PECULIARITIES OF THE EDAPHIC MESOFAUNA IN SOME CULTIVATED SOILS FROM THE CENTRAL MOLDAVIAN PLATEAU

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Abstract

The present study is a part of some ecological researches aiming investigation of the structure and functioning of the main ecosystem types from the Central Moldavian Plateau, being devoted to the agro-ecosystems that have a high share in the considered zone. Investigations on edaphic mesofauna evidenced increased weight of insects in most agro-ecosystems taken into study; among mites, gamasids or oribatids are the dominant group, or the abundance is similar between these two groups. Ratio between oribatid mites and collembolans, the major detritomicrophytophagous groups is clearly favorable to the latter, indicating the predominance of mineralization processes compared to those of humification. Analysis of ratio between the main trophic groups shows that in most cultures zoophages starkly dominate detritomicrophytophagous group, a situation rarely encountered in grassland or forest ecosystems.
Qualitative and cantitative study of oribatid mites (*Acari: Oribatida*), a representative group of edaphic mesofauna, showed that both the abundance and the number of taxa is lower in the analyzed crops compared to grassland soils in this zone. The oribatid communities are simple structured, with low specific diversity, that indicate a poor stability and reduced self-regulation capacity.
In this context four species have been recorded for the first time in Romanian fauna: *Ramusella (R.) sengbuschi* Hammer, 1968, *Rhinoppia tridentata* (Subias et Minguez, 1985), *Lauroppia fallax* (Paoli, 1908) and *Quadroppia (C.) monstruosa* Hammer, 1979.

Key words: soil microarthopods, agro-ecosystems, oribatid mites.

Sustainable management of soil resources is a global priority, as is assumed by the European countries in which research, policy and practice are involved alike. Soil biodiversity is one of the important topics in this context; many studies show the importance of edaphic organisms and indicator value of some groups, especially meso- and macrofauna groups (Huţu, M. *et al*., 1992, Jeffery S. *et al*. 2010).

Edaphic mesofauna represent an assemblage of living forms, diverse both from taxonomical and trophic points of view, that play an important role in bio-degradation processes of organic matter in terrestrial ecosystems, in energy and nutrient flows, contributing to the preservation of soils' fertility.

This study is placed within these current concerns and is dedicated to agro-ecosystems, which occupy large areas in the Central Moldavian Plateau and have not been investigated so far from an ecological perspective. The aim was to highlight structural features of edaphic mesofauna and of oribatid mites communities, as a representative group, depending on the crop type and stand conditions.

MATERIAL AND METHOD

Following the field observations and researches, 9 agro-ecosystems have been selected, situated on the territory of three localities, namely: 1. Ciorteşti, Iaşi county (46^{0}53'13" N, 27^{0}48'58" E); 2. Cănţălăreşti – Ştefan cel Mare, Vaslui county (46^{0}45'58" N, 27^{0}35'29" E); 3. Rebricea, Vaslui county (46^{0}53'15" N, 27^{0}35'51" E). Three annual cultures were taken into study, namely: wheat (abbreviated w in the faunistic synopsis), maize (m), sunflower (s), and in addition a fallow plot (f).

Series of 100 cm^2 soil samples have been taken over from each locality and culture type – 45 samples in all. Edaphic mesofauna has been extracted from samples through the Tullgren - Berlese method (the variant proposed by Balogh, 1958) and selected by systematic groups. The faunistic material has been submitted to microscopic study, in order to identify the taxa. In the case of oribatid mites, the abundance of each species was noted, on samples, cultures, and localities. The primary data thus obtained have been processed using some analytic and synthetic ecological estimators: average abundance of each species (ā) and global average abundance (Ā),

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expressed as individuals/100cm^2 and, respectively, m^2; number of species (S); frequency (C) and relative density (D.r.) of each species; index of ecological significance (W), expressed as classes: V and IV-edifying species, III-influential species, II and I-accompanying species; specific diversity (H(s)max, H(s), H.r.), estimated by the Shannon - Wienner equation; the adults/immatures ratio.

The faunistic synopsis of oribatid mites includes the list of recorded taxa, autecological peculiarities (according to Subias L. S., Arillo A., 2001; Vasiliu et al., 1993; Weigmann G., 2006) and world distribution of each species (Subias L. S., 2004, updated version 2013); also, for each species is indicated the presence in one or another of the investigated agro-ecosystems, as well as ecological significance, as follows: +++ edifying species, ++ influential species, + accompanying species; * indicates first record in Romanian fauna.

RESULTS AND DISCUSSIONS

In the investigated agro-ecosystems average density of edaphic microarthropods varies between 2,920 and 25,480 individuals/m^2 (*tab. 1*). The highest densities were found in wheat crops followed by maize crops, and then sunflower. Thus, the highly populated is wheat crop from Rebricea, with 2.6 times higher density than that of Ciorteşti and 3.2 times higher than in the wheat crop from Cănţălăreşti. Also, a high density of the edaphic microarthropods similar to that of wheat from Rebricea was calculated for fallow land at Ciorteşti. Comparing with a series of annual crops, investigated in 2005 and 2007 from the same geographical area, we note that the density of soil microarthropods from Rebricea wheat crop is 1.6 to 75 times higher (Călugăr A., 2007).

From qualitative point of view is observed numerical dominance of insects, compared with mites, in percentages ranging from 53% to 88% of the total effectives of mesofauna (*tab. 1*). Exceptions are the crops from Cănţălăreşti where mites are dominant, representing about 58% in maize crop and 80% in wheat. Among insects, the highest weight in all analyzed cultures is that of the order *Collembola*. Data from the above mentioned study indicate that in annual crops mites were the dominant group (Călugăr A., 2007), so the bio-edaphic conditions are different in the considered agro-ecosystems.

Table 1

Average density of the edaphic microarthropods from the analyzed agroecosystems

Type of culture/ locality Taxa	wheat			maize			sunflower		fallow field
	1	2	3	1	2	3	1	3	1
Gamasida	2020	1880	1940	560	720	360	560	1000	1600
Oribatida	340	3940	4000	400	700	680	-	1660	420
Actinedida	620	400	40	120	420	40	140	200	900
Acaridida	120	60	220	40	-	-	160	200	-
Total Acari	3100	6280	6200	1120	1840	1080	860	3060	2920
Collembola	6240	1380	19160	1200	1100	2280	2500	3160	20760
Other insects	260	100	100	220	140	140	160	240	580
Total Insecta	6500	1480	19260	1420	1240	2420	2660	3400	21340
Other groups	20	60	20	380	120	-	340	-	20
T O T A L	9620	7820	25480	2920	3200	3500	3860	6460	24280
O/C	0,05	2,86	0,21	0,33	0,64	0,29	0	0,52	0,02

Legend: the values represent the average of the abundance in individuals/m^2; O/C – ratio between: O – oribatid mites, C – collembolans; 1, 2, 3 – localities, as mentioned in § Material and method.

After Crossley et al., 1982 in agricultural ecosystems the populations of oribatid mites declined, while those of predatory mites, such as gamasids can be favored by the conversion to field cultivation. As regards the two mentioned groups of mites, the present study shows few distinct situations. Thus, in the crops from Ciorteşti was remarked that gamasid mites prevail (up to 65% of total mites) while the oribatid mites are less abundant (0-36% of the total mites) (*tab. 1*). A different situation was found in the crops from Rebricea and in the wheat crop from Cănţălăreşti with prevalence of oribatid mites (54% in sunflower and 60% in the rest of the crops). The third situation is that of the maize culture of Cănţălăreşti where the two groups of mites had almost similar representation. In the fallow land was observed the same unusual situation, represented by the predominance of gamasid mites compared with oribatids. So, here gamasid mites are 3.8 times more numerous than oribatids (*tab. 1*).

In the crops from Ciorteşti actinedids, another group of mites with predominantly zoophagous trophic regime (Krantz G. W., Walter D. E. 2009) outnumber oribatids, being about 1.8-3.3 times higher than the last ones (*tab. 1*). In the rest of studied agro-ecosystems the oribatids outnumber actinedid mites, as in the wheat crop from Rebricea where the first group is 100 times more numerous. Frequently, in meadow ecosystems the actinedids prevail within mites fauna (Călugăr A., 2005, 2006, 2007).

Acaridid mites, with preference for soils in which the anaerobic processes prevail were found in small percentages, from 0.95 to 6.5%, or even are missing, which indicates actually good soil aeration (*tab. 1*).

The value of the ratio between oribatids and collembolans - the main detritomicrophagous groups – was generally sub unit with one exception, the wheat crop in Cănţălăreşti, where oribatids found favourable conditions for development, representing 63% of the mites effectives (*tab. 1*)..

Large effectives were reported for collembolans, certainly due to the sufficient soil moisture in the sampling period. Existing literature data indicate this ratio as a good bioindicator for the quality and stage of humification of an organic substrate (Huţu et al., 1992). So, based on the results of this study we can conclude that in the analyzed crops mineralization process is dominant, with the exception above mentioned, where humification prevail.

As already mentioned, in agro-ecosystems under analysis oribatids represent between 0 and 64.5% of the total mites effectives, so have no numerical weight so important, as occurs in natural ecosystems and especially in forests. However, oribatid mites constitute a key group in the decomposers' subsystem because of species diversity and their bio-indicator value.

Detailed study of mites belonging to suborder *Oribatida* Dugès, 1834 resulted in identification of 25 species, 19 genera and 12 families, listed below in the Faunistic synopsis.

Faunistic synopsis of the oribatid mites

Fam. *Haplochthoniidae* Hammen, 1959

<u>*Haplochthonius (Haplochthonius)*</u> Willmann, 1930

-*H. (H.) simplex* (Willmann, 1930): 3-w (+); semi-cosmopolitan

Fam. *Epilohmanniidae* Oudemans, 1923

<u>*Epilohmannia*</u> Berlese, 1910

-*E. cylindrica* (Berlese, 1904): 3-m (+); euedaphic, grassland species; cosmopolitan

Fam. *Euphthiracaridae* Jacot, 1930

<u>*Acrotritia*</u> Jacot, 1923

-*A. ardua* (Koch, 1841): 1-w (+), 2-w (++), 3-w (++), 3-s (+); (mainly) silvicolous, eurytopic, mesophilous; cosmopolitan

Fam. *Tectocepheidae* Grandjean, 1954

<u>*Tectocepheus*</u> Berlese, 1896

-*T. velatus* (Michael, 1880): 1-w (+++), 1-f (+++), 2-w (++), 3-w (+), 3-s (+); euryplastic; cosmopolitan

Fam. *Oppiidae* Sellnick, 1937

<u>*Anomaloppia*</u> Subias, 1978

-*A. differens* Mahunka et Topercer, 1983: 2-w (++), 2-m (+), 3-w (+++), 3-m (++), 3-s (+++); eurytopic, mesophilous; Central, S Europe

<u>*Graptoppia (Graptoppia)*</u> Balogh, 1983

- *G. (G.) neonominata* Subias, 2004 [= *G. (G.) parva* (Kok, 1967)]: 2-w (+++); xerophilous, euedaphic; S Africa, S Europe

<u>*Ramusella (Ramusella)*</u> Hammer, 1962

-*R. (R.) sengbuschi* Hammer, 1968*: 2-w (+++); recorded frequently in cultivated soils, fallow fields, contaminated soils; pantropical, subtropical

<u>*Ramusella (Insculptoppia)*</u> Subias, 1980

-*R. (I.) insculpta* (Paoli, 1908): 1-f (+++), 2-w (+++), 2-m (++), 3-w (+++), 3-m (++), 3-s (+++); euryplastic; Palaearctic (except N)

<u>*Rhinoppia*</u> Balogh, 1983

-*R. tridentata* (Subias et Minguez, 1985)*: 2-w (+); prefers moist soils rich in organic matter, but it was recorded, also, in drier habitats; Spain

-*Rhinoppia* sp. 3-m (+)

<u>*Dissorhina*</u> Hull, 1916

-*D. ornata* (Oudemans, 1900): 2-m (+), 3-s (+); eurytopic, prefers forest soils; Holarctic, Seychelles Islands

<u>*Lauroppia*</u> Subias et Minguez, 1986

-*L. fallax* (Paoli, 1908)*: 3-m (++); recorded in various habitats, including cultivated soils, urban parks; semi-cosmopolitan

<u>*Oppiella (Oppiella)*</u> Jacot, 1937

-*O. (O.) nova* (Oudemans, 1902): 1-f (+), 2-w (+), 3-w (+), 3-s (+++); euryplastic; cosmopolitan

Fam. *Quadroppiidae* Balogh, 1983

<u>*Quadroppia (Coronoquadroppia)*</u> Ohkubo, 1995

-*Q. (C.) monstruosa* Hammer, 1979*: 3-w (+); species with wide ecological valence, tolerates moisture variations; recorded in various habitats, including industrial soils; Holarctic, Java

Fam. *Suctobelbidae* Jacot, 1938

<u>*Suctobelbella (Suctobelbella)*</u> Jacot, 1937

-*S. (S.) subcornigera* (Forsslund, 1941): 2-w (+); euryplastic; semi-cosmopolitan

Fam. *Oribatellidae* Jacot, 1925

<u>*Oribatella (Oribatella)*</u> Banks, 1895

-*Oribatella (O.)* sp.: 3-s (+)

Fam. *Ceratozetidae* Jacot, 1925

Ceratozetes (Ceratozetes) Berlese, 1908

-*C. (C.) conjunctus* Mihelčič, 1956: 3-m (++); meso-xerophilous; Mediterranean

Zetomimus (Protozetomimus) Perez – Iñigo, 1990

-*Z. (P.) acutirostris* (Mihelčič, 1957): 1-w (++), 1-m (+++), 1-f (+), 2-m (++), 3-s (+++); grassland species; S Europe

Fam. *Oribatulidae* Thor, 1929

Oribatula (Oribatula) Berlese, 1896

-*O. (O.) pannonica* Willmann, 1949: 2-w (+++), 2-m (+++), 3-w (+++), 3-m (+++), 3-s (+++); grassland species; Palaearctic

Oribatula (Zygoribatula) Berlese, 1916

-*O. (Z.) connexa* Berlese, 1904: 1-m (+++); eurytopic, recorded in cultivated soils; subtropical

-*O. (Z.) propinqua* (Oudemans, 1902): 1-m (++); xerophilous, arboricolous; Palaearctic

Fam. *Scheloribatidae* Grandjean, 1933

Scheloribates (Scheloribates) Berlese, 1908

-*S. (S.) barbatulus* Mihelčič, 1956: 1-f (++); thermo-xerophilous; S Palaearctic

-*S. (S.) fimbriatus* Thor, 1930: 2-w (+++), 2-m (+); recorded in meadows, in cultivated soils; cosmopolitan.

-*S. (S.) labyrinthicus* Jeleva, 1962: 2-w (+), 2-m (++), 3-w (+), 3-m (++), 3-s (++); eurytopic, grassland species; S and S-E Europe

Fam. *Protoribatidae* J. et P. Balogh, 1984

Protoribates (Protoribates) Berlese, 1908

-*P. (P.) capucinus* Berlese, 1908: 1-f (+), 2-w (++), 2-m (+++), 3-m (++); eurytopic, mesophilous; cosmopolitan.

The number of recorded taxa is considerably lower comparatively with grassland ecosystems in the same zone (Ivan O., 2005, 2010), but comparable with other cultivated soils (Ivan O., 2008). On the whole fauna, primitive oribatids represent 12%, superior, picnonotic ones – 48%, and poronotic oribatids – 40%. The high proportion of the picnonotic oribatids, and also the reduced representation of the primitive ones, which are less able to populate habitats with ample variations of the environmental factors, should be noticed. However, considering the number of individuals, the poronotic oribatids are well represented in most the analysed agro-ecosystems, this fact being characteristic for grassland communities. Few families, *Oppiidae*, *Scheloribatidae*, and *Oribatulidae* are better represented in the taxonomic spectrum, the first one comprising 32% of the total number of species. Furthermore, certain oppiid species have a high ecological significance in most of the investigated agro-ecosystems (Faunistic synopsis, *tab. 2*).

Zoogeographical analysis of the oribatid fauna shows that cosmopolitan and semi-cosmopolitan elements are the most numerous (48% of the total number of species), followed by the European (20%), Palaearctic (16%), and Holarctic species (8%). The species with southern areal represent about 40% of the total number, their weight being higher compared to the grasslands in this region (Ivan O., 2010).

As regards the ecological spectrum, the euryplastic elements represent the most numerous group (over 1/3 of the total number of species), followed by the grassland species, while sylvicolous ones are less represented. Noteworthy is the fact that most species have been previously recorded in cultivated soils, so the fauna is well adapted to specific conditions in agro-ecosystems (less requirements, reproductive rate, demographic strategies) (Ivan, 2008; Mahunka S., Topercer E., 1983; Subias L. S., Arillo A., 2001; Weigmann G., 2006).

In this context four species have been recorded for the first time in Romanian fauna: *Ramusella (R.) sengbuschi* Hammer, 1968, *Rhinoppia tridentata* (Subias et Minguez, 1985), *Lauroppia fallax* (Paoli, 1908) and *Quadroppia (C.) monstruosa* Hammer, 1979 (Vasiliu et al., 1993).

Analysis of global structural parameters of oribatid communities reveals large variations in global average abundance, especially depending on stand conditions and less on crop type (*tab. 2*). Thus, in all cultures analyzed at Ciortesti, density of oribatid mites was very low compared to the other stands. The number of species varies in the same direction as the global abundance, but not proportionally. Immature stages are generally underrepresented, so the ratio adults / immature is high, so populations stability is not ensured. Specific diversity has generally low values (compared to natural ecosystems), which shows a simpler structure of oribatid communities, their instability and reduced self-regulation capacity.

Regarding the species distribution, it can be observed that some species occur in the soil of most of the analyzed crops, often with high abundance and / or frequency, as *Ramusella (I.) insculpta, Anomaloppia differens, Oribatula pannonica, Tectocepheus velatus, Zetomimus (P.) acutirostris.* Other species have a high ecological significance only in some of agroecosystems: *Oppiella nova, Protoribates capucinus, Oribatula (Z.) connexa, Scheloribates fimbriatus, S. labyrinthicus* (Faunistic synopsis, *tab. 2*).

Table 2

Structural global parameters of the oribatid communities

Type of culture/ locality		Ā		S	Adults/ immatures	Specific diversity			Edifying species
		total	adults			H(s)max	H(s)	H. r.	
wheat	1	340	340	3	-	1.5849	0.8338	52.61	*Tectocepheus velatus*
	2	3940	3840	14	38.4	3.8073	2.9771	78.19	*Oribatula pannonica, Scheloribates fimbriatus, Ramusella (R.) sengbuschi, Ramusella (I.) insculpta, Graptoppia neonominata*
	3	4000	3760	9	15.7	3.1699	2.033	64.13	*Ramusella (I.) insculpta, Oribatula pannonica, Anomaloppia differens*
maize	1	400	200	3	1	1.5849	1.361	85.87	*Zetomimus (P.) acutirostris, Oribatula (Z.) connexa*
	2	700	560	8	4	2.9999	2.2728	75.76	*Oribatula pannonica, Protoribates capucinus*
	3	680	640	9	16	3.1699	2.6754	84.4	*Oribatula pannonica*
sunflower	1	0	0	0	-	-	-	-	-
	3	1660	1420	10	5.9	3.3219	2.6741	80.5	*Oppiella nova, Oribatula pannonica, Ramusella (I.) insculpta, Anomaloppia differens, Zetomimus (P.) acutirostris*
fallow field	1	420	400	6	20	2.5849	2.1629	83.67	*Tectocepheus velatus, Ramusella (I.) insculpta*

Legend: Ā - global average abundance, individuals/m^2; S - number of species; H(s)max - maximal specific diversity; H(s) - real specific diversity; H.r. – relative diversity (%);1, 2, 3 – localities, as mentioned in § Material and method.

In most cultures under investigation the number of species is reduced and distribution of effectives on species is uneven, leading to low levels of specific diversity and the tendency toward structural entropy in some agro-ecosystems (at Ciortesti, for example).

CONCLUSIONS

Within edaphic mesofauna of the investigated agro-ecosystems insects are dominant compared with mites; among mites either gamasids or oribatids hold the majority, independently by the crop type.

Agricultural specific works prints a certain physiognomy to the edaphic microarthropods communities, but more important seems to be specific conditions of each stand (soil type, slope, exposition etc.).

The ratio of Oribatida/Collembola is generally subunit, therefore mineralization processes prevail in soil of the analyzed cultures, compared to humification ones.

In the soil of agro-ecosystems the oribatid fauna comprises a limited number of species, compared with the natural ecosystems; among them, few species with low exigencies have high values of the ecological significance index in most of stands, irrespective of type of culture.

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