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Soil mites (Acari) of natural areas of a former military training field in Olsztyn (Poland)

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ABSTRACT: Due to restricted public access to military training fields such areas are quite interesting places for conducting faunistic research that would be simply impossible in other terrains. The area examined in the present study was the former military training field in Olsztyn, with the adjacent Lasek Pieczewski and the valley of Skanda Lake. The major aim of the study was to evaluate the current state of the environment in the terrain of the former military training field and the adjacent areas. In this study mites from the suborder Uropodina and cohort Labidostommatina (Acari: Mesostigmata et Prostigmata) were used as a bioindicators. These mites are useful for this purpose because of their specific habitat preferences. The community of mites in the area under scrutiny contained 23 taxa, comparing to 34 species found in whole voivoideship, which is 68% of local species biodiversity. *Oodinychus ovalis* turned out to be the most numerous species (the specimens of this species constituted almost 38% of the whole community and the frequency per sample was 55%). The other quite numerous species found in the examined area were *Janetiella pulchella* and *Oodinychus karawaiewi*, which constituted over 30% of the whole community. Taking into account the number of species and their habitat preferences two most valuable areas were found: southern part of Lasek Pieczewski and Skanda Lake valley.

Keywords: Military training fields; Soil mites; Uropodina; Labidostommatina; Biodiversity; Monitoring.

1. INTRODUCTION

Military training fields and areas adjacent to them due to restricted public access are interesting places, especially from the faunistic point of view, which in many cases have retained high biological diversity. Although such areas are often under intense anthropogenic pressure or are devastated for many years, they sometimes become habitats of rare species of animals and plants. Moreover, military training fields quite frequently contain unique microhabitats, which in natural conditions would not be sustained due to succession processes (e.g. plant overgrowth). For example puddles made by tank continuous tracks, which are habitats of a rare crustacean species *Branchipus schaefferi* [1, 2].

The area of the military training field in Biedrusko near Poznań (which is still used by the Polish Army), is protected by the regulations of the Nature 2000 Programme because this area contains habitats of such rare species as the hermit beetle (*Osmoderma eremita*), large copper butterfly (*Lycaena dispar*), marsh fritillary (*Euphydryas aurinia*), swamp minnow (*Rhynchocypris percnurus*), Eurasian beaver (*Castor fiber*), European fire-bellied toad (*Bombina bombina*), and great crested newt (*Triturus cristatus*). Similarly, the area of the military training field in Orzysz, which is also protected by the law, is inhabited by the black grouse (*Lyrurus tetrix*) [3], corn crake (*Crex crex*), common crane (*Grus grus*), and some other rare bird species [4]. As in this area there are also many rare plants, such as moorlands and sand turfs with many different plant species, the area is going to be made a green refuge. A good example of such a place is also Borne Sulinowo [5]. After many years of exploitation by German and Soviet armies, the area of the local military training field has regenerated and now it is inhabited by many species such as the white-tailed eagle (*Haliaeetus albicilla*), heron (Ardeidae), great cormorant (*Phalacrocorax carbo*), and many other species of birds, as well as beavers and other species of protected animals. Moreover, in the area of this military training field there are 400 species of plants, including 20 protected species among them. The trees growing in this area, which quite frequently contain ricochet bullets and pieces of bullets, will never be cut down because the wood from these trees has no value from the economic point of view.

One of the most obvious advantages of military training fields is that due to restricted public access they are quite interesting places for conducting faunistic research that would be simply impossible in other areas. A good example of non-military use of such areas as a source of valuable faunistic data is research in the field of forensic entomology (e.g. conducted by Konwerski, Sienkiewicz, Bajerlein, Matuszewski, and Mądra) [6-15].

Unfortunately, little is known about fauna and flora of military training fields, mostly due to the prolonged restricted public access to such areas.

Nowadays, the former military training field in Olsztyn and the adjacent valley of Skanda Lake (including the area of the so-called Lasek Pieczewski) are under severe anthropogenic pressure: they serve as leisure grounds for inhabitants, some military vehicle rallies were also held there in the past. The management plan for this area assumes the construction of big housing district, together with office and commercial infrastructure. Scientific Park (Park Naukowo-Technologiczny) and bypass road around the city were already constructed. The area of the former military training field is a part of natural green ring of the city and probably ecological route, which should remain connected and passable, especially in a situation when the urban areas of the city are extended every year. The maintenance of the net of well connected corridors and refuges of wilderness is extremely important for the biological diversity and should be taken into account in local decision making and urban planning. The evaluation of the state of the environment in the area under scrutiny was conducted before the investments were started and can serve as the starting point for comparisons and further research about urbanization of fauna and flora in Olsztyn. It may also help to present the most valuable remnants of the south-eastern part of green ring of the city that may need additional protection.

The major aim of the present study was to evaluate the state of the environment in the area of the former military training field and the adjacent areas in Olsztyn. In this case mites from the suborder Uropodina and cohort Labidostommatina (Acari: Mesostigmata et Prostigmata) were used as bioindicators. Uropodina is one of the best known groups of mites in Poland. According to Błoszyk [16], there are 137 Uropodina species in Poland. Wiśniewski and Hirschmann [17] claim that the total number of Uropodina species in Poland is about 150. Uropodina mites live in different types of habitats - including both soil and litter and unstable habitats (i.e. merocenoses) [see e.g. 16, 18]. Uropodina which inhabit unstable habitats (such as tree hollows, anthills, as well as bird and mammal nests), are very often capable of changing their habitat by passive dispersion (phoresy), i.e. they use other organism to spread over new areas [16, 19]. Most of Uropodina are steno- and oligotopic species [see e.g. 16, 20, 21], with very specific environmental requirements and very sensitive to any changes in the conditions of the environment such as *Trachytes lamda* [16, 22, 23]. But, there are also some species, for example *Oodinychus karawaiewi* which is known to prefer disturbed environments [24]. This diversity of habitat preferences and ecological tolerance, of Uropodina allows us to evaluate condition of forest ecosystems on the basis of occurrence and abundance of particular species. Moreover, Uropodina mites have numerous morphological differences in their size, shape, chaetotaxy with several different morphotypes and quite evident sexual dimorphism (different shape and size of genital shields in males and females) [16]. These features make them relatively easy to determine the species and sex. This is a very important feature of bioindicators used in valorisations and other expertises.

The second group of organisms used in this study as bioindicators of the current state of the soil environment in the examined area contains mites from the family Labidostommatidae, which in the analysed material was represented by one species, i.e. *Labidostomma luteum* Kramer, 1889. Poland is a habitat for three species from this group, which have different range of occurrence and habitat preferences [25-27]. *Labidostomma luteum* has the widest range of occurrence in Poland and frequently lives in lowlands. The species from the genus *Labidostomma* have one common characteristic, i.e. they avoid habitats with high levels of anthropogenic pressure [25, 27].

2. MATERIAL AND METHODS

The following paragraphs are a brief description of the study area and the methods used during sample collection in the examined ground plots. The detailed description of study area is available in Zduniak [28].

2.1. Study area

The former military training field examined in this study is located in the south-eastern outskirts of Olsztyn (Figure 1). It covers an area of roughly 3 km^2 with a circumference of 15 km. Moreover, in the examined area there is also Skanda Lake with the adjacent meadows and forests. The former military training field is located in the middle of the area and it mainly comprises open and thicket areas with forest succession. In the northern and western parts the area of the former military training field there is a zone consisting of mixed forests, whereas in the south - mostly mixed and deciduous forests. In the south the former military training field is adjacent to the so-called Lasek Pieczewski, which is governed by Olsztyn Forest Inspectorate (departments 161 and 162). This forest area contains mainly marshland woods, which have been naturally regenerated in the formerly arable lands (data from Olsztyn Forest Inspectorate).

The examined ground plots have been collated according to the numbering system presented on the map given below (Figure 1). The samples were collected and arranged according to the ground plots in which there were collected and the data. The full list of all ground plots from which the samples were collected is available in Soil Fauna Databank (Natural History Collections, Faculty of Biology AMU) marked with OLS-symbol stands for the number of the sample. The samples used for the analysis in this study were collected by Milena Zduniak.

2.2. Materials

The material for the analysis used in this study was collected in the area of the former military training field and the surrounding zone, around Skanda Lake, and in the area of national forests districts 161 and 162 during spring, summer and autumn 2012. In the 65 ground plots selected for the study (Figure 1) [28], 113 samples were collected - both qualitative (92) and quantitative (21). 63 samples were collected from soil and a number of 50 samples from different types of merocenoses such as dead wood and tree hollows. The volume of the quantitative samples was 30 cm^2 and they were collected with a biocenometre to a depth of 10 cm. The sieve samples (volume of approx. 0.51) were obtained by means of an entomological sieve, whose holes had a diameter of 0.4 cm. The samples from dead wood were also of a similar volume. The dead wood material comes from rotten trunks and stumps as well as from tree hollows. The material collected for the analysis was placed in Tullgren funnels for about 7 days and the extracted mesofauna was preserved in 75% ethyl alcohol.

The extracted specimens were deposited in the Natural History Collections at Adam Mickiewicz University in Poznań (some of the specimens were also used in molecular analyses). The data from the collected material were analysed with Analizator 2.0 software developed by Desmodus. The comparative analysis was also based on the data from Soil Fauna Databank (Natural History Collections, Faculty of Biology AMU) on Uropodina and Labidostommatina in Warmian-Masurian Voivoideship, collected by different researchers in different periods.

Figure 1. Location and distribution of the examined ground plots.

2.3. Data analysis methods

The following classes of ecological indices for Dominance (D%) and Frequency (F%) were used in this study [16]:

Dominance: D5, eudominants (>30%); D4, dominants (15.1-30.0%); D3, subdominants (7.1-15.0%); D2, residents (3.0-7.0%); and D1, subresidents (<3%).

Frequency: F5, euconstants (>50%); F4, constants (30.1-50%); F3, subconstants (15.1-30.0%); F2, accessory species (5.0-15.0%); and F1, accidents (<5%).

The single-variable analysis were conducted with the Mann-Whitney U test ($p<0.01$).

The maps illustrating the distribution were generated with MapInfo 11.0, CorelDraw 12, and Google Earth. The exact location and distribution of the examined ground plots were established with GPS devices Garmin Dakota 10. The Open Street Map (OSM) as a basemap was used for the distribution maps.

3. RESULTS

3.1. General characteristics of the analysed community

Table 1. Species of Uropodina found in the former military training field in Olsztyn: N - number of specimens, Ave ± SD - average number of specimens in a positive sample ± Standard Deviation, F% - frequency, D% - dominance, N - number of specimens, Nsp - number of species.

Species	N	Ave.±SD	D%	F%
Oodinychus ovalis (C. L. Koch, 1839)	1160	18.71±34.56	38.33	54.87
Janetiella pulchella (Berlese, 1904)	464	14.97±20.67	15.33	27.43
Oodinychus karawaiewi (Berlese, 1903)	459	32.79±84.55	15.17	12.39
Uroobovella obovata (Canestrini et Berlese, 1884)	213	53.25±48.68	7.04	3.54
Trachytes aegrota (C. L. Koch, 1841)	141	4.86±5.93	4.66	25.66
Dinychus inermis (C. L. Koch, 1841)	123	24.60±42.09	4.06	4.42
Urodiaspis tecta (Kramer, 1876)	112	5.09±5.20	3.70	19.47
Olodiscus minima (Kramer, 1882)	96	5.65±6.15	3.17	15.04
Trachytes pauperior (Berlese, 1914)	58	9.67±16.71	1.92	5.31
Labidostomma luteum Kramer, 1879	47	7.83±6.18	1.55	5.31
Dinychus carinatus Berlese, 1903	36	7.20±8.53	1.19	4.42
Iphiduropoda penicillata (Hirschmann et Z.-Nicol, 1961)	27	13.50±13.44	0.89	1.77
Uropoda orbicularis (Müller, 1776)	21	3.50±2.07	0.69	5.31
Dinychus woelkiei Hirschmann et Zirngiebl-Nicol, 1969	11	1.57±0.54	0.36	6.19
Uroobovella sp.	10	5.00±1.41	0.33	1.77
Uropoda sp.	9	4.50±4.95	0.30	1.77
Discourella modesta (Leonardi, 1889)	8	2.00±2.000	0.26	3.54
Olodiscus misella (Berlese, 1916)	8	4.00±4.24	0.26	1.77
Pseudouropoda sp.	7	7.00	0.23	0.88
Janetiella pyriformis (Berlese, 1920)	7	3.50±2.12	0.23	1.77
Leiodinychus orbicularis (C. L. Koch, 1839)	3	1.50±0.71	0.10	1.77
Dinychura cordieri (Berlese, 1916)	3	3.00	0.10	0.88
Dinychus arcuatus (Trägårdh, 1922)	3	3.00	0.10	0.88
N	3,026			
Nsp	23			

The community of Uropodina and Labidostommatina found in the examined area contained 23 taxa (Table 1). The most numerous species was *Oodinychus ovalis*, which constituted roughly 38% of the whole community and its frequency of occurrence in the analysed samples was 55%. The other numerous species found in the analysed material were *Janetiella pulchella* and *Oodinychus karawaiewi*, which make up 15% respectively of the community. Among the other species with fairly high abundance there were also *Uroobovella obovata*, *Trachytes aegrota*, *Dinychus inermis*, *Urodiaspis tecta*, and *Olodiscus minima*. Big participation of *J. pulchella* and *Uro. obovata* in the community probably stems from the fact that almost half of the analysed material (i.e. 44%) comes from merocenoses of dead wood.

3.2. Differences between communities of studied mites in soil and merocenoses

The Uropodina community inhabiting soil and litter contained 17 taxa and was dominated by *Oo. karawaiewi* (Table 2) but it was not the most frequent species in this community. The group of the most frequent species were *Oo. ovalis*, *T. aegrota*, *U. tecta*, and *O. minima* (Table 3). These 5 species constituted 80% of the community, however, the total frequency of each species was not higher than 40%.

Table 2. Species of Uropodina and Labidostommatina found in the study area: Ave ± SD - average number of specimens in a positive sample ± Standard Deviation; F% - frequency, D% - dominance, Nsp - number of species, Ns - number of samples, N - number of specimens.

Species	Soil				Merocenoses			
	N	**Ave±SD**	**D%**	**F%**	**N**	**Ave±SD**	**D%**	**F%**
Oo. karawaiewi	459	32.79±84.55	35.06	22.22				
Oo. ovalis	256	10.24±14.91	19.56	39.68	904	24.43±42.33	52.65	74.00
Uro. obovata					213	53.25±48.68	12.41	8.00
T. aegrota	132	5.74±6.38	10.08	36.51	9	1.50±0.55	0.52	12.00
D. inermis	121	30.25±46.36	9.24	6.35	2		0.12	2.00
U. tecta	110	5.50±5.29	8.40	31.75	2	1.00±0.00	0.12	4.00
O. minima	93	6.64±6.37	7.10	22.22	3	1.00±0.00	0.17	6.00
J. pulchella	40	8.00±10.86	3.06	7.94	424	16.31±21.96	24.69	52.00
L. luteum	37	7.40±6.80	2.83	7.94	10		0.58	2.00
Ur. orbicularis	21	3.50±2.07	1.60	9.52				
T. pauperior	12	4.00±5.20	0.92	4.76	46	15.33±23.97	2.68	6.00
Dis. modesta	8	2.00±2.00	0.61	6.35				
O. misella	8	4.00±4.24	0.61	3.17				
Uroobovella sp.	4		0.31	1.59	6		0.35	2.00
L. orbicularis	3	1.50±0.71	0.23	3.17				
D. arcuatus	3		0.23	1.59				
D. carinatus					36	7.20±8.53	2.10	10.00
I. penicillata					27	13.50±13.44	1.57	4.00
Pseudouropoda sp.					7		0.41	2.00
J. pyriformis					7	3.50±2.12	0.41	4.00
Di. cordieri					3		0.17	2.00
D. woelkiei	1		0.08	1.59	10	1.67±0.52	0.58	12.00
Uropoda sp.	1		0.08	1.59	8		0.47	2.00
Nsp	17				17			
Ns	63				50			
N	1,309				1,717			

Table 3. Abundance and frequency of Uropodina mites in the analysed soil material.

Quantity /incidence	Very common	Common	Rare	Very rare
Very frequent	*Oo. ovalis*	*U. tecta*		
Frequent	*Oo. karawaiewi*	*O. minima*		
Not frequent	*T. aegrota*	*D. inermis*	*J. pulchella*	*Ur. orbicularis, Dis. modesta*
Occasional				*T. pauperior, O. misella, Uroobovella sp., L. orbicularis, D. arcuatus, Uropoda sp., D. woelkei*

Table 4. Abundance and frequency of Uropodina in the analysed dead wood merocenoses.

Quantity/incidence	Very common	Common	Rare	Very rare
Very frequent	*Oo. ovalis* *J. pulchella*			
Frequent				
Not frequent		*Uro. obovata*		*T. pauperior, D. carinatus, Di. woelkei, T. aegrota, O. minima*
Occasional				*I. penicillata, Uropoda sp., Pseudouropoda sp., J. pyriformis, Uroobovella sp., Di. cordieri, U. tecta, D. inermis*

The community of Uropodina inhabiting the examined merocenoses of dead wood contained also 17 taxa. In this community the most numerous species were *Oo. ovalis*, *J. pulchella* and *Uro. obovata* (Table 2, 4), which constituted almost 90% of the whole community. The frequency of the first two species in the collected samples was very high and exceeded 50% (Table 2). The other species were less frequent and not so numerous (Table 4).

Comparison of habitat preferences of selected species of mites shows that there were 6 species that were found only in the dead wood material, i.e. *Uro. obovata*, *D. carinatus*, *Ip. penicillata*, *D. woelkiei*, *J. pyriformis*, and *Di. cordieri*. There is also group of 6 species which were found only in the soil material, but not present in merocenoses. These species are: *Oo. karawaiewi*, *Ur. orbicularis*, *O. misella*, *Dis. modesta*, *D. arcuatus* and *Le. orbicularis*. Analysis shows, that species that occurred in both types of habitat usually preferred one of them. For example, *L. luteum* was much more frequent in dead wood (7.94%) than in soil (2%) (Table 2). Only in the case of *T. pauperior* there were no significant differences between the abundance of the species in the dead wood and soil (U Mann-Whitney rank test; $U = 1293$, $z = 0,12$; $p > 0,05$) (Table 5). *T. aegrota* and *U. tecta* were much more numerous in soil (rank test U Mann-Whitney: $U = 951,5$, $z = 2,38$; $p < 0,05$; $U = 871$, $z = 2,92$; $p < 0,01$), whereas *Oo. ovalis* and *J. pulchella* were more numerous in the dead wood material (U Mann-Whitney rank test: $U = 825$, $z = 3,22$; $p < 0,01$; $U = 739,5$, $z = 3,89$; $p < 0,001$).

Table 5. Comparison of habitat preferences of selected species of Uropodina mites. Values represent mean number of specimens per sample: * - statistically significant differences with habitat preference.

Species	Merocenoses	Soil
*T. aegrota**	0,2	2,1
T. pauperior	0,2	1,0
*U. tecta**	>0,1	1,9
*Oo. ovalis**	18,8	4,4
*J. pulchella**	9,0	0,7

3.3. Spatial distribution of Uropodina and Labidostommatina in the examined area

Most of the 65 ground plots of the examined area (i.e. 89%) were inhabited by the species enumerated above. However, the two analysed groups were considerably different as to the frequency of occurrence and spatial distribution. Labidostommatina were far less frequent and the specimens of *L. luteum* were found in samples only from 3 ground plots (i.e. 58, 64, 65), located in the southern part of the examined area (Figure 2).

Figure 2. Ground plots with *Labidostomma luteum* occurrrence.

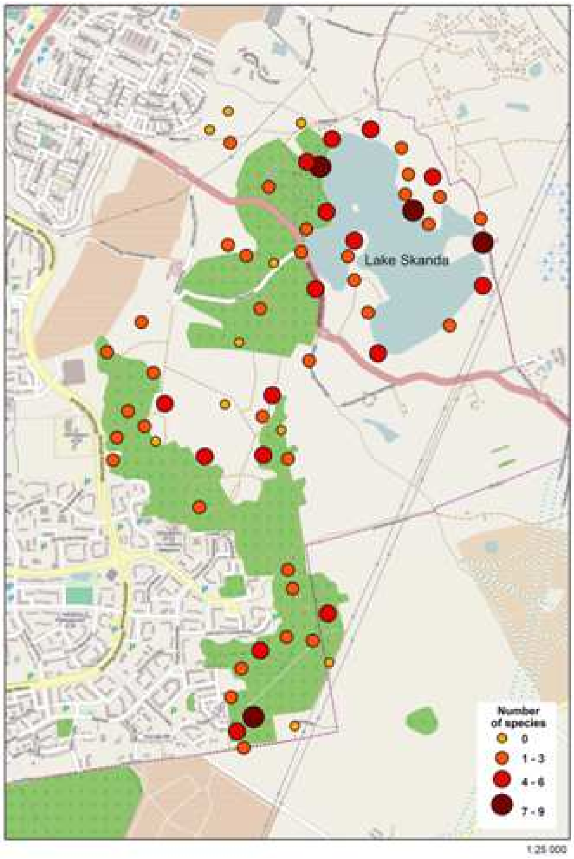

Figure 3. Number of species per ground plot.

The spatial distribution of the found Uropodina mites was much more regular here. These mites occurred in the whole area, except ground plots no. 1, 2, 3, 26, 34, 46, 59, and 63, where no specimen was found. The number of species found in the examined plots fluctuated between 0 and 9 (Figure 3). The most interesting and abundant Uropodina species were those found around Skanda Lake and in the southern part of the examined area - Lasek Pieczewski.

3.4. Frequency of occurrence and spatial distribution of Uropodina in examined area

The most common Uropodina species, which occurred in the whole examined area, were *Oo. ovalis* (39 - Number of ground plots in which a given species occurred), *J. pulchella* (25), and *T. aegrota* (23) (see Figures 4A-C).

As can be seen, the species which were sporadic in the examined area were *U. tecta* (14), *O. minima* (13), and *Oo. karawaiewi* (10) (Figures 4D, 5A, and 5B). In a few cases such species as *D. arcuatus*, *I. penicillata*, and *Di. cordieri* were also found (Figure 8). The other species were attested only in 2-7 ground plots (for details see Figures 5 C, D, 6 and7).

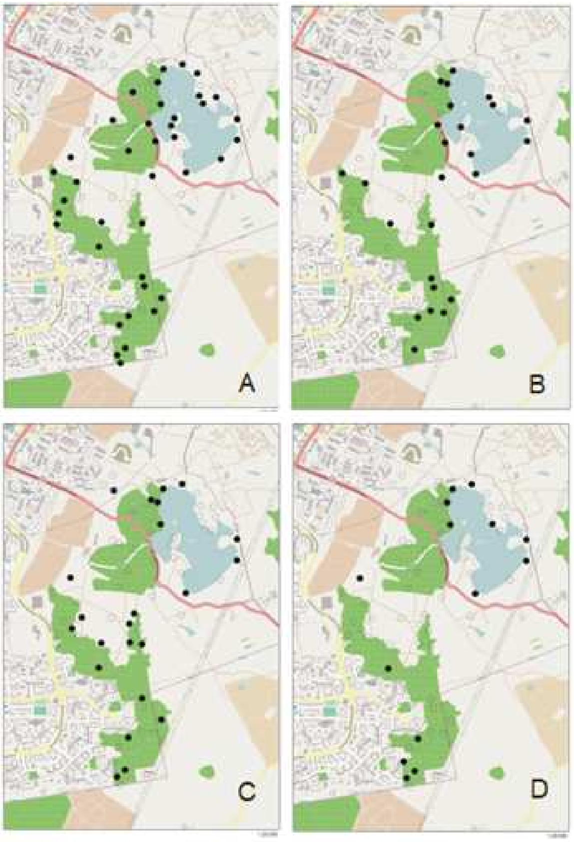

Figure 4. Spatial distribution of the found species: A - *Oodinychus ovalis*, B - *Janetiella pulchella*, C - *Trachytes aegrota*, D - *Urodiaspis tecta*.

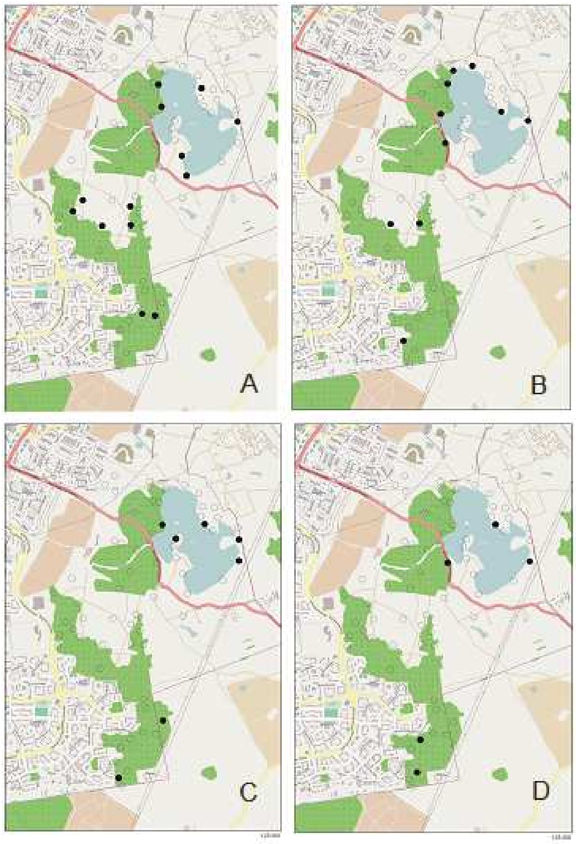

Figure 5. Spatial distribution of the found species: A - *Olodiscus minima*, B - *Oodinychus karawaiewi*, C - *Dinychus woelkei*, D - *Dinychus carinatus*.

3.5. Species composition of Uropodina community in examined area of Warmian-Masurian voivoideship

The earlier observations made by Błoszyk (unpublished data) and the data stored in the database *Soil Fauna Bank* (Natural History Collections, Faculty of Biology, Adam Mickiewicz University in Poznań) have been very helpful in assessing the diversity of Uropodina mites in the area of the former military training field and the whole region. However, this region of Poland is one of those which still have not been thoroughly examined in this respect, so little is known about the acarofauna of this region. In the area of Warmia-Masurian voivoideship 34 species of Uropodina mites were found. The most abundant species found in this region are *T. aegrota* and *Oo. ovalis*, which constituted 54% of the whole community. These two species and *U. tecta* are apparently common in this region, and the frequency of occurrence in the analysed samples fluctuated between 39% and 55% (Table 6).

As can be seen, the Uropodina community in the examined area is less diverse and constitutes only 53% of all species found so far in the whole region (Table 7). In the analysed material there was one species which was quite dominant, i.e. *Oo. ovalis*, which is probably due to the fact that the collected material contained many samples from merocenoses of dead wood. The high frequency of *J. pulchella* can be also explained by this fact.

Table 6. Analysis of Uropodina community in Warmian-Masurian voivoideship.

Dominance	Frequency
Eudominants -	Euconstants *T. aegrota* - 54.7%
Dominants *T. aegrota* - 27.6% *Oo. ovalis* - 26.4%	Constants *Oo. ovalis* - 44.2% *U. tecta* - 38.95%
Subdominants *U. tecta* - 11.8% *Oo. karawaiewi* - 10.2% *Tr. elegans* - 7.9%	Subconstants *O. minima* - 24.2% *T. pauperior* - 15.8%
Recedents *C. cassideasimilis* - 3.7%	Accessorial species *U. pannonica* - 13.7% *Oo. karawaiewi* - 12.6% *C. cassideasimilis* - 11.6% *Tr. elegans* - 10.5% *D. perforatus* - 8.4% *N. splendida* - 7.4% *D. carinatus* - 7.4% *Di. modesta* - 5.3%
Subrecedents 28 species	Accidental species 21 species

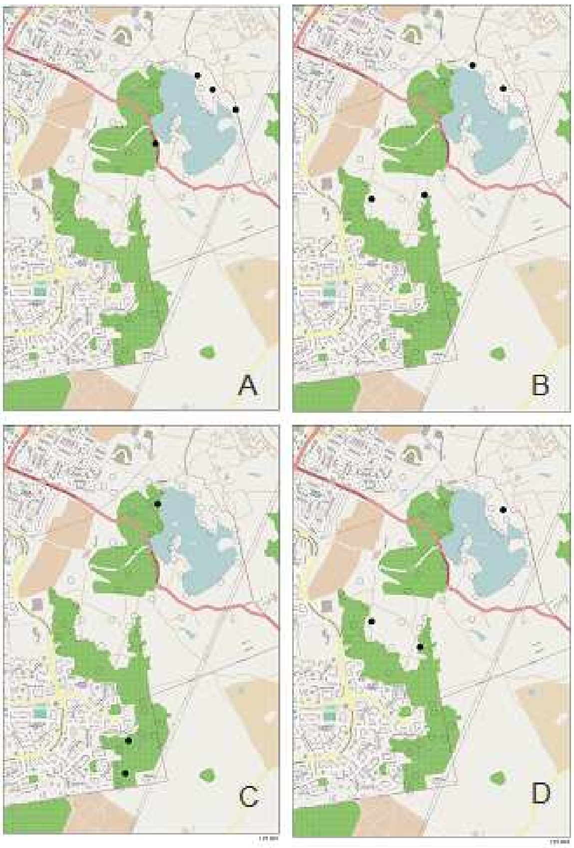

Figure 6. Spatial distribution of the found species: A - *Dinychus inermis*, B - *Uropoda orbicularis*, C - *Trachytes pauperior*, D - *Discourella modesta*.

Figure 7. Spatial distribution of the found species: A - *Uroobovella obovata*, B - *Olodiscus misella*, C - *Leiodinychus orbicularis*, D - *Janetiella pyriformis*.

Table 7. Analysis of Uropodina community in former military training field in Olsztyn.

Dominance	**Frequency**
Eudominants *Oo. ovalis* - 38.3%	Euconstants *Oo. ovalis* - 54.9%
Dominants *J. pulchella* - 15.3% *Oo. karawaiewi* - 15.4%	Constants -
Subdominants *Uro. obovata* - 7.0%	Subcontstans *J. pulchella* - 27.4% *T. aegrota* - 25.7% *U. tecta* - 19.5% *O. minima* - 15.0% Accessorial species
Recedents *T. aegrota* - 4.7% *D. inermis* - 4.1% *U. tecta* - 3.7% *O. minima* - 3.2%	*Oo. karawaiewi* - 12.4% *D. woelkei* - 6.2% *T. pauperior* - 5.3% *Ur. orbicularis* - 5.3%
Subrecedents 15 species	Accidental species 14 species

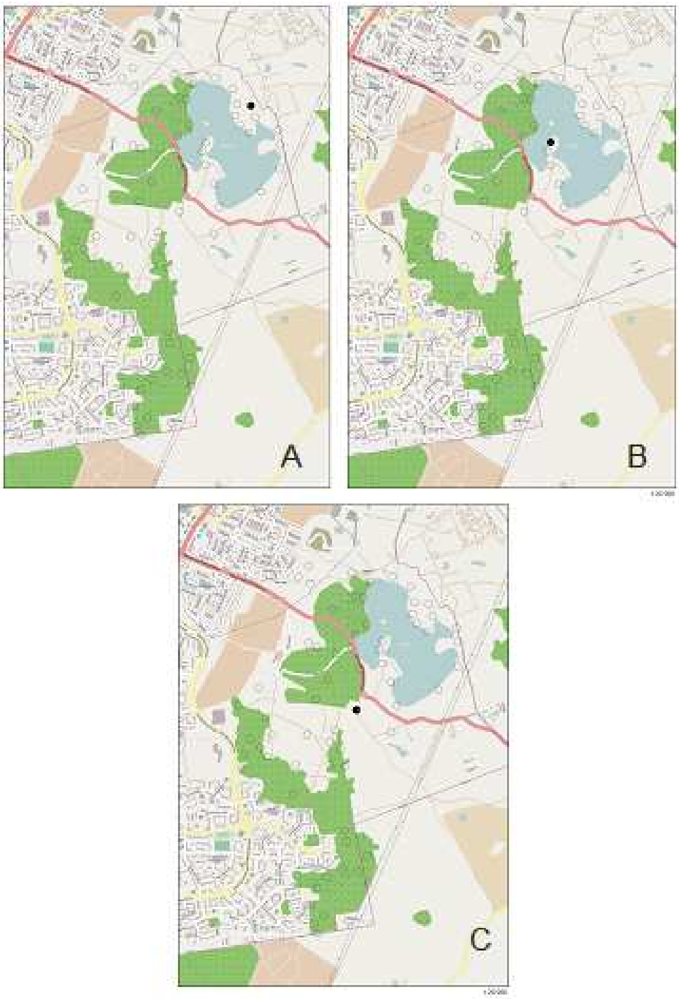

Figure 8. Spatial distribution of the found species: A - *Dinychus arcuatus*, B - *Ipiduropoda penicillata*, C - *Dinychura cordieri*.

4. DISCUSSION

Abandoned military areas often become a refuge for many rare species of plants and animals [see e.g. 4-8]. Because of that, it is very important to manage these terrains properly and preserve their natural values. There are many examples of such areas in Poland, for example Biedrusko or Orzysz [3-5], that were appreciated for their natural values and became part of Natura 2000 conservational program.

On the other hand they often require restoration and management plans to provide them with proper protection. Our study field is subject to heavy anthropogenic pressure - the evidence is that synanthropic species [24] *Oo. karawaiewi* is common. But we also found a relatively large number of species (23) of mites from cohort Uropodina and Labidostommatina, especially in the neighborhood of Skanda Lake. Higher species richness of these mites can be a sign of good soil condition, and probably also other organisms engaged in ecological (i.e. trophic) relations with it, such as plants and animals (especially invertebrates). On the western and southern shore of the lake, some authors described occurrence of a patch of well preserved old growth of alder-ash forest and riparian forest [28] - in these regions the highest number of Uropodina species was found (Figure 4). *Labidostomma luteum* inhabits deciduous old growth forests [25] and also in our field this species was found in a similar ecosystem. However, in the same patch of old oak forest we found *Oo. karawaiewi*, which inhabits places transformed by human [24]. That means this area is affected by human activities. Skanda Lake is also under urbanization pressure.

Former military zone in Olsztyn and adjacent areas serve as an interesting subject for various ecological studies. Terrain relief is very diverse; there are some swamps and small water bodies, which create habitats for many plants and animals. Such heterogeneous mosaic of habitats can be essential for biodiversity. Furthermore, part of this area is designed for construction of a new housing district. The works were already started and are destroying part of its ecosystems, and others will be exposed to even more severe human impact in the near future. Because of that, regular zoological and botanical inventory research is needed for evaluation and monitoring of ecological changes in this system.

Moreover, the inventory can serve as a basis for adequate management and conservation of more valuable parts of this terrain. Data on mites in this area suggests that the most valuable forests are situated around Skanda Lake (the highest species richness of Uropodina mites) and southern part of Lasek Pieczewski (occurrence of rare species *Labidostomma luteum*). In the former military zone (in the middle of our study field), many fewer species of Uropodina were found. Although, this area can still be important for many species of fauna: as a refuge, food base and an ecological corridor. Preserving refuges of unmanaged wild refuges in the most valuable areas (in contrast to high-maintanance parks and other managed green areas) would help local ecosystems to maintain relative stability in the face of urbanization.

Results obtained in this project should be taken with some precaution. We need to take into account that most habitats in Olsztyn's military zone are in early stage of succession and in this kind of habitats, Uropodina mites are less frequent than in mature forests [16, 22, 23]. It is impossible to make comparisons of mite communities from forests and meadows based on species richness. So, habitat selectivity of these organisms makes them indicators of limited use - they should be used just in one type of environment.

Although the land use plan for this area assumes that part of green areas will be preserved, connectivity and functioning of the whole system will change dramatically, and its ecological role will weaken without any doubt. Ecologically friendly land use planning could at least partially reduce the deterioration of this area and could be also an interesting study site for urban ecology research. To evaluate this area's ecosystems there is a need to conduct more research focused on fauna's and flora's diversity. Changes in functioning of ecosystems in this area, such habitat fragmentation, synurbization of fauna and flora could also be an interesting subject for urban ecologists. However, the research may serve as one of the elements of the natural valorisation of the area of the former military training field in Olsztyn and be helpful in preparing of the land use plan of this area in the future.

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