Gamasina communities (Acari, Parasitiformes) of arable soils with two different soil types

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Gamasina communities (Acari, Parasitiformes) of arable soils with two different soil types

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Summary. During 1991–1993 Gamasina communities were investigated in two agricultural areas in East Slovakia: the East-Slovak Lowland and the Košice Basin. The study was carried out in cultivated fields on two different soil types: albic luvisol and eutric fluvisol, which were each replicated at six sites and sampled at two-month intervals. Species richness of Gamasina varied between 11–26 species and significantly correlated with content of organic carbon in the soil. *Arctoseius cetratus*, *Alliphis siculus* and *Rhodacarellus silesiacus* were dominant species at sites. Abundance of assemblages was generally low, not having a significantly higher mean value on the eutric fluvisol (280 ind. m^{-2}) compared to the albic luvisol (230 ind. m^{-2}). The results from cluster and ordination analysis of quantitative data showed no effect of soil type, composition of Gamasina assemblages being more affected by geographical area or particular site. Populations of *Pachylaelaps pectinifer*, *Alliphis siculus* and Eugamasoidea nymphs correlated significantly with sandy mineral content in the soil.

Key words: Gamasina, agroecosystem, arable soil, soil type, Slovakia

Introduction

Agricultural systems are repeatedly affected by human practices. In contrast to natural systems, they are in general impoverished in soil fauna abundance and species diversity (Wallwork 1970). As with other microarthropod groups several species of predatory Gamasina may survive and reproduce in these conditions and may be assumed as typical in arable soils (Edwards & Lofty 1969; Karg 1983). The biology and ecology of mesostigmatic mites in agroecosystems have been reviewed by Koehler (1997).

In the present paper detailed analysis of Gamasina assemblages from East Slovakia from 1991–1993 is given. The main aims of the investigations were as follows:
– to obtain community data on Gamasina in agroecosystems of East Slovakia;
– to estimate the possible effects of soil type on Gamasina assemblages in arable fields.

Materials and Methods

The research sites were situated in two areas of East Slovakia: the East-Slovak Lowland (ESL) and the Košice Basin (KB). The climate of both areas is continental with mean annual temperature of + 9.0 °C (the monthly means range from –2.6 °C for January and +19.1 °C for July) with annual precipitation of 540–600 mm at ESL. In KB the mean annual temperature is + 8.4 °C (the monthly means range from –4.2 °C for January and + 19.0 °C for July) and annual precipitation is 600–850 mm.

Table 1. Location, crop rotation and edaphic characteristics of sampling sites (1991–1993)

Locality	Site	Grid references		Crop 1991/92/93	T_1 [%]	T_2 [%]	W [%]	pH_{H_2O}	C_{ox} [%]	N_t [%]	P_t mg·kg⁻¹
Parchovany	L1 (ESL)	21° 42'	48° 45'	WW/FB/BA	39.69	1.16	19.5	6.37	1.17	0.13	641
Egreš	L4 (ESL)	21° 36'	48° 37'	WW/PE/WW	39.86	1.38	20.8	5.70	1.22	0.15	742
Trhovište	L5 (ESL)	21° 50'	48° 42'	WW/WR/WW	36.01	2.01	17.2	6.55	1.07	0.08	718
Čičarovce	L6 (ESL)	22° 01'	48° 33'	WW/CL/MA	33.98	0.72	15.5	7.21	0.84	0.09	542
Janík	L7 (KB)	21° 00'	48° 32'	WW/MA/WW	55.45	14.14	16.5	7.01	1.11	0.09	310
Šebastovce	L8 (KB)	21° 15'	48° 41'	(WW/MA/BA	38.38	2.84	16.7	7.14	1.42	0.12	917
average					*40.56*	*3.71*	*17.7*	*6.66*	*1.14*	*0.11*	*645*
standard deviation					7.64	5.16	2.0	0.58	0.19	0.03	206
Hraň	F3 (ESL)	21° 47'	48° 34'	WW/PE/WW	33.27	0.94	21.1	7.90	1.20	0.11	638
Svätá Mária	F4 (ESL)	21° 51'	48° 26'	WW/BA/PE	52.00	0.64	22.0	5.47	1.77	0.19	1233
Trhovište	F5 (ESL)	21° 48'	48° 42'	WW/PE/WW	48.04	0.71	20.7	7.73	1.26	0.11	723
Čičarovce	F6 (ESL)	22° 00'	48° 33'	WW/CL/WW	71.08	0.23	26.2	6.08	2.21	0.25	791
Péder	F7 (KB)	20° 58'	48° 34'	WW/MA/WW	38.04	3.81	19.2	6.91	1.49	0.13	960
Válaliky	F8 (KB)	21° 16'	48° 41'	WW/MA/WW	47.94	16.05	19.8	7.45	1.98	0.16	871
average					*48.40*	*3.73*	*21.5*	*6.92*	*1.65*	*0.16*	*869*
standard deviation					13.14	6.17	2.5	0.97	0.40	0.06	211

L   – albic luvisol, F – eutric fluvisol
WW   – winter wheat, FB – fodder beet, PE – peas, WR – winter rape, CL – clover, MA – maize, BA – spring barley
T_1 – soil texture: clay particles (<0.01 mm)
T_2 – soil texture: sand particles (0.25–2.00 mm)
W   – average moisture of 0–5 cm soil layer in vegetation seasons (1991–1993)
pH_{H_2O} – soil acidity
C_{ox} – content of organic C
N_t – total N content
P_t – total P content

Table 2. Abundance (A) of Gamasina species at research sites (A_{av} – average abundance [ind m^{-2}], D – dominance [%])

Taxa	L1	L4	L5	L6	L7	L8	F3	F4	F5	F6	F7	F8	A_{av}	D
Alliphis siculus (OUDEMANS, 1905)	3	27	7	58	102	27	14	34	41	24	41	44	35.2	13.68
Amblyseius agrestis (KARG, 1960)	–	–	–	–	20	–	–	–	–	–	3	3	2.2	0.84
Amblyseius alpinus (SCHWEIZER, 1922)	–	3	–	14	–	–	–	7	–	–	7	–	2.3	0.91
Ameroseius corbiculus (SOWERBY, 1806)	–	3	–	3	–	3	–	–	–	–	3	–	0.5	0.19
Ameroseius plumigerus (OUDEMANS, 1930)	17	–	3	3	3	3	3	–	–	10	3	14	4.9	1.91
Antennoseius bacatosimilis (KARG, 1960)	–	–	–	3	–	–	–	–	–	–	–	–	0.3	0.09
Arctoseius cetratus (SELLNICK, 1940)	41	34	51	41	34	41	54	37	20	10	343	20	60.5	23.53
Arctoseius insularis (WILLMANN, 1952)	–	–	–	–	–	–	–	7	–	–	–	–	0.6	0.23
Arctoseius semiscissus (BERLESE, 1917)	3	–	–	–	3	–	–	–	–	–	–	–	0.5	0.19
Asca bicornis (CAN. & FANZ., 1887)	–	–	7	–	–	–	–	–	–	–	–	–	0.6	0.23
Ascoidea juv.	–	–	–	–	–	3	3	14	–	–	–	–	1.7	0.65
Cheiroseius borealis (BERLESE, 1904)	–	–	3	–	–	–	–	–	–	–	–	–	0.3	0.09
Dendrolaelaps rectus (KARG, 1962)	–	–	–	–	–	–	–	3	–	–	–	–	0.3	0.09
Dermanyssoidea juv.	–	–	–	14	–	44	3	7	7	3	–	27	8.8	3.40
Epicriopsis palustris (KARG, 1971)	–	–	–	–	–	–	3	–	–	–	–	3	0.3	0.09
Eugamasoidea juv.	17	41	20	27	30	34	27	37	14	20	17	75	29.9	11.64
Eugamasus berlesei (WILLMANN, 1935)	7	7	3	3	–	3	–	–	–	–	–	–	0.3	0.09
Eviphidoidea juv.	7	7	3	3	–	7	–	–	3	–	–	10	3.3	1.30
Gamasellus montanus (WILLMANN, 1936)	–	–	–	–	–	–	–	–	–	–	–	–	0.3	0.09
Gamasodes spiniger (TRAGARDH, 1910)	–	–	–	–	–	–	–	–	3	3	–	–	0.3	0.09
Geholaspis mandibularis (BERLESE, 1904)	–	–	–	–	–	–	–	–	–	–	–	3	0.3	0.09
Hirstionyssus sp.	3	–	–	–	–	3	–	–	3	–	–	–	0.3	0.09
Hyperlaelaps microti (EWING, 1933)	3	–	–	–	–	–	–	–	–	–	–	–	0.3	0.09
Hypoaspis aculeifer (CANESTRINI, 1883)	3	–	7	3	3	7	10	3	–	7	7	10	5.0	1.95
Hypoaspis astronomica (KOCH, 1839)	–	–	3	7	–	–	3	7	–	–	–	–	1.1	0.42
Hypoaspis cf. *aculeifer* (CANESTRINI, 1883)	–	–	–	–	–	3	7	17	–	3	–	–	3.1	1.20
Hypoaspis oblonga (HALBERT, 1915)	–	–	–	–	–	–	–	–	–	3	–	–	0.3	0.09
Hypoaspis pini (HIRSCHMANN, 1969)	–	–	–	–	–	–	–	–	3	–	–	–	0.3	0.09
Hypoaspis praesternalis (WILLMANN, 1949)	3	–	–	–	20	–	7	–	–	–	–	10	3.1	1.20
Hypoaspis similisetae (KARG, 1965)	–	–	–	–	17	–	–	–	–	–	–	10	2.8	1.07
Hypoaspis sp.	3	3	–	7	–	3	3	7	3	3	–	–	1.7	0.65
Leioseius bicolor (BERLESE, 1918)	–	–	–	–	–	–	–	3	–	–	–	–	0.3	0.09
Leptogamasus drassus (ATHIAS-HENRIOT, 1967)	–	–	–	–	–	–	–	–	–	–	–	–	0.3	0.09
Leptogamasus gimescus (ATHIAS-HENRIOT, 1967)	3	–	–	–	–	3	–	–	–	7	3	–	1.7	0.65
Leptogamasus leruthi (COOREMAN, 1951)	–	–	–	–	–	–	–	7	–	7	–	–	0.3	0.09
Leptogamasus lobatus (WILLMANN, 1951)	3	–	–	3	–	–	–	–	–	3	–	3	0.8	0.29
Leptogamasus obesus (HOLZMANN, 1969)	–	–	–	–	–	3	–	–	–	–	–	–	0.3	0.09
Leptogamasus pertelicrus (ATHIAS-HENRIOT, 1967)	–	–	–	–	–	–	–	3	–	–	–	–	0.3	0.09

Table 2. (continued)

| Taxa	L1	L4	L5	L6	L7	L8	F3	F4	F5	F6	F7	F8	A_m	D
Lysigamasus jugincola (ATHIAS-HENRIOT, 1967)	–	–	–	–	–	–	3	–	–	–	–	–	0.3	0.09
Lysigamasus misellus (BERLESE, 1904)	3	3	–	–	3	7	3	–	–	–	14	7	3.1	1.20
Lysigamasus rostriforceps (ATHIAS-HENRIOT, 1967)	–	–	–	–	3	3	–	3	–	–	–	–	0.8	0.29
Lysigamasus sp.	–	–	3	–	–	–	–	–	–	7	–	–	0.8	0.32
Lysigamasus vagabundus (KARG, 1968)	7	–	–	–	–	–	–	3	–	–	–	–	0.3	0.09
Macrocheles robustulus (BERLESE, 1904)	7	–	–	–	–	–	–	3	–	–	3	3	0.6	0.23
Olopachys suecicus (SELLNICK, 1950)	–	–	–	–	–	–	3	3	–	–	3	3	0.5	0.19
Pachylaelaps laeuchlii (SCHWEIZER, 1922)	–	–	–	–	–	–	3	3	–	–	3	3	0.8	0.29
Pachylaelaps nidicolens (KOROLEVA, 1977)	–	–	–	–	–	3	3	–	–	–	–	–	0.3	0.09
Pachylaelaps pectinifer (G. & R. CAN., 1882)	–	7	7	7	34	–	7	–	7	3	–	20	7.7	2.98
Pachylaelaps regularis (BERLESE, 1920)	3	–	–	7	–	–	–	–	–	10	–	14	2.8	1.10
Pachylaelaps tesselatus (BERLESE, 1920)	–	3	–	–	–	–	–	7	–	–	–	–	0.8	0.32
Pachyseius humeralis (BERLESE, 1910)	7	–	–	–	–	–	–	–	–	–	–	–	0.6	0.23
Paragarmania dendritica (BERLESE, 1918)	–	–	–	10	3	–	–	–	3	7	3	–	2.2	0.84
Parasitus beta (OUDEMANS & VOIGTS, 1904)	–	–	–	–	–	–	–	–	–	3	–	–	0.3	0.09
Parasitus hyalinus (WILLMANN, 1949)	–	–	–	–	–	3	–	–	–	3	–	3	0.5	0.19
Pergamasus cf.theseus (BERLESE, 1886)	–	–	3	–	–	10	–	–	–	–	–	24	2.0	0.78
Pergamasus crassipes (BERLESE, 1904)	–	–	3	27	–	–	–	24	–	10	3	7	7.0	2.72
Pergamasus humusorum (SCHWEIZER, 1961)	–	–	–	–	–	–	–	–	–	–	10	3	0.3	0.09
Pergamasus norvegicus (BERLESE, 1905)	–	3	–	–	7	–	–	–	3	3	–	–	1.6	0.62
Pergamasus quisquiliarum (G. & R. CAN, 1882)	3	3	–	–	–	7	–	–	–	–	–	–	1.1	0.42
Phytoseioidea juv.	17	10	7	7	14	–	24	3	–	3	–	10	7.9	3.08
Proctolaelaps pygmaeus (MÜLLER, 1860)	17	7	3	3	7	–	14	20	–	3	–	7	6.5	2.53
Proprioseiopsis sororculus (WAINSTEIN, 1960)	–	–	3	7	–	3	–	3	–	3	3	–	1.3	0.52
Punctodendrolaelaps sp.	3	3	10	–	7	7	3	3	3	–	–	10	4.3	1.69
Rhodacarellus apophyseus (KARG, 1971)	–	–	–	–	–	–	–	–	–	–	–	–	0.3	0.09
Rhodacarellus silesiacus (WILLMANN, 1935)	3	3	17	37	61	17	3	7	3	78	37	17	23.6	9.14
Rhodacarus haarlovi (SHCHERBAK, 1977)	–	–	–	–	3	–	–	–	–	–	3	–	0.3	0.09
Typhlodromus sp.	–	–	–	–	–	–	–	–	–	–	–	3	0.3	0.09
Veigaia cerva (KRAMER, 1876)	–	–	–	–	–	3	–	–	–	–	–	3	0.3	0.09
Veigaia exigua (BERLESE, 1917)	–	–	–	–	–	3	–	–	–	–	–	–	0.3	0.09
Veigaia nemorensis (C. L. KOCH, 1839)	–	–	–	–	7	3	7	3	10	7	3	3	2.8	0.97
Zercon alpestris (MIHELCIC, 1964)	–	–	–	–	–	–	–	3	–	–	–	–	0.3	0.09
Zercon fageticola (HALASKOVA, 1970)	–	3	–	–	–	–	–	3	–	–	–	–	0.5	0.19
Zercon schweizeri (SELLNICK, 1949)	–	–	–	–	–	–	–	3	–	–	–	–	0.3	0.09
Zercon spatulatus (KOCH, 1839)	–	–	–	–	–	–	–	3	–	–	–	–	0.3	0.09
Zercon tuberosus (WILLMANN, 1936)	–	–	–	–	–	–	–	3	–	–	–	–	0.3	0.09
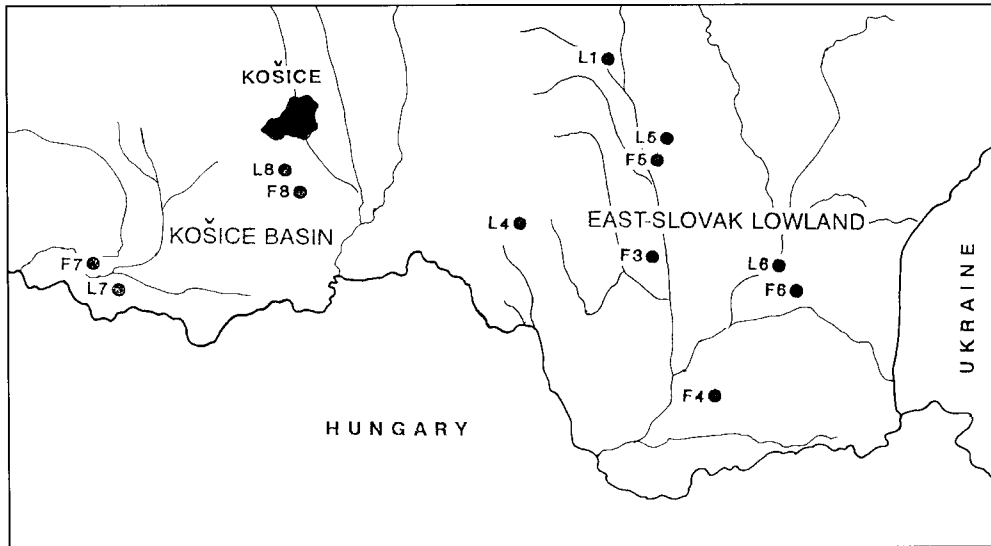
Fig. 1. Location of research sites

The investigations were performed on twelve research sites on arable soils with albic luvisol and eutric fluvisol being the most widespread at the study areas (Fig. 1). Characteristics of the research sites are given in Table 1. In this paper FAO classification of soil types is used (Němeček et al. 1990).

The soil samples were taken regularly at two month intervals from each site during January 1991 – December 1992. An additional sampling followed in May 1993. Eight replicate samples (soil cores) were collected randomly with a sampling device 6 cm in diameter and 10 cm deep from a 4 × 8 m² field site per date and locality. Berlese-Tullgren funnels were used for fauna extraction from samples over 10 days, where temperature above the samples gradually increased from +15 °C to +40 °C. Gamasina were identified into species after Karg (1993) and Ghilarov & Bregetova (1977) with a light microscope after clearing in modified Swann-Gemish medium or lactic acid.

Abundance (A), dominance (D), species richness (S), Shannon's diversity index (H′) and Pielou's index of evenness (J′) were calculated as community parameters (indices are based on the whole sample set of each site). Differences in environmental factors and synecological parameters were tested by t-test. Data sets on the species presence and abundance from each locality were log(n+1) transformed and performed by PC-ORD System package (Mc Cune 1987). Ward's method of hierarchic grouping and Euclidean distance for calculating the similarity matrix were used. Part of the transformed data on community composition and the environmental variables (edaphic factors) were processed by CCA ordination technique using the CANOCO program (Ter Braak 1988).

Results

Synecological characteristics

In material of Gamasina from all sites 22.6 % comprised juveniles, i.e. larvae and nymphs. In total, 70 species of Gamasina were registered (Table 2). *Arctoseius cetratus* (Sellnick, 1940), *Alliphis siculus* (Oudemans, 1905), *Rhodacarellus silesiacus* (Willman, 1935), *Pachylaelaps pectinifer* (G. & R. Canestrini, 1882), *Pergamasus crassipes* (Berlese, 1904) and *Proctolaelaps pygmaeus* (Müller, 1860) were dominant overall in whole samples. They contributed together 61.7 % of Gamasina dominance. According to habitat preference (Karg 1993) 37 species are ubiquitous, 18 species prefer open habitats and 15 of them prefer forest sites.

Average abundance of Gamasina at particular sites ranged between 120–500 ind. m^{-2} (Table 3). High community abundance at F7 was caused by high numbers of *A. cetratus*. Mean total abundance as well as standard deviation were higher on eutric fluvisol compared to those on albic luvisol (Table 3). However, differences of abundance were not significant. Species richness of Gamasina communities varied between 11 - 26 species per site, the average value being higher (although not significantly) at sites with eutric fluvisol. Diversity index and index of evenness were the highest at F4, F8, L8. Very low indices H' and J' at F7 were caused by high dominance of the *A. cetratus*. The mean Shannon's diversity was similar for both soil types, but on eutric fluvisol the standard deviation of this index was large (Table 3). The mean of evenness index was higher at sites with albic luvisol and, as with the other parameters, its standard deviation highest at sites with eutric fluvisol.

Differences in synecological parameters also appeared between the areas under investigation. At sites from KB average abundances were significantly higher compared to those from ESL (p < 0.05). However, higher mean structural indices were observed in ESL in comparison with KB: H' = 2.27 vs. 2.15 and J' = 0.81 vs. 0.74, but these differences were not statistically significant. Species richness was almost the same (Table 3).

Correlation analysis of abiotic factors and average abundance of dominant species at individual sites showed significant correlations. A positive correlation was found between sandy mineral content in the soil and the abundance of *P. pectinifer* (r = 0.84, p < 0.01), *A. siculus* (r = 0.62, p < 0.05) and Eugamasoidea nymphs (r = 0.66, p < 0.05). Abundance of *R. silesiacus* correlated significantly with clay mineral content (r = 0.64, p < 0.05). Abundance of *P. pectinifer* was negatively correlated with content of total phosphorus (r = –0.62, p < 0.05). Total Gamasina abundance did not correlate with any environmental factor. From other synecological parameters species richness correlated significantly with organic carbon content (r = 0.66, p < 0.05) and N$_t$ content (r = 0.58, p < 0.05). Soil humidity and pH$_{H_2O}$ had no influence upon Gamasina.

Table 3. Synecological characteristics of Gamasina of the research sites in 1991–1993

Site	A	S	H'	J'	Site	A	S	H'	J'
L1	170	17	2.31	0.82	F3	200	17	2.29	0.81
L4	160	13	2.12	0.83	F4	280	26	2.81	0.86
L5	160	14	2.09	0.79	F5	120	11	1.85	0.77
L6	290	17	2.32	0.82	F6	230	20	2.35	0.78
L7	360	16	2.12	0.77	F7	500	16	1.24	0.45
L8	240	18	2.42	0.84	F8	360	23	2.80	0.89
av.	*230*	*16*	*2.23*	*0.81*	*av.*	*280*	*19*	*2.22*	*0.76*
SD	83	2	0.14	0.03	SD	134	5	0.60	0.16

A – average abundance (ind. m^{-2})
S – species richness
H' – Shannon diversity index
J' – Pielou index of evenness
av. – average
SD – standard deviation

Multivariate analysis

The quantitative similarity of the Gamasina communities at sites in arable fields is shown in Fig. 2. Sites were divided into two main clusters. In cluster B two sites from KB were separated (L7 and F8). Cluster A may be divided into two sub-clusters. Sub-cluster A1 consists of 5 sites, all from ESL. Sub-cluster A2 contain 3 sites from ESL and 2 sites from KB. Here communities at L6 and F6 were the most similar.
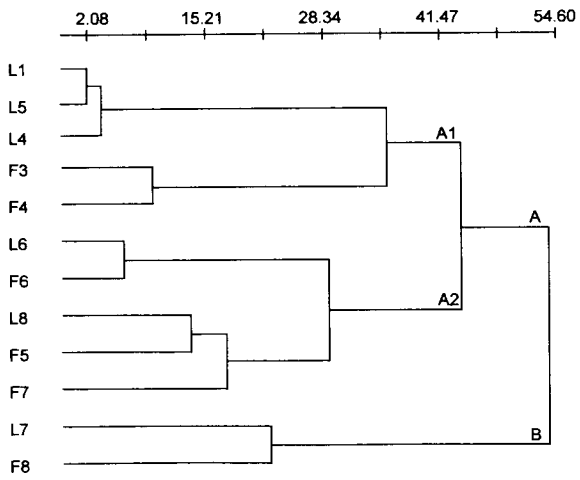
Fig. 2. Cluster analysis of quantitative community data at sites from 1991–1993 (Ward''s method, Euclidean distance)

Only data from May and June 1991 were processed by CCA ordination technique due to non-significance of ordination axes in the whole set of samples. Winter wheat was growing at all sites at that time and therefore the influence of the crop may be eliminated. Species that were present just in one sample were arbitrarily discarded from the analysis (18 from total number of 25 species). After this limitation, 3 sites fell out from the analysis: L5, F5 and F7. The scatter of samples (sites) and species may be divided into three distinct branches (Fig. 3).
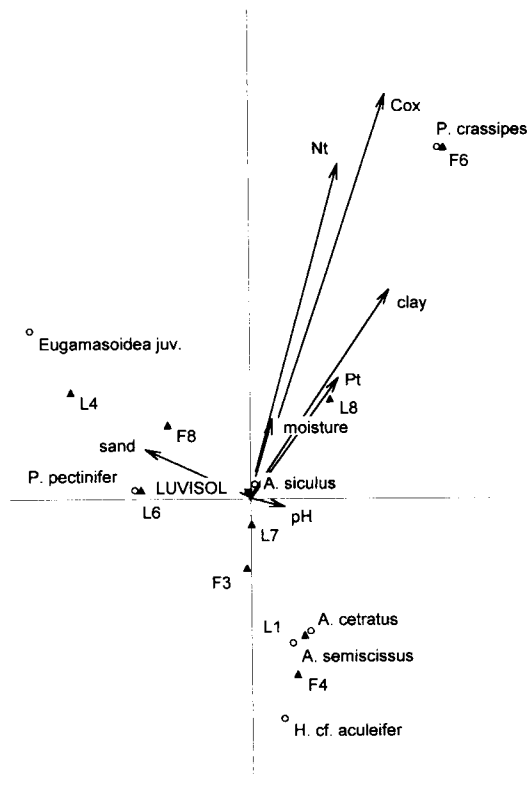
Fig. 3. Ordination diagram based on CCA, samples from May–June 1991 (quantitative environmental variables are represented by arrows, nominal variable reflected by its centroid (full square), eigenvalue of axis 1 = 0.65, axis 2 = 0.56)

Branch A is composed of the samples L4, L6 and F8 and the species *P. pectinifer* with Eugamasoidea nymphs that were mainly affected by content of sandy mineral particles in the soil. Here, *A. siculus* has been less affected, but in projection of the first and the third axes both sand content and the population of this species are orientated together in the direction of the third axis. In branch B samples F6 and L8 are distributed together with *P. crassipes* that were affected mainly by nutrient and clay mineral content in the soil and, to a lesser extent by soil moisture. Branch C consists of samples F4, L1 and F3 and the species *Hypoaspis* cf. *aculeifer, Arctoseius semiscissus* and *A. cetratus*.

Discussion

The species composition of Gamasina assemblages found in this study (Table 2) is similar to that reported from other studies in arable land (El Titi 1984; Lagerlöf & Andrén 1988; Glockemann & Larink 1989; Heisler 1989, 1993; Andrén et al. 1990) with *Arctoseius cetratus, Alliphis siculus* and *Rhodacarellus silesiacus* as dominant species. The same authors note species numbers of Gamasina at the studied sites or areas as ranging between 14 and 45. The total number of 70 recorded species in the present study is high and according to Luxton (1982) and Schaefer & Schauermann (1990) it resembles Gamasina communities of undisturbed sites. This number may be associated with the higher number of investigated sites/localities belonging to two different agricultural and geographical areas. The number of samples collected and duration of the study have to be taken into consideration too. It is worth mentioning here that Gamasina species richness was significantly correlated with carbon and nitrogen content in the soil. It shows the indirect effect of soil organic matter on predator community diversity.

Mean abundances of gamasine communities in agricultural soils of East Slovakia in 1991–1993 reached very low values. Other authors obtained abundances ten or more times higher in agricultural soils in comparison with our data (Lagerlöf & Andrén 1988; Glockemann & Larink 1989; Heisler 1989, 1993). A lower efficiency of the extraction technique used in this study is probably the most important reason. For example, Vannier (1970) gives for adult Parasitiformes an efficiency for high-gradient apparatus more than eight times higher compared with that of the standard Tullgren-type. The other important factor that might influence low abundances is that high temperature (+ 60°) required for good efficiency of the final stage of the Gamasina extraction (Koehler, pers. comm.) was not used in our case. Continental drier climatic conditions and soil degradation caused by intensive agriculture in the areas under study (ESL and KB) may also play a role in depressed abundance of Gamasina.

The sampling programme was designed in order to eliminate the effects of particular tillage practices at the sites and to concentrate on the effect of the soil type. Given soil type is characterised by its own origin and development where climate and bedrock play the most important role. As the result of special conditions during its formation, it has special pedological parameters. On the other hand, these parameters within a soil type in arable soils may vary, depending on many factors, such as intensity of cultivation and soil degradation. In the study this is well documented by the high standard deviation of edaphic factors at sites with eutric fluvisol especially (Table 1) and reflected by Gamasina community parameters (Table 3).

Ghilarov (1975) showed a proportional interrelationship between density of microarthropods and content of soil organic matter (estimated as humus in standard procedure) in a range of agricultural soils as a general rule. This was reported for Gamasina from soil fauna investigations in Swedish agricultural cropping systems (Andrén & Lagerlöf 1983). From these observations, it may be hypothesised, that Gamasina assemblages will be more affected by the status of organic matter in the soil than by the general soil type. However, a relationship between Gamasina abundance and organic matter content (estimated as C_{ox}) was not confirmed in the present study. The only correlation between soil nutrients and abundance was shown for *P. pectinifer*, populations of which significantly correlated with total phosphorus in

the soil. On the other hand, the effect of organic matter content upon Gamasina species diversity was clearly demonstrated by the present study.

There are no adequate comparative studies testing the effect of soil type on gamasid communities in cultivated fields. In field crops with different soil types in the Middle Wolga Lands, Alejnikova (1965) investigated Gamasida among other soil faunal groups. Abundance of this group was higher in chernozems, soils rich in humus, compared with poorer kastanozems and greyzems. The same may be expected for the subfamily Gamasina, though the author did not specify the proportion of the subfamily to overall Gamasida.

Soil types investigated in the present study differ in average values of pedological characteristics (Table 1), where content of clay soil particles, average humidity and soil nutrients were higher in eutric fluvisol. This fact was reflected in the higher abundance and species richness of communities at sites with eutric fluvisol and may be assumed as the principal effect of soil type on the fauna. However, the results from cluster and ordination analyses suggest that soil type is not a factor having a strong influence on the structure of Gamasina assemblages.

The interesting relationship between *P. pectinifer, A. siculus* and Eugamasoidea nymphs tested in correlation analysis was also shown in canonical correspondence analysis of the data from the period with winter wheat as a planted crop (May–July 1991). Thus, soil texture may also play an important role in Gamasina community composition.

Liss et al. (1986) stressed the importance of the species pool of potential colonists present in natural habitats in the surroundings of the fields for arthropod assemblage development. Such species pools were mentioned for Collembola in the same study (Ková & Miklisová 1997). They influenced markedly collembolan community structure at research sites and overshadowed the effect of soil type. In Gamasina the presence of the same pool of species is well documented just at sites L6 and F6, which belong to the same locality (see Fig. 1 and Table 1) that have very similar community composition (Fig. 2). Within the analysis of quantitative community data, sites from KB in cluster B are orientated close to the part of sub-cluster A2 where two other sites from KB are located. From this it may be assumed that, for community composition of Gamasina, geography of the area is important, too.

In comparison with data on Collembola from the same study (Ková & Miklisová 1997), Gamasina were less affected by edaphic parameters and studied soil types, with the exception of a positive correlation between soil nutrients and gamasine species richness. These results reflect the character of Gamasina assemblages as predators on higher trophic level where relationships between soil conditions/soil types and Gamasina community structure is more indirect compared with mainly fungivorous Collembola.

Acknowledgement

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