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Perić S., Orlić s., Ivanković M.: **Rast šiestich ihličnatých druhov v rôznej bioklíme Chorvátska.**

Vo výskumnom ústave v Jastrebarsku sme kvôli zisteniu dobrej selekcie ihličnatých druhov pre založenie kultúr začali na tomto probléme pracovať už od r. 1960. Pokusnú výsadbu sme začali s troma pôvodnými a troma cudzími druhmi. Pôvodnými druhmi boli *Pinus sylvestris* (L.), *Pinus nigra* (A r n.) a *Picea abies* (K a r s t.) a cudzími druhmi boli *Larix decidua* (M i l l.), *Pinus strobus* (L.) a *Pseudotsuga menziesii* (var. viridis F r a n c o). Z ekonomického hľadiska to boli medzi cudzími druhmi najzaujímavejšie, ktoré sa často používali v Chorvátsku na založenie nových kultúr v nelesných oblastiach a na rekonštrukciu nižšej kvality širokolistových porastov. Na jar 1969 tri porovnávacie výsadby boli založené v troch ekologicky charakteristických lesných regiónov Chorvátskej republiky.

Pre úspešnú produkciu je dôležitá jedna podmienka, ktorú možno vyjadriť takto: „Správny druh na správnom mieste". Môžeme to dosiahnuť vtedy, ak základné indikátory produkčnej schopnosti porastov ako aj bioekologických vlastností druhov sú známe.

Absolútny úspech môžeme očakávať iba v kultúrach, kde sa dosiahne najvyšší stupeň požiadaviek harmonizácie druhov. V práci prezentujeme 32 ročný vývoj rastlín uvedených druhov.

INVERTEBRATE FAUNA IN HABITATS WITH DIFFERENT SOIL MOISTURE IN FLOODPLAIN MEADOWS OF THE RIVER MORAVA

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Abstract

Kalúz S., Čarnogurský J., Čejka T., Krumpálová Z., Majzlan O., Rychlik I.: Invertebrate fauna in habitats with different soil moisture in floodplain meadows of the river Morava. Ekológia (Bratislava), Vol. 23, No. 1, 99-112, 2004.

During the research in floodplain of river Morava several groups of invertebrate fauna (Mollusca, Acari, Araneae, Collembola and Coleoptera) were studied. These animal groups were studied in various habitats with different soil moisture during the years 2000-2002. Standard methods of field research were used there. During the research the basic soil characters were observed (ammount of water, porosity, air content, specific weigth of soil samples) and the ammount of rainfall was measured. Two the most wet habitats involved the lower number of invertebrate species with both the lowest density and the frequency. Mildly wet flooded meadow showed the richest communities of the majority of invertebrates. This habitat included mainly semihygrophilous species with the highest abundance, frequency and the highest number of species.. Vertically the highest situated habitat was inhabited mainly by species requiring mildly wet or drier soils. The abundance and number of hygrophilous species decreased with the decreasing ammount of water in the soil. Community structure of invertebrates changed within the gradient of soil moisture and each habitat showed characteristic species living there.

Key words: habitats, fauna, floodplain, Acari, Araneae, Coleoptera (Carabidae), Collembola, Mollusca, moisture, river Morava, soil

Introduction

The attention of specialists to study various groups of animals has been focussed to the Slovak part of floodplain of the river Morava since 1992. While vertebrates are well stu-

died there, the information on many other groups of small animals (mainly soil invertebrates) is still missing. The first information on several groups of soil invertebrate fauna from floodplain of the river Morava from South Morava (the Czech Republic) comes from the paper of Rusek (1984). However, during several research projects some results, dealing with invertebrate fauna, appeared from this area. In floodplain of river Morava soil mites (Acari) were studied by Kalúz (1994, 1999) and Kalúz, Čarnogurský (2000). The papers, stated above, enlarge the knowledge on soil mite in the conditions of natural hydrological regime of this area. Within the typical groups of soil fauna, the field research was focussed on the springtails (Collembola) in floodplain of this area (Čarnogurský, 2000), too. Since 1991 the attention was devoted to the study of beetles (Coleoptera) in forests and meadows in the vicinity of river Morava, including floodplain. Various groups of mainly epigeic beetles (Curculionidae, Staphylinidae, Pselaphidae) were elaborated by Majzlan (1993, 1994, 1995), Kolimár, Majzlan (1995), Majzlan, Jászay (1997), Majzlan, Rychlík (2000). Besides beetles, another group of insects were studied by Majzlan, Štepanovičová (1998). Less information on molluscs comes from this area. This interesting group of invertebrates was studied in floodplain meadows of river Morava last years, and the results are available in the papers of Kučeravý (1995) and Čejka (2000). The same situation concerns the spider fauna. Spiders of floodplain area of river Morava were studied by Gajdoš (1994) and Krumpálová (1999, 2000). These papers presents the information on spiders of forests and meadows in this interesting area.

Study area

Study area comprised habitats on the left side of river Morava in the vicinity of Devínske jazero railway station (DFS-7767 – grid reference of the Databank of the Fauna of Slovakia). The research of Mollusca, Acari, Araneae, Collembola and Coleoptera run there from the year 2000 to 2002.

Study habitats:

1. *Gratiolo-Caricetum* (depression involving the bottom and bank of former arm of river Morava without any connection with river, supported by subsoil waters only. Plant association: *Gratiolo-Caricetum praecocis-suzae.*
2. *Phragmitetum.* Study site in the neighbour of the same arm approximately 80 m apart from the first habitat, this habitat was situated vertically 1 m higher. Plant association *Phragmitetum communis*, in flooded meadow with typical plant *Clematis integrifolia.*
3. *Arrhenarrheretum.* Periodically flooded meadow with solitary willows (*Salix sp.*), on higher situated terrace. This habitat was covered by low grass, differrential plant species was *Allopecurus pratensis.*
4. Terrace. Sandy habitat on the highest situated river terrace, closed to the road from Devínska Nová Ves. Typical plants: *Robinia pseudacacia, Sambucus ebulus, Lamium purpureum, Aristolochia clematitis, Chelidonium maius, Agropyrum arvense.*

Methods and material

Invertebrates were studied using standard methods of the field research

Mollusca: In three habitats (*Gratiolo-Caricetum, Arrhenarrheretum,* Terrace) the quadrat method of soil samples was used. Samples of soil (50x50 cm) to the dept of 3 cm were taken quarterly from March to November each year. Due to this the results from 1 m^2 were obtained. Soil samples were treated according to Evans (1972). Molluscs were identified using the keys by Wiktor (1973, 1989) and Riedel, Wiktor (1974). Several categories of species were stated: dominant (more than 15% of dominance), subdominant (6-14.9%), recedent (1-5.9%) and subrecedent (less than 1%).

Acari: 5 soil samples of standard volume 300 cm^3 (5x6x10 cm, the last is the depth of sample) were taken from each habitat each month from April to November. Samples were put into plastic bags and mites were isolated in fotoeclectors of the Tullgren type. Mites were preserved in 70% ethylalcohol and identified in microscopic slides using Liquide de Swanne. Keys used to identification: Bregetova et al. (1977), Bulanova-Zakhvatkina et al. (1975), Karg (1993), Vainstein et al. (1978) and Zacharda (1980).

Araneae: The spiders were studied in three habitats (*Gratiolo-Caricetum, Arrhenarrheretum,* Terrace). A line of pitfall traps of the volume 0.72 l and diameter 7.5 cm were used (6 traps in habitat), the distance between each two traps was 15 m. Formaldehyd (4%) was used as attractant and conservative medium. Material was collected each month from April to November (2000-2002). Then spiders were conserved in 70% ethylalcohol and subsequently identified.

Collembola: The same method (same soil samples) like in mites was used.

Coleoptera (Carabidae): The same method of pitfall traps like in spiders was used. Material of beetles was collected regularly each two weeks from April to October (2000-2002). Beetles were preserved in 75% ethylalcohol and identified according Hůrka (1996).

Soil characters: Basic soil characters were observed using standard methods by Tesařová (1989). Soil characters (absolute water volume in the soil, ammount or air, porosity and bulk content) were obtained from each soil sample. Water ammount is stated in % of the volume of samples, the same way was used registering the volume of the air and porosity.

During the research the ammount of rainfall was measured in the area from three collectors, the data were collected each month. The average of rainfall (each month) is used for the purposes of paper. The rainfall during the season 2000 and basic soil characters are presented in Fig. 1.

Rainfall in mm:

2000 – June (32), July (33), August (47), September (62), October (92), November (67), December (24)

2001 – January (28), February (19), March (35), April (46), May (29), June (26), Kuly (102), August (44)

Water ammount, air content, porosity and bulk content including all soil samples, span and the average values are stated in Table 1.

During the 2000 the influence of subsoil water was not visible and the level was more than 50 cm deep from the surface. The level of subsoil water influenced the first habitat and partially the second during 2001. Both habitats were flooded in April. June and August. Higher situated habitats were not influenced. Due to this there was impossible to measure soil characters in hanitats No.1 and No. 2 during this part of the year 2001. The values in Table 1 show the situation in the year 2000.

In the text of paper the indices of divesity (Shanon-Weawer) and similarity (Margalef) were used to express some ecological characters.Various methods were used in collecting soil invertebrates effectively. Resulting from this the abundance of activity is used in spiders and beetles, while total abundance is used in springtails, mites and molluscs. The correlations between the ammount of soil water and the abundance of some mite species were calculated using each soil sample in the year 2000.

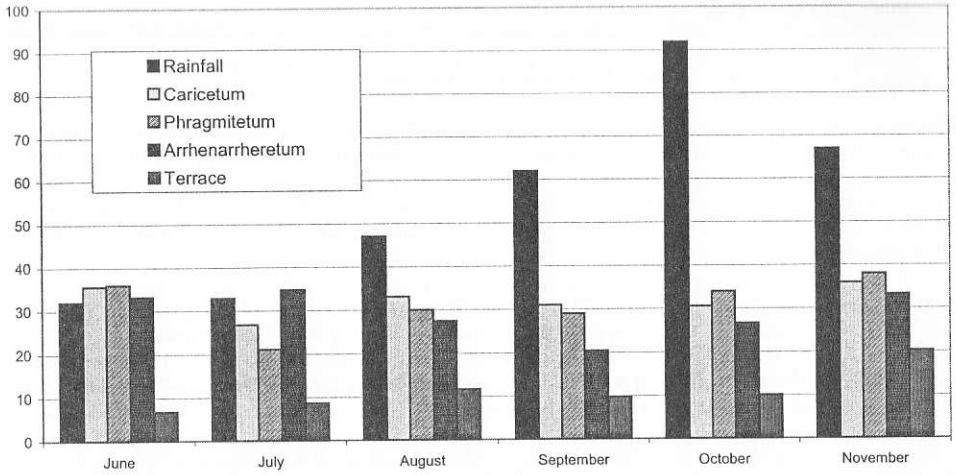

Fig. 1. Dynamics of rainfall [mm] and soil water [mm] in habitats (average per month) in the year 2000.

Table 1. Soil characters in habitats (average per the period June-December 2000)

Soil characters	Gratiolo-Caricet. min.- aver.- max.	Phragmitetum min.- aver.- max.	Arrhenarrheretum min.- aver.- max.	Terrace min.- aver.- max.
Water content [%]	20 - 32.1 – 39.7	16.3 - 31.3 – 41.4	19.1 - 27.6 – 36.9	4.2 - 11.2 – 23.0
Porosity [%]	63.0 - 68.1 – 75.0	54.3 - 61.3 – 74.7	42.2 - 49.5 – 56.3	37.0 - 46.5 – 53.4
Specific weigth [g/ccm]	0.99 - 1.27 – 1.66	1.41 - 1.63 – 1.99	1.72 - 1.96 – 2.10	1.45 - 1.93 – 2.25
pH	6.24 - 6.65 - 7.02	6.66 - 7.18 - 7.43	6.7 - 7.10 - 7.69	6.27 - 6.73 – 7.16
Span values				
Water [%]	19.7	57.7	17.8	18.8
Porosity [%]	12	20.4	14.3	16.4
Specific weigth	0.668	0.439	0.375	0.777
pH	0.78	0.77	0.69	0.89

Results

Habitat No. 1 (*Gratiolo-Caricetum*)

The soil in this habitat involved the highest ammount of water (Table 1) and the highest values of porosity in comparison to all study sites. Seasonal dynamics of rainfall and the ammount of soil water is shown in Fig. 1. A small decreasing of soil moisture is visible in July, while the rest of the year shows the values of the absolute water ammount in the soil higher than 30%.

Mollusca. Overall average density reached 157 ind. 0.25 m^{-2}. This habitat involved 9 terrestrical and 13 aquatic species. At this study site two polyhygrophilous species dominated *Zotinoides nitidus* (43.75%) and *Succinea putris* (28.13%). The habitat was closed to a former river arm with temporary water. Resulting from this, individuals of freshwater molluscs occurred in habitat regularly. Several species belonged to paludicolous ones and to the group of species inhabiting various types of temporal waters. Paludicolous species *Planorbis planorbis* dominated (55.2%) in water malacocoenose of the habitat. Another well-represented, mainly stagnicolous, species there was *Planorbarius corneus*. The dominance of this subdominant species reached 11.7%. Another subdominant species occurring in floodplains was *Anisus spirorbis* (8.5%).

Table 2. Abundance of soil mites regularly occurring in samples (average per sample in the year 2000)

Habitats/Mites	Caricetum.	Phragmit.	Arrhenarrh.	Terrace
Oribatei	51.07	14.03	61.5	22.57
Eupodes sp.	28.4	16.3	6.67	2.13
Rhizoglyphus echinopus	1.7	1.47	61	3.53
Bakerdania quadrata	10.27	0.39	2.77	0.03
Scutacaridae	1.3	0	0.4	0.1
Eustigmaeus pinnata	0.67	0.03	0.2	0.27
Coccorhagidia clavifrons	1.97	1.5	1.77	0.63
Rhodacarellus silesiacus	2.57	0	1.67	0.13
Hypoaspis nolli	5.13	0.2	6.37	0.37
Opsereynetes norvegicus	0.47	0	0.03	0

Acari. In this type of habitat the average abundance of mites was 107 individuals per sample. Oribatei were the most abundant group (51 ind./sample). Besides above mentioned group, two dominant species appeared there *Eupodes sp.* (28.4 ind./sample) and *Bakerdania quadrata* 10.3 ind./sample. Remaining other species had lower abundance in samples (Table 2). The abundance of *Eupodes sp.* was the highest there in comparison to other study habitats. The same was observed in small predaceous species *Rhodacarellus silesiacus,* edaphic rhagidiid mite *Coccorhagidia clavifrons* and small mesohygrophilous mites from the family Scutacaridae (Table 2). More species and groups had high frequency in soil samples. The most frequent species there were *Coccorhagidia clavifrons* (76.7%), *Rhodacarellus silesiacus* and *Hypoaspis nolli* with the same values of frequency (63.3%). Relatively high frequency was registered in several species mainly of mesostigmatic mites. The correlation between the ammount of water in the soil and frequent species *Eupodes sp.* did not appeared (0.0047). On the contrary, the same correlation in Oribatei was higher (0.7953). Overall species diversity reached 1.6759.

Araneae. Community structure of spiders involves 10 families. Representatives of family Linyphiidae involves 37,9% of the dominance of community, while Lycosidae 31.8%. Other dominant spiders belonged into families Liocranidae (11.6%) and Tetragnathidae

(10.3%). *Pardosa lugubris* and *Pirata hygrophilus* belonged to eudominant species in the year 2000. Among the dominant species appeared *Oedothorax apicatus* and *Diplocephalus picinus*, only. During the year 2001, the habitat showed the change in dominance of spiders. One eudominant species occurred there (*Pirata hygrophilus)* only. The change was visible in dominant species, also. In this year with the increasing of the level of underground water *Ozyptila praticola* was dominant, while *Pelecopsis mengei* and *Pachygnatha listeri* belonged to subdominant species.

Collembola. In total 25 springtail species occurred there. The highest dominance showed *Parisotoma notabilis* (26.1%). Another species with higher dominance were *Lepidocyrtus cyaneus* (13.6%) and *Protaphorura armata* (11.1%). Within the springtail community three accompanying species occurred, *Isotomiella minor*, *Sminthurinus aureus*, *Stenaphorurella quadrispina*. *Metaphorura affinis* belonged to rare species. The average abundance of this group per season was 2211 ind./m^2, springtails were the most abundant in August (4334 ind./m^2), their abundance was the lowest in December (667 ind./m^2). Among the characteristic species of this habitat *Anurida ellipsoides*, *Lepidocyrtus cyaneus*, *Protaphorura armata* can be included.

This habitat as compared to other ones showed the highest value of Shannon-Weaver diversity index: H = 2.56 and the equitability was 0.795.

Coleoptera (Carabidae). Altogether 55 carabid species (904 ind.) appeared in this habitat. Margalef diversity index showed the highest value (15.5) there. While *Patrobus atrorufus* dominated in the habitat (39%), differential species *Lasiotrechus discus* and *Odacantha melanura* were stated among species with high ecosozological importance. Both hygrophilous (30 species) and semihygrophilous (25 species) carabids occurred in this wet habitat. The expressively hygrophilous there were the species within the genera *Bembidion, Elaphrus* and *Platynus*. Considering the relation to the moisture, the species with the affinity to xerotherm comditions did not appear there.

Habitat No. 2 (*Phragmitetum*)

The soil of this habitat contained nearly the same ammount of water (in an average) (Table 1). The dynamics of soil water showed the decreasing in July (Fig. 1) and the dynamics was very similar to the previous habitat.

Acari. Altogether 16 mite species were registered there. Total average abundance of mites reached 36.2 ind./sample. The most abundant species *Eupodes sp.* occurred in samples the most frequently (100%) and its abundance (Table 2) was 16.3 ind./sample. This species used to occur commonly in conditions with higher soil moisture. Oribatei were less numerous (14 ind./sample), but their frequency was the same (100%), like in *Eupodes sp*. Besides *Eupodes sp.* the only *Coccorhagidia clavifrons* had higher frequency (60%) in this habitat. Two interesting taxa *Rhodacarellus silesiacus* and mites of family *Scutacaridae* were absent there, while in other study habitats occurred normally. The majority of common species had low frequency. Mite community was the least numerous there. The correlation coefficient between the ammount of water in samples and frequent representatives of mites was in Oribatei 0.4232 and in *Eupodes sp.* –0.1728. Overall species diversity index reached 0.9639.

Collembola. Nearly the same number of species occurred there in comparison to the previous habitat. Four springtail species within altogether 21 dominated: *Isotomiella minor* (28.6%), *Parisotoma notabilis* (13.6%), *Protaphorura cancellata* (12.1%) and *Anurida ellipsoides* (10.2%). The dominance of accompanying species *Sphaeridia pumilis* reached 3.88%. In the soil of this habitat *Metaphorura affinis*, *Protaphorura fimata* and *P. islandica* belonged to the rare species. While springtail community was the most numerous in December (9334 ind./m^2), the lowest abundance of this group appeared in October (200 ind./m^2). Average abundance per season was 2289 ind./m^2. Within the species spectrum *Anurida ellipsoides*, *Isotomiella minor* and *Protaphorura cancellata* appeared as the characteristic species for this type of habitat. The values of indices of diversity and equitability were: H = 2.39 and E = 0.773.

Coleoptera (Carabidae). Total species spectrum of this habitat included 51 species (786 individuals) and the Margalef diversity index reached 14.3. The highest number of carabid beetles appeared in this habitat in comparison to other study sites. In this habitat the dominant species was *Europhilus micans* (13.7%) and variant of the socion was *Oxypselaphus obscurus* with the frequency 100%. Peaks of abundance during the season appeared in spring and autumn. Within altogether 51 species we can distinguish three categories with the affinity to soil moisture. Total 36 carabid species belonged to hydrophilous species, 12 were semihygrophilous. Three species were considered xerophilous ones. As the abundance of activity was concerned, a great majority of individuals belonged to hygrophilous (83.6%), while 15% of carabids were semihygrophilous. Among all specimens 1.4% belonged to xerophilous species, only.

Habitat No. 3 (*Arrhenarrheretum*)

The soil of this habitat contained less water (Table 1). Seasonal dynamics of soil water differed in comparison to other study habitats. The decreasing of soil moisture started in August. The lowest value occurred in September and the highest one (Fig. 1) was visible in November.

Mollusca. The overall density in this meadow habitat was low (33 ind. 0.25 m^{-2}). Three species appeared in soil samples only. Two of them were dominant, *Vallonia pulchella* (79.9%) and *Succinella oblonga* (20%). The slug *Arion subfuscus,* heliophilous open country inhabiting species, was very scarce. Moreover, rare species *Deroceras laeve* and *Vallonia constata* sometimes appeared.

Acari. This habitat was characteristic by the highest abundance of mites in the soil (131.9 ind./sample). Total number of identified species reached 45. Mesostigmatic mites, Prostigmata and Tarsonemina showed the highest increasing of species number. An interesting situation appeared there. The abundance of all oribatid mites (45.9 ind./sample) was lower than it was (Table 2) in solely acarid mite *Rhizoglyphus echinopus* (61 ind./sample). Mesostigmatic predators *Rhodacarellus silesiacus and Hypoaspis nolli* had practically the same abundance (6.67 and 6.37 ind./sample respectively). High frequency of mites in samples indicate more homogeneous distribution of conditions in the soil. Besides *Eupodes sp.* (100%), the highest frequency appeared in typical representatives of flooded meadows

Rhizoglyphus echinopus (96.7%), *Poecilophysis pratensis* (73.3%) and *Rhodacarellus silesiacus* (43.3%). Even, less frequent in other habitats, the species *Hypoaspis nolli* occurred more than in 50% of samples, there. The most frequent representatives of mites showed different (and very low) values of correlations between the ammount of water in soil samples and number of mite individuals (Oribatei: -0.1913, *Eupodes sp.*: 0.3131). Overall species diversity index was 1.7433 in this habitat.

Araneae. From this habitat altogether 1143 spider specimens were obtained, belonging into 13 families and 65 species. *Pardosa lugubris* and *Pirata hygrophilus* belonged into the eudominant species there, but *Diplocephalus picinus* and *Oedothorax apicatus* were dominant ones. While in 2000 the most dominat species in *Arrhenarrhretum* was *Pardosa lugubris,* in 2001 it was very interesting to observe an increasing of the dominance of species *Pirata hygrophilus.*

Collembola. The richest springtail spectrum appeared in this meadow habitat (33 species), when *Schoettella ununguiculata* (37.6%), *Parisotoma notabilis* (11.7%) were the dominant species. *Isotomiella minor, Lepidocyrtus cyaneus, Protaphorura procampata* can be included into accompanying, and *Metaphorura affinis*, *Protaphorura islandica* among rare species. Springtail community showed the highest abundance in December (28401 ind./m^2), while in August the abundance was the lowest (2800 ind./m^2). Comparing all study habitats, the average abundance ot this animal group per season in the soil of this meadow was the highest (8755 ind./m^2). It is difficult to state any typical species for this type of habitat. More euryecious species occurred within the high number of springtails. The values of indices of diversity and equitability there were: H = 2.37 and E = 0.679.

Coleoptera (Carabidae). Altogether 42 carabid species occurred in this habitat with the Margalef diversity indice 11.8. *Poecilus cupreus* was the dominant species there (21.0%) and variant of the socion there was *Pterostichus melanarius* (frequency = 100%). The occurrence of carabid beetles was nearly even from spring to autumn, without any expressive peak.Within all carabid species 20 were hygrophilous, 16 semihygrophilous and 6 xerophilous. Abundance of activity included 27.1% of hygrophilous, 70.8% of semihygrophilous and 2.1% od xerophilous species.

Habitat No. 4 (*Terrace*)

This the driest habitat with the average of water content in the soil 11.2% only (Table 1) and the heaviest sandy soil showed different assemblages of invertebrates in comparison to above stated habitats. Seasonal dynamics of soil water fully differed as compared to other study sites. Fig. 1 shows low values with a very slight increasing in August and with a more expressive peak in November.

Mollusca. This more dry and sandy habitat showed very low total density of molluscs (12 ind./ 0.25 m^{-2}). Altogether 8 terrestrial species occurred there, three of them dominated. The highest dominance showed *Truncatellina cylindrica* (41.67%), then *Vallonia pulchella* (25.0%). The dominance of euryecious species *Vitrina pellucida* was the lowest (16.67%). Among the rare species on vegetation *Vallonia costata, Cochlicopa lubricella* and *Xerolenta obvia* appeared.

Acari. Altogether 26 mite species occurred in this habitat with an average abundance 40.27 ind./sample. The most prevailing group there were oribatid mites (22.57 ind./sample). Other groups had very low abundance. The only *Rhizoglyphus echinopus* and *Eupodes sp.* showed higher abundance than 2ex./sample (3.53 and 2.13 ind./sample respectively). Comparing all study habitats, three mesohygrophilous mite species had the lowest abundance there (*Eupodes sp., Bakerdania quadrata* and *Coccorhagidia clavifrons).* The most frequent species in this habitat (Table 2) was *Eupodes sp.* (96.7%), but this frequency was the lowest when comparing all study habitats. Another relatively frequent species there were *Coccorhagidia clavifrons* (43.3%), *Rhizoglyphus echinopus* (33.3%) and *Hypoaspis nolli* (30%). The same words can be said on the frequency of *Coccorhagidia clavifrons*. Relatively high, but there was the lowest one, comparing the frequency of this species in all habitats. This driest habitat showed positive correlations between the ammount of soil water and abundance of mites. The value in Oribatei was 0.5464 and in *Eupodes sp.* 0.5145. Overall species diversity was the highest there, the index reached 2.4923.

Araneae. The highest dominance in the community there showed the families Linyphiidae (43%) and Lycosidae (17%). In comparison to flooded habitats the number of eudominant species increased. Besides *Pirata hygrophilus* two other species occurred there *Centromerus sylvaticus* and *Pachygnatha listeri. Ozyptila praticola, Agroeca brunnea* and *Agraecina striata* belonged to dominant species. In 2001 the most expressive decreasing of abundance activity was registered in *Pardosa lugubris* (from dominant to subdominant). On the other side, the dominance of *Centromerus sylvaticus* increased and reached more than 12%.

Collembola. Altogether 19 springtail species inhabited this habitat, *Parisotoma notabilis* (31.6%) dominated there. Like in the previous *Arrhenarrheretum* 4 accompanying species were registered there: *Lepidocyrtus cyaneus*, *Metaphorura affinis*, *Sphaeridia pumilis* and *Stenaphorurella quadrispina*. Several specimens of two relatively scarce species *Mesaphorura hylophila* and *Metaphorura affinis* appeared in the soil of this habitat. Average abundance of springtails was low there (1089 ind./m^2), the highest abundance appeared in december (2267 ind./m^2) and the lowest in August (467 ind./m^2). *Stenaphorurella quadrispina*, *Orchesella cincta* and *Parisotoma notabilis* were considered the characteristic species of this type of habitat. The indices of species diversity and equitability reached there the values 2.45 and 0.833 respectively.

Coleoptera (Carabidae). This study site was inhabited by altogether 40 carabid species (484 individuals) and their diversity according Margalef reached 8.8. *Leistus ferrugineus* was the dominant species there, its dominance was 45%. Another carabid species *Trechus quadristriatus* was considered a variant of the socion and its frequency was 80%. An expressive peak of occurrence of beetles appeared in this habitat during the summer. This was caused by rich occurrence of dominant species *Leistus terminatus*. This dry habitat provides another aspect in the composition of carabid species spectrum. While the hygrophilous species were more presented in the previous habitats, these ones were less numerous there. Only 6.6% of them occurred, while the dominance of semihygrophilous species rapidly increased (69.2%). The same appeared in xerophilous carabids (24.2%). Such, within all species, the carabids involved 12 hygrophilous, 13 semihygrophilous and 15 xerophilous species.

Discussion

Mollusca

According to the affinity of molluscs to soil moisture of habitats, we can see the differences between the occurrence of hygrophilous and polyhygrophilous species in these habitats. Resulting from this aspect the density of hygrophilous species was the highest at the most wet habitats sequentially: habitat No. 1, 3 and habitat No. 4. Euconstant species in three study sites with higher soil moisture were *Vallonia pulchella, Succinella oblonga* and *Cochlicopa lubrica*. While the density of the first one was the same in study habitats, the density of *Succinella oblonga* decreased due to decreasing the ammount of water in the soil from first to the third habitat.

Soil moisture is one of the most important factors, influencing the distribution of terrestrial molluscs in biocoenoses (Čejka, 2000). For areas, periodically flooded by flowing water (one or several times during the season), a low density of extremely hygrophilous to paludicolous species is characteristic. Some species, typical for mildly or mesic biocoenoses (Kučeravý, 1995), can migrate into wetlands (e.g. *Cochlicopa lubrica*). Abundance and dominance of these species depend on how the habitat is situated in biocoenose, its position within the gradient of soil moisture and the degree of anthropic changes. In the case of four study habitats is visible, that malacocoenoses of habitats differ, and these differences reflect various conditions of soil moisture. Due to this the majority of polyhygrophilous species appeared in the lowest situated habitat.

Very important factor in flood plain are periodical floods. Their destructive influence is the most visible in lower situated meadows. Due to this the density and number of species used to be very low, there.

Total density of molluscs in flood plain of river Morava, if compared with flood plain of river Danube, is practically seven times lower (48-56 ind.m^{-2}). This probably reflects two factors: long stagnation of water on the territory and very low ammount of carbonats in the soil. This is typical for the large part of the alluvium of river Morava in Slovakia.

Acari

According to the tolerance of mites to soil moisture some ecological groups of mites were established (Athias-Henriot, 1969), mainly in mesostigmatic mites. The occurrence of mites in habitats with various soil moisture were observed by Mašán (2001), Kalúz (1994, 1999) and Kalúz, Čarnogurský (2000). Total abundance of mites in study habitats did not show the influence of water in the soil. In one species only (*Eupodes sp.)* the decreasing of soil moisture reflected in decreasing of the average abundance of this mesohygrophilous species (Table 2). Despite of this, the frequency of this species was very high in all habitats. Three more wet habitats had not very different values of soil moisture. But in the soil of terrace the water content was substantially lower. In weakly chitinized prostigmatic mites (*Eupodes sp. Coccorhagidia clavifrons, Bakerdania quadrata)* the lowest values both of

abundance and frequency appeared in the driest soil of terrace. These mainly edaphic mites prefer mildly wet soil and their abundance is higher in the soil with soil moisture from 40% to 50 % of the volume of samples (Kalúz, Čarnogurský, 2000), in drier soils their abundance decreases. This fact can influence the peak of occurrence of mites during the season. The peak in flood plain appears in autumn, but the floods or higher ammount of water in the soil sometimes interrupt the development of mites. The correlations between the ammount of water in the soil and the abundance of *Eupodes sp.* in study habitats were low during the season. The majority of correlations were negative: *Caricetum* (3 of 6), *Phragmitetum* (4 of 6), *Arrhenarrheretum* (4 of 6) and terrace (5 of 6). In other mite species the corelations were not visible.

Araneae

Rich population of spiders involves two interesting eudominant species *Pardosa lugubris* and *Pirata hygrophilus.* While during the first year of the research both species prevailed, in the next year the second mentioned species was dominant, only. Considering the floods and the ammount of water in the soil, the year 2001 brought the increasing of underground water in whole locality. This phenomenon influenced mainly lower situated habitats *Caricetum, Phragmitetum* and *Arrhnarrhetum.* The increasing of dominance and abundance of activity of *Pardosa lugubris* in 2001 reflects more wet conditions in flooded meadow. This corresponds with the results of Krumpálová (2000) and Gajdoš (1994). According these authors this prevailing species inhabits flooded meadows and its dominance reflects the conditions in habitats.

Collembola

The structure of springtail community used to be influenced by conditions of soil moisture of biotops. Higher ammount of water in the soil has the importance for the life of euedaphic species (e.g within the genera *Protaphorura, Mesaphorura, Metaphorura*) and species sensitive to the drying of the soil (*Anurida ellipsoides*). Some species, able to inhabit various types of environment (*Parisotoma notabilis*, *Folsomia quadrioculata*, *Isotomiella minor*), are not influenced both by changing of moisture in the soil and temporary drying of habitat. Hemiedaphic *Isotomodes productus* belongs to the species, tolerant to changing soil moisture. This species occurred mainly in mildly wet conditions (Čarnogurský, 2000). The moisture was the lowest in the soil of the highest situated terrace. Besides omnipresent euryecious species in the soil of terrace, more epigeic species appeared there. These species are able to live in more dry biotopes (*Orchesella cincta*, *Lepidocyrtus cyaneus*). The same features can show atmobiont species (*Sminthurinus aureus*, *Sphaeridia pumilis*) utilizing some plants. To the end of the year (higher soil moisture) the species *Metaphorura affinis* and *Stenaphorurella quadrispina* were registered there, also.

Rusek (1984) states these the most typical species in flood plain meadows: *Isotomiella minor*, *Folsomia quadriocullata*, *Friesea truncata*, *Isotoma anglicana*, *Micranurida hygrophila*, *Sminthurinus aureus*. During the research in flood plain meadows of river Morava Čarnogurský (2000) found several dominant springtail species there: *Parisotoma notabilis*, *Isotomiella minor*, *Sphaeridia pumilis* and *Protaphorura armata*. The values of diversity indice were not very different within the whole locality Devínske jazero, the indices of equitability showed higher differences.

Springtail fauna in habitats with a different soil moisture includes mainly eurytopic species, common on the whole territory of Slovakia. A few rare and specialized species were registered, there. The most dominant species in whole study area Devínske jazero were *Schoettella ununguiculata*, *Parisotoma notabilis* and *Isotomiella minor*. The first one is common epigeic species, inhabiting forests and wet meadows (Čarnogurský, 2000). Euedaphic species *Protaphorura islandica* was found in December both in *Phragmitetum* and *Arrhenarrheretum*. This one is rare palearctic representative of springtails of wet habitats (Fjellberg, 1998).

Coleoptera (Carabidae)

Like as it was seen in the previous chapter, the total number of carabid species decreased from *Phragmitetum* to the highest situated terrace (51-42-40). Diversity index (Margalef) showed the same (14.3-11.8-8.8). On the base of species similarity (Sörensen) the habitats can be evaluated as follow: *Phragmitetum – Arrhenarrheretum* = 48%, *Phragmitetum*-Terrace = 40%, *Arrhenerrheretum* – Terrace = 48%. The lowest similarity appeared comparing habitats with the highest differences of soil moisture (Majzlan, Rychlík, 2000). On the contrary, study habitat *Arrhenerrheretum* shows the same species similarity as compared to *Arrhenarrheretum* and Terrace. This indicates, that *Arrhenarrheretum* serves as contact zone (habitat) among the populations of hygrophilous and semihygrophilous carabid beetles.

To characterize topic dependence of populations of carabids to the soil moisture, three categories were stated. These categories correspond to results in the paper of Hůrka (1996). The abundance of hygrophilous species decreases from *Phragmitetum* to Terrace, while the abundance of xerophilous species has the opposite tendence. Due to this phenomenon, the majority of semihygrophilous species is concentrated mainly in the third study habitat (*Arrhenarrheretum)* and Terrace. Periodically flooded *Arrhenarrheretum* is not so much influenced by underground water, but habitats 1 and 2 yes. Due to optimal conditions the socions of semihygrophilous carabids can origine in this habitat. Then, they can pervade more into habitat *Phragmitetum*, then to Terrace. In the case of permanently wet *Phragmitetum*, hygrophilous carabids used to inhabit this type of habitat more than semihygrophious species..

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Kalúz S., Čarnogurský J., Čejka T., Krumpálová Z., Majzlan O., Rychlik I.: **Fauna bezstavovocov v habitatoch s rozdielnou pôdnou vlhkosťou na lúkach inundácie rieky Moravy.**

V inundačnom území rieky Moravy sme v rokoch 2000-2002 sledovali faunu bezstavovcov ((Mollusca, Acari, Araneae, Collembola a Coleoptera-Carabidae) v štyroch rozdielnych lúčnych habitatoch. Uvedené živočíšne skupiny sme sledovali v podmienkach rôznej pôdnej vlhkosti. Pritom sme použili štandardné metódy terénneho výskumu. Počas výskumu sme sledovali základné pôdne charakteristiky (množstvo vody, pórovitosť, objem vzduchu a mernú hmotnosť pôdy v pôdnych vzorkách). V habitatoch s najvyššou vlhkosťou pôdy sme zistili najmenej druhov s najnižšou početnosťou a frekvenciou výskytu. V stredne vlhkom lúčnom habitatate sa vyskytovali najbohatšie spoločenstvá u väčšiny skupín sledovaných bezstavovcov. Tento habitat zahrňoval prevažne semihygrofilné druhy s najvyššou abundanciou, frekvenciou a najvyšším počtom druhov. Vertikálne najvyššie situovaný habitat bol obývaný prevažne druhmi, vyžadujúcimi stredne vlhké až suché pôdy. Početnosť a počet hygrofilných druhov sa znižovali s klesajúcim obsahom vody v pôde. Štruktúra spoločenstiev sa menila v rámci vlhkostného gradientu a v každom habitate sa vyskytovali charakteristické druhy.

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The journal takes into account above all papers dealing with theoretical, methodological, as well as actual problems of landscape protection and planning at the level of ecosystems or their configuration.

When investigating ecological aspects of the care that is being paid to living conditions the journal respects the true foundation of ecology taken as the science of mutual relations among organisms and their connections to environment. Therefore the journal does not take into consideration either the study of organisms themselves or of surroundings they live in, but emphasizes both functional and formal interrelations of matter and energy, which in their turn enable to investigate the dynamical processes as matter phenomena.

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- deterioration of ecosystems and their parts, bioindication of changes in landscape
- theoretical and methodological questions of landscape ecology with regard to their application in ecological optimum of landscape use.

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The original typed manuscript and one copy in English as well as one set of original figures and one copy of them should be submitted. The entire paper including abstract, text, references, and figure captions, must be typed double spaced on one side of the page only, with at least 3 cm left margin. The pages are to be numbered consecutively in the given order. The maximum length of an accepted paper is 25 pages including tables and figures.

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The structure depends on the kind of work. Papers referring to field work are as usual divided in the following way:

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