Investigations of Gamasina mites in natural and man-affected soils in Latvia (Acari: Mesostigmata)

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Abstract
A short overview is presented on Gamasina material collected in 22 natural and man-disturbed habitats in Latvia. Species diversity, average density and species dominance were investigated. Altogether 167 Gamasina species from 14 families were found. The highest number of species was found for field margins and the lowest for pine forests and arable lands affected by calciferous dust. The highest densities of mites were observed for arable lands, and the lowest for coastal meadows. There were no habitats, neither natural nor man-affected, with both a high number of species and high densities. Some specific habitats such as spruce forests polluted by pig slurry and arable lands polluted by calciferous dust had a low number of species and high densities. Generally, man-affected habitats had higher average abundances, whereas natural habitats had higher species diversity. 25 Gamasina species were registered as eudominants or dominants. The most common species was the ubiquitous *Veigaia nemorensis*. The dominant species differed among polluted habitat types, but were similar for non-polluted sites within a habitat type.

Key words: soil Gamasina mites, natural and human-affected habitats, species diversity, average abundance, species dominance.

Introduction
Soil-dwelling mites and among them Gamasina mites (Acari, Mesostigmata; fig. 1, 2) are widely distributed in soils, rich in species and have great ecological significance in the respective ecosystems (Coleman & Crossley 1996, Koehler 1997, Lebrun 1979, Walter & Proctor 2000). Mites are known to be good indicators of various changes in the soil (Edwards & Bohlen 1995, Hogervorst et al. 1993, Kaczmarek 2000, Karg 1968, Krivolutsky 1994).

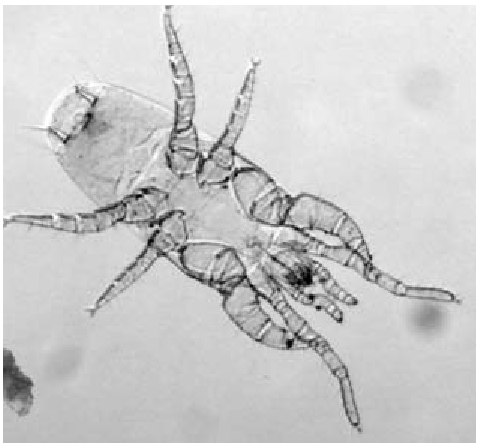

Figure 1
Dendrolaelaps nostricornutus (Rodacaridae).
Photo Ineta Salmane.

Since the middle of the last century studies have been conducted on predatory Gamasina in soils of Latvia (Eglitis 1954, 1972, Lapina 1976a, 1976b, 1988, Melecis et al. 1994, Paulina & Salmane 1999, Salmane 1996, 2000a, 2000b, 2000c, 2001, 2002, Salmane et al. 1999, Salmane & Heldt 2001) and on their response to different types of environmental pollution (Kachalova et al.1989, Karps et al. 1990, Lapina & Melecis 1985). Many species were found and published by Lapina (1988). During recent years, the author of the present paper has investigated mite communities of various habitats, and has found species new for the fauna of Latvia, especially in coastal meadows and seashore habitats.
A short overview is presented on soil Gamasina mites investigated in Latvia.

Discussion of results
Altogether 167 Gamasina species from 14 fami-

Table 1
List of Gamasina species found in the observed habitats.

Parasitidae
Parasitus kraepelini Berlese, 1903
P. fimetorum Berlese, 1903
P. numismaticus Vitzthum, 1930
P. lunaris Berlese, 1906
P. remberti (Oudemans, 1912)
P. celer (C. K. Koch, 1835)
P. loricatus (Wankel, 1861)
P. oudemansi Berlese, 1903
P. kempersi Oudemans, 1902
P. lunulatus (Muller, 1859)
P. halophilus (Sellnick, 1957)
P. brevicornis Berlese, 1903
Gamasodes spiniger (Trägardh, 1910)
Poecilochirus necrophori Vitzthum, 1930
Holoparasitus excipuliger (Berlese, 1905)
Pergamasus crassipes (Linnaeus, 1758)
P. septentrionalis (Oudemans, 1902)
P. vagabundus Karg, 1968
P. teutonicus Willmann, 1956
P. lapponicus Tragardh, 1910
P. wasmanni (Oudemans, 1902
P. suecicus (Trägardh, 1936)
P. quisquilarum (Canestrini, 1882)
P. mirabilis Willmann, 1951
P. robustus (Oudemans, 1902)
P. holzmanae Micherdzinsky, 1969
P. parrunciger Bhattacharyya, 1963
P. misellus Berlese, 1904

Veigaiaidae
Veigaia nemorensis (C.L. Koch, 1839)
V. cervus (Krämer, 1876)
V. exigua (Berlese, 1917)
V. kochi (Trägardh, 1901)
Gamasolaelaps excisus (C.L.Koch, 1879)

Ameroseiidae
Ameroseius corbicula (Sowerby, 1806)
A. insignis Bernhard, 1963
Epicriopsis horridus (Kramer, 1876)

Aceosejiidae
Aceoseius muricatus (C. L. Koch, 1839)
Neojordensia levis (Oudemans et Voigts, 1904)
Lasioseius youcefi Athias-Henriot, 1959
Cheiroseius borealis (Berlese, 1904)
C. necorniger (Oudemans, 1903)
C. viduus C. L. Koch, 1839
C. unguiculatus Berlese, 1887
C. serratus (Halbert, 1915)
Leioseius minusculus (Berlese, 1905)
L. montanulus Hirschmann, 1963
L. bicolor (Berlese, 1918)
L. insignis Hirschmann, 1963
L. halophilus (Willmann, 1949)
L. minutus (Halbert, 1915)
L. semiscissus (Berlese, 1892)
L. longispinosus Hirschmann, 1963
Platyseius italicus (Berlese, 1905)
Iphidozercon venustulus (Berlese, 1917)
Melichares juradeus Schweizer, 1949
Proctolaelaps pygmaeus (Müller, 1860)

Phytoseiidae
Amblyseius obtusus (C.L.Koch, 1839)
A. aurescens Athias-Henriot, 1961
A. zwoelferi (Dosse, 1957)
A. reductus Wainstein, 1962
A. rademacheri Dosse, 1958
A. bicaudus Wainstein, 1962
A. marinus (Willmann, 1952)
A. messor Wainstein, 1960
A. graminis Chant, 1956
A. meridionalis (Berlese, 1914)
A. agrestis (Karg, 1960)
A. andersoni (Chant, 1957)
A. bakeri (Garman, 1948)
A. herbarius Wainstein, 1960

Antennosejidae
Antennoseius borrusicus Sellnick, 1945
A. delicatus Berlese, 1916
A. bacatosimilis Karg, 1965

Rhodacaridae
Minirhodacarellus minimus (Karg, 1961)
Rhodacarellus silesiacus Willmann, 1936
Rhodacarus mandibularis Berlese, 1921
R. reconditus Athias-Henriot, 1961
R. haarlovi Shcherbak, 1977
Dendrolaelaps foveolatus (Leitner, 1949)
D. arenarius Karg, 1971
D. stammeri Hirschmann, 1960
D. cornutus (Krämer, 1886)
D. tenuipilus Hirschmann, 1960

D. latior (Leitner, 1949)
D. nostricornutus Hirschmann et Wisnewski, 1982
D. fallax (Leitner, 1949)
Dendrolaelaspis angulosus Willmann, 1936
Asca aphidioides (Linnaeus, 1758)
A. bicornis (Canestrini et Fazago, 1877)
Gamasellus montanus (Willmann, 1936)
Euryparasitus emarginatus (C. L. Koch, 1839)
Cyrtolaelaps minor Willmann, 1952
C. mucronatus G. et R. Canestrini, 1881
Halolaelaps balticus Willmann, 1954
H. incisus Hyatt, 1956
H. marinus (Brady, 1875)
H. communis Goetz, in Hirschmann, 1966

Macrochelidae

Macrocheles glaber (Muller, 1860)
M. montanus Willmann, 1951
M. submotus Falconer, 1924
M. decoloratus (C. L. Koch, 1839)
M. rotundiscutis Bregetova et Koroleva, 1960
M. merdarius (Berlese, 1889)
M. carinatus (C. L. Koch, 1839)
M. tardus (C. L. Koch, 1841)
Geholaspis mandibularis (Berlese, 1904)
G. longispinosus (Krämer, 1876)
Holostaspella subornata Bregetova et Koroleva, 1960
H. ornata (Berlese, 1904)

Pachylaelaptidae

Pachyseius humeralis Berlese, 1910
Pachylaelaps furcifer Oudemans, 1903
P. pectinifer (G.et R.Canestrini, 1882)
P. magnus Halbert, 1915
P. littoralis Halbert, 1915
P. sculptus Berlese, 1921
P. regularis Berlese, 1921
P. longisetis Halbert, 1915
P. fuscinuliger Berlese, 1921
P. siculus Berlese, 1892
P. karawaiewi Berlese, 1921

Laelaptidae

Eulaelaps stabularis (C. L. Koch, 1836)
Hypoaspis aculeifer (Canestrini, 1883)
H. praesternalis Willmann, 1949
H. vacua (Michael, 1891)
H. karawaiewi (Berlese, 1903)
H. incertus Bernhard, 1955
H. kargi Costa, 1968
H. angusticutatus Willmann, 1951
H. heyi Karg, 1962, var. latvicus
H. miles Berlese, 1881
H. rigensis Lapina, 1976
H. claviger (Berlese, 1883)
H. oblonga Halbert, 1915
H. lusisi Lapina, 1976
H. sclerotarsa Costa, 1968
H. similisetae Karg, 1965
H. austriacus (Sellnick, 1935)
Laelaspis markewitschi Pirianyk, 1959
L. astronomicus C. L. Koch, 1839
L. humerata (Berlese, 1904)
Ololaelaps placentula (Berlese, 1887)
O. sellnicki Bregetova et Koroleva, nom. n., 1964
O. veneta (Berlese, 1903)
Holotaspis montana (Berlese, 1904)
Haemolaelaps casalis (Berlese, 1887)
H. glasgowi (Ewing, 1925)

Haemogamasidae

Haemogamasus ambulans (Thorell, 1872)

Hirstionysidae

Hirstionyssus isabellinus Oudemans, 1913

Eviphidae

Alliphis siculus Oudemans, 1905
Eviphis ostrinus (C. L. Koch, 1836)
Iphidosoma fimetarium (Müller, 1859)
I. physogastris Karg, 1971
Thinoseius spinosus (Willmann, 1939)

Zerconidae

Prozercon kochi Sellnick, 1943
P. tragardhi (Halbert, 1923)
P. sellnicki Halaskova, 1963
P. sarakensis Willmann, 1939
Mixozercon sellnicki Schweizer, 1948
Zercon spatulatus Willmann, 1939
Z. zelawaiensis Sellnick, 1944
Z. forsslundi Sellnick, 1958
Z. carpathicus Sellnick, 1958
Z. jodathae Sellnick, 1944
Z. montanus Willmann, 1953
Z. fageticola Halaskova, 1970

lies were recorded in 22 natural and man-affected habitats of Latvia (table 1, 2). Parasitidae (28 species), Rhodacaridae (24) and Laelaptidae (21) were the most diverse families, Haemogamasidae and Hirstionyssidae were represented by only one species each.

The highest species diversity was found on margins of fields (90 species), followed by mixed forests and coastal meadows (fig. 3). The high species diversity in field margins is caused by the non-intensive agricultural practices and by plant litter (Lapina 1988). Coastal meadows consist of diverse habitats with a variation of microhabitats from xerophytic to flooded by sea (Eiduks 1982). Several authors have found that coastal meadow habitats support high species richness of microarthropods, among them Gamasina mites, due to the heterogeneity of environmental conditions (Paulina & Salmane 1996, 1999, Salmane et al. 1999, Salmane 2000a). High numbers of species in the mixed forests are related to the diverse environmental conditions: rich organic soils and abundant vegetation (Lapina 1988).

The highest average abundance was observed in arable lands and inland meadows polluted by pig slurry (fig. 3), which was three times and two times higher, respectively, than in the other habitats. The Gamasina mites found and described by Lapina (1988) in arable lands are diverse. The agricultural practices and fertilizers used seemed to be quite favourable to support a high number of species, as well as high densities. Environmental conditions caused by pollution of inland

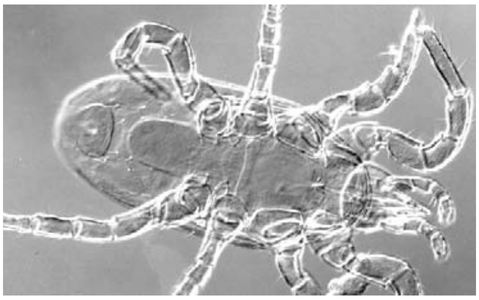

Figure 2
Hypoaspis sclerotarsa (Parasitidae). Photo Ineta Salmane.

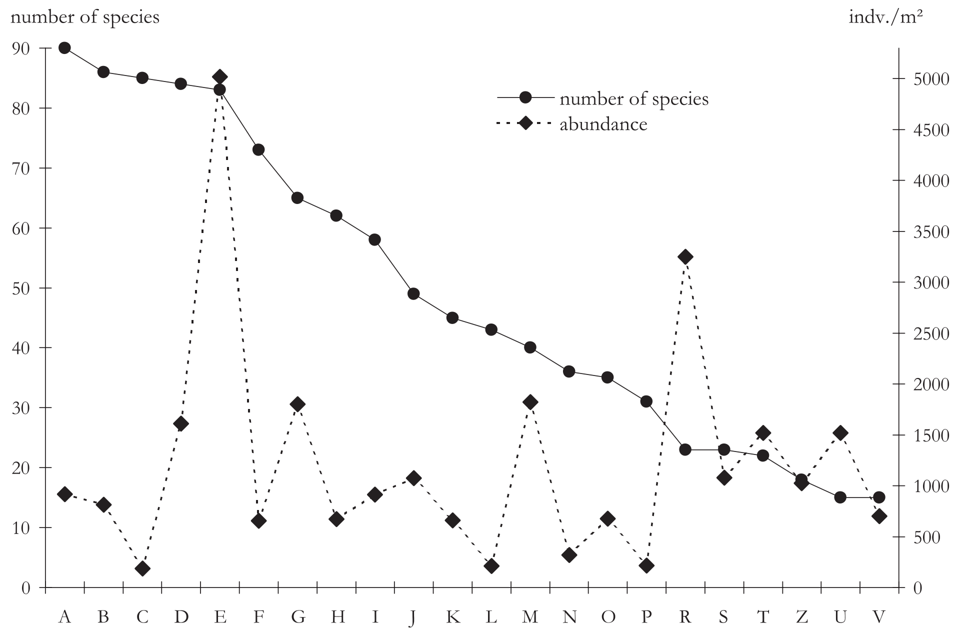

Figure 3
Species diversity and density of Gamasina mites in all observed habitats (abbreviations for habitats are given in table 2).

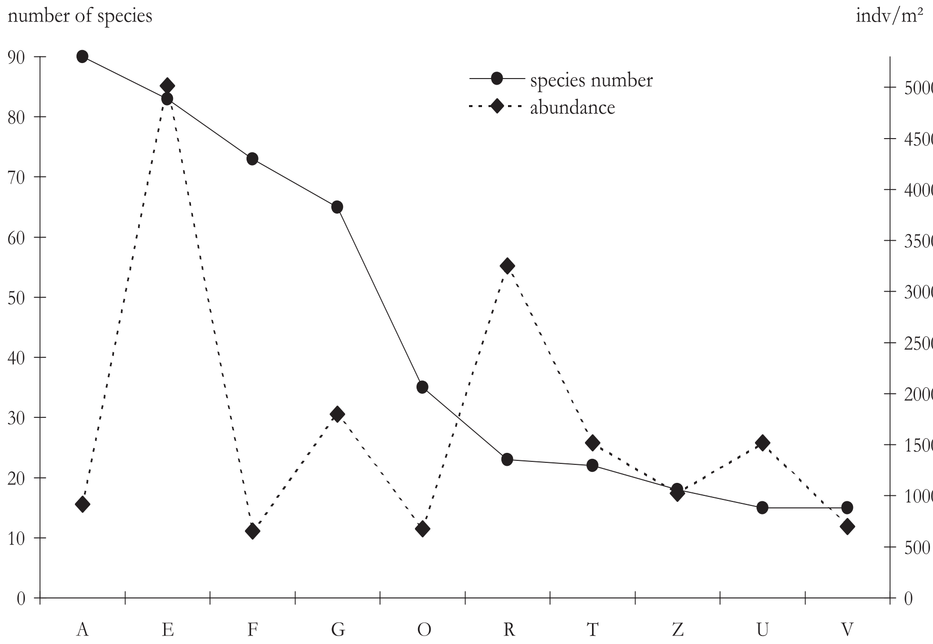

Figure 4
Species diversity and densities in the man-affected habitats (abbreviations for habitats are given in table 2).

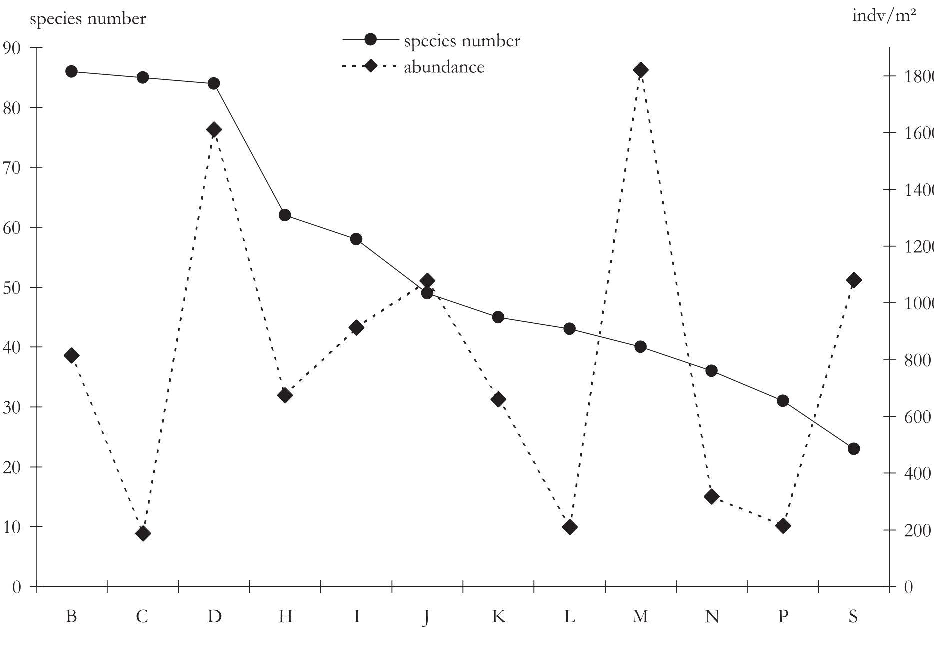

Figure 5
Species diversity and density in the natural habitats (abbreviations for habitats are given in table 2).

Table 2
Habitats investigated, number of Gamasina species (N) and average abundance (A) stated there.

Habitats	**Abbreviations to habitats used**	**N**	**A**
Edges of fields	A	90	918
Mixed forest	B	86	814
Coastal meadows	C	85	188
Piceetum oxalidosa	D	84	1612
Arable lands	E	83	5016
Inland meadows	F	73	654
Parks & Gardens	G	64	1763
Narrow-leaved forests	H	62	674
Pineetum vaccinosa	I	58	913
Broad-leaved forest	J	49	1077
Pineetum myrtilosa	K	45	660
White dunes	L	43	210
Bogs	M	40	1822
Grey dunes	N	36	318
Inland meadows polluted by calciferous dust	O	35	675
Primary dunes	P	31	214
Inland meadows polluted by pig slurry	R	23	3250
Driftline	S	23	1080
Piceetum oxalidosa polluted by pig slurry	T	22	1520
Reservoires with pig slurry	Z	18	1024
Arable lands polluted by calciferous dust	U	15	1520
Pine forest polluted by calciferous dust	V	15	700

meadows by pig slurry resulted in specific Gamasina species composition dominated by so-called ‘dung and compost’ species or ubiquists (Karps et al. 1990). Non-polluted inland meadows typically have high species diversity, but after release of large amounts of organic matter, favourable conditions remained only for some species-specialists, which became abundant. Spruce forests polluted by pig slurry were neither rich in species nor did they have high densities (Karps et al. 1990) (table 1).

Reservoirs with pig slurry are very specific habitats. In these habitats only 18 species were found and they were presented in high densities (fig. 3). Washed ashore (driftline) material was comprised by different jetsam deposited by sea and was usually rich in organic matter. 23 Gamasina species were found there in high abundance.

Among the studied habitats none had high values for both density and diversity (fig. 3), only arable lands showed the highest density and also relatively high number of species. It is known from literature (Schwerdtfeger 1975) that high species diversity usually is associated with low densities.

The lowest number of species was recorded for arable lands and pine forests polluted by calciferous dust (fig. 3). Non-polluted arable lands had the highest densities and also the highest number of species, but when polluted by calciferous dust, densities decreased by more than three times and diversity more than five times. Inland meadows polluted by calciferous dust had twice as many species as the other two habitats polluted by this source, while densities were low.

The impact of pollutants on soil Gamasina communities is obvious for habitats polluted by pig slurry and by calciferous dust (fig. 3, 4). Gamasina mites diversity is enhanced by non-intensive human activity, which does not cause a drastic change in environmental conditions, such as at field margins or inland meadows. Nevertheless, arable lands also had high species diversities and densities (Lapina 1988). Natural habitats mostly have a high microhabitat diversity, which leads to diverse soil Gamasina communities (fig. 5). When the diversity of natural habitats is disturbed by human activities, environmental conditions change and become favourable only for a few Gamasina species or species communities. Pollution by calciferous dust is harmful for gamasins, while the degree of impact is highly dependent on the respective habitat type. In the case of pollution by pig slurry, a high number of mites was observed being distributed by means of phoresy on different insects, especially on dung beetles (Coleoptera) coming to slurry (Karps et al. 1990). The species lists of those Gamasina mites were almost similar for all habitats. In the habitats polluted by pig slurry the total number of species was not high (table 2).

Among the forest types, mixed forests had the highest Gamasina densities and the highest number of species. Of the seashore habitats, the sand dunes were the most rich in species, but the highest densities were found in the washed ashore material. Coastal meadows and inland meadows had the highest species diversity.

In total 12 natural and ten man-affected habitats were investigated and compared (fig. 4, 5). The average species diversity was higher in natural habitats, but the average densities were about three times higher in affected habitats. Among natural habitats, the highest number of species was observed in mixed forests, spruce forests and coastal meadows; among affected habitats – field margins and arable lands (fig. 4, 5). Among the natural habitats, the highest densities were found in bogs and spruce forests; and in man-affected habitats - arable lands and inland meadows - polluted by pig slurry.

The dominance structure of Gamasina mites was

Table 3

Gamasina species found in the respective habitats as eudominants or dominants.

	Pineetum myrtilosa	*Piceetum oxalidosa*	*Pineetum vaccinosa*	Mixed forest	Broad-leaved forest	Parks & Gardens	Inland meadows	Inland meadows polluted by calciferous dust	Inland meadows polluted by pig slurry	*Piceetum oxalidosa* polluted by pig slurry	Narrow-leaved forest	Edges of the fields	Reservoirs with pig slurry	Arable lands	Arable lands polluted by calciferous dust	Bogs	Coastal meadows	Driftline	Primary dunes	White dunes	Grey dunes	Pine forest polluted by calciferous dust
Parasitus lunaris														●	●							
P. fimetorum													●									
Pergamasus vagabundus		●	●	●	●						●	●										
P. lapponicus											●											
P. robustus						●																
P. teutonicus							●															
P. suecicus												●										
P. misellus								●														
P. wasmanni																						●
P. teutonicus									●													
P. brevicornis										●												
Veigaia nemorensis	●	●	●	●	●	●	●	●	●	●												
Cheiroseius necorniger																		●				
Leioseius bicolor																			●			
L. halophilus																			●			
L. insignis																				●		
Minirhodacarellus minimus																				●		
Asca aphidioides	●		●													●						
Halolaelaps balticus																				●	●	
Macrocheles glaber													●									
Hypoaspis aculeifer																	●					●
H. vacua																					●	
Alliphis siculus														●								
Thinoseius spinosus																		●				
Prozercon kochi	●															●	●					
Zercon carpathicus																					●	

also studied (table 3). 25 Species were registered as eudominants or dominants. The most common species was the ubiquitous *Veigaia nemorensis*, which was dominant in ten habitats. The most widely represented family was Parasitidae with 11 species, the most common being the ubiquitous *Pergamasus vagabundus*. The dominant species differed among the affected habitat types, but not among polluted and non-polluted habitats of a particular habitat. In the reservoirs with pig slurry, the 'dung species' *Macrocheles glaber* and *Parasitus fimetorum* clearly dominated.
Although samples were taken in different seasons and years, and the size and number of samples was different, the general trends of Gamasina occurrence and diversity in the diverse habitats were still apparent.

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