Introduction

The soil is a unique habitat that supports rich and diverse life assemblages of living organisms (GILLER et al. 1997), including springtails (Collembola) which substantially contribute to the decomposition of organic matter. They are the most abundant hexapods on Earth. One litre of healthy soil contain an average of 1000 Collembola specimens (HOPKIN 1994).

The United Nations has declared 2010 to be the International Year of Biodiversity and soil biodiversity came into the spotlight for the first time (JEFFERY et al. 2010). On the occasion of the 6th Hungarian Biodiversity Day held on 5 June 2010 in the area of Vasvár-Nagymákfa and surroundings (Őrség National Park), the survey of the collembolan fauna was also carried out. This paper presents a comparative study of Collembola communities of the most typical habitats for the area.

Material and Methods

Study area

The study sites are situated along the Csörnöc river, between 47°01'35" and 47°02'43" N and 16°43'54"E and 16°45'14" near Vasvár-Nagymákfa, Vas county, Hungary. Sampling was conducted in four different habitats including both forests and open areas

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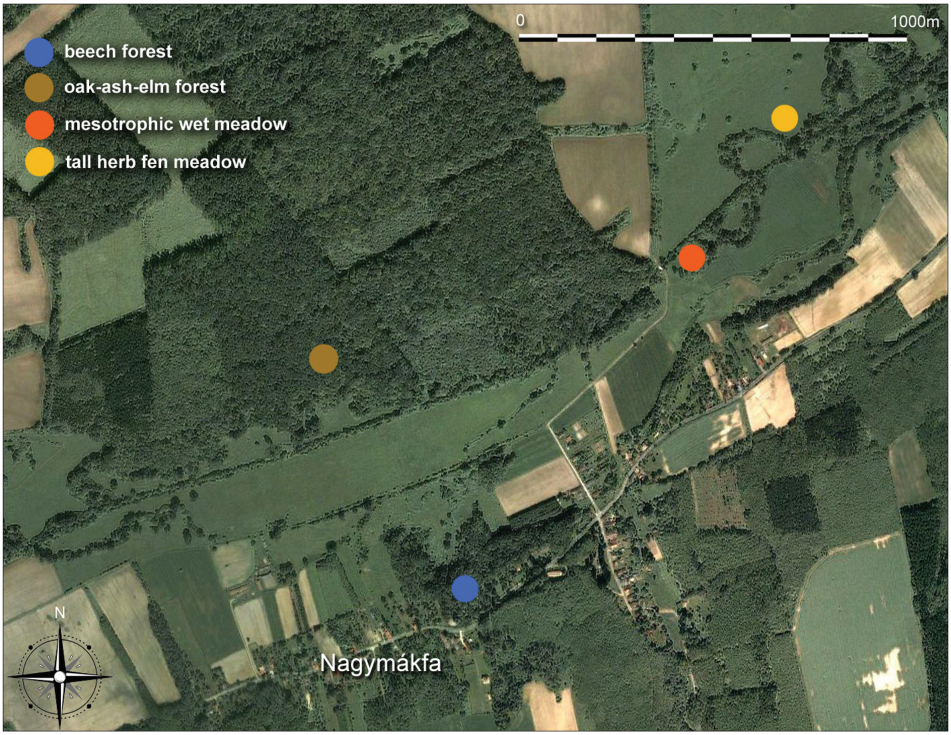

Fig. 1: Study sites in Vasvár-Nagymákfa (Google Earth)

(Fig 1).

BF - beech forest (47°1'35.15"N; 16°44'8.32"E, 202 m asl) with beech (*Fagus sylvatica*) monodominace. Scattered trees of European Alder (*Alnus glutinosa*) and Wild Cherry (*Cerasus avium*) are also present.

OAEF – lowland riverine oak-ash-elm forest (47°2'1.55"N; 16°43'54.40"E, 188 m asl). Beside the Pedunculate Oak (*Quercus robur*) and European Ash (*Fraxinus excelsior*) several riverine forest species constitute the tree layer.

WM – lowland mesotrophic wet meadow Á-NÉR: D34 (47° 2'23.20"N, 16°44'51.09"E, 178 m asl) with typical dominant grass species (e.g. *Agrostis alba, Deschampsia caespitosa, Festuca pratensis, Poa pratensis*) and numerous protected plant species.

THFM – tall herb fen meadow association (47° 2'22.77"N; 16°44'54.19"E, 178 m asl), with characteristic species like *Angelica sylvestris, Cirsium oleraceum, Filipendula ulmaria*. The presence of *Solidago* spp. is prominent.

Sampling, extraction and taxonomic identification

Soil cores samples of 100 cm^3 were taken from the 0 to 5 cm layer. A total of 37 samples were obtained from the three different habitats ranging from 8 to 12 samples per site. Extraction of Collembola specimens from the soil was carried with the help of a modified Tullgren's apparatus at room temperature (BALOGH 1958). Supplementary sampling was done in the beech forest and in the wet meadow using suction method to detect the species mainly present aboveground with more efficiency. Specimens were collected in 70% ethanol and separated under a binocular microscope. The Collembola species have been stored in the archives of the authors. Springtails were identified at the species level according to GISIN (1960), STACH (1960, 1963), MASSOUD (1967), DEHARVENG (1982), FJELLBERG (1980, 1998), BABENKO et al. (1994), ZIMDARS & DUNGER (1994), WEINER (1996), JORDANA et al. (1997), POMORSKI (1998), BRETFELD (1999), POTAPOW (2001) and THIBAUD et al. (2004). Taxonomic classification is primarily based on the annotated checklist of the Hungarian Collembola fauna (DÁNYI & TRASER 2008).

Abbrevations used in the descriptions: Ant. = Antennal segments; Abd. I–VI = abdominal tergites.

Data analysis

Average abundance values (specimens/100 cm^3) for each species per habitat type are given. Data obtained using the suction sampling method were not included in the quantitative analysis, only grades of abundance (BERNDT & WINKEL 1983) were given for the additional species.

The attributes of Collembola communities in the sampled habitats are presented via comparison of species richness, ecological composition, abundance and diversity indices. On species level, we used the measure 'habitat amplitude' (HA), according to the formula of SIMPSON (1949), which reflects the relative abundance of each Collembola species in the sampled habitats. Rank abundance curves were used to examine general trends in the Collembola dominance structure and abundance for each habitat type. Dominance structure was quantified by using community dominance index (CDI), which reflects how large a proportion of the total species present (in terms of numbers of individuals) is made up of the two most abundant species. Two measures of species α diversity were calculated for each habitat: the Shannon index ($H' = -\sum p_i \ln p_i$) and equitability ($J = H' / \ln S$ - where S is species richness). Community structure comparison between the different habitats was estimated using single linkage cluster analysis based on the Jaccard and Bray-Curtis similarity indices.

Results and Discussion

Faunistical results

A total of 5557 specimens representing 14 families and belonging to 67 species (Table 1) were collected and identified. Up to the present time 54 Collembola species have been reported from the Őrség area (TRASER 1995). Out of the species collected in Vasvár-Nagymákfa, 49 are new to the fauna of Őrség peaked at 103 species recently. Two species, namely *Tetracanthella pericarpatica* Kaprus & Tsalan, 2009 (Isotomidae) and *Arrhopalites acanthophthalmus* Gisin, 1958 (Arrhopalitidae) proved to be new to the Hungarian fauna, therefore some detailed information and illustrations are given below. Furthermore, a rare and interesting species, *Pseudosinella* cf. *horaki* Rusek, 1985 (Entomobryidae) is also illustrated and described.

Tetracanthella pericarpatica Kaprus & Tsalan, 2009 (Fig. 2) was formerly known only from the Transcarpathian Lowland and Roztochchia Hill, Ukraine (KAPRUS & TSALAN 2009). A total of 65 specimens were collected mainly from the lowland riverine oak-ash-elm forest, but it also occurred, in lower abundance, in the tall herb fen meadow association.

Fig. 2: ***Tetracanthella pericarpatica*** **(Photo: D. Winkler)**

Description: A predominantly bluish-black species (the specimen on Fig. 2 is marbled due to the preparation). The very strong, amber coloured and bent anal spines are clearly visible in Fig. 2. Detailed description has already been given by WINKLER et al. (2011) with some corrections and additions to the original description (KAPRUS & TSALAN 2009).

Arrhopalites acanthophthalmus Gisin, 1958 (Figs 3-5) is known from Romania, Austria, France and Spain, while its presence in Germany is doubtful (BRETFELD 1999, BETSCH & FJELLBERG 2011). Like the latter species, *A. acanthophthalmus* was also found in the oak-ash-elm forest as well as in the tall herb fen meadow habitat.

Description: A small, white-reddish species (Fig. 3) with unpigmented eye. Ant. IV not divided, while Ant. III strongly swollen at the base. Head with 13 spines (Fig. 4). Retinaculum with 1 seta. Anal appendage rod-like, slightly curved and pointed, slender, seta-like (Fig. 5). Circumanal setae are strong but not winged. Dens with E1-4 and I1-2 spines. Mucronal edge both serrated, tip spherical.

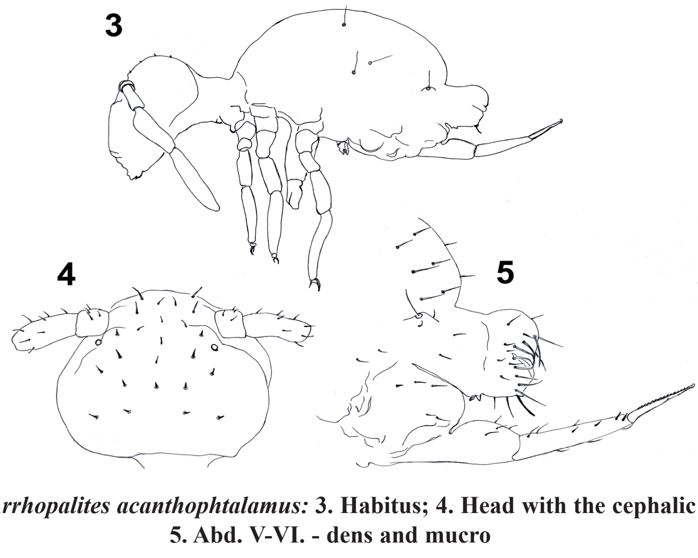

Fig. 3-5: ***Arrhopalites acanthophtalamus:*** **3. Habitus; 4. Head with the cephalic spines; 5. Abd. V-VI. - dens and mucro**

Pseudosinella* cf. *horaki Rusek, 1985 (Fig. 6) was described from Moravia, Czech Republik (RUSEK 1985) and later it was also found in Slovakia, Hungary and Moldova (BEDOS & FJELLBERG 2011). In the study area Vasvár-Nagymákfa, this species was collected in the beech forest and, with lower abundance, in the oak-ash-elm forest.

Description: Body length max. 1.2 mm (without head nor furca). Colour pale gray. The species belongs to the *P. wahlgreni* group characterized by 5+5 ommatidia. Eyepatch is dark. Antenna without scales, antenna-head ratio 1.2. Ant. IV without apical bulb. Antenna base with two pseudopori. Labrum and frontoclypeal area as on Fig. 7. Praelabral setae ciliated, labral setae smooth, in 4/554 arrangement. Maxillary outer lobe with 3 sublobal hairs. Lateral process on the papilla E slightly curved, not reaching the top of the papilla (Fig. 8). Formula of the labial triangle (=basomedial setae) $M_1M_2rEL_1L_2$: r smooth and shortened, only about 1/3-lenght of the other setae. The 'a' setae in the anterior row are smooth. Along the labial ventral grove 4+4 ciliated setae. Dorsal cephalic macrochaetae $R_0R_{1s}R_2$ (Fig. 9), S and T absent. Body dorsal macrochaetae 00/0101+2. Abd. II chaetotaxy (Fig. 10) $paBq_1q_2$ (notation after GISIN 1967). Abd. III chaetotaxy as on Fig. 11. Chaetotaxy and trichobotrial complex of Abd. IV as in Figs 12 and 13, macrochaeta 's' absent.

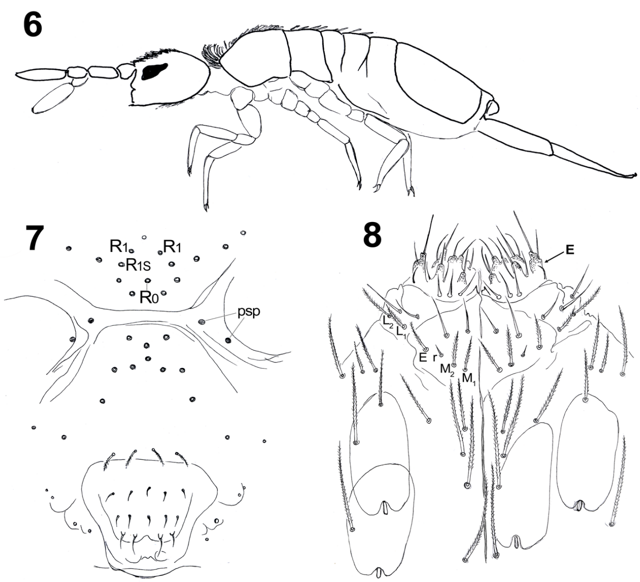

Fig. 6-8: *Pseudosinella* cf. *horaki*: 6. Habitus; 7. Mouthparts and frontoclypeal area; 8. Labial triangle and labial papillae

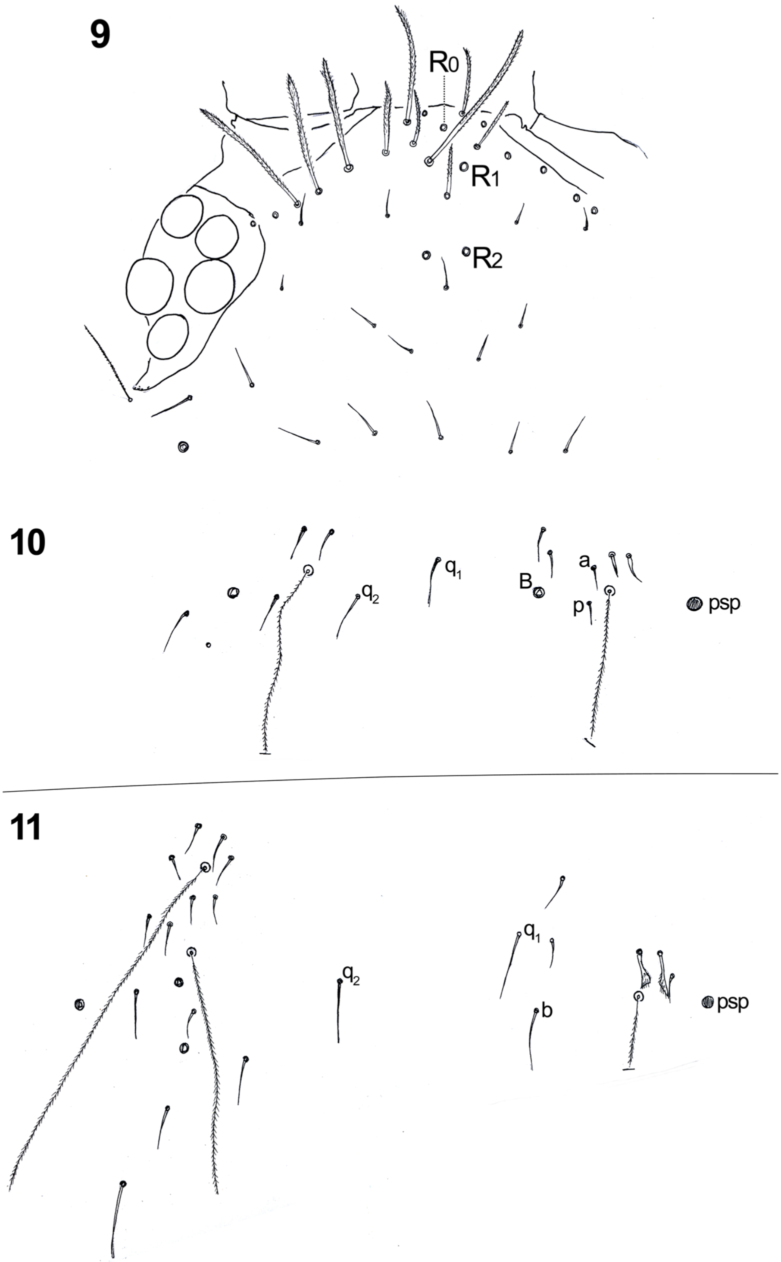

Fig. 9-11: *Pseudosinella* cf. *horaki*: 9. dorsal head chaetotaxy; 10. Abd. II complete chaetotaxy (left side); 11. Abd. III complete chaetotaxy (left side)

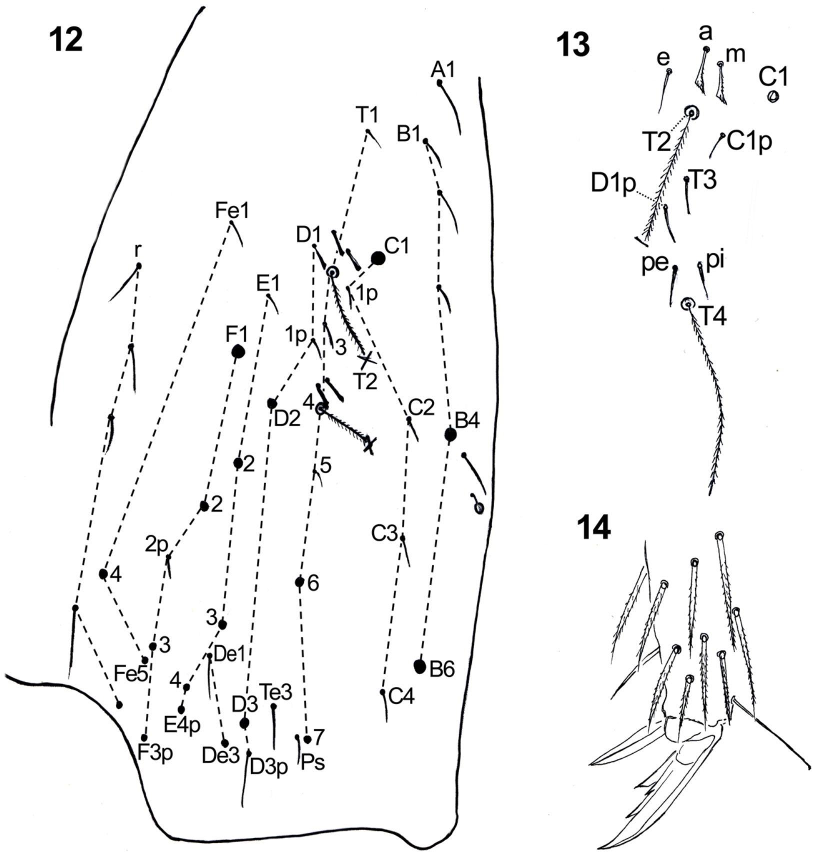

Fig. 12-14: *Pseudosinella* cf. *horaki*: 12. Abd. IV complete chaetotaxy; 13. Abd. IV trichobotrial complex; 14. Claw and empodium (leg III)

Claws with paired proximal teeth (Fig 14). The inner proximal unpaired tooth reaching to 65% of length of ventral lamella. Manubrial plate with 2+2 setae on both sides of the 2 pseudopori.

Remarks: our species shows some differences compared with *P. horaki*, such as the smooth 'r' seta in the labium. Nevertheless, not having seen any specimens of *P. horaki* for comparison, we decided to consider it as *P.* cf. *horaki*.

Collembola community analysis

Average abundance and habitat amplitude of the occurred species are presented in Table 1.

Table 1: Average abundance (specimens/100 cm^3) and abundance grade (based on the suction sampling method) of Collembola species in the studied habitat and species habitat amplitude according to Simpson's formula

(BF – beech forest, OAEF – oak-ash-elm forest, WM – mesotrophic wet meadow, THFM – tall herb fen meadow; HA – habitat amplitude; + sporadic occurrence; ++ scattered occurence ; +++ occurence in high abundance)

	BF	OAEF	WM	THFM	*HA*
Hypogastruridae					
Ceratophysella denticulata (Bagnall, 1941)	-	15.25	-	-	1.00
Ceratophysella granulata Stach, 1949	0.08	-	-	-	1.00
Hypogastrura sp. juv	-	-	1.11	-	1.00
Willemia virae Kaprus, 1997	-	0.38	-	-	1.00
Xenylla boerneri Axelson, 1905	18.58	-	-	-	1.00
Neanuridae					
Friesea truncata Cassagnau, 1958	-	0.38	-	3.13	1.24
Bilobella braunerae Deharveng, 1981	0.50	-	-	-	1.00
Deutonura albella (Stach, 1920)	0.92	-	-	-	1.00
Deutonura benzi Traser, Thibaud & Najt, 1993	0.58	3.50	-	-	1.32
Deutonura conjuncta (Stach, 1926)	0.17	-	-	-	1.00
Neanura cf. *alba* von Törne, 1956	0.08	-	-	-	1.00
Neanura muscorum (Templeton, 1835)	0.08	1.75	-	-	1.10
Anurida granulata Agrell, 1943	0.08	-	-	-	1.00
Pseudachorutes dubius Krausbauer, 1898	0.08	-	-	1.75	1.10
Pseudachorutes parvulus Börner, 1901	-	0.25	-	-	1.00
Pseudachorutes subcrassus Tullberg, 1871	0.17	-	-	-	1.00
Xenyllodes armatus Axelson, 1903	-	2.50	-	-	1.00
Onichiuridae					
Heteraphorura variotuberculata (Stach, 1934)	6.42	-	-	-	1.00
Hymenaphorura dentifera (Stach, 1934)	-	0.63	-	-	1.00
Onychiuroides granulosus (Stach, 1930)	7.67	7.00	0.22	-	2.06
Protaphorura armata (Tullberg, 1869)	-	-	10.44	-	1.00
Protaphorura bicampata (Gisin, 1956)	-	-	4.33	2.38	1.84
Protaphorura cancellata (Gisin, 1956)	3.25	18.38	-	-	1.34
Protaphorura serbica (Loksa & Bogojevic, 1967)	-	-	0.22	-	1.00
Tullbergiidae					
Mesaphorura macrochaeta Rusek, 1976	0.17	1.25	-	-	1.26
Paratullbergia callipygos (Börner, 1902)	0.08	-	-	-	1.00
Stenaphorurella quadrispina (Börner, 1901)	-	0.13	0.44	-	1.52
Cyphoderidae					
Cyphoderus albinus Nicolet, 1842	0.50	-	0.11	-	1.42
Entomobryidae					
Entomobrya corticalis (Nicolet, 1842)	2.67	0.88	0.33	0.25	2.11
Entomobrya multifasciata (Tullberg, 1871)	-	-	-	-	1.00
Lepidocyrtus arrabonicus Traser, 2000	-	0.25	-	-	1.00
Lepidocyrtus cf. *tellecheae* Arbea & Jordana, 1989	3.83	-	0.11	-	1.06
Lepidocyrtus cyaneus Tullberg, 1871	-	-	2.56	-	1.00
Lepidocyrtus lanuginosus (Gmelin, 1788)	5.58	0.38	-	-	1.13
Lepidocyrtus paradoxus Uzel, 1890	-	-	0.11	-	1.00
Pseudosinella cf. *horaki* Rusek, 1985	4.42	1.00	-	-	1.43
Heteromurus nitidus (Templeton, 1835)	0.83	-	-	-	1.00
Orchesella cincta (Linnaeus, 1758)	-	-	+	-	
Orchesella flavescens (Bourlet, 1839)	0.17	0.13	-	0.13	2.94
Willowsia nigromaculata (Lubbock, 1873)	-	-	-	0.13	1.00

Table 1 continued

	BF	OAEF	WM	THFM	*HA*
Isotomidae					
Cryptopygus bipunctatus (Axelson, 1903)	-	-	0.33	-	1.00
Folsomia manolachei Baggnall, 1939	2.33	10.25	-	-	1.43
Folsomia penicula Bagnall, 1939	60.75	-	-	-	1.00
Folsomia quadrioculata (Tullberg, 1871)	1.00	1.00	6.33	66.13	1.26
Isotoma viridis Bourlet, 1839	-	-	4.56	8.25	1.85
Isotomiella minor (Schäffer, 1896)	25.17	69.63	29.11	90.00	3.17
Isotomurus palustris (Müller, 1776)	-	-	-	3.88	1.00
Parisotoma notabilis (Schäffer, 1896)	0.17	0.13	3.78	-	1.16
Subisotoma pusilla (Schäffer, 1900)	14.67	-	-	-	1.00
Tetracanthella pericarpatica Kaprus & Tsalan, 2009	-	7.75	-	0.50	1.13
Tomoceridae					
Tomocerus minor (Lubbock, 1862)	5.83	-	-	-	1.00
Tomocerus mixtus Gisin, 1961	11.58	-	-	-	1.00
Tomocerus vulgaris (Tullberg, 1871)	0.08	-	-	-	1.00
Pogonognathellus flavescens (Tullberg, 1871)	0.17	-	-	-	1.00
Neelidae	-	-	-	-	
Megalothorax minimus Willem, 1900	0.75	5.88	-	0.13	1.30
Dicyrtomidae					
Dicyrtomina minuta (Fabricius, 1783)	-	-	1.11	1.13	2.00
Arrhopalitidae					
Arrhopalites acanthophthalmus Gisin, 1958	-	0.13	-	0.63	1.38
Arrhopalites terricola Gisin, 1958	0.33	-	-	-	1.00
Arrhopalites ulehlovae Rusek, 1970	-	0.13	-	-	1.00
Katiannidae					
Sminthurinus aureus (Lubbock, 1862)	-	-	++	0.13	1.00
Sminthurinus bimaculatus Axelson, 1902	-	1.63	0.33	12.13	1.32
Sminthurididae					
Sphaeridia pumilis (Krausbauer, 1898)	0.92	0.25	-	2.50	1.88
Sminthuridae					
Allacma fusca (Linnaeus, 1758)	0.25	-	-	-	1.00
Caprainea marginata (Schött, 1893)	0.83	1.50	-	0.88	2.77
Lipothrix lubbocki (Tullberg, 1872)	0.42	-	0.22	0.50	2.74
Sminthurus nigromaculatus Tullberg, 1871	-	-	+++	-	
Sminthurus viridis (Linnaeus, 1758)	-	-	+	-	

Of the collected species only about the 42% occurred in more than one habitats, which means that most of the species are habitat specialists. The species with the highest habitat amplitude was *Isotomiella minor* occurring with high abundance in both the forest and open habitats. The collected Tomoceridae species (*Tomocerus minor, T. mixtus, T. vulgaris* and *Pogonognathellus flavescens*) are typical surface dwelling forest species, which were only found in the samples from the beech forest. Another silvicolous species connected to the beech forest and sampled in high abundance are *Xenylla boerneri* and *Folsomia penicula*. The euedaphic *Protaphorura* species (Onychiuridae) were mostly collected from the two wet meadow habitats with the exception of *P. cancellata* which, although also known from meadows, seems to be more "silvicolous" in this area compared with the other *Protaphorura* species typical for open habitats (*P. armata* and *P. bicampata*). Further characteristic meadow species are *Isotoma viridis* and *Isotomurus palustris*.

Table 2 shows the most important structural characteristics of the Collembola communities found in the four habitats.

Table 2: Collembola community characteristics in the sampled habitats

S – species richness, A – average abundance (specimens/100 cm^3), H' – Shannon's diversity index, J – Pielou's equitability index, CDI – community dominance index (%)

	S	*A*	*H'*	*J*	*CDI*
beech forest	39	182.17	2.382	0.6501	47.16
oak-ash-elm forest	28	152.25	2.006	0.6021	57.80
mesotrophic wet meadow	19	65.78	1.874	0.6366	60.13
tall herb fen meadow	20	195.13	1.474	0.4922	80.01

Species richness was higher in the forest habitats compared with the meadows (Fig. 15a) due to the wider range of microhabitats usually offered in a woodland area. The highest number of species (39) was found in the beech forest, which can probably be explained also by the diversity of plant species including trees, since in a "pure" beech forest the species richness is usually lower (TRASER 1980). In the meadow habitats the species number was about the half (19-20) while the lowland oak-ash-elm forest represents an intermediate habitat with the 28 species collected.

Shannon diversity showed a similar yet not the same trend as experienced in species number (Fig. 15b). Its numerical value was the highest in the beech forest and somewhat lower in the oak-ash-elm stand. For what concern the open habitats, despite of the lower species richness, diversity was higher in the mesotrophic wet meadow compared with the tall herb fen meadow, due to the more even distribution of specimens among species (Fig. 15c).

Rather unexpectedly, the habitat containing the most abundant Collembola community appeared to be the tall herb fen meadow (Fig. 15d). This interesting phenomenon

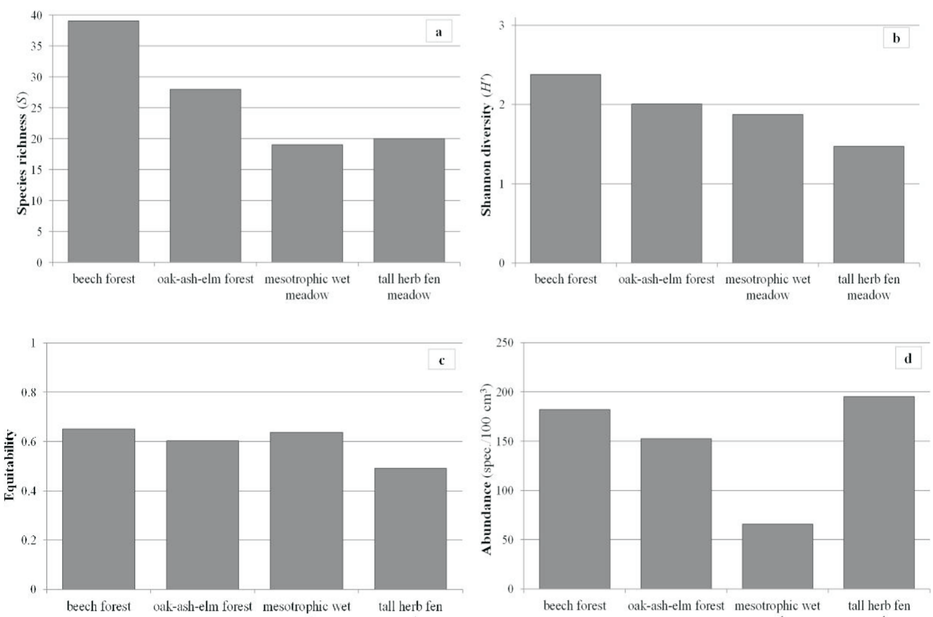

Fig. 15 a-d. Species richness, Shannon diversity, equitability and abundance

can probably be explained with the presence of the huge amount of decaying plant matter washed down by the river Csörnöc to the bank sediment, offering optimal environment for the mass occurrence of surface dwelling and hemiedaphic Collembola species such as *Isotomiella minor* or *Folsomia quadrioculata*. The latter species is especially known for its colonisation ability.

The values of the community dominance index (CDI) and the species rank abundance curves (Fig. 16) well emphasise the differences between the dominance structures of Collembola communities found in the sampled habitats. The dominance index was the lowest (~47%) in the beech forest indicating a relatively balanced dominance structure. The most dominant species was *Folsomia penicula*, a rather silvicolous, mesophil species occurring with an average of 60 spec./100 cm^3 abundance. Subdominant species were *Isotomiella minor* and *Xenylla boerneri*. The dominance indices of the communities in the lowland oak-ash-elm forest and in the mesotrophic wet meadow were about the same (~60%). In both communities, the eudominant species appeared to be *Isotomiella minor*, while the second dominant species came from the genus *Protaphorura* (*P. cancellata* in the oak-ash-elm forest and *P. armata* in the wet meadow). The highest dominance index was obtained in the community found in the tall herb fen meadow. The dominance structure is therefore unbalanced and the equitability is very low mainly because of the already mentioned mass occurrence of *Isotomiella minor* and *Folsomia quadrioculata.*

The agglomerative cluster analysis based on two measures of similarity, the Jaccard's single linear index and the Bray-Curtis index, resulted in two different dendrograms

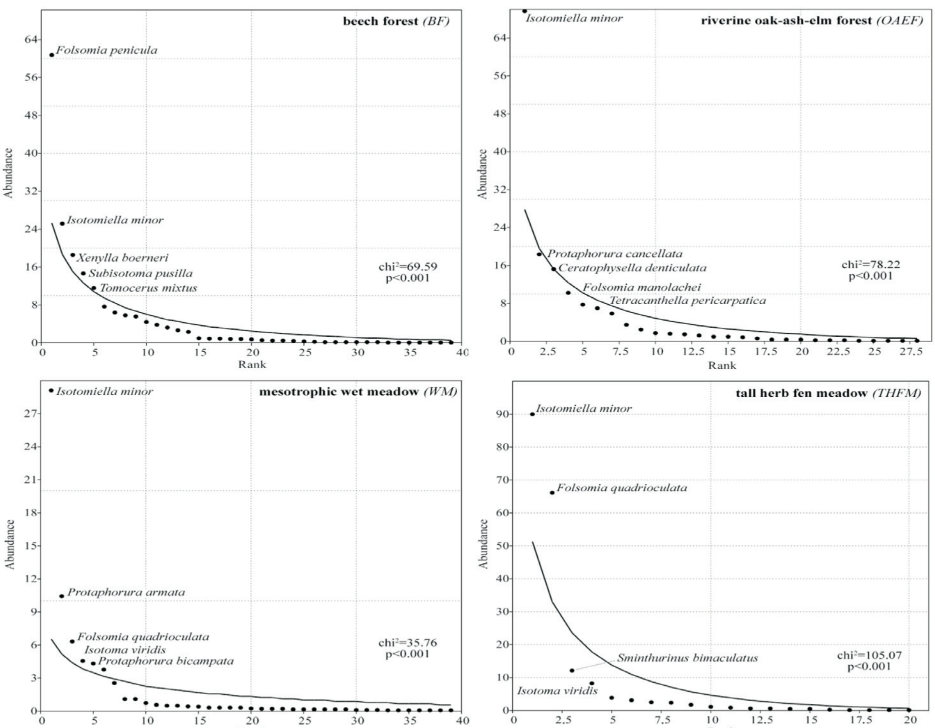

Fig. 16: Rank abundance curves (log series) of Collembola communities of the studied habitats

(Fig. 17a-b). The first classification (Jaccard) revealed two groups of habitats, the open and forest habitats. The second classification (Bray-Curtis) shows the complete separation of the beech forest from the other habitats. Apart from the different vegetation type, explanations for this phenomenon could be the higher altitude of the beech stand and the greater distance from the river, which can have a remarkable impact on soil conditions and, in consequence, on the Collembola communities. The second group contains the three lowland habitats. This group is further subdivided into two subgroups, separating the oak-esh-elm forest from the two open meadow habitats with relevant differences.

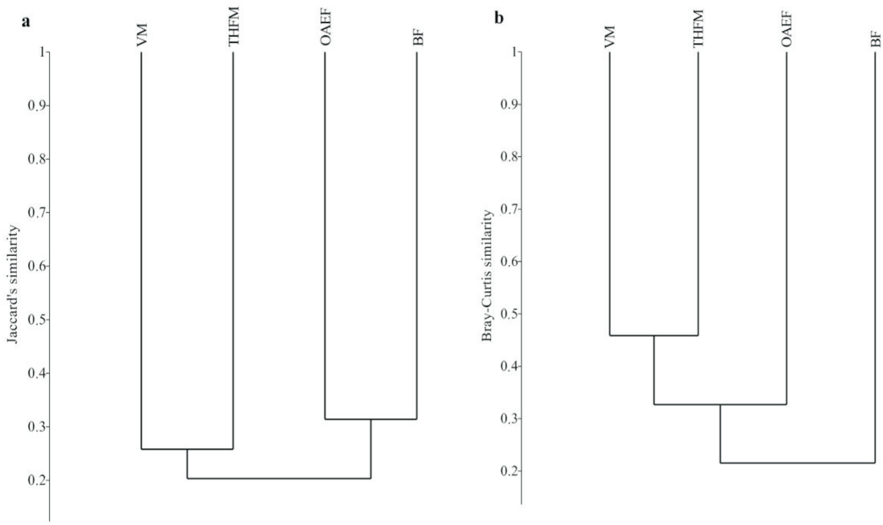

Fig. 17a-b: Dendrogram based on cluster analysis using the Jaccard index (a) and the Bray-Curtis index (b) of similarity

(BF – beech forest, OAEF – oak-ash-elm forest, WM – mesotrophic wet meadow, THFM – tall herb fen meadow)

Conclusions

The Vasvár-Nagymákfa area is characterized by a rich Collembola fauna. With the sampling carried out in the 6th Hungarian Biodiversity Day the number of Collembola species known from the Őrség has almost doubled and, including the two species new to the Hungarian fauna (*Tetracanthella pericarpatica* and *Arrhopalites acanthophthalmus*), the number of recorded species in Hungary increased to 435.

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