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GRADU AMAIERAKO LANA
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BACHELOR´S THESIS

COLONIZATION AND DEVELOPMENT OF ORIBATID MITE COMMUNITIES (ACARI: ORIBATIDA) IN THE FOREST RECLAIMED LIMESTONE MINE DUMPS.

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1. ABSTRACT

In order to study the colonization and development of moss mites (Oribatida) communities in a Scots pine forest of a reclaimed limestone mine dump in Northern Poland, 3 plots from the dump were chosen. The selected plots differed in age, 5 years old, 35 and 50 years old. From a total of 30 samples 499 mites (Acari) were extracted in Tullgren funnel from which 262 were Oribatida. Abundance (N) was analyzed in all mites and after determining the species of both, juvenile and adult stages of oribatids, the following indices were analyzed: Abundance (N), Dominance (D), Species diversity (S), Species richness (s) and Shannon's diversity index (H). Regarding to the results obtained; oribatid mites were dominant with the highest abundance in all assemblages (Plot 1: 139 Oribatida /299 Acari. Plot 2: 40/55 and Plot 3: 83/145). *Tectocepheus velatus* showed a very high dominance (45,99%) in plot 1; the highest value for Shannon's diversity index belonged to plot 3. On the other hand, juvenile's percentage was significantly higher than adult's percentage, especially at plot 2 (95,02%). These results made us to conclude that the high abundance of oribatids in the youngest forest is due to *T. velatus*'s high abundance and that plot 3 is the best habitat for mites. Finally, the high occurrence of juvenile stages requires keeping on studying the area.

1.1. LABURPENA

Pinu gorriko baso batetako Oribatida akaro komunitatearen kolonizazio eta garapena aztertzeko, basoan zeharreko 3 gune aztertu genituen (3 lagin). Basoa kareharriko meategi batetako zabortegi, errekuperatutako zabortegi, batean aurkitzen da, Poloniako iparraldean. Aukeratutako guneak adinean ezberdintzen ziren, 5 urte, 35 eta 50 urteko basoak, hain zuzen ere. Guztira, 30 laginetatik 499 akaro (Acari) erauzi ziren Tullgren inbituaren bitartez, horietatik 262 Oribatida zirelarik. Akaro guztien Ugaritasuna (N) aztertu genuen. Ondoren Oribatida indibiduoak, gazte zein helduak, determinatu eta ondorengo indizeak aztertu genituen: Ugaritasuna (N), Dominantzia (D), Espezie dibertsitatea (S), Espezie aberastasuna (s) eta Shannon dibertsitate indizea (H). Ikerketan zehar lortutako emaitzei dagokienez, Oribatida taldeak, ugaritasun handiena erakutsiz, dominantzia erakutsi zuen aztertutako multzo guztietan. (1.go lagina: 139 Oribatida /299 Acari. 2. lagina: 40/55 eta 3. lagina: 83/145). *Tectocepheus velatus* espezieak dominantzia altua erakutsi zuen 1.go gunean (45,99%); Shannon dibertsitate indizearen baliorik altuena 3.guneari zegokion. Bestlade, aztertutako gazteen ehuneko portzentaia helduena baino handiagoa izan zen, batez ere, 2.en

laginean (95,02%). Lortutako emaitzekin honakoa ondoriozta dezakegu; 1.go gunean lortutako oribatida akaroen ugaritasuna *T. velatus* espeziearen ugaritasun balioaren ondorioa da eta 3.gunea habitat aproposena da akaroentzat. Azkenik, lortutako gazteen portzentaia altuak, eremua aztertzen jarraitzea eskatzen du.

2. INTRODUCTION

Mites, with the exception of the open ocean, exist in every sort of terrestrial, aquatic, arboreal and parasitic habitat. They are not passive inhabitants of ecosystem; rather they are strong interactors, important indicators of disturbance in ecosystems and major components of biological diversity (Walter & Proctor, 1999). Mites play an essential part in the biological fertility of the soil and they affect soil energetic. Their activity contributes greatly to organic decomposition, the synthesis of humus, the restitution of biogenic elements, and the stimulation of fungal and bacterial metabolism (Rusek, 1975; Crossley, 1977; Lebrun, 1979; Norton, 1986). Microbes have limited abilities to move from one resource patch to another. Once biomass shuts down and remains dormant until new resources become available (Lavelle, 1997). Even the driest, hottest or coldest of soils are dominated by Acari, and its most evident representatives are Oribatid mites (Davis, 1963; Skubała, 1995).

Temperate forest with well-developed surface organic layers and a predominance of fungal over bacterial decomposition are home to the highest diversities of oribatids. Moss mites (Oribatida) can comprise about 50% of the total micro-arthropod fauna (González & Seasted, 2000). Densities of 50 000-250 000 or more mites per square metre in the upper 10cm of soil are commonly reported (Petersen, 1982).

Oribatids are characterized by low fecundity, long immature and adult life spans and a low capacity for population increase, whereas the opposite has been suggested for Acaridida, high fecundity and short immature and adult life spans (Lebrun & Van Straalen, 1995).Few Oribatid mites have modifications for dispersal, and those that do disperse as adults (Norton, 1994). As a result oribatid mites cannot easily escape from stress conditions (Behan-Pelletier, 1999). General life-history traits of oribatids have been considered typical of "*K*-selected" species (Norton, 1994) and "*K*-selected" species have long life span and late colonization (Baker, 1955).

Oribatid species and their communities offer several advantages for assessing the quality of terrestrial ecosystems (Lebrun & Van Straalen, 1995; Behan-Pelletier, 1999). Their high densities and diversities have been noted previously. They are easily sampled and they can be sampled at all seasons. It is noteworthy that oribatids are in close contact with defined micro-environmental conditions. Adult identification is relatively easy, most live in the organic horizons, the site of soil fertility, and they represent a trophycally heterogeneous group (Behan-Pelletier, 1999). When sudden changes occur, oribatids are unable to escape: they are sedentary or slow moving, lack marked dispersal mechanisms, and are therefore subjected directly to conditions of stress (Skubała, 2004).

The successional theory is one of the most important trends in the study of ecosystems, and research on dumps can contribute a lot to this approach (Starý, 1999). Dumps seem to be an excellent tool for the study of biological communities in relation to environmental gradients (Davis, 1986). Dumps offer a tremendous experimental field in which to study the colonization by animals and the development of their communities in this hostile environment (Skubała, 2004). Orbatid mites are especially useful in successional research, they are sensitive to small differences in environmental factors and they species pool is large (Verschoor & Krebs, 1995).

Many research have been done among the mite communities of dumps to contribute to the understanding of succession process. However, our understanding of oribatid community's structure and function is still far from complete (Wallwork, 1983). Reclaimed and non-reclaimed, dumps and post-industrial dumps have been studied to approach to the actual research (Skubała, 2004).

The aim of this investigation was to study the succession of mite community, especially Oribatids, in the succession of the Scots pine forest on a reclaimed limestone mine dump in Northern Poland. In order to see how such ecosystem affects the mite community. Thus, we could contribute to the actual research.

In our research we expected to find higher abundance of Actinedida and Acaridida mites at the young forest. In addition, it was predicted to find more mites as the succession of the forest was going further. Moreover, Oribatids were thought to obtain higher abundance within Acari mites in old forests. As far as the Oribatid community is concerned, we forecasted to find pioneer species in the youngest plot whereas in older plots more species were predicted to appear, more species characteristic of forest.

3. STUDY AREA

Our research took place in Piechcin (52º 49' 13''N 18º 02' 19''E), a village in the administrative district of Gmina Barcin, within Żnin County, Kuyavian-Pomeranian Voivodeship, in north-central Poland. It lies approximately 7 kilometres (4 mi) south-east of Barcin, 24 km (15 mi) east of Żnin, and 33 km (21 mi) south of Bydgoszcz. The village has a population of 3,186. A limestone quarry is situated there which provides limestone to the Lafarge cement factory. This quarry has been operational since 1860, and was acquired by the Lafarge Group in 1996 (www.wikipedia.org).
To sum up, Kuyavian-Pomeranian is the region with the lowest precipitation-rates in all over Poland (Woś, 2010).

Soil extracted from the quarry in order to remove the limestone, is placed around the quarry, in the areas where the limestone is too deep (30m) for digging. Thus, such zones had become dump. This dump had been reclaimed little by little; firstly by a soil layer with a slight amount of organic matter, after by grass and finally by plant association *Leucobryo-Pinetum*, where Scots pine (*Pinus sylvestris* L.) predominates.

The forest areas in Northern and Central Poland are covered mainly with Scots pine forests planted by men. In these forests Scot pine trees usually grow for about 100 years, and then they are cut down and replaced by a new generation of trees. Before the Scots pine culture is created, the soil is usually ploughed in rows, where trees are planted, which partly protect them from competition with various grasses. All these manipulations highly destroy the previous ecosystem, including the soil, so the succession of soil fauna begins with the succession of plants. In old Scots pine forests the soil is usually sandy and acid, and forms the moor humus type, with a well-developed organic layer. This layer is highly overgrown by mycelium and inhabited by many mites, in which oribatid mites predominate. Both mycelium and mites are very important factors which decay the soil organic matter and create soil fertility (Bukowski & Seniczak, 1998).

In this area, dump had been reclaimed by Scots pine forest piecemeal, thus, we can find young or older forests. In our study 3 plots which differ in age were chosen. Plot 1 belonged to a young forest of 5 year old. Plots 2 and 3 appertained to older forests, 35 and 50 years old, respectively.

Figure 1. Map of the limestone quarry. Cement factory and the dump with the tested plots.

This reclaimed dump is influenced by Lafarge factory. Therefore, due to the industry basic/neutral soil is characteristic of the area. The analyzed plots showed the following pH values respectively: 8,42; 7,80; 7,64.

4. MATERIAL AND METHODS

Samples were taken from a Scots pine forest of a reclaimed limestone mine dump on the 9th of November of 2012. To analyse the succession of the mite community, we chose 3 sites (plots) and determined the age of the trees of such an area. For that, we used a Pressler drill, which enabled us to reach to the heartwood. The selected plots were 5 years old, 35 and 50 years old forests. Due to have a representative data of the micro-arthropod community, we collected 10 samples from upper part of soil from each plot with a 50 cm^3 deep steel tube corer. Surplus soil was kept in a bag so as to analyze its properties. These are thought to be of importance in the pedogenesis of the plots and of possible significance to the mite fauna (Skubała, 2004).

Micro-fauna was extracted with litter profile inverted for 7 days (until thoroughly dry) on a modified Tullgren style high-gradient extractor, first exposed to 30ºC and then to less temperature. Micro-arthropods extracted were those capable of passing through a 1.5 x 1.5

mm screen mesh, and they were directly collected into bottles containing 75% ethyl alcohol. This is the most commonly used method for separating small arthropods from soil and litter (Behan-Pelletier, 1999).

Mites were separated from the alcohol and were collected in slides. From a total of 30 slides nearly 499 Acari mites were sorted into Acaridida, Actinedida, Mesostigmata, Oribatida and Tarsonemida by using Hammen (1972). For identification, mites were mounted on slides in Hoyer's liquid and examined under a microscope. Big adult oribatids which were stuck one to another were macerated in lactic acid. A total of 262 oribatids were determined to species or genus, both the juvenile and adult stages. The systematic classification proposed by Weigman (2006) was used for adult's identification. The juveniles of Oribatida were identified with help of Dr. Bogusław Chachaj from Department of Ecology, University of Technology and Life Sciences, Bydgoszcz, Poland, based on different publications.

Data of Acari communities were examined and characterised by abundance (N) [thousand individuals /m^2]; Oribatid mites were characterized by the following indices as well: Dominance (D) [% of the number of all individuals of all species], species diversity (S) [the effective number of different species that are represented in a collection of individuals] and species richness (s) [number of species per sample] (Skubała, 2004). Shannon's diversity index (H) was calculated so as to obtain the biodiversity, the species richness of the area (Gallardo- Mayenco & Shaw, 2008).

5. RESULTS

In total, 499 Acari mites were investigated, from which 262 were Oribatids. Assemblages from all the plots were dominated by Oribatids; Plot 1 showed 139 Oribatids from 299 Acari mites. In plot 2, from 55 Acaris 40 were Oribatids; and in plot 3, 145 Acaris and 83 oribatids were collected.

Thereby, Oribatids showed the highest dominance within mites in all the plots, followed by Actinedida. Mesostigmata was the 3rd most abundant order (Figure 1). Plot 1 was characterized by a dominance of 8,25% of oribatids, 5,90% of Actinedidas and 2,11% of Mesostigmatas. Plot 2 and 3 showed lower values of dominance for the three orders; Oribatids 2,41% and 4,70%; Actinedidas 0,72% and 2,77%; and Mesostigmatas 0,18% and

0,60%. Between plot 1 and 2, diversity dropped down, whereas from plot 2 to 3 a small increase was noticed. The decrease of Oribatids and Actinedidas were the most significant.

The less abundant orders, Acaridida and Tarsonemida, both were absent in plot 2. Plot 1 showed a dominance of 1,02% of Acaridida and 0,42% of Tarsonemida, while plot 3 had a 0,06% of Acaridida and 0,30% of Tarsonemida. The decrease in abundance was more significant for Acaridida than for Tarsonemida.

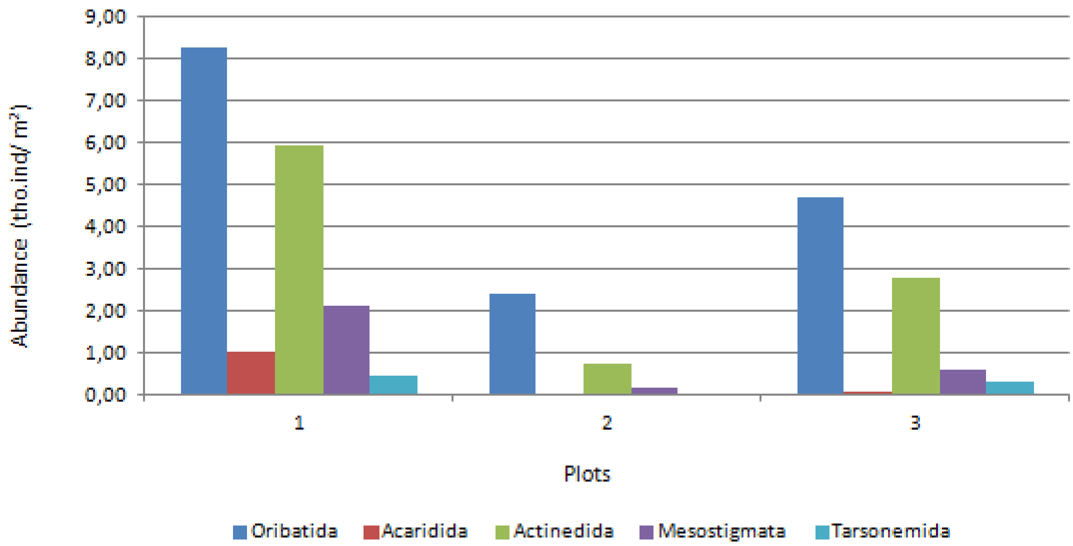

Figure 2. Abundance (N) [thousand individuals/ m^2] of the Acari in the investigated plots.

Oribatids were determined to 14 different species, some specimens were determined just to genus. Data of dominance (D) and abundance (N) of all the species showed that all mites had different conducts among the different plots (Table 1.). *Tectocepheus velatus* showed the highest value of dominance in plot 1 (45,99 %), being the second most dominant species in plot 2 (17,05%). A significant decrease in its abundance was noticed from plot 2 to 3 (from 3,79 tho.ind/ m^2 to 0,42 tho.ind/ m^2) . *Adoristes ovatus* takes up the first place in plots 2 and 3 with the dominance values of 35% and 19,23%, respectively. However, its abundance was slightly bigger in plot 3 (0,90 tho.ind/ m^2). *Oppiella nova* and *Brachychthonius* sp. having a considerable value of dominance in plot 1 (18,98%; 13,14% respectively), were absent in plot 2. Only *O. nova* showed a very low abundance in plot 3 (0,06 tho.ind/m^2). *Nothrus* sp. appeared in plots 2 and 3 with a appreciable dominance of 10,00% and 11,54%, respectively. To sum up, *Oribatula tibialis* and *Scheloribates laevigatus* were dominant species in plot 3.

These species did not occur in plot 2 and *O. tibialis* appeared with low abundance in plot 1 (0,36 tho.ind/ m^2).

Table 1. Dominance (D) [% of the number of all individuals of all species], and abundance (N) [thousand individuals/ m^2] of the oribatid species in the investigated plots.

Taxon	Plots					
	1		2		3	
	D	N	D	N	D	N
Adoristes ovatus (C. L. Koch, 1939)	2,19	0,18	35,00	0,84	19,23	0,90
Brachychthonius sp.	13,14	1,08	-	-	-	-
Carabodes subarcticus (Tragardh, 1902)	0,73	0,06	-	-	-	-
Damaeus sp.	-	-	-	-	3,85	0,18
Eupelops torulosus (G. L. Koch, 1939)	-	-	5,00	0,12	2,56	0,12
Galumna sp.	1,46	0,12	7,50	0,18	1,28	0,06
Metabelba pulverosa (Strenzke, 1953)	-	-	2,50	0,06	-	-
Nothrus silvestris (Nicolet, 1855)	-	-	2,50	0,06	-	-
Nothrus sp.	-	-	10,00	0,24	11,54	0,54
Oppiella 1	-	-	5,00	0,12	2,56	0,12
Oppiella nova (Oudemans, 1902)	18,98	1,57	-	-	1,28	0,06
Oribatula tibialis (Nicolet, 1855)	4,38	0,36	-	-	17,95	0,84
Phthiracarus sp.	0,73	0,06	-	-	2,56	0,12
Platynothrus peltifer (C. L. Koch, 1839)	-	-	-	-	6,41	0,30
Quadroppia quadricarinata (Michael, 1885)	-	-	-	-	1,28	0,06
Scheloribates laevigatus (C.L. Koch, 1835)	-	-	-	-	14,10	0,66
Scheloribates latipes (C. L. Koch, 1844)	0,73	0,06	7,50	0,18	8,97	0,42
Suctobelba sp.	2,92	0,24	-	-	-	-
Tectocepheus velatus (Berlese, 1913)	45,99	3,79	17,50	0,42	6,41	0,30
Trhypochthonius cladonicola (Willmann, 1919)	5,84	0,48	-	-	-	-
Trichoribates incisellus (Kramer, 1897)	1,46	0,12	2,50	0,06	-	-
Xenillus tegeocranus (Hermann, 1804)	-	-	2,50	0,06	-	-
Scutovertex sculptus (Michael, 1879)	0,73	0,06	-	-	-	-
Carabodes sp.	0,73	0,06	2,50	0,06	-	-
All		8,25		2,41		4,70

Adult (a) and juvenile's (j) percentages of the investigated plots were studied (Table 2). All in all, a higher percentage of juveniles were observed. Plot 1 and 3 had almost the same percentages (j: 78,06%;78,08%) (a: 21,94%;21,92%), whereas plot 2 had a really high juvenile percentage (95,02 %) and a very low percentage of adults (4,98%). Specimens from *Adoristes ovatus*, *Brachychthonius* sp. and *Oppiella nova* were 100% adults. *Nothrus* sp. appeared just in adult stage in plot 2, whereas more juveniles (55,55 %) than adults of the species were found in plot 3. Furthermore, the highest percentage of juveniles belonged to this species. *Tectocepheus velatus* and *Oribatula tibialis*, appeared in juvenile stages just in plot 1 (36,41%; 66,67**%** respectively). *Scheloribates laevigatus* not only did it appear in plot 3, but it appeared in both, juvenile and adult stages at very similar percentages (45,45% and 54,54%).

Table 2. Age structure of oribatid mites in the investigated plots [%]; juveniles (j), and adults (a).

Taxon	Age	Plots		
		1	2	3
Adoristes ovatus	j	-	-	-
	a	100	100	100
Brachychthonius sp.	j	-	-	-
	a	100	-	-
Carabodes subarcticus	j	-	-	-
	a	100	-	-
Damaeus sp.	j	-	-	100
	a	-	-	-
Eupelops torulosus	j	-	-	50
	a	-	100	50
Galumna sp.	j	-	-	-
	a	100	100	100
Metabelba pulverosa	j	-	-	-
	a	-	100	-
Nothrus silvestris	j	-	100	-
	a	-	-	-
Nothrus sp.	j	-	-	55,55
	a	-	100	44,44
Oppiella 1	j	-	-	-
	a	-	100	100
Oppiella nova	j	-	-	-
	a	100	-	100

Oribatula tibialis	j	66,67	-	-
	a	33,33	-	100
Phthiracarus sp.	j	-	-	-
	a	100	-	100
Platynothrus peltifer	j	-	-	20
	a	-	-	80
Quadroppia quadricarinata	j	-	-	-
	a	-	-	100
Scheloribates laevigatus	j	-	-	45,45
	a	-	-	54,54
Scheloribates latipes	j	-	-	28,57
	a	100	100	71,43
Suctobelba sp.	j	-	-	-
	a	100	-	-
Tectocepheus velatus	j	36,41	-	-
	a	63,59	100	100
Trhypochthonius cladonicola	j	37,5	-	-
	a	62,5	-	-
Trichoribates incisellus	j	-	100	-
	a	100	-	-
Xenillus tegeocranus	j	-	-	-
	a	-	100	-
Scutovertex sculptus	j	-	-	-
	a	100	-	-
Carabodes sp.	j	-	-	-
	a	100	100	-
Oribatids r	j	78,06	95,02	78,08
	a	21,94	4,98	21,92

Statistical indices showed that plot 1 and plot 3 had the biggest number of species (14), whereas plot 2 had less diversity (12) (Table 3). The highest values for the 3 index (S,s,H) were observed in plot 3. Plot 2 showed the smallest number of species per sample (2,70). Regarding to Shannon’s diversity index, the highest value belonged to plot 3 (2,29) while the lowest belonged to plot 1, the youngest forest (1,73).

Table 3. Number of species (S), number of species per sample (s) and Shannon index of diversity (H) of Oribatida in the investigated plots.

Index	Plots		
	1	2	3
S	14	12	14
s	3,10	2,70	4,00
H	1,73	2,05	2,29

6. DISCUSSION

Spoil heaps, created as a result of the activity of industrial plants, are inescapable elements of the landscape of industrial regions. They are found in concentration in the Upper Silesian region. The proportion of spoil heaps created by mining is highest in this region and is estimated at 72% (Jarzebski, 1997). Wastelands are constantly increasing in areas (Wanner *et al*., 1998). It seems obvious that dumps should at first be managed biologically, in this way the negative influence of dumps on the natural environment may be limited. Vegetation cover on dumps may develop naturally (Skubała, 2004). Although spontaneous succession of plants is more desirable, the spontaneous process of colonization and succession is a long-term process (Weidemann *et al*., 1982). Therefore, some dumps are reclaimed for faster and further studies. Such degraded land usually displays an extremely unpredictable future. Since a post-industrial dump differs in its physical and botanical structure from that of the surrounding vegetation, it may function as an ecological “island” (Majer, 1989). There is also a need to study artificial biotopes, those created by man. One of the reasons is because they form a significant part of our present landscape (Niedbała, 1972).

Among the different studies that have been made, it is worth to point out Skubała’s (2004) work, in which the colonization and development of oribatid mite communities was studied in 7 post-industrial dumps thoroughly from 1998 to 2002. They represent different types of dumps, having originated from the mining, iron metallurgy and zinc-processing industries. On most dumps there was no reclamation management, so the primary succession of soil communities proceeded more or less naturally. These data had been used to compare our own results.

As far as the proportion of Oribatida in the investigated assemblages is concerned, 262 oribatids were collected in total. We can ascertain that oribatids abundance predominated within Acariin all plots while the abundance of the other groups was smaller (Fig.1), despite the fact that the amount is not very big. Furthermore, the highest abundance of oribatid mites was found in the pioneer/colonizer community, plot 1 (8,25 tho.ind/ m^2), whereas plot 2 had the lowest abundance (2,41 thousands ind/ m^2). It should be pointed out that the second most abundant group, in all plots, was Actinedida.

Most authors agree that oribatids are slow colonizers and that other groups of mesofauna prevail over them during succession for many years (Skubała, 2004). According to Skubała's results, this pattern is followed in most of the studied pioneer communities on non-reclaimed dumps. Representatives of Actinedida and Acaridida prevailed over oribatids on these dumps. However, on two partly-reclaimed dumps, at Biskupice and Murcki, Oribatids were the dominant (12695 ind./m^2) group among mesofauna at the pioneer stage of succession. Something similar was seen on a reclaimed brown-coal spoil heaps in Germany. Oribatid mites were relatively important during the first stages of soil formation followed by a significant abundance of Actinedida (Dunger, 1968).
Although this has not been seen on newly reclaimed dumps, on a coal pit heaps in England-up to 300 ind./m^2 oribatids were collected (Hutson, 1980) and on an ash dump in Poland- fewer than 500 ind./m^2 (Bielska & Paszewska, 1995).

Values of dominance differ significantly within the plots. In plot 1, *Tectocepheus velatus* showed a 45,99% of dominance between all the species, whereas the 2^{nd} most dominant species, *Oppiella nova*, showed a lower value: 18, 98%. In plots 2 and 3 *Adoristes ovatus* takes up the first place. It could be clearly seen that a decrease of dominance had been given there (35% and 19,23%; respectively). Besides, *A. ovatus* and *Oribatula tibialis* showed very similar dominance values in plot 3. Therefore, we can conclude that the high abundance of oribatids in plot 1 is due to the abundance of *T.velatus* (3,79 tho.ind/ m^2) since it constituted almost the half of the dominance.

Skubała marked that even dumps of a similar type were characterized by a totally different set of dominants. However, *T. velatus* and *O. nova* were the only species appearing as dominants in most of the sites. Therefore, they are the most important species that are able to attain a high abundance in almost all of these unfriendly habitats (dumps). They are considered to be early successional species, which means that they do not lose their status with increasing age of the dumps (Skubała, 2004).

In fact, *T. velatus* is the most frequent and common species. It is an extremely ubiquitous species with very wide ecological tolerance (Aoki, 1967; Luxton,1981a). Presumably, due to its parthenogenetic mode of reproduction, the species recovers quickly from disturbance (Norton *et al*., 1993). It has a total lifespan of less than a year and it is known to colonize new habitats quickly (Norton, 1994; Skubała, 1995). *Oppiella nova* shows a rather high humidity requirement (Rajski, 1967). Taking into account the precipitation-rates of the area, we can conclude that clime might help in the occurrence of the species. Nevertheless, it disappeared from plot 1 to 2 and occurred with a small abundance in plot 3 (0,06 tho.ind/ m^2).

Figure 3: *Tectocepheus velatus* image in the microscope (x40).

Figure 4: *Oppiella nova* image in the microscope (x40).

Ph values showed an acidification process as the forests become older. Plot 1 had a 8,42 value for this factor, while plot 3 showed a slightly lower value (7,64). pH significantly influence the rate of ecosystem transition through a certain stage (Dunger, 1968). pH is one of the prime factors responsible for changes in abundance and community structure of oribatid mites (Koskenniemi & Huhta, 1986; Lebrun & Van Straalen, 1995). This basic/neutral soil might be influenced by Lafarge factory.

Adoristes ovatus was found in north Germany only in wet and humid layers of raw humus in acid forest soils (Strenzke, 1952). It occurs in coniferous and deciduous forests (Peus, 1932). In pine forest is fairly abundant with uniform distribution, thus, we can suppose this habitat to be optimal (Rajski, 1967). However, in accordance with our results, it showed the highest abundance (0,90 tho.ind/ m^2) in plot 3, where the lowest pH value was found.

Figure 5: *Adoristes ovatus* image in the microscope (x40).

Oribatula tibialis with the dominance value of 17,95% and *Scheloribates laevigatus* (14,10%), together with *A. ovatus,* dominanted plot 3 showing no presence at other plots except *O. tibialis* that appeared with low abundance in plot 1 (0,36 tho.ind/ m^2). *Oribatula tibialis* did not show significant preference for any site in Skubala's work. Besides, it had been observed on post-industrial dumps in the past, but in low numbers (Żbikowska-Zdun, 1988; Bielska, 1989; Madej & Skubała, 1998).

On the other hand, *S. laevigatus* can be considered as a form characteristic for meadows as the highest indices of occurrence are usually in this habitat (Frenzel, 1936). However, regarding to our results, it was found just in plot 3. Both, *Scheloribates latipes* and *S. laevigatus* species are known from dumps. Regarding to their occurrence, *S.latipes* is sensitive to habitat complexity, while *S. laevigatus* is sensitive to pH. Just *S. laevigatus* has been recorded as dominant (Babenko, 1980; Bielska, 1982; Skubała, 1998). According to our data, *S. laevigatus* occurred in the oldest forest, but at the same time were the lowest pH was found.

Fauna is richer in species and less dominated by a single species on the older sites (Giller, 1996). In accordance with the results we have obtained, dominance decreased as the succession of the forest went further but species richness did not vary much.

Regarding to species diversity, it could be seen that even if the highest abundance belonged to plot 1, plot 3 was the one that showed the highest value for Shannon diversity index (table 3). Although species richness did not increase (14), species number per sample was a little bit higher (1,73; 2,29). Nevertheless, species richness is not very specific as there are some specimens that had been determined just by the genera. Considering diversity values shown, we can conclude that old forest (plot 3) is a better habitat for species.

Comparing with Skubała's results, it should be considered that at Biskupice, despite the fact that a significant higher abundance of oribatids (as we have already seen), species richness, and an extremely high proportion of juveniles (76%) was observed, species diversity was generally low. Besides, at Makoszowy and Biskupice, the increase of this index was related to an increase in species number.

Going back to specimens of oribatid community; Phthiracaridae was found in plot 1 with a not very significant abundance and its abundance doubled in plot 3 (0,12). All the inmature stages of this group are endophagous, burrowing in decaying plant material and it may exist in a habitat without threat from enemies (Norton, 1994). Adults may live for more than one year (Luxton, 1981b). Therefore, it has obstacles in the ability of the species to colonize new habitats. However, it showed appearance in plot 1, in the youngest forest.

Scutovertex sculptus and *Brachychthonius* are sprinters, their abundance noticeably decreased at older sites (Skubała, 2004). Such a phenomenon could be noticed with *Brachychthonius* sp. It was a dominant species at plot 1 and then showed no presence at all. *Scutovertex* appeared with a very low abundance (0,06 tho.ind/ m^2), so it is not very significant. *Damaeus* sp. appeared in plot 3 with quite a low abundance (0,18 tho.ind/ m^2) and just in juvenile stages. It is considered to be a rare species (Rajski, 1967).

It is worth mentioning that, in all plots, juvenile stages predominate among oribatid specimens. The highest percentage of juveniles belonged to plot 2 (95,02%), whereas a similar percentage was observed for plots 1 and 3 (78,06% and 78,08%, respectively)(table2). Data obtained at plot 2, showed such a big amount of juveniles that leads us to think of doing another research in the area, maybe in spring. Our samples were taken in autumn and many authors have cited: oribatids are most abundant during spring and autumn in the European climate (Block, 1966; Harding, 1969; Schenker, 1986).

Moreover, possibly there are many ways of passive or active dispersion of oribatid mites over a longer distance, which play a role in a dump's colonization. Oribatid mites undoubtedly are dispersed by wind current from one site to another (Lindroth *et al.*, 1973; Behan-Pelletier & Winchester, 1998; Starý & Block, 1998). Oribatid nymphs were carried by air currents (Whelan, 1978). However, wind is not a characteristic of a Scots pine forest so this might not play any role in our case.

Successional oribatid communities can differ noticeably with regard to abundance, specie richness, diversity, proportion of juveniles, or set of dominant species. Environmental factors that influence the differentiation between pioneer oribatid communities are also variable. We can consider that this reclaimed dump is influenced by Lafarge factory. Therefore, industry might be responsible for the basic/neutral soil that had been found and thus, can influence the microhabitat.

7. CONCLUSIONS

1. The high value of oribatid's abundance in 5-year old forest on the dump near cement factory is due to *Tectocepheus velatus*. It constituted almost 50% of the dominance within the species since it is a tolerant species to pollutions.
2. Shannon H index, leads us to conclude that 50 year old forest is a better habitat for species than young forests.
3. The high percentage of juveniles founded in autumn in plot 2 should be considered a reason to research in spring.

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