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ORIBATID FAUNA (ACARI: ORIBATIDA) OF ABANDONED GALENA-CALAMINE WASTELANDS

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FAUNA MECHOWCÓW (ACARI: ORIBATIDA) NA NIEUŻYTKACH GALENO-GALMANOWYCH

Streszczenie

W pracy zaprezentowano podsumowanie wyników badań nad fauną mechowców (Oribatida) prowadzonych na różnego typu nieużytkach galeno-galmanowych w Polsce południowej. Próby glebowe pobierano na 9 stanowiskach usytuowanych w trzech rejonach górnictwa rud cynku i ołowiu. W pracy analizowano materiał obejmujący ogółem 24267 osobników z rzędu Oribatida należących do 160 gatunków. Analizowane stanowiska różniły się okresem kiedy zaprzestano na nich eksploatację, składem gatunkowym roślinności i stopniem jej sukcesji. Zagęszczenie i bogactwo gatunkowe mechowców (Oribatida) było wyższe na zalesionych stanowiskach i stanowiskach wcześniej ukształtowanych. Zagęszczenie Oribatida na nieużytkach było ogólnie niższe niż w wielu naturalnych czy semi-naturalnych biotopach. Godnym podkreślenia jest fakt, że bogactwo gatunkowe roztoczy na zalesionych stanowiskach warpii było wyższe niż w wielu naturalnych lasach. W analizie klasterowej wyróżniono dwie grupy zgrupowań Oribatida na „młodych" i „starych" nieużytkach galeno-galmanowych. Ponadto zauważono, że charakter zadrzewień (liściaste lub iglaste) nie wpływał na grupowanie się zespołów mechowców. W oparciu o analizę korespondencji (CA) wyróżniono gatunki charakterystyczne dla poszczególnych typów galeno-galmanowych nieużytków. Występowały gatunki charakterystyczne dla zalesionych nowych nieużytków, warpii oraz roztocze typowe dla nieużytków niezalesionych. Bioróżnorodność fauny mechowców odnotowanych na badanych stanowiskach należy ocenić jako bardzo wysoką. Wystąpiło tutaj 15 gatunków nowych dla fauny Polski, niektóre z nich znane są tylko z pojedynczych stanowisk w świecie.

Summary

The recapitulation of the investigations on oribatid mite fauna carried out at various kinds of abandoned galena-calamine wastelands in the south of Poland is presented. Soil samples were collected at nine sites in three regions of zinc-lead mining. In total, 24267 oribatid individuals belonging to 160 species were analyzed. The sites differing in the period of ceasing exploitation, species composition of plants and their stage of succession were chosen. The abundance and species richness of oribatid mites were generally higher on afforested sites and sites of older origin. The abundance of oribatids noted on wastelands was generally lower than in most natural or semi-natural biotopes. Surprisingly, the species richness on afforested wastelands was higher than in many natural forest biotopes. With regard to species similarity, the oribatid communities have been grouped due to localities instead of been organized due to the type of wastelands or vegetation. Correspondence analysis (CA) indicated that certain species of Oribatida preferentially occurred in a certain type of wastelands. Species characteristic of afforested new and old or unforested wastelands were distinguished. The biodiversity of oribatid fauna on galena-calamine wastelands was high with many new species for the Polish fauna (15). Some of them were recorded only from a few localities in the world.

INTRODUCTION

The exploitation of zinc, lead and silver ores had a long tradition in Poland. These easily attainable metal ores have been extracted since the early Middle Ages. Exploitation was carried out at different intensities, both in space and in time. It caused the entire transformation of the landscape. Moreover, the changes had a mainly devastating character and totally changed the morphology as well as the hydrographic and floral conditions [6]. As a result of opencast zinc-lead mining activity a large, so-called abandoned galena-calamine wasteland, was created between Tarnowskie Góry and Olkusz (southern Poland). These areas are characterized by misshapen and grooved surfaces with numerous depression, ditches and hillocks. There are plenty of such areas where the exploitation has stopped at various times.

There are many publications on spontaneous development of vegetation on various kinds of post-industrial wastelands [15]. Some authors stress the fact that ironically the poor quality of the substrates forming industrial waste tips often render them peculiarly suitable for the spontaneous development of unusual vegetation and the survival of uncommon species [23]. The data on the development of soil fauna on post-industrial wastelands are still scarce.

The development of oribatid mite communities on abandoned galena-calamine wastelands has been described in a series of publications [9, 10, 18, 19, 22]. In this paper a recapitulation of the results is presented. Sites where the exploitation has been stopped at various times have been compared. Species characteristic of specific kind of biotopes, created as a result of ores exploitation, are described. The biodiversity of oribatid fauna on zinc-lead wastelands is estimated.

MATERIAL AND METHODS

The sampling was carried out at monthly intervals in years 1988–1990. Mites were obtained from 60 to 150 soil samples depending on an investigated site. In total, 690 samples were collected. Samples were taken at random from a representative quadrate (10 x 10 m) to a depth of 7.5 cm using a cylindrical steel corer with working area 18 cm^2. In the laboratory, soil cores where placed in Tullgren funnels with 2-mm mesh for 5 days. Adult oribatid mites were determined at species level. More information on methods can be found in the mentioned above papers. Large material containing 24267 oribatid specimens belonging to 160 oribatid species was studied.

The Sörensen's quotient of similarity [5] was used to create resemblance matrices of pairwise comparisons among all sites. The resemblance matrices were then analyzed by the hierarchical cluster analysis employing an unweighted pair-group method with arithmetic averaging (UPGMA) [14]. The species composition of the oribatid communities was examined by means of correspondence analysis [4, 7]. Only dominant species (with dominance index higher than 5%) were analyzed. The first analysis was done with STATISTICA program and the second using the MVSP program.

SITE DESCRIPTION

There were three regions of zinc and lead mining in Poland. The exploitation was stopped at most of localities [8]. Some sites of investigation were chosen in each region (Fig. 1). In the „Tarnowskie Góry – Bytom" region soil samples were taken on the old abandoned galena-calamine wasteland in the „Segiet" Reserve. The spontaneous succession led to the development of a beech forest of the *Dentario glandulosae-Fagetum* type [19]. The second well-known region of mining is the area between Olkusz and Trzebinia. Two study plots were located at Galman. Site I was greatly overgrown by Scots pine (*Pinus silvestris* L.) and Austrian pine (*Pinus nigra* Arnold). Site II had a uniform canopy layer consisting of beech (*Fagus silvatica* L.) [9]. Furthermore, samples were taken at Bukowno. Four study sites were chosen differing in age of pilling, species composition and their stage of plant succession. The investigated area has been deeply modified by mining carried out for the last ten years [18]. The remaining sites were chosen in Korzeniec. It belongs to the „Siewierz – Chrzanów" region of zinc-lead mining. Site I (afforested) was greatly overgrown by Scot pine and site II (unforested) was situated on the wasteland with *Trifolio-Geranietea Sanguinei* [10]. The detailed data concerning description of sites are found in the mentioned articles.

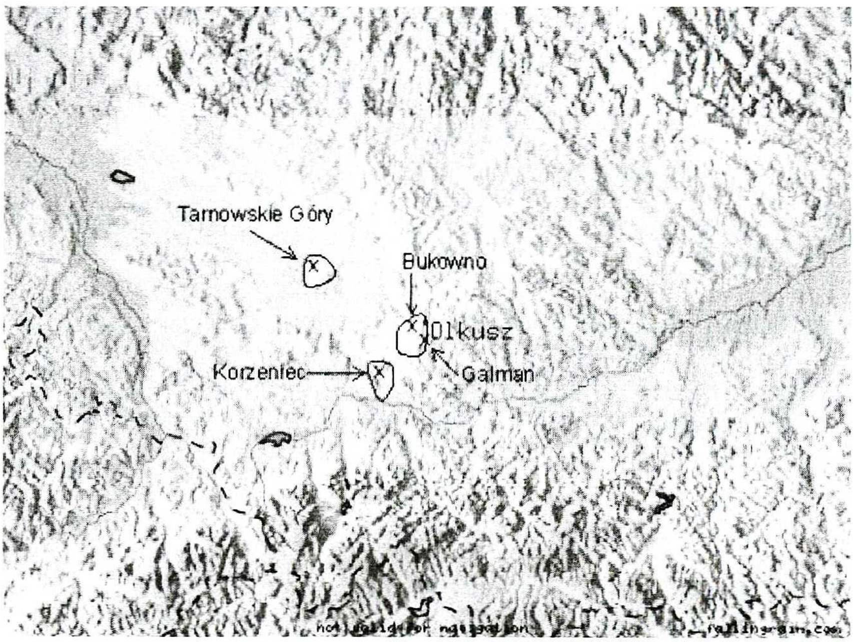

Fig. 1. Regions of zinc and lead mining in Poland and localities of sampling.

RESULTS AND DISCUSSION

The abundance of oribatids recorded on afforested sites of abandoned galena-calamine wastelands varied from 8954 indiv./m^2 (Bukowno III) to 51792 m^2 (Galman – pine) (Fig. 2). The number of oribatids was generally lower on sites at Bukowno, which represents youngest zinc-lead wastelands. In natural forests, especially coniferous ones, abundance of oribatids can be much higher, e.g. in the pine forest in Puszczykowo [13]. However, in some natural forests, e.g. in the pine forest at Złoty Potok [2], the number of mites was lower than on the investigated site at Galman (pine). With regard to deciduous forests, the abundance of oribatids at Galman (beech) or Segiet was higher than in the beech forest in the „Pod Rysianką" Reserve [20].

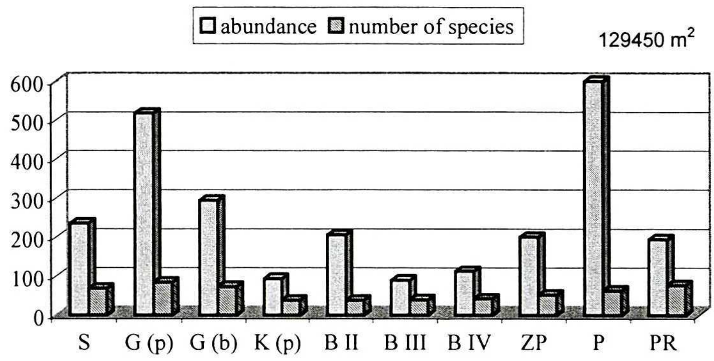

Fig. 2. Abundance of oribatids (100 indiv./m²) and species richness on afforested sites on galena-calamine wastelands and in similar biotopes.

S – Segiet
G (p) – Galman (pine)
G (b) – Galman (beech)
K (p) – Korzeniec (pine)
B II – Bukowno II
B III – Bukowno III
B IV – Bukowno IV
ZP – pine forest at Złoty Potok [2]
P - pine forest at Puszczykowo [13]
PR – beech forest, „Pod Rysianką" Reserve [20]

Similarly, the species richness on the younger zinc-lead wastelands was significantly lower than on older ones. It varied from 38 species (Bukowno II and Korzeniec – pine) to 84 at Galman (pine) (Fig. 1). Surprisingly, the number of oribatid species observed on old galena-calamine wastelands was even higher than in many natural forests.

The abundance of oribatids noted on unforested wastelands (Korzeniec, Bukowno I) was about 5000 indiv./m^2. It was significantly lower than on different kinds of open biotopes of natural or anthropogenic origin (Fig. 3). The number of species (28 and 26 species) was also lower than in other open biotopes. However, the difference was small.

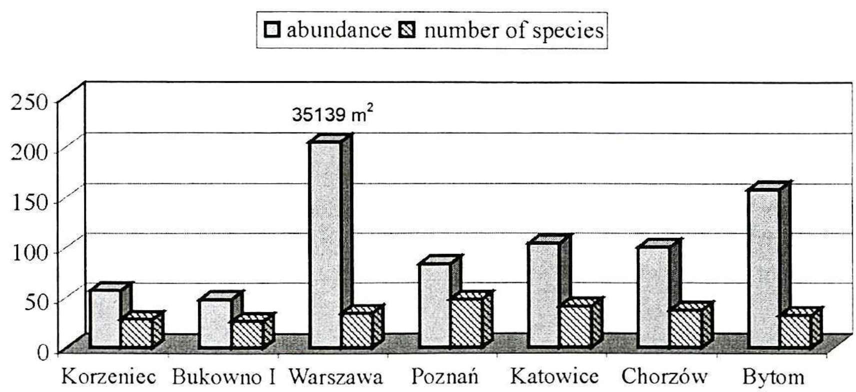

Fig. 3. Abundance of oribatids (100 indiv./m^2) and species richness on unforested sites on galena-calamine wastelands and in open biotopes.

Warszawa – meadow [11]
Poznań – meadow [13]
Katowice – lawns [21]
Chorzów and Bytom – metallurgic dumps [17]

Species similarity amidst oribatid mite communities sampled at nine sites is illustrated in Fig. 4. Although in this figure the sites were divided into two main clusters, these enclose some subgroups that must be explained. One cluster grouped all oribatid communities from galena-calamine wastelands at Bukowno. They are sites where the exploitation was stopped significantly later than on other localities. In the cluster, the site I is separated from others. It is the only site without trees covering the area. The second cluster may be divided into three sub-clusters. These clusters contain sites from different localities (Korzeniec, Galman and Segiet). The oribatid community from the „Segiet" Reserve forms a separate cluster in the figure. It was the site where the succession proceeded longest and led to the well-developed beech forest. The separation of the unforested sites (Bukowno I and Korzeniec) as well as sites with similar type of trees (e.g. Galman – pine and Korzeniec – pine) was not observed. It may be concluded that the influence of the local fauna on the development of oribatid mite communities on galena-calamine wastelands is strong. It was reflected by the specific grouping of sites according to localities instead of being grouped due to a type of wasteland or vegetation.

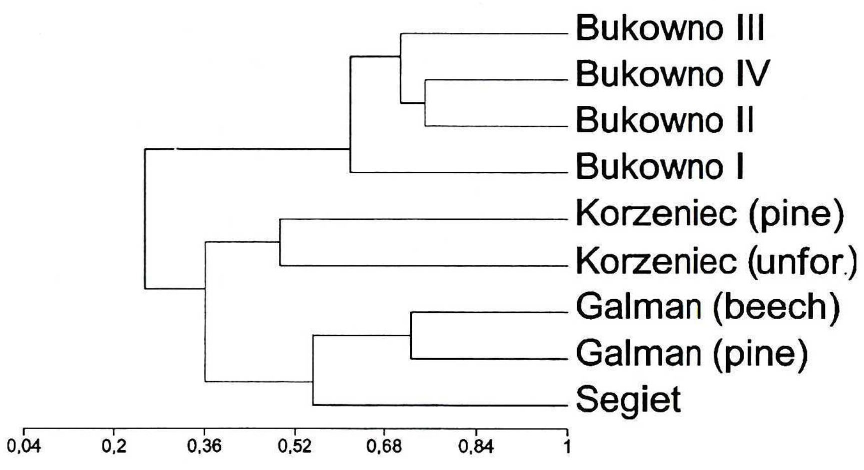

Fig. 4. Cluster analysis of qualitative community data at investigated sites (UPMGA method, Sörensen's index).

The species composition of the oribatid fauna was examined by means of correspondence analysis (CA) (Fig. 5). CA was performed to extract the major patterns of covariation in both species composition and population size among communities. The similarity patterns of species were well-reflected using CA ordination, which position species within a coordinate system. Only species which attained over 5% of the whole number on at least one investigated site were selected for the analysis.

The graph displays an ordination of the data according to the first and second axis of ordination, which explained 40.4 per cent and 23.2 per cent of the total variance. The eigenvalues of the axes are 0.52 and 0.30, respectively. The distribution of species in the factorial plane of the axis 1 and 2 of the analysis of correspondence shows four well differential groups. The species typical of new abandoned galena-calamine wastelands (Bukowno) are grouped in the negative part of the axis 1. Seven species formed this group, e.g. *Achipteria nitens* (Nicolet, 1855), *Eupelops tardus* (C.L. Koch, 1836), *Oribella paolii* (Oudemans, 1913) and *Pergalumna nervosa* (Berlese, 1914). Some species were previously observed as dominants on post-industrial wastelands (e.g. *Zygoribatula exilis* (Nicolet, 1855), *Eupelops tardus* or *Protoribates capucinus* (Berlese, 1908) [1, 17, 25]. The other species (e.g. *Achipteria nitens*, *Oribella paolii* and *Tegoribates sp.*) were not found on other post-industrial wastelands. Species characteristic of old abandoned galena-calamine wastelands are distributed in the positive part of the same axis. Eight species belong to this group, e.g. *Dissorhina ornata* (Oudemans, 1900), *Lauroppia falcata* (Paoli, 1908) or *Suctobelbella subcornigera* (Forsslund, 1941). Some of these species are well known as forest species, e.g. *Lauroppia falcata*, *Chamobates voigtsi* (Oudemans, 1902) or *Metabelba pulverulenta* (C.L. Koch, 1839). Others are eurytopic species [16]. The species ordinated close to the left end of the second axis are those displaying their highest abundance on unforested sites, e.g. *Scutovertex sculptus* Michael, 1879 and *Protoribates variabilis* Rajski, 1958. The former is a species typical of open habitats, whereas the latent is eurytopic species [16, 24]. The remaining species, ordinate close to the cross section of both axes, are those displaying no preferences to any sites. *Oppiella nova* (Oudemans, 1902) is a typical member of this group as one of the widest distributed oribatid in the world. Other species, e.g. *Achipteria coleoptrata* (Linné, 1758), *Oribatula tibialis* (Nicolet, 1855) or *Hemileius initialis* (Berlese, 1908) are also eurytopic species of cosmopolitan distribution [16].

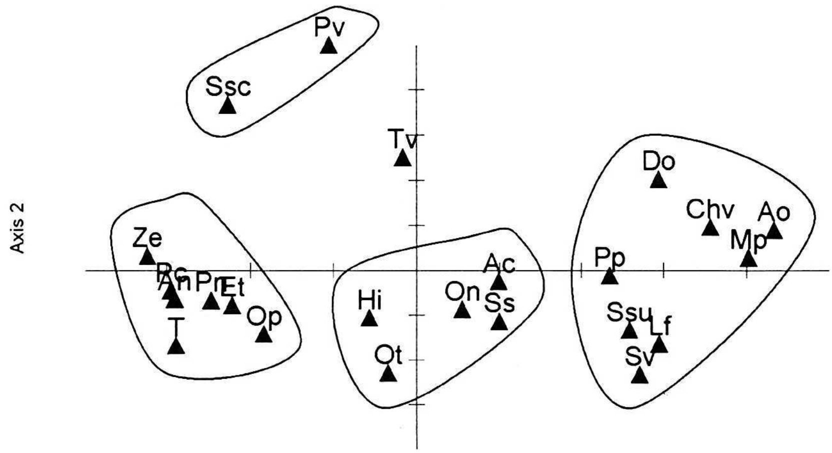

Fig. 5. Correspondence analysis (CA) of dominant oribatid species on abandoned galena-calamine wastelands

Ac – *Achipteria coleoptrata*	Pn – *Pergalumna nervosa*
An – *Achipteria nitens*	Pc – *Protoribates capucinus*
Ao – *Adoristes ovatus*	Pv – *Protoribates variabilis*
Chv – *Chamobates voigtsi*	Pp – *Punctoribates punctum*
Do – *Dissorhina ornata*	Ssc – *Scutovertex sculptus*
Et – *Eupelops tardus*	Ss – *Suctobelbella sarekensis*
Hi – *Hemileius initialis*	Ssu – *Suctobelbella subcornigera*
Lf – *Lauroppia falcata*	Sv – *Suctobelbella vera*
Mp – *Metabelba pulverulenta*	Tv – *Tectocepheus velatus*
On – *Oppiella nova*	T – *Tegoribates sp.*
Ot – *Oribatula tibialis*	Ze – *Zygoribatula exilis*
Op – *Oribella paolii*	

Finally, some general remarks on the biodiversity of oribatid mites occurring on this type of wasteland seem to be worthwhile to consider. In total, 160 oribatid species were found on nine sites. It is about 30% of the total number of oribatid species recorded in Poland so far [12]. Furthermore, 15 species new for the Polish fauna were found at these several localities (Table 1). Some of the species have hitherto been reported only from few localities in the world. For example *Oribatula longelamellata* Schweizer, 1956 was recorded only twice from Switzerland [3] (Fig. 6). Others, e.g. *Nanhermannia sellnicki* Forsslund, 1958; *Machuella draconis* Hammer, 1961 or *Galumna rossica* Sellnick, 1926 have not been additionally recorded in Poland.

Table 1. Oribatid species new for the Polish fauna of the abandoned galena-calamine wastelands

1. *Nanhermannia sellnicki* Forsslund, 1958 (Bukowno)
2. *Suctobelbella baloghi* (Forsslund, 1958) (Galman)
3. *Suctobelbella bella* (Berlese, 1902) (Galman, Segiet)
4. *Suctobelbella messneri* Moritz, 1971 (Bukowno)
5. *Licnoliodes andrei* Grandjean, 1931(Bukowno)
6. *Eremaeus tuberosus* Gordeeva, 1970 (Galman, Segiet)
7. *Tectocepheus minor* Berlese, 1903 (Galman, Segiet)
8. *Machuella draconis* Hammer, 1961(Bukowno)
9. *Quadroppia michaeli* Mahunka, 1977 (Galman)
10. *Qadroppia paolii* Woas, 1986 (Galman)
11. *Oppiella orientata* Rjabinin, 1975 (Galman)
12. *Galumna rossica* Sellnick, 1926 (Bukowno)
13. *Oribatula longelamellata* Schweizer, 1956 (Bukowno)
14. *Zygoribatula trigonella* (B.-Z., 1967) (Segiet)
15. *Trichoribatella baloghi* Mahunka, 1983 (Korzeniec)
16. *Tegoribates sp.* (Bukowno)

The data were previously published in the separate papers [3, 9, 10, 18, 19, 22].

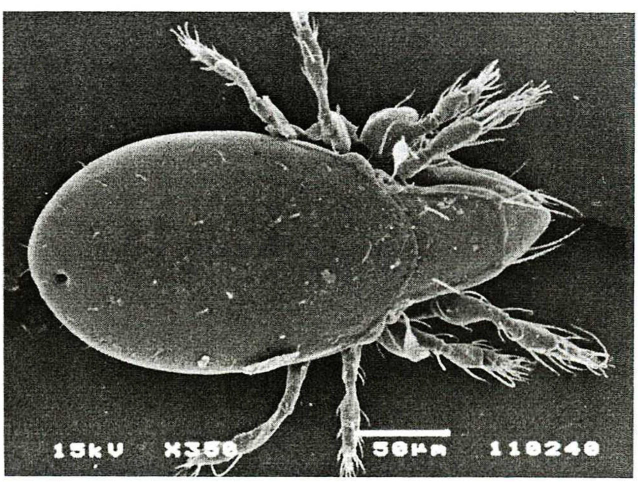

Fig. 6. *Oribatula longelamellata* Schweizer, 1956 – new species for the Polish fauna, previously recorded only in Switzerland

CONCLUSIONS

1. The abundance of oribatids recorded on abandoned galena-calamine wastelands is generally lower than in most natural or semi-natural biotopes. With regard to species richness on afforested wastelands, it is higher than in many natural forest habitats.
2. The species composition of oribatid communities on different kinds of investigated wastelands is formed under the strong influence of the local mite fauna.
3. Several groups of oribatid species typical of different kinds of galena-calamine wastelands can be distinguished. There are species characteristic of old abandoned wastelands, e.g. *Dissorhina ornata*, *Lauroppia falcata* or *Suctobelbella subcornigera*. Different species dominated at new wastelands, e.g. *Achipteria nitens*, *Eupelops tardus* or *Pergalumna nervosa*. They were also species typical of unforested wastelands, e.g. *Scutovertex sculptus* and *Protoribates variabilis*.
4. The biodiversity of oribatid fauna on galena-calamine wastelands is comparatively high with many new interesting rare species recorded for the first time from the territory of Poland.

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