AN AGROECOLOGICAL APPROACH FOR DANUBE DELTA BIOSPHERE RESERVE: STRUCTURE OF EDAPHIC MESOFAUNA COMMUNITY IN AGRICULTURAL CROPS AND THE SURROUNDINGS NATURAL ECOSYSTEMS

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Abstract

As part of a larger research developed within the Core Program and dedicated to the natural and anthropogenic ecosystems of the Danube Delta Biosphere Reserve, this study aims to investigate the edaphic mesofauna in several agricultural ecosystems and in the meadows of their vicinity. In both natural and anthropogenic ecosystems, edaphic mesofauna in interrelation with soil microorganisms actively participates in the processes of degradation of vegetal necromass. The comparative analysis of edaphic microarthropod communities indicates that agroecosystems do not provide favorable conditions for their development, with the densities being the smallest, while higher values have been noted in meadows, especially in non-grazed ones. In both agroecosystems and meadows, the mites dominate the rest of the microarthropods. Among the mites, the predominance of thrombidiforms is observed both in meadows (42% and 54% respectively) and in most agricultural crops (38-89%). In non-grazed meadows and in some agricultural crops, oribatids are predominant (39% - 66%). Among thrombidiforms, tydeid - mites with a diversified trophic regime - are common to crops and meadows. They were found in most of the samples from investigated agroecosystems and also in meadows, but with great representation only in the last category.
The ratio of the main detritomicrofitophagous groups (oribatids / collembolans), a good bioindicator of the quality and humification stage of an organic substrate, was superior in most of the examined plots being subunit in only 23% of cultures and in a pasture. On the basis of all these findings it can be appreciated that humification is predominant, and the nutrient cycle is slower in almost all the considered plots. The study also reveals that the influence of agroecosystems on neighboring natural ecosystems at the level of edaphic mesofauna communities has not been confirmed.

Key words: soil, microarthropods, agroecosystems, meadows

In Europe Danube Delta Biosphere Reserve represents an important centre for biodiversity and a natural genetic bank with a great value for global natural heritage. Some of the natural resources especially grasslands, are sometimes over-exploited as a consequence of the human activities which are not in harmony with the environment.

An old occupation of the local population within the DDBR is agriculture. The traditional agriculture, developed on a few hectares plot generally concerned monoculture; sanitary treatments and culture rotation are not usually used, results being generally weak, covering only the family needs. On the other hand, currently, on an area of about 35,000 ha intensive agriculture is practiced and chemical fertilizers and plant protection treatments are used, facts that have a significant negative impact on the delta ecosystems and could radically alter them.

Totally, on the territory of the DDBR, the agricultural lands represent 12.9%, the largest share being arable land (63%), followed by natural meadows (36.7%). Vines and orchards occupy insignificant areas on the private lands of the inhabitants. The largest areas of arable land are cultivated with wheat, corn, sunflower, rape, fodder crops.

This study is dedicated to the knowledge of the structural features of the edaphic microarthropods from agro-ecosystems and surrounding meadows from the DDBR territory in order to establish a linkage between soil usage, stand conditions and anthropogenic pressure.

MATERIAL AND METHOD

The research was conducted in a series of crops and grasslands, as follows: Beștepe (corn, sun flower, rape, meadow), Murighiol (barley, sun flower, alfalfa, meadow), Plopu (wheat, meadow),

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Sarinasuf (alfalfa, sun flower, meadow, wheat), Sarichioi (green peas). Samples were taken in 2017 and 2018, as in table1.

For each of these stations it has been proceeded at a serial prelevation of the soil samples, each sample with a surface of 100 cm^2 - 85 samples in all.

Extraction of the microarthropods from the eighty-five samples was made by Tullgren – Berlese method, in the Balogh manner. The assessment of the biodiversity of the edaphic microarthropods is done by inventory and analyse the mites of the Parasitiformes (Mesostigmata order) and the Acariformes (orders Trombidiformes and Sarcoptiformes - Oribatida subdivision and Astigmatina cohort), an order belonging to the class Entognatha (Collembola) and insects as a whole and other edaphic microarthropods. Then, for the faunistic material subjected to microscopic study, the abundance of each group was recorded sample by sample and the average abundance in individuals/100 cm^2 was calculated. In the case of Trombidiformes, the representation (R%) of each family (Müller *et al,* 1978), i.e.the percentage of individuals belonging to a certain family, found in each plot, relative to the total number of individuals recorded in a series of investigated plots, was calculated.

RESULTS AND DISCUSSIONS

Average density of edaphic microarthropods varies in agro-ecosystems between 3.4 individuals/100 cm^2 (Plopu - wheat crop) and 141.4 individuals/100 cm^2 (Beștepe - rape crop) (*table 1*). In the samples taken one year later from the wheat culture from Plopu the densities were approximately 15 times higher while at Sarinasuf at the same type of culture the densities are almost 21 times higher (*table 2)*

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Table1

Locality	Coordinates		Type of ecosystem			Code		Collecting data
	N	E						
Beștepe	45º05'15''	29º02'26.76''	anthropic	corn	annual crop	1	c	12th of July 2018
				sun flower			sf	
				rape			r	
			natural	meadow			mw	
Murighiol	45º01'54.52''	29º08'11.56''	anthropic	barley	annual crop	2	b	6th of June 2017
				sun flower			sf	13thof July 2018
				alfalfa			a	
			natural	meadow			mw	
Plopu	45°01´23.47''	29°06´33.63''	anthropic	wheat	annual crop	3	w	7 th of June 2017
				wheat			w	13th of July 2018
			natural	meadow			mw	
Sarinasuf	45°0.5´50.59''	29°04´53.34''	anthropic	alfalfa	perennial crop	4	a	6th of June 2017
				sun flower	annual crop		sf	
				alfalfa	perennial crop		a	13th of July 2018
			natural	meadow			mw	
			anthropic	wheat	annual crop		w	
Sarichioi	44º55'35.39''	28º50'13.47''		peas		5	p	6th of June2017

In the period between 2005-2016 some researches concerning crops and meadows were done (Călugăr A., 2005, 2006, 2007, 2010; Călugăr A., Ivan O., 2009; Acatrinei A. L., Călugăr A., 2010; Călugăr A. et colab., 2015; Călugăr A., Ivan O., 2018); among these some were done in wet meadows from Prut riverside and some in saline ones from the Danube Delta Biosphere Reserve (Călugăr A., 2005, 2010; Călugăr A., Ivan O., 2018).

Comparing the results from this work with those from a series of annual crops, investigated from the lower section of Prut meadow, we noticed that the density of soil microarthropods from wheat crop is approximately the same as at Plopu counted from the samples taken in 2018 (Constantineanu I. *et al*, 2010).

In the meadows average density of edaphic microarthropods varies between 217,8-471,8 individuals/100 cm^2, values which are 3-139 times higher than those in agricultural ecosystems. The higher value was obtained for the meadow with an integrated system of protection (Murighiol) and the lowest value was observed in a grazed meadow (Sarinasuf). The values are up to 4.6 times higher than that registered in meadows from the lower

section of Prut (Călugar A., 2005, Constantineanu I. *et al*, 2010).

From qualitative point of view, without exception, in all investigated plots we can see a numerical dominance of mites compared with insects, in percentages ranging from 38% to 96% of the total effectives of mesofauna (*table 1*).

Crossley D. A. et al, 1982 stipulated that 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. Despite this consideration, results of the present research have shown that both in crops and in the meadows oribatids (39-80%) or trombidiform mites (38-89%) prevail.

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Table 2

Average density of the edaphic microarthropods from the analyzed agroecosystems

Taxa	Locality	1				2				3			4					5
	Culture	c	sf	r	mw	b	sf	a	mw	w	w	mw	a	sf	a	w	mw	p
	Year	2018				2017	2018			2017	2018		2017	2018				2017
Mesostigmata		1.2	0.2	15.4	73	11.2	5.6	2.6	139.4	0	6.2	2.4	3.2	2.8	4.2	4.8	8.8	0.2
Trombidiformes		9.8	4.6	6	22	33.4	2.2	4.2	80.6	2	8	51.4	19.6	12.6	15.6	1.8	91.4	5
Sarcoptiformes	Oribatida	1.2	0.4	26.8	173.4	19	8.8	3.2	157.4	0.2	12.2	40	24.4	31.6	28	27.4	48.2	3
	Astigmatina	0	0	79.6	0.4	5.4	2.4	1.2	5.2	0.6	3	1.2	15.8	1	0.6	0	1.2	3.4
Total Acari		12.2	5.2	127.8	268.8	69	19	11.2	382.6	2.8	29.4	95	63	48	48.4	34	149.6	11.6
Entognatha		2.6	0.4	11.2	57.2	2.2	8.4	5.4	61.2	0.2	16	3.6	5	3.2	9	17.6	54.6	0.2
Insecta		0.2	0.8	2.2	77	6.5	0.4	5.4	28	0.4	5	153	9.8	0.8	3.4	17.8	13.6	0.2
Alte grupe		0	0	0.2	1.4	0	0.2	0	0	0	0.4	1.6	0	0.6	1	0.4	0.4	0
TOTAL		15	6.4	141.4	404.4	77.7	28	22	471.8	3.4	50.4	253.2	77.8	52.6	61.8	69.8	217.8	12

Mites from Mesostigmata have the biggest abundance only in the meadow from Murighiol, with 36% of total mites, oribatid mites also owning the majority with 41% of the total of mites; Murighiol is also the only one plot where in the samples were found uropodid mites (only 18 individuals). Their presence, even in a small number, shows a less modified environment (Athias-Binche 1981, Karg 1989, Gulvik 2007).

In 35% of the investigated plots trombidiform mites have the majority with percentages which reach 33- 80%. Astigmatina mites which are stimulated by anaerobic environments rich in nitrogenous substances were identified, only with three exceptions (corn and sun flower from Beștepe, wheat from Sarinasuf), in all analyzed soils, with percentages between 0.2 - 62% of total mites, at Beștepe in the rape culture holding the supremacy (*table 1*).

A bioindicator of the quality and stage of humification of an organic substrate - the Oribatida/ collembolans ratio (Huțu et al, 1992) was also calculated. This ratio was subunit in four ecosystems: corn from Beștepe, alfalfa from Murighiol, wheat from Plopu and the natural meadow from Sarinasuf; in the last two cases the obtained values are only slightly under-unit. In the other analyzed ecosystems the ratio Oribatida/collembolans is supraunit, the biggest value being at sun flower from Sarinasuf (*table 1*). These results have shown that humification is prevalent in the majority of the studied plots both crops and meadows; the nutrient cycling is slow and the soil quality is improved ensuring an optimal functioning of those ecosystems.

In the case of *Trombidiformes*, a varied group from the trophic point of view (Krantz & Walter, 2009), a family analysis was performed. A total of 1825 individuals from 22 families were sampled and identified. Analysis of the trophic regime revealed that trombidiform mites which have a zoophagous diet represent approximately 50%, those with microfitophagous and polyphagous trophic regime approximately 18%, respectively 23%, and only two families have a phytophagous diet.

Many studies certify that a greater environmental heterogeneity below ground, provided by the diversity of plant roots, would ensure a greater edaphic biological diversity and the existence of all the functional groups. In this way essential soil functions such as the nutrients cycling and carbon mineralization are expressed, increasing fertility and improving the soil structure (Peredo *et al*, 2009). This observation is confirmed by our researches, into the samples extracted from meadows, where plants are very diverse, a more diverse spectrum of trombidiform mites, illustrated by a bigger number of families was remarked. As regards crops we noticed in a perennial culture of alfalfa (Sarinasuf) the highest biodiversity, the same as in the meadow from Beștepe. In the case of annual cultures the highest biodiversity was observed for the sun flower culture from Sarinasuf; here the number of the trombidiform families is comparable with alfalfa from Sarinasuf and the meadow from Plopu. At the alfalfa crop from Murighiol which was in the first year of vegetation and was mowed at the time of sampling, the number of the identified trombidiform families was two times lower (*table 3*), therefore this anthropogenic activity influencing the community.

From the qualitative point of view, on the the basis of the values of representation index, one can notice that mites from Tydeidae are common to majority of crops and meadows (*table 3*).

Table 3

Representation (%) of the trombidiform families in the studied ecosystems

Trophic regime	Family	1				2				3			4					5
		2018				2017	2018			2017	2018		2017	2018				2017
		c	sf	r	mw	b	sf	a	mw	w	w	mw	a	sf	a	mw	w	p
P	*Stigmaeidae*																	
	Rhagidiidae																	
	Bdellidae																	
	Erythraeidae																	
	Cunaxidae																	
	Trombidiidae																	
	Caligonellidae																	
	Anystidae																	
	Teneriffiidae																	
	Ereynetidae																	
	Paratydeidae																	
M	*Nanorchestidae*																	
	Tarsonemidae																	
	Scutacaridae																	
	Pygmephoridae																	
D	*Eupodidae*																	
	Tydeidae																	
	Pachygnatidae																	
	Cryptognathidae																	
	Raphignathidae																	
Ph	*Tetranychidae*																	
	Eryophiidae																	

Legend: c, sf, r, a, w, mw - types of crops as in § Material and method; P - predator, M - microphytophagos; D - diverse (detritomicrophytophagos, predator, microphytophagos, algivore); Ph - phytophagous; - under 1%, - 1-25%, - 25-50%, - 50-100%, - 100%

Thus, they were identified in 88% of the considered plots, being found in most of the samples from investigated agro-ecosystems and also in all meadows, but with greater values of representation in the last category, especially at Sarinasuf (62%). Likewise, tydeid mites, eupodids, with a diverse trophic regime were found in the majority of ecosystems meaning 76% of the plots. The predator cunaxids were identified in 70% of plots; both tydeid and cunaxid mites have the biggest values of representance in meadows (both with an alike value of representation - 43%, respectivelly 42%). At the opposite pole, with a

small representation or even absent in some meadows, but identified also in lots of plots - 88% are the microphytophagous mites from Nanorchestidae (*table 3*).

The families *Stigmaeidae, Erythraeidae, Tarsonemidae, Bdellidae* are also present in lots of habitats (58-64%). Among these, stigmaeid mites, with a zoophagous trophic regime, are distinguished by a large representation in meadows, especially at Murighiol (52%) (*table 3*).

On the other hand, it is worth noting the presence of some families in only two or three ecosystems but with a high percentage of representation in a certain type of culture (for example, *Anystidae* in sun flower and Tetranychidae in alfalfa) or in one grassland (*Caligonellidae, Cryptognathidae*). Some families were found only in one plot from a crop or a meadow (*Tenerriffidae, Ereynetidae, Raphignathidae, Eryophiidae*) (*table3*).

On the base of a high value of representance index (50.1-100%) only in the crops one could considered characteristics for this kind of ecosystems the following families: Ereynetidae and *Pygmephoridae* (barley), *Anystidae* (sun flower), *Scutacaridae* (rape), *Raphignathidae* (alfalfa). Based on the same principle, could be considered characteristic for the meadows four families: *Stigmaeidae, Caligonellidae, Eupodidae, Cryptognathidae* (*table 3*). Mites from *Tetranychidae* and *Eryophiidae* are pest mites who are feeding by sucking up the liquid contents from plant cells, being collected in a small number of individuals together with the plants that accompanied the soil samples from the respective crops. So, even with a big percentage of representation they aren't characteristic for a certain culture/meadow (*table 3*).

CONCLUSIONS

Habitat type with the plot peculiarities was the main factor which influences both quantitative and qualitative structure - taxonomic and trophic structure of the communities. Also, climatic conditions that occur in the sampling period influenced edaphic mesofauna. In the meadows average density of edaphic microarthropods is higher than that in agricultural ecosystems. In the grazed meadows the densities are lower than in the non - grazed ones.

Within edaphic mesofauna of the investigated agro-ecosystems, mites are dominant compared with insects; among mites, either trombidiforms or oribatids hold the majority. In non-grazed meadows and in some agricultural crops, oribatids are predominant.

An analysis of trombidiform mites by trophic regime shows that the mites with zoophagous trophic regime are predominant.

An overview on the biodiversity of trombidiforms in the two categories of ecosystems - crops and meadows revealed that certain families are characteristics for the first category and some for the second. For crops five families of trombidiforms could be considered characteristic: *Ereynetidae* and *Pygmephoridae* (barley), *Anystidae* (sun flower), *Scutacaridae* (rape), Raphignathidae (alfalfa). For meadows, four families could be considered characteristic: *Stigmaeidae, Caligonellidae, Eupodidae, Cryptognathidae*. More researches are necessary to verify the findings, especially those referring to characteristics families for an ecosystem category, because these findings could be influenced only by the conditions from the sampling moments.

Tydeid mites - are common to crops and meadows with a great representation only in the last category; even so, these mites could be considered with large ecological valence, additionally considering that they have also a diversified trophic regime.

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Management plan of DDBR available at http://www.ddbra.ro/plan_manag_RBDD.php