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IM. JANA I JĘDRZEJA ŚNIADECKICH
W BYDGOSZCZY

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Contents

Spis treści

In Memoriam

Professor B. Kiełczewski (on the left) after receiving the title of doctor honoris causa. Professor J. Rafalski (on the right) congratulates him for this honoured title (photo by M. Skorupski)

On 6 February 1998, Professor Dr. hab. Bohdan Kiełczewski, Dr. h.c., a retired professor of Forest Faculty of the Agricultural University in Poznań died. He was recognised as a great professor for his wide scientific, didactic and organising activity and uncommon friendliness to all his co-workers and students.

Professor Kiełczewski was born on 7 July 1912, in Kowno. He graduated from the Faculty of Agriculture and Forestry at Adam Mickiewicz University in Poznań, and serving as an engineer of forestry he began his work in Potoczek Forest. During World War II he participated in the battle near Bzura and in the defence of Warsaw, and was active in the military underground AK structures.

After World War II Professor Kiełczewski began his scientific and didactic work in the Department of Zoology and Entomology at Adam Mickiewicz University in Poznań. In 1945 he finished his doctoral thesis and was promoted as a doctor. In 1949 he finished his thesis qualified him as an assistant professor in the Department of Entomology, Forest Faculty of the Agricultural University in Poznań, but was promoted to this position not before 1955. In 1968 he was promoted to full professor. In 1982 he retired, being still active in scientific research and didactic duties, taking care of students who prepared their master's dissertations. For his great scientific, didactic and organising activity, the Agricultural University in Poznań honoured him in 1992 with the title doctor honoris causa.

Professor Kiełczewski wrote over 150 papers, which were published in France, Germany, USA, Great Britain and Poland. These papers considered a wide field, including such problems as forest, nature and environmental protection, forest inspirations in art, biorhythms, biometeorology, cosmoecology etc. Most papers were devoted to arachnids and insects. Many of them concerned the ecology and taxonomy of mites which inhabited forests (trees and soil), corn-elevators and were connected with insects and mammals. He paid considerable attention to the function of these animals in the environment, especially to predatory mites, which play a great role in forest ecosystems. This research was supported by the US Department of Agriculture in Washington and was honoured with a diploma. He also investigated some other factors like supersonic, ionisation of the surface of insects and cybernetic connections to populations of forest insects, which are very important for forest homeostasis, was also investigated. For his great scientific activity on the field of acarology, other acarologists honoured Professor Kiełczewski by naming six new mite species with his name. These species are the following:

Trichouropoda kielczewskii Wiśniewski, 1977,
Proctolaelaps kielczewskii Wiśniewski, 1979,
Bakerdania kielczewskii Metwali, 1981,
Cunaxoides kielczewskii (Michocka, 1982),
Dendrolaelaps kielczewskii Skorupski et Gwiazdowicz, 1992,
Dinychus kielczewskii Wiśniewski, 1992.

Professor Kiełczewski wrote 11 books for students, and promoted 120 masters and seven doctors of forestry. He also reviewed many doctoral theses and the theses or opinions of candidates for assistant and full professorship.

Professor Kiełczewski was very active in the organisation of research and didactic duties. For many years he was head of the Department of Forest Protection, and for some years the pro-dean of Forest Faculty at the Agricultural University. He also worked in the Academy of Sport Education in Poznań and for some years was the pro-rector in this Academy. He was a chairman or member of many scientific organisations like the Counsel of Wielkopolski National Park, the Counsel of Forest Culture Centre in Gołuchów, the Counsel of Institute of Plant Protection and others. For all this activity he was an honorary member of the Polish Society of Forest, the Poznań Society of Patrons of Science, the Polish Society of Entomology and the League of Nature Protection. For the scientific, didactic and organising activity, Professor Kiełczewski was distinguished with many Polish medals like Krzyż Kawalerski, Oficerski and Komandorski Odrodzenia Polski, Medal Komisji Edukacji Narodowej, Medal za udział w wojnie obronnej, Krzyż Armii Krajowej, and with many prizes from the Ministry of Education and rector of the Agricultural University in Poznań .

Stanisław Seniczak
Maciej Skorupski

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ZESZYTY NAUKOWE NR 214 - OCHRONA ŚRODOWISKA 2 (1998) 13-16

RELATIONSHIPS OF ERIOPHYOID MITES (ERIOPHYOIDEA) TO THEIR HOST PLANTS

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Synopsis. The relation of the world eriophyoid mites to their host plants was compared to the species known in China, Yugoslavia, Poland and Czech Republic. The frequency of occurring of vagrant species, causing rusting and discoloration, erineum, galls, leaf rolling and virus transmission was computed in these countries.

Key words: eriophyoid mites, host plants, plant-mite relationship, plant injury

1. INTRODUCTION

More than 3300 species of eriophyoid mites (Eriophyoidea) are known over the world. Most of them are host specific, attacking all flowering plants, conifers and ferns parts-except roots. Species known to attack plants belonging to different families may represent species complexes [4]. It is estimated that no more than 1-2% of existing species have been described till now. Up to middle of 1981 [3], 1859 species and up to January 1993 [1] - 2833 were known. This indicates that about 85 new species are described each year. There are about fourty eriophyoidologists describing new species in the world now: in the USA, India, China, Thailand, Japan, Brazil, New Zealand, Australia, South Africa, Egypt, Russia, Italy, Yugoslavia and Poland.

2. MATERIAL

During the past years the catalogues of world fauna [1] and of China [7], Yugoslavia [5] and Czech Republic [6] were prepared. Including the data of Poland [2] I was able to compare the relation of the eriophyoid mites to their host-plants (Tab.1).

Table 1. Relation of eriophyoid mites (%) to host plants (* on trees and shrubs only)

Types of relation	World	Poland	Yugoslavia	China	Czech R*
Vagrancy	47	40	23	64	0
Rust, discoloration	11	23	16	11	1
Erineum	17	8	15	4	27
Galls	18	14	16	13	40
Deformations	4	13	21	6	19
Leaf rolling, curling	3	2	9	2	13
No. of species found	>3300	243	256	205	96

3. DISCUSSION

It can be seen on the table that distinct differences exist in the frequency of occurence of various types of the mite-plant relationship. Zero to three-quarters of eriophyoid species, about 50% in average, are free living species not causing any damage. The date of collection during the growing season and the population level, however, may darken the picture. At higher populations, in the later part of the growing season some discoloration and rusting of leaves and fruit were observed for species defined as free living species in the spring. These two groups of the mite-plant relationship should be therefore evaluated together.

Quite frequent was the occurrence of erinea (4-27, in the world 17%), and galls (13-40, in the world 18%). The data from the Czech Republic [6], regarding only trees and shrubs, indicate that on perennial plants most common are galls and erinea and rusting and discoloration are rare.

The relationship of eriophyoid mites to their host plants classified by mite family is presented in Table 2.

The data show that in the above mentioned countries only a few species of family Diptilomiopidae cause damage to plants. None of them were found to cause galls. The family Eriophyidae includes most of pests of economic importance, all the recognised vectors of viruses and nearly all gall-forming species. Very numerous species are leaf vagrants, constituting 76% in China, 38% in Poland, 17% in Yugoslavia and 0% (on trees and bushes only) in Czech Republic.

About a dozen plant diseases are known to be transmitted by eriophyid mites [4]. In Poland at least 4 eriophyid species areknown as vectors of viruses and appearon grasses, small grains, garlic, onion and ornamental bulbs, blackcurrant and plum trees (Tab.3).

Reversion of blackcurrants is the most common and important. Wheat streak mosaic virus is found worldwide including Poland. Further such viruses will probably be detected in the future.

The largest losses caused in the world by eriophyoid mites are in citrus trees, apple and plum trees, blackcurrant, blackberries, wheat (13% in the USA), tomato, coconut palms, sugarcane, coffee, tea, juniperus and some other ornamental plants. In Poland the largest losses usually occurred on apple and plum trees, on blackcurrants and black berries.

Table 2. Relationship of species of different families of eriophyoid mites to the host plants

	Phytoptidae	Eriophyidae	Diptilomiopidae
China	5 sp.: 4 vagr. 1 deform.	156 sp.: 118 vagr. 8 deform. 23 rust. 7 erineum 26 galls 4 leaf roll. 4 virus	44 sp.: 42 vagr. 1 deform. 1 rust.
Yugoslavia	18 sp.: 10 vagr. 4 rust. 2 galls 2 deform.	225 sp.: 38 vagr. 40 rust. 37 galls 50 deform. 38 erineum 22 leaf roll.	13 sp.: 10 vagr. 3 rust.
Poland	9 vagr. 2 deform.	210 sp.: 80 vagr. 52 rust. 18 galls 30 deform. 20 erineum 10 leaf roll.	17 sp.: 12 vagr. 3 rust. 2 deform.
Czech R.	2 galls 2 deform. 1 erineum 1 leaf roll.	90 sp.: 1 rust. 36 galls 16 deform. 25 erineum 12 leaf roll.	

Table 3. Occurrence in Poland of eriophyoid mites vectors of plant viruses they transmit

Abacarus hystrix	agropyron mosaic virus ryegras mosaic virus
Aceria tulipae **	wheat streak mosaic virus* wheat spot mosaic virus barley stripe mosaic virus garlic mosaic virus* onion mite born latent virus shallot mite born latent virus
Cecidophyopsis ribis	reversion (?) (*Ribes nigrum**, *R. alpinum*, *R. spicatum*)
Vasates fockeui	latent plum virus*

* viruses detected in Poland
** probably a complex of species

4. CONCLUSIONS

Many species of eriophyoid mites await description. Probably only 1-2% are known till now. Urbanization and deforestation will cause that many existing species to perish before they are described. Several species of mites are of economic importance as pests to cultivated plants, more in tropical than in temperate regions of the world. About half of the species are known as vagrants or rust-causing. Some species of Eriophyidae family are vectors of plant pathogens. Numbers of species causing specified damage vary in different countries.

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POWIĄZANIA POMIĘDZY SZPECIELAMI (ERIOPHYOIDEA) I ICH ROŚLINAMI ŻYWICIELSKIMI

Streszczenie

Porównano częstość występowania określonych typów uszkodzeń powodowanych przez szpeciele w Chinach, Jugosławii, Czechach i w Polsce. Stwierdzono duże różnice między tymi krajami. Blisko połowa gatunków to formy żyjące wolno, nie powodujące wyraźnych uszkodzeń. Przedstawiciele rodziny Diptilomiopidae nigdy nie tworzą galasów, najczęściej nie powodują wyraźnych uszkodzeń. W Polsce występują cztery gatunki znane jako wektory wirusów roślinnych.

Słowa kluczowe: szpeciele, roślina żywicielska, powiązania, uszkodzenia roślin

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OCCURRENCE AND REPRODUCTION OF LINDEN SPIDER MITE (*EOTETRANYCHUS TILIARIUM* HERM.) ON VARIOUS SPECIES OF LINDEN GROWING UNDER URBAN CONDITIONS

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Synopsis. The observations on the occurrence of linden spider mites on 6 species of linden trees growing in Warsaw were carried out in 1997. It found that the highest populations were on *Tilia platyphyllos* and *T. americana* growing close to avenues with high traffic. Time of development, fecundity and longevity as well as life tables and demographic parameters were calculated for the mites living on the tree species of the lindens: *T. platyphyllos*, *T. euchlora*, *T. varsoviensis*.

Key words: traffic pollution, *Tilia* sp., *Eotetranychus tiliarum*, life history parameters

1. INTRODUCTION

Eotetranychus tiliarium occurs commonly on ornamental trees growing both under field and urban conditions [3, 4, 10]. According to Scaltriti et al. [11] this species attacks chestnut (*Aesculus* sp.), maple (*Acer* sp.), hawthorn (*Crategus* sp.) as often as *Tilia cordata*, *T. platyphyllos*, *T. americana*. In Japan high populations of *E. tiliarium* were noted on *Alnus japonica* and *A. hirsuta* [6]. Under field conditions this species develops 5-7 generations per year [2, 7, 11]. In countries with warm climates females start eggs laying in April or in early May [7, 11]. In Poland the first females appear usually in June [9]. Various authors found that the highest populations occurs at the end of July [2, 9]. Comparing the population level of *E. tiliarium* in natural and urban conditions it was found that the highest populations were on trees growing along streets with intensive traffic [5, 9, 10]. Only scarce data dealing with life history parameters of *E. tiliarium* are available. Gotoh [6] calculated such parameters for *E. tiliarium* for mites collected and reared on *A. japonica* and *A. hirsuta*. Czajkowska et al. [5] were comparing these parameters for the population of *E. tiliarium* on *T. platy-*

phyllos and *T. euchlora* in relation to the degree of pollution of the leaves with urban dusts.

The aim of this research was to:

a) define the susceptibility of various linden species to the feeding by *E. tiliarium* under urban conditions,
b) compare the rate of reproduction in relation to the degree of pollution of *T. platyphyllos, T. euchlora* and *T. varsoviensis* leaves with street dusts.

2. MATERIAL AND METHODS

Two problems were studied:

a) population dynamics of *E. tiliarium* on 6 linden species: *Tilia platyphyllos, T. euchlora, T. americana, T. tomentosa* and the hybrid *T. varsoviensis*. Eight sites situated at main Warsaw traffic lines and in a Park (control) were selected. A hundred leaf samples were taken to define the susceptibility of consecutive linden species to mite feeding. Eggs and all active stages of the pest were counted on the leaves. The samples were taken out of ten trees from each site.
b) the development and reproduction of *E. tiliarium* was compared in relation to the degree of pollution on the leaves by urban transport dust. Laboratory tests were carried out in 1997 according to the Helle and Overmeer [8] method. Samples of leaves were taken twice, in the middle of June and August of three linden species (*T. platyphyllos, T. euchlora* and *T. varsoviensis*) growing along streets and in the Park. A hundred eggs were taken from each tree for the calculation of time of development and mortality. Fecundity and longevity were calculated for 25 females. Life tables and demographic parameters were calculated according to Andrewartha and Birch [1].

3. RESULTS

Weather conditions in the first half of 1997's growing season were unfavourable for the development of *E. tiliarium*. Data presented on Figure 1 indicates a low population level of the pest in June. The average number of mites was then 0.01 per leaf of *T. americana*, 0.2 per leaf of *T. cordata* and 3.8 per leaf of *T. platyphyllos*.

In July the increase of population level was found on all linden species. The highest population was noted on *T. platyphyllos* (55 mites/leaf). High temperatures and dry days in August caused a rapid increase of the mite population. The population level reached then 90 mites/leaf on *T. americana* and 135 mites/leaf on *T. platyphyllos*. On other linden greater population densities were also seen when compared to June's readings.

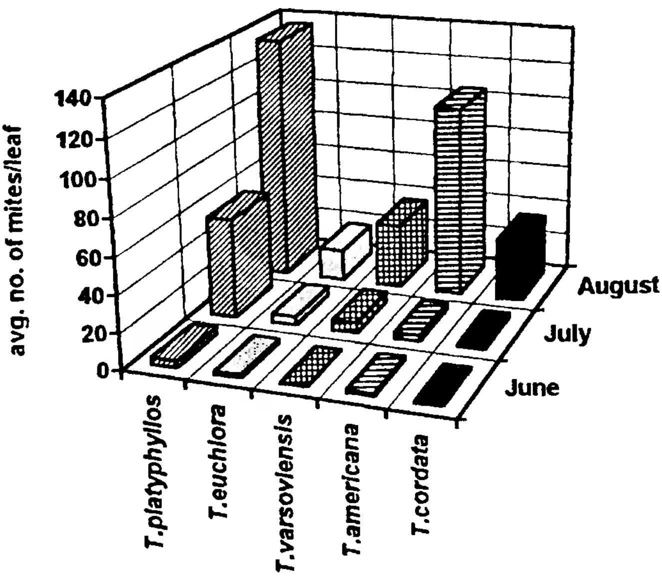

Fig.1. Population dynamics of *E. tiliarium* on different species of linden trees

Laboratory observations showed a whole generation development of the spider mites on all tested linden species (Tab.1).

Table 1. Development of *E. tiliarium* feeding on the leaves of three species of linden trees exposed to traffic pollution

Parameters	Location	*Tilia platyphyllos*		*Tilia euchlora*		*Tilia varsoviensis**	
		I	II	I	II	I	II
Development (days)	A	13.0	15.8	12.6	15.0	15.4	14.9
	B	14.6	13.0	13.2	12.6	15.1	15.4
Mortality (%)	A	7.0	32.0	11.0	31.0	34.0	62.0
	B	31.0	42.0	38.0	14.0	38.0	57.0
Females (%)	A	55.2	86.8	64.0	79.7	78.8	76.3
	B	72.5	69.0	74.2	72.1	87.1	81.4
Males (%)	A	44.8	13.2	36.0	20.3	21.2	23.7
	B	27.5	31.0	25.8	27.9	12.9	18.6

A – Sikorskiego street; B – control (park)
I – June; II – August
* Żwirki & Wigury street

An average length of development on leaves of *T. platyphyllos* and *T. euchlora* in August was slightly higher (15.8 and 13.0 days) than in June (12.6 and 15.0 days). In the case of *T. varsoviensis* no significant differences were found in the time of development - an average of 15 days in both dates. Dust on leaves did not affect the mites´ rate of development but distinctly increased its mortality in developmental stages. The mortality in August was high, ranging from 32% on *T. platyphyllos* to 62% on *T. varsoviensis* and it was 2-4 times higher in comparison to June (on *T. platyphyllos* 7%). The average time of development on leaves taken from the control trees and on leaves sampled from trees grown close to the street was similar: 12.6 and 15.4 days, respectively, whereas mortality was usually much higher on control leaves.

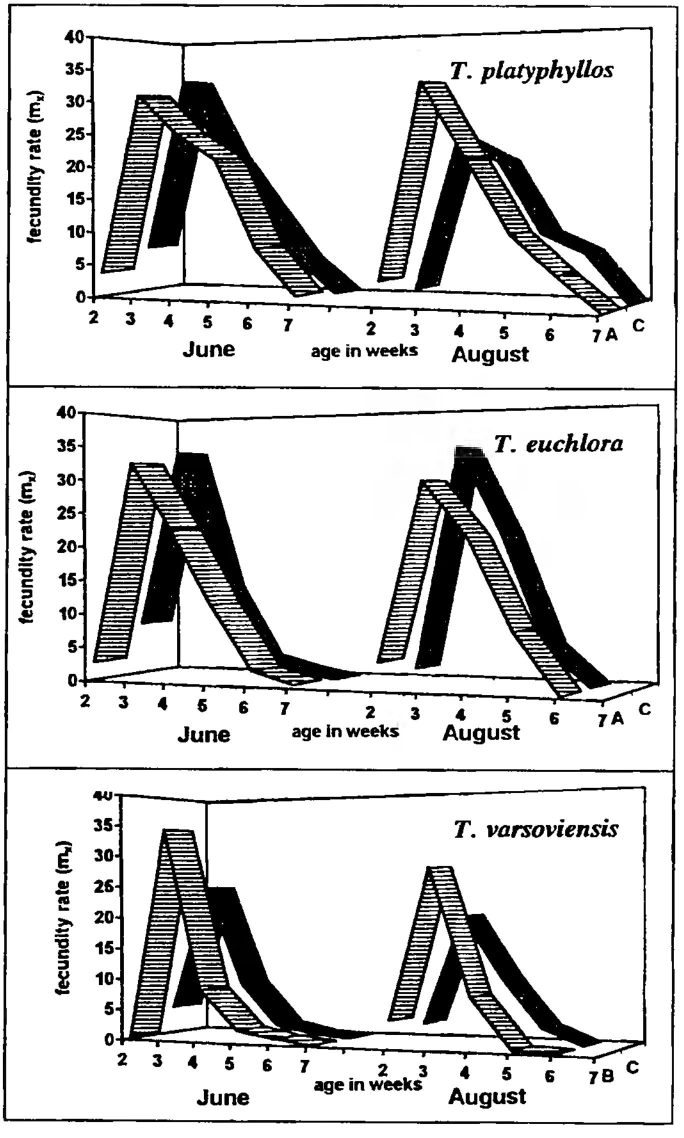

Fig.2. Age specific fecundity (m_x) of *E. tiliarium* on leaves of linden trees exposed to traffic pollution. A – Sikorskiego street; B – Żwirki & Wigury street; C - Park

Fecundity of *E. tiliarium* on studied linden species varied (Fig.2). On control leaves, except *T. euchlora*, it was distinctly lower both in June and August. The number of eggs laid on street leaves was similar in both periods of observations. The highest number of eggs was noted on *T. platyphyllos*, the lowest on *T. varsoviensis*, species considered to be resistant to *E. tiliarium* feeding. The highest number of eggs was laid in the third and fourth week of a female´s life irrespective of combination.

Comparing the development parameters of *E. tiliarium* population on three linden species some differentiation was observed. The values of r_m on *T. platyphyllos* and *T. euchlora* were comparable on both observation dates ($r_m = 1.08$ to $r_m = 1.10$) whereas on *T. varsoviensis* was always below one ($r_m = 0.99$ and $r_m = 0.81$ respectively) (Tab.2).

Table 2. Life history parameters of *E. tiliarium* feeding on the leaves of linden trees exposed to traffic pollution

Species of linden trees	r_m	R_0	T	λ
June				
Tilia platyphyllos	1.09	44.26	3.45	3.00
T. euchlora	1.10	38.29	3.29	3.03
T. varsoviensis	0.99	22.59	3.12	2.71
August				
T. platyphyllos	1.12	35.79	3.17	3.08
T. euchlora	1.08	31.01	3.15	2.96
T. varsovinsis	0.81	11.07	2.94	2.26

r_m - the intrinsic rate of natural increase
R_0 - the net reproduction rate
T - the generation time
λ - the finite rate of natural increase

It was also found that R_0 on *T. platyphyllos* and *T. euchlora* on both dates of observation was distinctly higher than on *T. varsoviensis*. On *T. varsoviensis* the mites multiplied its population during the development of one generation 22 times in June and 11 times in August, twice or three times lower in comparison to the population on other linden species ($r_0 = 44.22$ in June and 35.70 on *T. platyphyllos* in August). The development parameters of the *E. tiliarium* population on control leaves were close to or slightly lower than those on street leaves (Tab.3).

Table 3. Life history parameters of *E. tiliarium* feeding on the leaves of linden trees growing in Park (control)

Species of linden trees	r_m	R_0	T	λ
June				
Tilia platyphyllos	1.14	36.36	3.14	3.13
T. euchlora	1.15	25.80	2.91	3.05
T. varsoviensis	1.02	29.95	2.95	2.78
August				
T. platyphyllos	0.89	23.02	3.50	2.44
T. euchlora	1.12	36.75	3.20	3.07
T. varsoviensis	0.78	11.48	3.09	2.20

r_m - the intrinsic rate of natural increase
R_0 - the net reproduction rate
T - the generation time
λ - the finite rate of natural increase

The differences were, however, no significant enough for pollution to be a factor responsible for numerous appearances of mites on leaves.

4. CONCLUSION

All six species of linden trees were infested by *E. tiliarium*. On two linden species - *T. platyphyllos* and *T. americana* - the population level of mites was distinctly higher than on other linden species. The lower surface of *T. platyphyllos* leaves is covered with a dense layer of hair and street dust attaches to this hair. The dust does not have a direct contact with the lower leaf surface on which the spider mites developed high populations. It is probably one of the main factors affecting the numerous occurrence of the mite on this linden.

Low temperatures and intensive precipitation are important factors affecting the population level of *E. tiliarium*. During the 1997 growing season low temperature and intensive rain took place. Mass appearance of the spider mite was therefore seen in the second half of the growing season. The level of leaf pollution with street dust did not affect the reproduction rate of the mite. It seems rather that the pollution stimulated its development. Development parameters of *E. tiliarium* on *T. varsoviensis* indicate lower sensitivity of this linden to the infestation of the mite pest.

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WYSTĘPOWANIE I NAMNAŻANIE SIĘ PRZĘDZIORKA LIPOWCA (*EOTETRANYCHUS TILIARIUM* HERM.) NA RÓŻNYCH GATUNKACH LIP ROSNĄCYCH W WARUNKACH MIEJSKICH

Streszczenie

W sezonie wegetacyjnym 1997 prowadzono obserwacje nad występowaniem przędziorka lipowca na 6-ciu gatunkach lip rosnących w obrębie Warszawy. Z badań wynika, że najliczniejsze populacje przędziorków występują na lipach: szerokolistnej (*Tilia platyphyllos*) i amerykańskiej (*T. americana*). Uzyskane dane wykazały, że liczebność przędziorka lipowca była najwyższa na drzewach rosnących wzdłuż ulic o szczególnie natężonym ruchu miejskim.

Zebrane dane dotyczące rozwoju, płodności i długości życia *E. tiliarium* w zależności od stopnia zanieczyszczenia powierzchni liści pyłami emitowanymi przez środki komunikacji miejskiej. Opracowano parametry demograficzne dla przędziorka lipowca na lipie szerokolistnej (*T. platyphyllos*), krymskiej (*T. euchlora*) i warszawskiej (*T. varsoviensis*).

Słowa kluczowe: zanieczyszczenia miejskie, lipa, przędziorek lipowiec, parametry rozwoju populacji

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EFFECTS OF GAMMA RADIATION ON THE REPRODUCTION OF *TYROPHAGUS NEISWANDERI* JOHNSTON ET BRUCE (ACARI, ACARIDAE), A MITE PEST OF ORNAMENTAL PLANTS

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Synopsis. Acarid mites are known to feed on decaying organic materials in the soil and to damage stored products. Under certain conditions they can cause damage to plants grown commercially in greenhouses. Among them, *Tyrophagus neiswanderi* is a species commonly infesting a wide range of vegetables and ornamental plants. *Tyrophagus neiswanderi* mites may be controlled by using chemicals, but irradiation appears to offer promise. However, a dose as high as 1.8 kGy did not cause the immediate mortality of treated males and females, but all mites were dead during the first week post-treatment. The complete sterility of *T. neiswanderi* mites occurs for gamma radiation applied at 0.4 kGy, and this dosage is suggested for radiation disinfestation of agricultural commodities infested by *T. neiswanderi* mites. Radiation may be applied for disinfestation of either straw bales on which plants will grow, or cut-flowers, in order to limit the spread of these mites.

Key words: acarid mites, ionizing radiation, mortality, sterility, ornamental plants, pest

1. INTRODUCTION

The majority of the acarid mites are saprophagous or mycetophagous. They are known to feed on decaying organic material in the soil and to damage stored products. Under certain conditions they can cause damage to plants grown commercially in greenhouses. Among them, *Tyrophagus neiswanderi* is a species commonly infesting a wide range of vegetables and ornamental plants [2, 3, 10]. These mites are probably introduced into the greenhouses in the straw bales upon which the plants are grown. Some of the soil population invades the plants and does damage to the developing leaves and flower buds [2].

Flowers of *Gerbera* sp.damaged in the bud stage may have only a few petals fully expanded, depending on the number of mites and the development stage of the flowers when the mites feed. *Viola* sp. and *Cyclamen* sp. flowers may become infertile as a result of mite damage to the anthers. Leaves of various plants may show a wide variety of damage symptoms: small punctures, brown spots, and malformed leaves. The shoots show narrow brown streaks of corky tissue and the apex is often damaged, resulting in plant death [2].

Tyrophagus neiswanderi mites may be controlled using chemicals, but irradiation appears to offer promise. Radiation may be applied for disinfestation of either (a) straw bales on which plants will grow, or (b) cut flowers, in order to limit the spread of the mites. However, the radiosensitivity of *T. neiswanderi* mites has not been studied yet. Therefore, the purpose of this study was to determine the effects of gamma radiation on reproduction of *T. neiswanderi* mites.

2. MATERIAL AND METHODS

The greenhouse mites (*T. neiswanderi*) were isolated from ornamental plants grown in a greenhouse. The stock colonies were maintained at the Department of Applied Entomology, Warsaw Agricultural University in Warsaw, Poland. These colonies were maintained in rearing cages [1], at 20-24°C and 85±5% R.H., and provided with wheat germ as food. All mites used in the study were obtained from these stock colonies.

Samples of the mites within the medium were irradiated with the cobalt-60 gamma rays using an irradiator of the type "RChM-gamma-20". Dose rate was about 20 Gy per min. A Fricke dosimeter was used for calibration [4].

Tests were initiated by selecting inert deutonymphs from stock colonies and holding them in separate cages. On the day following emergence, the adults were sexed and treated with Co-60 radiation. On the same day, following the radiation treatment, the mites were paired. During rearing and observation, the mites were kept in rearing cages supplied with wheat germ. The rearing cages were stored in darkness at 25±1°C and 85±5% R.H.

Every week the number of eggs laid by females was determined, the eggs and hatched larvae were removed from the cages and food was added. Fecundity was recorded by counting the eggs laid by each female until her death. The viability of these eggs was observed. Mortality of females and males was recorded.

The effects of gamma radiation on the inert deutonymphs were studied using similar methods. Irradiated inert deutonymphs were allowed to reach the adult stage. Then males and females that emerged were paired, and their fecundity, fertility, and longevity were observed.

3. RESULTS

Irradiation of adults of *T. neiswanderi* mites with gamma radiation significantly affects their egg production (Tab.1).

Table 1. Fecundity of *T. neiswanderi* mites irradiated as 24-48 hour-old adults

Dose (kGy)	Number of mite pairs observed	Unfecund pairs		Fecundity (no. of eggs/female)	
		number	%	mean ± S.D.	range
0.0 (control)	26	1	3.8	201.7 ± 97.6	54 - 439
0.1	23	0	0.0	195.4 ± 121.4	12 - 514
0.2	28	1	3.6	112.4 ± 101.0	12 - 467
0.25	27	0	0.0	53.5 ± 41.6	3 - 148
0.3	25	1	4.0	48.6 ± 25.8	9 - 102
0.35	26	0	0.0	37.5 ± 17.9	10 - 79
0.4	28	2	7.1	22.7 ± 13.8	2 - 50
0.5	29	1	3.4	10.0 ± 7.1	1 - 31
0.6	29	1	3.4	16.5 ± 7.7	2 - 33
0.9	33	7	21.2	7.0 ± 5.2	1 - 25
1.2	20	19	95.0	2.0 ± 0.0	2
1.5	30	30	100.0	0.0	0
1.8	20	20	100.0	0.0	0

* per the fecund pair of mites
** mean ± standard deviation

All or almost all pairs were fecund when treated with doses up to 0.6 kGy. However, the number of non-fecund pairs increased as dosage increased, and at 0.9 kGy there were 21% non-fecund pairs, and at 1.2 kGy about 95% of pairs failed to produce eggs. All mites were non-fecund when treated with a 1.5 kGy dose or higher (Fig.1).

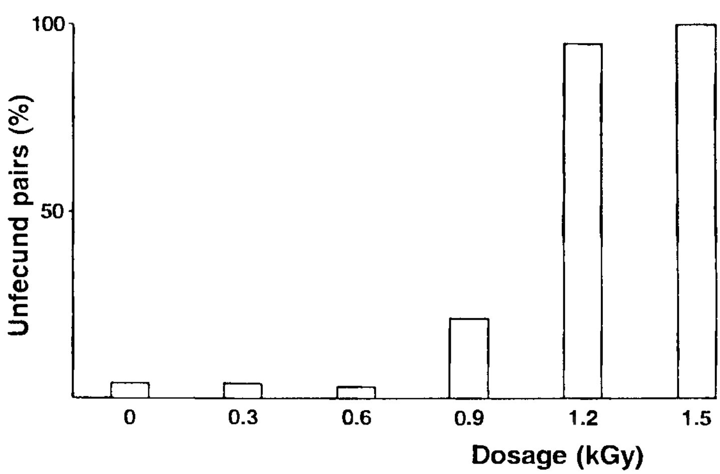

Fig.1. Inhibition of egg production caused by gamma radiation when the adults of *T. neiswanderi* were treated

The number of eggs laid per female (= fecundity) for mites irradiated with 0.1 kGy did not differ from that of the control, but at 0.2 kGy the fecundity was about half that of the control value. The fecundity of mites irradiated with 0.3 kGy was a quarter of that of the control, and 1/8 at 0.4 kGy. At a dose of 0.5 kGy or higher dosages, the mites laid several eggs, being non-fecund at a dose of 1.5 kGy or higher (Fig.2).

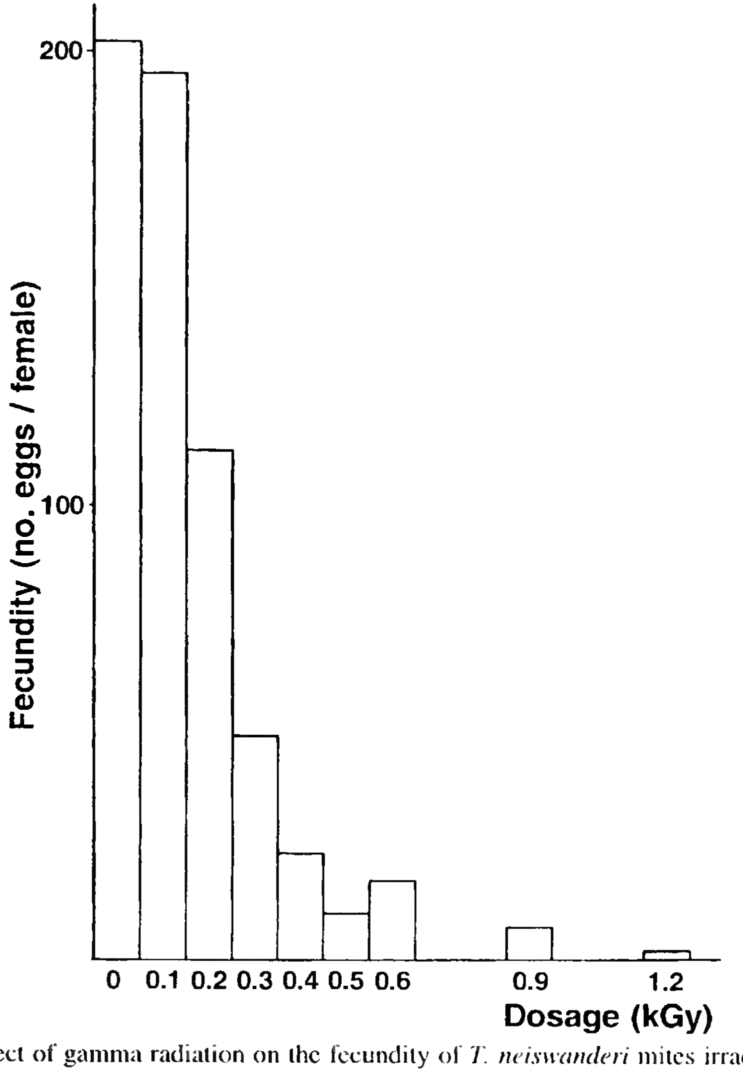

Fig.2. Effect of gamma radiation on the fecundity of *T. neiswanderi* mites irradiated as 24-48 hour-old adults

Untreated mites (control) produced eggs during almost the whole period of their life (Fig.3).

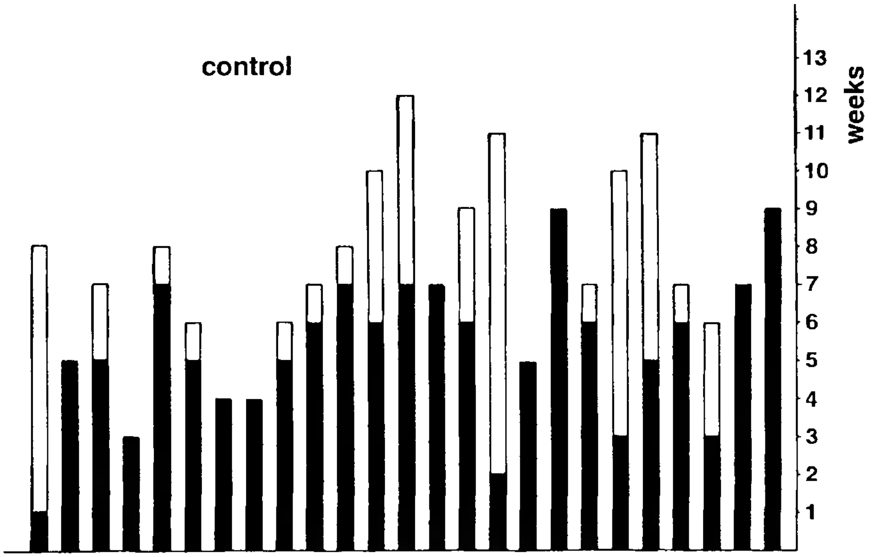

Fig.3. Periods of egg production (black) and periods of infecundity (white) during the lifespan of non-irradiated females of *T. neiswanderi*

On Figure 3, "black" shows the period of oviposition, while the „white" shows the period of non-fecundity. The length of the whole band means the length of the female life. Irradiated mites produced eggs during the first weeks, being nonfecund thereafter (Figs.4-6).

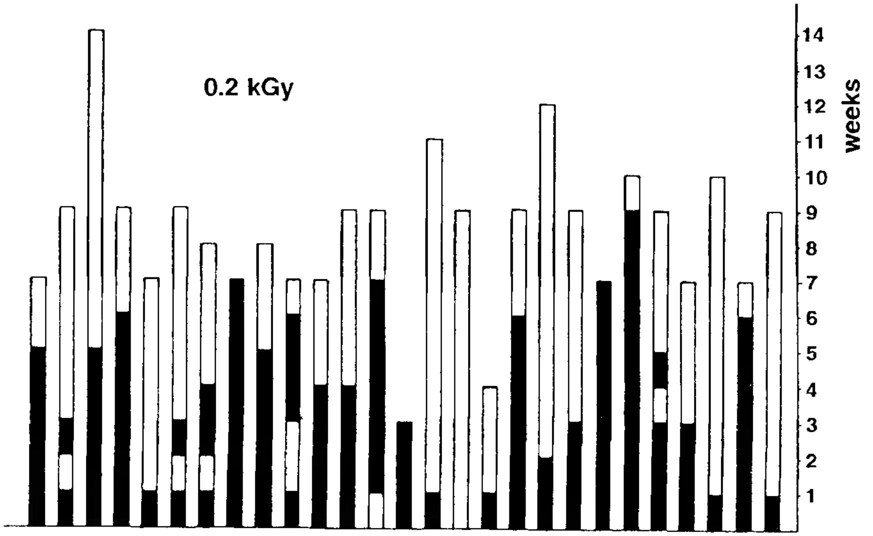

Fig.4. Periods of egg production (black) and periods of infecundity (white) during the lifespan of *T. neiswanderi* females irradiated with a 0.2 kGy dose of gamma radiation

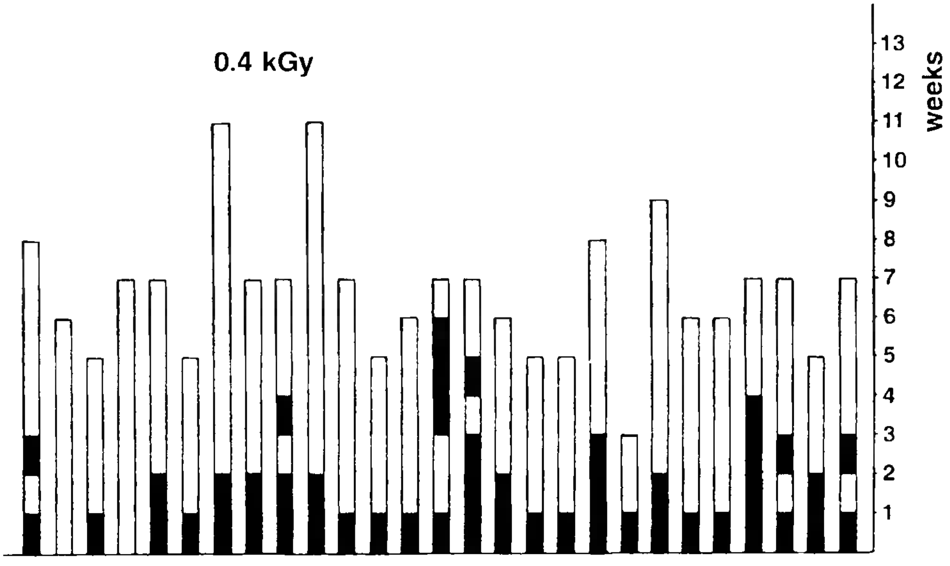

Fig.5. Periods of egg production (black) and periods of infecundity (white) during the lifespan of *T. neiswanderi* females irradiated with a 0.4 kGy dose of gamma radiation

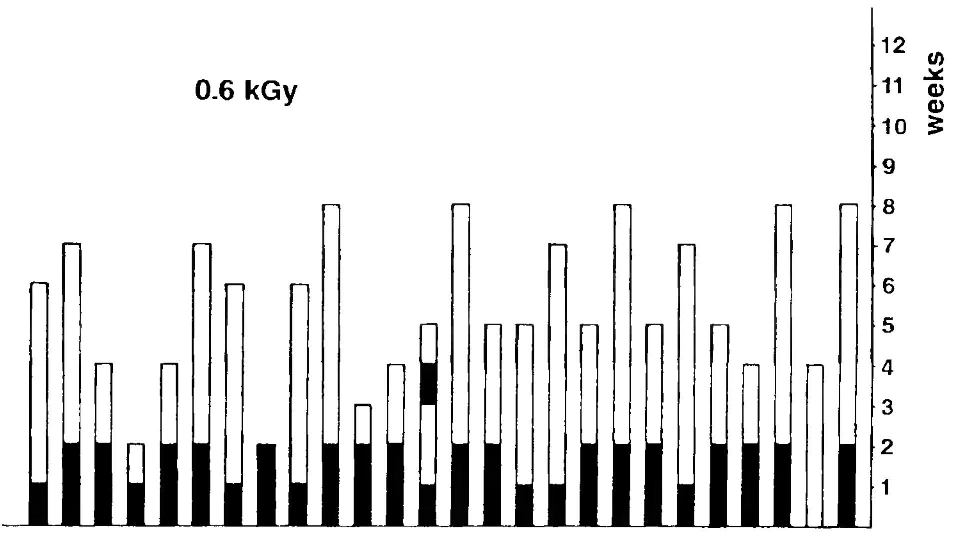

Fig.6. Periods of egg production (black) and periods of infecundity (white) during the lifespan of *T. neiswanderi* females irradiated with a 0.6 kGy dose of gamma radiation

The higher dose of radiation, the shorter period of egg production. For example, mites irradiated with 0.4 kGy produced eggs during the first, second and third week post-treatment. Those treated with 0.6 kGy laid eggs only during the first and second week (Figs.5, 6). The similar relationship is also illustrated in Figure 7.

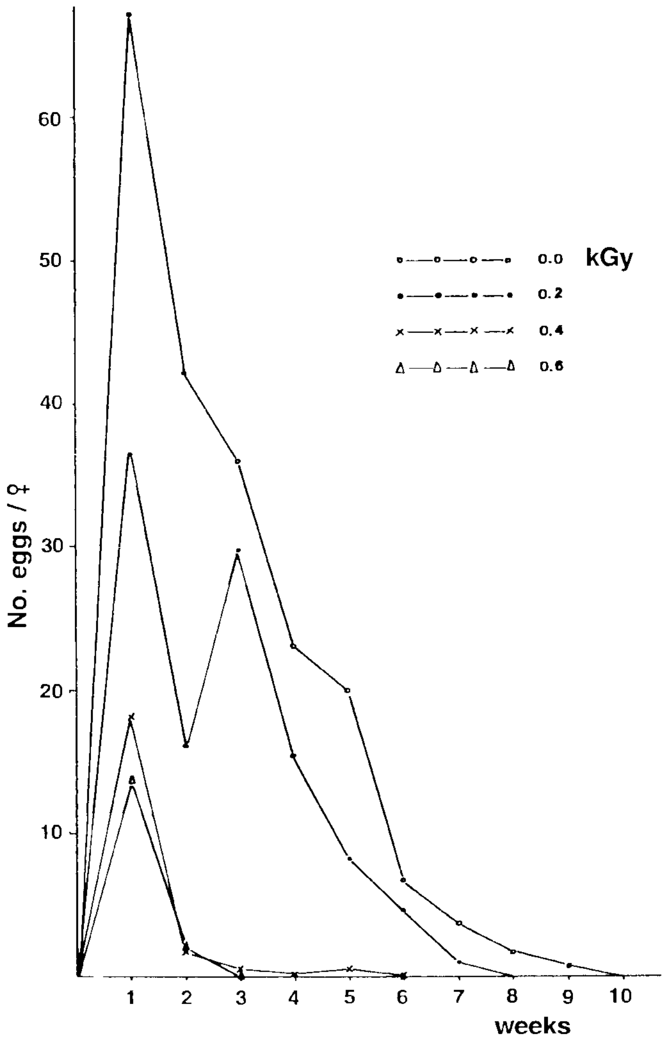

Fig.7. The egg-laying rate of control and irradiated females of *T. neiswanderi* at various times after treatment

The average number of eggs laid by *T. neiswanderi* females at the 1st, 2nd, 3rd, and 5th week post-treatment is shown in Figure 8.

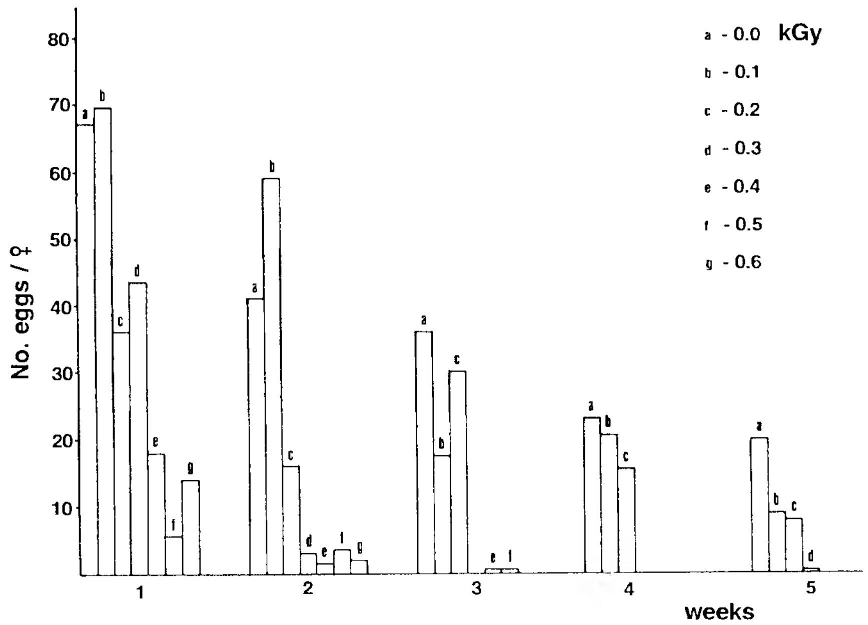

Fig.8. Average number of eggs laid by *T. neiswanderi* females at the 1st, 2nd, 3rd, 4th and 5th week post-treatment

The viability of eggs produced by irradiated mites decreased with an increase of dosage. At merely 0.1 kGy, more than 40% of eggs hatched, but at 0.2 kGy and 0.3 kGy doses the mortality of the eggs was 86% and 92%, respectively. At higher doses, the eggs hatched only occasionally (Tab.2).

Table 2. Viability of eggs laid by *T. neiswanderi* mites irradiated as 24-48 hour-old adults

Dose (kGy)	Number of eggs observed	Number of eggs hatched	Viability of eggs (%)
0.0	230	199	86.5
0.1	342	141	41.2
0.2	284	39	13.7
0.25	176	20	11.4
0.3	133	11	8.3
0.35	127	1	0.8
0.4	187	3	1.6
0.5	48	0	0.0
0.6	46	0	0.0
0.9	0	-	-

To facilitate an understanding of the effect of irradiation on fertility of these mites, an "index of net sterility" was calculated, for each dose used, according to the following formula:

$$NS(\%) = \frac{FE(control) - FE(treated)}{FE(control)} \times 100,$$

where, NS (%) - percentage of net sterility, and FE = fecundity x egg viability.

The results obtained are presented in the Table 3.

Table 3. Effect of gamma radiation on fecundity and fertility of greenhouse mites, *T. neiswanderi*

Dose (kGy)	Average fecundity (number of eggs per female)*	Viability of eggs (%)	Net sterility coefficient (%)
0.0	186.9	86.5	0.00
0.1	187.3	41.2	52.26
0.2	108.4	13.7	90.79
0.25	53.5	11.7	96.10
0.3	46.7	8.3	97.59
0.35	37.5	0.8	99.81
0.4	21.1	1.6	99.81
0.5	9.6	0.0	100.00
0.6	15.9	0.0	100.00
0.9	5.5	0.0	100.00
1.2	0.1	0.0	100.00

* All mite pairs, i.e., the fecund and nonfecund pairs of *T. neiswanderi*, were observed

The complete sterility of mites, i.e., NS(%) = 100%, occurs for gamma radiation applied at 0.4 kGy or higher doses, but NS(%) = 90% is induced by only 0.2 kGy dosage. The viability of eggs laid by mites irradiated with low dosages of radiation (0.2-0.3 kGy) is not constant (Tab.4).

Table 4. Viability of eggs laid during the first (I) and the second (II) week post-treatment by *T. neiswanderi* mites irradiated as 24-48 hour-old mites

Dose (kGy)	Period of egg laying	Number of eggs observed	Number of eggs hatched	Viability of eggs (%)
0.0	1st week	375	343	91.5
	2nd week	423	392	92.7
0.2	1st week	284	39	13.7
	2nd week	420	96	22.9
0.3	1st week	133	11	8.3
	2nd week	160	61	38.1

It decreases with time since treatment, possibly indicating the differential response of the developmental stage of eggs to radiation. The mechanisms underlying this post-radiation recovery are yet to be investigated.

Deutonymphs of *T. neiswanderi* of intermediate age were isolated from the culture and irradiated on the same day. After two days, adults that emerged were paired and their fecundity and fertility were recorded. Irradiation significantly affected the egg production of adults that emerged from treated deutonymphs. The production of eggs was inhibited completely by a dose of 1.2 kGy. At lower doses, the mites laid fewer eggs than the control (Tab.5).

Table 5. Fecundity of *T. neiswanderi* mites irradiated as inert deutonymphs

Dose (kGy)	Number of mite pairs observed	Unfecund pairs		Fecundity (no. of eggs/female)	
		number	%	mean ± S.D.	range
0.0 (control)	26	1	3.8	201.7 ± 97.6	54 - 439
0.2	27	8	29.6	61.8 ± 67.8	4 - 202
0.3	28	2	7.1	15.1 ± 16.3	1 - 84
0.4	28	8	28.6	7.8 ± 8.1	1 - 30
0.5	29	11	37.9	2.7 ± 2.9	1 - 9
0.6	28	7	25.0	6.3 ± 5.8	1 - 22
0.9	26	7	26.9	7.0 ± 5.2	1 - 15
1.2	20	19	95.0	2.0 ± 0.0	2

* per the fecund pair of mites
** mean ± standard deviation

The results summarized in Tables 5 and 6 show that the deutonymphs were more susceptible to irradiation than the adults. Irradiation lowered the fecundity of adults that emerged from treated deutonymphs much more than in the case of irradiated adults (compare Tabs.1 and 5). For example, adults treated with 0.2 kGy laid 112.4 eggs during their life, whereas the adults that emerged from irradiated deutonymphs produced only 61.8 eggs.

When mites were irradiated as deutonymphs, the viability of the subsequent adults' eggs was much more affected than when adults were treated directly. At a dose of 0.2 kGy, 13.7% of eggs produced by treated adults were viable, but only 5.4% of eggs laid by mites irradiated as deutonymphs. All eggs were dead after treatment with 0.3 kGy (Tab.6).

Table 6. Viability of eggs laid by *T. neiswanderi* mites irradiated as inert deutonymphs

Dose (kGy)	Number of eggs observed	Number of eggs hatched	Viability of eggs (%)
0.0	230	199	86.5
0.2	148	8	5.4
0.3	38	0	0.0

Gamma radiation applied at doses up to 0.6 kGy had very little effect, if any, on the longevity of *T. neiswanderi* mites. Males treated with 0.1-0.3 kGy lived somewhat longer than the controls, and the number of days required for 50% and 95% was higher than for the control mites (Tab.7).

Table 7. Mortality of *T. neiswanderi* males irradiated with 0.1-0.9 kGy doses

Dose (kGy)	Days required for	
	50% mortality	95% mortality
0.0 (control)	42.5	75.0
0.1	49.0	77.0
0.2	54.0	79.5
0.3	50.0	77.0
0.4	44.0	60.5
0.5	47.0	63.0
0.6	41.0	54.0
0.9	37.5	49.0

Mites treated with 0.4-0.6 kGy lived as long as the untreated mites. The longevity of males was shortened by a dose of 0.9 kGy or higher.

The mortality of mites increased as the dose of gamma radiation increased. In general, females were found to be more resistant than males. At a dose 1.2 kGy, 50% mortality of females and males occurred after 27 and 13.5 days, respectively. A dose as high as 1.8 kGy did not cause the immediate mortality of treated males and females. All mites (100% mortality) were dead during the first week post-treatment (Tab.8).

Table 8. Effectiveness of gamma radiation for the control of *T. neiswanderi* mites

Dose (kGy)	Sex	Days required for	
		50% mortality	95% mortality
0.0 (control)	female	57.0	89.0
	male	42.5	75.0
1.2	female	27.0	36.5
	male	13.5	31.0
1.5	female	3.2	24.6
	male	2.5	17.5
1.8	female	0.6	3.7
	male	1.5	6.0

The longevity of males that emerged from deutonymphs irradiated with 0.3 and 0.6 kGy doses was similar to that of the control.

4. DISCUSSION

Effects of gamma radiation on *T. neiswanderi* mites include mostly the inhibition of reproduction and the shortening of their lifespan. Susceptibility of these mites to irradiation is somewhat lower than the mold mites and the bulb mites (Tab.9).

Table 9. Comparison of fecundity (mean number of eggs per female) and viability (%) of eggs laid by adults of acarid mites treated with gamma radiation

Dose (kGy)	*Tyrophagus putrescentiae* Schrank		*Tyrophagus neiswanderi* Johnson et Bruce		*Rhizoglyphus echinopus* R. et F.	
	Fecundity	Egg viability	Fecundity	Egg viability	Fecundity	Egg viability
0.0	415.0	96.0	201.7	86.5	335.6	99.2
0.1	189.9	73.8	195.4	41.2	261.0	30.6
0.2	-	-	112.4	13.7	104.8	0.4
0.25	15.4	0.0	53.5	11.7	43.6	0.2
0.3	-	-	48.6	8.3	30.5	0.0
0.35	8.9	0.0	37.5	0.8	-	-
0.4	-	-	22.7	1.6	65.6	0.0
0.5	9.5	0.0	10.0	0.0	59.7	0.0
Ref.	[6]		This paper		[7]	

The results obtained show that the longevity of irradiated males and females of *T. neiswanderi* varies inversely with the radiation dose. Younger metamorphic stages of mites (deutonymphs) are more radiosensitive to the lethal effects of irradiation than adults. However, a dose as high as 1.8 kGy does not cause the immediate mortality of treated mites; all mites die during the first week post-treatment. Use of high doses of ionizing radiation is expensive.

Sterility in *T. neiswanderi* mites is achieved following irradiated deutonymphs and adults at much lower doses than needed to kill the mites. Therefore, control of *T. neiswanderi* infestation in agricultural products may be considered in the following general terms. For immediate mortality of the mites, doses higher than 2.0 kGy of gamma radiation are required. Doses in the range of 1.3 to 1.5 kGy would be sufficient, if lethality within a few weeks is the goal. A dose of 0.3 kGy would be effective, if the goal is the inhibition of reproduction of living mites. The same was proposed by Ignatowicz [6] and Ignatowicz & Wróblicka-Sysiak [9] for controlling mold mite and the bulb mite infestations, respectively.

Tyrophagus neiswanderi mites infest not only stored products, but also a wide range of vegetables and ornamental plants grown in greenhouses [2]. These mites are probably introduced into the greenhouses with the straw bales upon which plants are grown. Radiation or quarantine treatment, may be applied for disinfestation of both straw bales on which plants will be grown, or cut flowers in order to limit the spread of the mites.

The criterion for irradiation efficacy as a quarantine treatment may be based on (a) the immediate mortality of the pest, or (b) the inability of a pest to produce viable offspring [8]. The purpose of quarantine treatment schedules is to prevent the establishment of the pest in an area where it does not exist. Therefore, the criterion for irradiation efficacy of agricultural commodities should be based on the inability to perpetuate the pest at a new location rather than causing immediate mortality [5]. The results of this study show that the complete sterility of *T. neiswanderi* mites occurs for gamma radiation applied at 0.4 kGy and higher doses. This dosage is suggested for the quarantine treatment of cut flowers and other agricultural products infested by *T. neiswanderi*.

At these doses, however, adult survivors will be present in the treated commodities, but they will not give rise to offspring, and thus this pest would not be able to perpetuate in a new area. The live mites present in the agricultural products after radiation treatment will be of concern to quarantine personnel. Thus, a simple test is needed to ensure that the pest was irradiated and it does not pose a quarantine risk.

Untreated mites produce eggs during almost the whole period of their life. Irradiated adults produce eggs during the first weeks only, being infecund thereafter. Also, it was found that irradiation lowered the fecundity of adult mites that emerged from treated deutonymphs much more than in the case of treated adults. Mites irradiated as inert deutonymphs usually produce eggs for a shorter period of time than treated as adults. Ignatowicz [6] and Ignatowicz & Wróblicka-Sysiak [9] reported similar effects of radiation on fecundity of other acarid mites. The results obtained show that the test based on infecundity of irradiated mites may be used for the identification of irradiated mites of *T. neiswanderi* which were given a 0.3 kGy dose or higher. These findings may be used in the tests for the detection of irradiated mites as described earlier by Ignatowicz [7].

5. CONCLUSIONS

1. The number of non-fecund pairs increased in *T. neiswanderi* as the dose of gamma radiation increased, and at a 1.2 kGy dose about 95% of pairs failed to produce eggs.
2. Irradiated mites produced eggs during the first weeks, being nonfecund thereafter.
3. The viability of eggs produced by irradiated mites of *T. neiswanderi* decreased with the dosage increase.
4. The complete sterility of mites (NS = 100%) occurs for gamma radiation applied at 0.4 kGy or higher doses, but NS = 90% is induced by only 0.3 kGy. A dose of 0.4 kGy is suggested for the quarantine treatment of cut flowers and other agricultural products infested by *T. neiswanderi* mites.
5. The deutonymphs of *T. neiswanderi* were more susceptible to irradiation than adults.
6. A dose as high as 1.8 kGy did not cause the immediate mortality of treated males and females of *T. neiswanderi*. All mites were dead during the first week post-treatment.

7. Susceptibility of *T. neiswanderi* is somewhat lower than the mold mite, *T. putrescentiae*, and the bulb mite, *Rhizoglyphus echinopus*.

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WPŁYW PROMIENIOWANIA GAMMA NA ROZRODCZOŚĆ ROZKRUSZKA SZKLARNIOWEGO, *TYROPHAGUS NEISWANDERI* JOHNSTON ET BRUCE (ACARI, ACARIDAE)

Streszczenie

Zabieg z zastosowaniem promieniowania jonizującego ogranicza produkcję jaj przez napromieniowane samice rozkruszka szklarniowego, *Tyrophagus neiswanderi*. Wszystkie lub prawie wszystkie pary rozkruszka składały jaja po napromieniowaniu dawką do 0.6 kGy. Jednocześnie liczba bezpłodnych par rosła i przy dawce 0.9 kGy stwierdzono 21% bezpłodnych par, a przy dawce 1.2 kGy około 95% par nie składało jaj. Wszystkie pary nie składały jaj po napromieniowaniu dawką 1.5 kGy i wyższą. Płodność wyrażona liczbą jaj złożonych przez samicę malała wraz ze wzrostem dawki promieniowania. Po napromieniowaniu dawką 0.5 kGy i wyższą samice składały po kilkanaście jaj. Napromieniowane roztocze składały większość jaj w ciągu pierwszych tygodni życia, podczas gdy roztocze kontrolne produkowały jaja w ciągu całego okresu życia. Żywotność jaj złożonych przez napromieniowane rozkruszki była bardzo niska. Po napromieniowaniu dawką 0.1 kGy, z ponad 40% jaj wylęgły się larwy, a już przy dawce 0.2 i 0.3 kGy ich śmiertelność wynosiła odpowiednio 86 i 92%. Zauważono, że żywotność jaj złożonych przez napromieniowane rozkruszki nie jest wartością stałą, a zmienia się z czasem. Deutonimfy wyizolowane z hodowli masowej napromieniowano i po 2-3 dniach powstałe z nich osobniki dorosłe połączono w pary. Rozrodczość roztoczy otrzymanych z napromieniowanych deutonimf była bardzo niska, niższa niż u rozkruszków napromieniowanych w stadium dojrzałości płciowej. Pary powstałe z deutonimf napromieniowanych dawką 1.2 kGy nie składały jaj. Przy niższych dawkach roztocze składały znacznie mniej jaj niż kontrolne. Ich żywotność była bardzo niska. Przy dawce 0.2 kGy tylko 5.4% jaj było żywych, a przy dawce 0.3 kGy wszystkie jaja były martwe.

Słowa kluczowe: rozkruszki, promieniowanie jonizujące, śmiertelność, sterylność, rośliny ozdobne, szkodnik

AKADEMIA TECHNICZNO-ROLNICZA IM. JANA I JĘDRZEJA ŚNIADECKICH
W BYDGOSZCZY
ZESZYTY NAUKOWE NR 214 - OCHRONA ŚRODOWISKA 2 (1998) 41-47

CONCENTRATION OF SOME PHENYLPROPANOID COMPOUNDS AND THE ACTIVITY OF OXIDATIVE ENZYMES IN THE INTRA-TOMATO PLANT (*LYCOPERSICON ESCULENTUM* MILL.) LOCALLY INFESTED BY THE CARMINE SPIDER MITE (*TETRANYCHUS CINNABARINUS* BOISD.)

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Synopsis. The results of the present study demonstrate that the feeding of the carmine spider mite (*Tetranychus cinnabarinus*) simultaneously induces changes in the concentration of chlorogenic acid and rutin as well as in the activity of polyphenol oxidase within directly damaged tomato leaves and leaves located far from the site of pest feeding. These findings support the hypothesis that the induction in plant chemistry dealing with some damage caused by herbivorous pests is plant-systemic.

Key words: tomato, *Lycopersicum esculentum*, phenolic compounds, carmine spider mite, *Tetranychus cinnabarinus*, oxidative enzymes

1. INTRODUCTION

The systemic induction of resistance (SIR) to disease in a plant by prior inoculation with an infectious agent, exposure to an environmental influence or treatment with chemicals is a well known phenomenon in both resistant and susceptible plants [21]. Research of the last twenty years indicates that chemical responses resulted in the resistance of plants to herbivores may also be induced [1, 4, 5, 8, 9, 12, 13, 16-19, 24, 25], and a distinction has been made between induction which is local and induction which is plant-systemic [6, 23, 26].

It was previously shown that in tomato plants, along with the occurrence of constitutive barriers, the strong hypersensitive response against the carmine spider mite (*Tetranychus cinnabarinus*) is locally formed [20]. Hypersensitive response involved activation of plant defense substances and programmed cell death. Visually, the hypersensitive response manifested as the formation of local necrotic lesions on the leaves. Many secondary tomato compounds are now considered to be defensive chemicals that contribute to the resistance of this plant against pests; however, the potential role of oxidative and nutritional stress as a plant defensive response to herbivore has also been discussed [7, 10, 14, 19, 23, 24, 25]. The inducible chemicals within tomato plants, which usually occur constitutively, includes such substances as chlorogenic acid, rutin, tomatine; and oxidative enzymes such as polyphenol oxidase (PPO), peroxidase (POX), and lipoxygenase (LOX) as well as proteinase inhibitors [7, 12, 14, 22, 24].

The aim of this study was to find out whether the feeding of the carmine spider mite (*T. cinnabarinus*) induces changes in the concentration of the chosen tomato allelochemicals and the activity of oxidative enzymes simultaneously within directly damaged leaves and leaves located far from the site of pest feeding.

2. MATERIAL AND METHODS

The tomato plants (*Lycopersicon esculentum*) cv. Recento (De Ruiter Seeds, NL) were grown in a peat substrate, in a glasshouse. Three-month-old plants were infested by the carmine spider mites (CSM) *Tetranychus cinnabarinus* using 10 females per each of 7th and 8th leaves. The rate of population development was observed during three weeks of mite feeding. Leaves injured by this time, with local necrotic lesions, and upper leaves (distant from the site of CSM feeding) were collected simultaneously and analysed for the concentrations of chlorogenic acid (CHA), rutin (RUT) and total phenolics. CHA and RUT were analysed from methanolic leaflet extracts using a diphenylborinic acid ethanolamine complex reagent [2]. The concentrations of total phenolics in methanol extracts were analysed using a Folin-Ciocalteau reagent [15]. Polyphenol oxidase (PPO) and peroxidase (POX) activity in buffered extracts of leaflets was assayed according to the method described by Felton et al. [9].

3. RESULTS AND DISCUSSION

Figure 1 presents the rate of development of CSM on tomato plants over a three-week period.

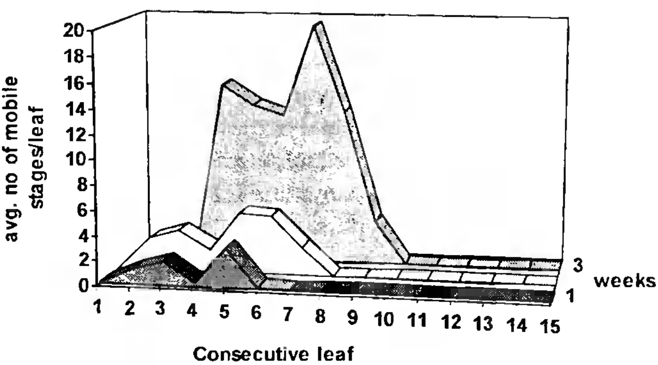

Fig.1. Development of *T. cinnabarinus* population on tomato plant cv Recento

Counting from the bottom of the plant, ten consecutive leaves were habitated by CSM. On these leaves, the population reached an average of 8.3 specimens/leaf. However, at that time the plants possessed an avg.15 leaves, thus the upper five were grown in the absence of pests. It was found that feeding by different phytophagous can induce chemical responses which differ in their strength at different positions related to the damage [23, 24, 25]. These authors showed also that in young tomato plants, damage increases within and between the plant variation in chemical activities, and this induces variation may affect pest performance, physiology and behaviour.

Figures 2a-f show the effect of feeding by CSM on the mean level of total phenolics, CHA, RUT and the mean activity of PPO and POX at two plant positions (bottom and top). From these figures it is clear that the constitutive level of the total phenolics (Fig.2a), CHA (Fig.2c) and RUT (Fig.2b) in the uninfested bottom leaves was lower compared to the level of those compounds in the upper leaves by 41%, 37% and 56%, respectively. The activity of PPO in these uninfested leaves was 47% lower than the activity of this enzyme in the upper leaves (Fig.2e), whereas the activities of POX in the bottom and upper leaves were very similar (Fig.2f).

After 3 weeks of *T. cinnabarinus* feeding, severe necroses were seen on each infested leaf. Necrotic tissues of these leaves showed significant increase (relative to controls) in the content of total phenolics (by 57%) (Fig.2a), RUT (by 50%) (Fig.2b) and other than CHA and RUT phenolics (by 149%) (Fig.2d). There was no significant change in the content of CHA in infested bottom leaves compared to controls (Fig.2c). In these leaves, substantial increases of activity of PPO (by 144%) and POX (by 83%) were detected (Figs.2e and 2f). Similarly, 4 days of russet mite feeding on the 3rd tomato leaf caused a significant local induction of PPO, POD and LOX activity [25].

In upper leaves, not inhabited by CSM throughout the experimental period, no significant changes in the level of total phenolics were noted (Fig.2a). However, a significant decrease in the content of CHA (by 41%) and in the level of remained soluble in methanol fraction of phenolics (by 68%) was observed (Figs.2c and 2d). The content of RUT was markedly enhanced (by 25%) (Fig.2b). The activity of PPO increased by 48%, whereas the activity of POX was not affected (Figs.2e and 2f). PPO was induced plant-systemic by *Helicoverpa zea* feeding, while activities of both PPO and POX were plant-systemic induced by russet mite feeding on tomato plants [25]. Constabel et al. [3] reported that PPO activity increases systemically in leaves of wild plants in response to wounding and is induced in tomato plants supplied with systemin or methyl jasmonate, components of the wound-inducible octadecanoidbased signal transduction pathway.

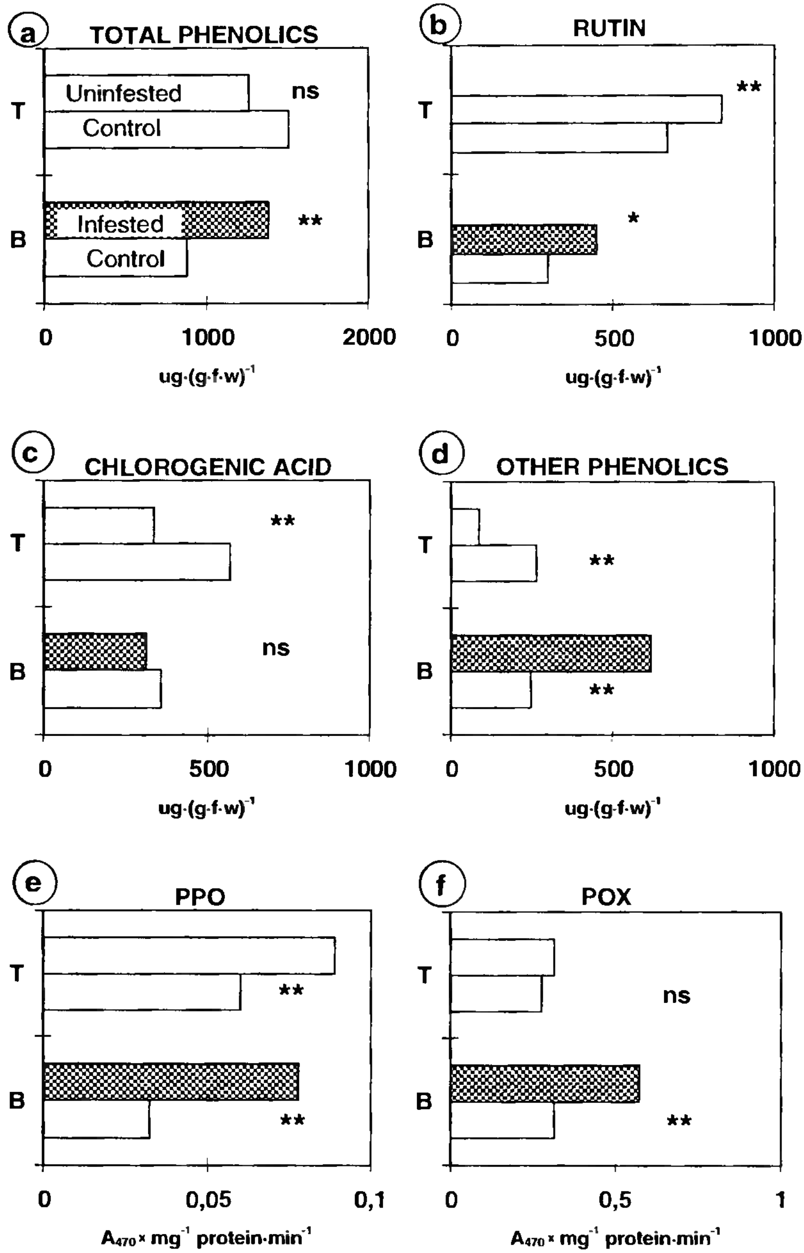

Fig.2. The effect of *T. cinnabarinus* feeding on the mean content of total phenolics (a), rutin (b), chlorogenic acid (c), other phenolics (d) and the mean activity of PPO (e) and POD (f) at two plant positions: B-bottom and T-top. Content of substances was expressed as absorbance changes at 470 nm/mg of protein/min. Means followed by * and ** are significantly different at P = 0.01 and P = 0.05, respectively (Mann-Whitney U-test)

Obtained results showed that CSM feeding on bottom tomato leaves leads to the induction of both local and systemic responses. However, the magnitude of chemical induction was most pronounced in directly damaged (bottom) rather than in undamaged (upper) leaves. In young leaves, systemic responses manifested as an enhanced level of RUT and increased activity of PPO. PPO is an inducible enzyme that oxidises a wide range of plant phenolics [27] and possibly has a defensive role against herbivores [8, 9, 10, 11]. Thus, observed here the enhanced oxidative status of tomatoes infested by CSM may result from such mechanisms. Further research is needed to show, if induced chemistry of upper leaves affects CSM performance.

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ZAWARTOŚĆ ALLELOZWIĄZKÓW W LIŚCIACH POMIDORÓW (*LYCOPERSICON ESCULENTUM* MILL.) PORAŻONYCH PRZEZ PRZĘDZIORKI (*TETRANYCHUS CINNABARINUS* BOISD.)

Streszczenie

Wykazano, że w liściach pomidora szklarniowego (*Lycopersicon esculentum* cv. Recento) porażonych przez przędziorki (*Tetranychus cinnabarinus*) następuje wzrost zawartości fenoli ogólnych, rutyny, rozpuszczalnych w metanolu substancji fenolowych innych niż kwas chlorogenowy i rutyna, przy równoczesnym wzroście aktywności enzymów: oksydazy polifenolowej i peroksydazy. W tkankach liści nieporażonych, odległych od miejsca żerowania szkodnika, obserwowano istotne zwiększenie zawartości rutyny i aktywności oksydazy polifenolowej. Uzyskane wyniki wskazują, że żerowanie przędziorków na pomidorach wywołuje lokalne zmiany w liściach bezpośrednio zaatakowanych oraz systemiczną (=układową) indukcję metabolizmu wtórnego tych roślin.

Słowa kluczowe: pomidor szklarniowy, przędziorek szklarniowy, substancje fenolowe, enzymy redukujące

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EFFECT OF FEEDING OF THE APPLE RUST MITE *ACULUS SCHLECHTENDALI* (NAL.) (ACARI, ERIOPHYIDAE) ON APPLE SHOOTS ELONGATION

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Synopsis. Significant irregularities in shoot growth were noticed on three apple cultivars infested with *Aculus schlechtendali*. In cultivars numerously inhabited by the eriophyoid mite the growth of shoots, especially apical ones, was inhibited. Feeding of a small number of eriophyoids stimulated shoot growth. The rate of shoot elongation correlated with the size of this mite population.

Key words: apple cultivars, apple rust mite, shoot growth

1. INTRODUCTION

Eriophyoid mites (Eriophyoidea) cause various plant damages, including inhibited growth resulting from this pest's feeding [3, 7, 8]. The apple rust mite injures leaf undersides [1, 2, 4] and apple fruits [1], disturbs metabolic and biochemical processes [5, 6], which likely leads to inhibition of the apple tree growth and yielding [3]. The purpose of this work was to find to what degree the mite feeding affects shoot growth of different apple cultivars.

2. MATERIAL AND METHODS

The studies were carried out in the production orchard at Parzęczewo in the Wielkopolski climatic sub-region. Considerable leaf damages, and precocious leaf fall resulting from *A. schlechtendali* feeding on the apple trees have been observed since 1994. During the next year observations on the population dynamics of this pest were conducted on 3-year-old apple trees of the cvs. Jonagold, Šampion and Idared. Six plots with 10 apple trees infested with the eriophyoid mite were chosen for each cultivar. On three of them preventative treatments against *A. schlechtendali* were applied. In 1996, three main shoots (lower, median and apical) and two-second order shoots on each of them (one at the conductor in the internal part of the crown and another at the apex in the external part of the crown) were designated on each apple tree. The length of these shoots was measured at eight dates from the end of May to the end of August. Mean length increments of the shoots were estimated from May 30 to each successive date of observation. The rate of shoot elongation was determined in cm per 10 days. Leaves from these shoots were collected at the same dates to evaluate the number of apple rust mites per 1 cm^2 of leaf area.

3. RESULTS AND DISCUSSION

On the trees infested with the eriophyoid mite the population peak of the pest occurred in 1995 by the end of the first decade of July (on the cv. Jonagold - 17.8 indiv./cm^2 leaf area, on the cv. Šampion - 39.4, on the cv. Idared - 34.5) and in 1996, in the first days of August (on the cv. Jonagold - 13.8 indiv./cm^2 leaf area, on the cv. Šampion - 28.6, on the cv. Idared - 29.9). The cv. Jonagold was slightly infested with the pest. The population peak on the cv. Jonagold was followed by the rapid fall in the mite population, whereas on the two remaining apple cultivars the number of eriophyoids decreased slowly and in 1996 another population peak of these mites was observed by the end of August.

At the first date of observations (June 10), the length increments of the main shoots (lower, median and apical) and second order shoots arising from them (at the base and in the apical part of the main shoots) were similar on all observed apple trees. Length differences of the main shoots were observed in the second half of June, when shoot elongation was the most intensive (Tab.1).

Table 1. Mean shoot elongation (cm) on 3 apple cultivars from May 30 to June 26, 1996

Cultivar	N/I	Lower part of crown			Median part of crown			Apical part of crown		
		A	B	C	A	B	C	A	B	C
Jonagold	N	14.00	11.83	19.33	14.67	9.50	14.33	10.17	11.67	20.33
	I	7.33	10.83	17.33	11.50	9.33	18.67	10.00	10.17	45.67
Šampion	N	10.83	15.33	18.33	13.33	16.83	23.33	11.17	16.67	59.33
	I	12.00	13.83	16.33	13.33	19.50	21.67	17.00	14.33	15.67
Idared	N	11.00	18.00	20.00	9.67	15.50	21.00	19.50	16.67	42.00
	I	6.33	19.67	21.67	14.67	17.00	20.67	11.33	10.83	21.33

N - non-infested trees,
I - trees infested with *A. schlechtendali*
A - a second order shoot arising at the base of a given main shoot (internal part of crown),
B - a second order shoot arising at the apical of a given main shoot (external part of crown),
C - main shoot (lower, median, apical).

The largest differences between the eriophyoid-infested and non-infested trees at that time concerned apical shoots. Shoot growth on the infested trees as compared to the control was longer - by 25 cm on the cv. Jonagold and the inhibition of shoot growth was greater - to 44 and 21 cm on the cvs. Šampion and Idared, respectively.

In the period from May 30 to August 23 (Tab.2), the largest mean length increments were observed in the main shoots in the apical part of the crown. They amounted, on average, to 45 cm on the eriophyoid-infested and non-infested trees. The elongation of the main lower and median shoots at that time was significantly less - constituting 21 and 22 cm, respectively. All second order shoots elongated appreciably less. A significant influence of the eriophyoid feeding on shoot elongation was found on the cvs. Šampion and Idared. In the period from May to August the main apical shoot of the cv. Šampion elongated, on the average, 68 cm on the non-infested trees and only 42 cm on the infested trees, while on the cv. Idared it elongated, on average, 70 and 36 cm, respectively. The cv. Jonagold responded to the pest feeding markedly less than the cvs. Šampion and Idared. As follows from the observations, the largest differences in length increments occurred in the main apical shoots.

Table 2. Mean shoot elongation (cm) on 3 apple cultivars in the vegetation season of 1996 (from May 30 to August 23) and results of Tukey's test, $\alpha = 0.05$. N, I, A, B, C - see Table 1

Cultivar	N/I	Lower part of crown			Median part of crown			Apical part of crown		
		A	B	C	A	B	C	A	B	C
Jonagold	N	15.33	13.50	19.67	16.67	12.50	15.33	12.17	13.00	49.67
	I	13.67	14.00	21.00	18.50	11.00	23.33	14.67	12.50	58.33
Šampion	N	12.50	18.00	24.67	14.33	19.17	28.67	11.50	20.67	68.33
	I	13.00	15.50	21.33	14.00	20.50	26.67	17.67	15.67	42.33
Idared	N	20.00	28.33	28.67	16.67	21.17	29.00	44.17	21.67	69.67
	I	13.00	28.67	29.33	25.33	29.00	29.33	19.33	19.17	36.33
Mean		11.90 d	17.21 c	21.13 b	14.69 cd	16.57 c	22.49 b	15.69 c	14.83 cd	45.48 a

When comparing the mean shoot elongation on particular apple cultivars at the successive dates of observations, substantial differences were found between the cvs. Jonagold and Idared. The main shoots in the median part of the crown of non-infested trees and second order shoots in the external part of the crown (median and lower) of trees infested with the eriophyoid mite had significantly larger length increments on the cv. Idared than on the cv. Jonagold.

It was found out that shoot growth was considerably inhibited on the apple cultivars which were heavily infested with the pest in the preceding year (Tab.3). Feeding by eriophyoid mites had a significant influence on the inhibition of shoot growth in the apical part of the tree crowns. Length increments of shoots were significantly larger on non-infested than on mite infested trees. Limitation of shoot growth under the influence of *A. schlechtendali* was also reported by Jeppson et al. [3] who observed this pest on young apple trees in the north-western part of the USA.

Table 3. Effect of feeding of *A. schlechtendali* on elongation of apple shoots (Tukey's test $\alpha = 0.05$)

Cultivar	Non-infested shoots	Infested shoots
Jonagold	16.64 d	17.89 cd
Šampion	21.99 ab	18.92 cd
Idared	24.21 a	20.35 bc
Part of crown	**Non-infested shoots**	**Infested shoots**
Lower	17.48 cd	16.01 d
Median	17.01 c	18.82 c
Apical	28.34 a	22.33 b
Mean	19.06 b	20.94 a

It was statistically found that at the second date of observations (mid-June) a correlation between the population size of the eriophyoid mites and the elongation rate of the main shoots and second order shoots there occurred. Both correlations were negative, and the relationship between these characteristics was linear.

In Fig.1, a simple regression $y = 5.49 - 0.323x$ presents a relationship between the length increment of the main shoot in cm/10days (variable y) and the number of apple rust mites per 1 cm^2 leaf area (independent variable x, $x \leq 17$).

A simple regression $y = 3.03 - 0.167x$ represents a relationship between elongation of the second order shoots in cm per 10 days (y) and the number of pest individuals per 1cm^2 leaf area ($x \leq 17$). In both cases, together with the increased population of the eriophyoid mites there occurs a stronger inhibition in the rate of shoot elongation. The inhibition of elongation rate was larger on the main shoots than on the second order shoots.

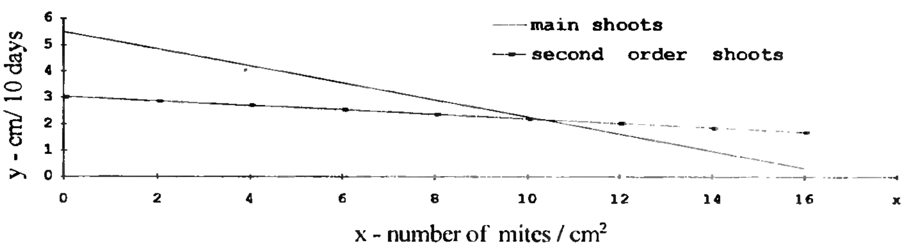

Fig.1. Rate of shoot elongation on apple trees (cm/10 days) and the population size of the apple rust mite (on cm^2 leaf) - June 1996

While comparing the elongation rate of the main shoots on three apple cultivars, it was observed that its decrease was more rapid on the infested trees.

A significant decrease occurred at the second date of observations, being the highest on the cvs. Šampion and Idared.

The observed irregularities in shoot growth on the trees infested with the apple rust mite were a response of plants to a long-lasting feeding of this pest. Also the other species of the eriophyoid mite, such as *Colomerus vitis* (Pagenstecher) on grape-vines [7], and *Aculus fockeui* (Nal., Trt) on plum trees, inhibited shoot growth of host plants. In our studies, the trees infested with the apple rust mite were probably strongly weakened as a result of the pest feeding lasting several years. Hence the inhibition in shoot elongation was observed at the beginning and in the second half of June, that is in the period, when the size of the eriophyoid mites population was relatively small. The strongest response was displayed by the cultivars heavily infested with the eriophyoid mite in the year preceding the study. Feeding of a small number of eriophyoids can stimulate shoot growth. That was observed in the case of the cv. Jonagold, where the population peak of the pest occurring early in the year preceding the study was followed by a rapid fall. That made it possible for plants to compensate their losses and to have a more intensive shoot growth at the beginning of the next year in relation to the control.

4. CONCLUSIONS

1. Feeding of the apple rust mite causes irregularities in shoot growth of apple trees.
2. On apple cultivars numerously infested with the eriophyoid mites there occurs a strong inhibition in the elongation of apical shoots (by about 50% in comparison to the control).
3. Feeding of a small number of eriophyoid mites stimulates shoot growth.
4. On eriophyoid-infested apple trees there occurs an inhibition in the rate of shoot growth.
5. The rate of shoot elongation depends on the population size of the apple rust mite, apple cultivar and observation date.

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WPŁYW ŻEROWANIA PORDZEWIACZA JABŁONIOWEGO *ACULUS SCHLECHTENDALI* (NAL.) (ACARI, ERIOPHYIDAE) NA PRZYROSTY PĘDÓW JABŁONI

Streszczenie

Na trzech odmianach jabłoni porażonych i nie porażonych przez *Aculus schlechtendali* obserwowano wzrost pędów podczas sezonu wegetacyjnego. Stwierdzono, że żerowanie pordzewiacza jabłoniowego powodowało istotne zakłócenia we wzroście pędów. Na odmianach licznie zasiedlanych przez szpeciela (Šampion, Idared) wzrost pędów, zwłaszcza wierzchołkowych, ulegał zahamowaniu. Żerowanie niewielkiej liczby szpecieli stymulowało wzrost pędów (Jonagold). Stwierdzono skorelowanie tempa przyrostu pędów i liczebności populacji szpeciela, dla pędów wierzchołkowych i pędów II rzędu badanych odmian jabłoni.

Słowa kluczowe: odmiany jabłoni, pordzewiacz jabłoniowy, wzrost pędów

AKADEMIA TECHNICZNO-ROLNICZA IM. JANA I JĘDRZEJA ŚNIADECKICH
W BYDGOSZCZY
ZESZYTY NAUKOWE NR 214 - OCHRONA ŚRODOWISKA 2 (1998) 55-60

PREDATION BY *NEOSEIULUS REDUCTUS* (WAINSTEIN) ON PLANT FEEDING MITES INFESTING APPLE SEEDLINGS

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Synopsis. The impact of *Neoseiulus reductus* on *Tetranychus urticae*, *Panonychus ulmi* and *Vasates schlechtendali* populations infesting apple seedlings was studied under climatic room conditions. *Neoseiulus reductus* was able to control all three tested species and to persist at low prey densities.

Key words: *Neoseiulus reductus*, *Panonychus ulmi*, *Tetranychus urticae*, *Vasates schlechtendali*, predation

1. INTRODUCTION

During the last few years the two-spotted spider mite (*Tetranychus urticae* Koch) became an important pest of apple orchards in Poland. The implementation of IPM program based on mite control by *T. pyri* Scheuten did not give efficient results because this predator shows a limited effectiveness against *T. urticae*. Among naturally occurring indigenous phytoseiids, *Neoseiulus reductus* showed a number of promising characters as a biological control agent of *T. urticae*. This predator occurs commonly on several species of deciduous trees, shrubs and annual plants in temperate regions of Europe, in Kazakstan and Georgia [1, 2, 8, 9]. In Poland it was found on raspberries (Sahajdak unpublished data). The research of Kolodochka [3, 4] provided the basic biological parameters of this species. The experimental evidence indicated its ability to suppress two-spotted spider mite populations on strawberries [6, 7]. The predator can be easily reared on all stages of *T. urticae* and on pollen [5].

In this paper we present the results of experiments on the ability of *N. reductus* to suppress phytophagous mite populations on young apple trees growing in climate rooms.

2. MATERIAL AND METHODS

Neoseiulus reductus used in the study was collected from *Rubus idaeus* L. in the neighbourhood of Płock (Central Poland). The stock culture of this predator was maintained on bean leaves infested with *T. urticae*.

Experiments were conducted on potted apple seedlings which were kept in two climat rooms (26 ± 2°C, 65-75% RH and 16:8 L:D). Trees were arranged in 6 groups of 10 seedlings each. On each seedling 25 leaves were left. The leaves and branches of the individual trees in the group touched each other and mites were able to disperse over all the trees. Four groups of trees were infested with females of *T. urticae*. After two weeks mite density was estimated and then females of the predator were introduced to 3 groups of trees.

The following variants of experiments were applied:

1. 9 *T. urticae* + 1 predator
2. 25 *T. urticae* + 1 predator
3. 50 *T. urticae* + 1 predator
4. Trees without predators

At weekly intervals mites and eggs were counted on all the leaves of the two sample trees. This provided a record of the population development and a continuous record of the number of prey and predators present on individual leaves.

Two other groups of experimental plants consisted of trees naturally infested with *Vasates schlechtendali* (Nalepa). On these trees 25 females *P. ulmi* (Koch) were introduced per tree. Two weeks later, after an estimation of phytophagous mite density, females of *N. reductus* were placed on half the trees with a ratio of 1 predator per 10 spider mites. At weekly intervals, 25 leaves were taken from each experimental group of trees, and all the mites and their eggs present on the leaves were counted.

3. RESULTS AND DISCUSSION

3.1. The influence of predatory mites on population development of *Tetranychus urticae*

Total numbers of prey and predatory mites on apple seedlings, receiving different numbers of predatory mites during the experiment, are given in Figs. 1-3. In tests without predator releases, spider mites rapidly increased to 700-800 specimens per tree during the first 2-3 weeks of the experiment. Then a decline in their number was observed due to the over exploiting of leaves by a fast-developing spider mite population.

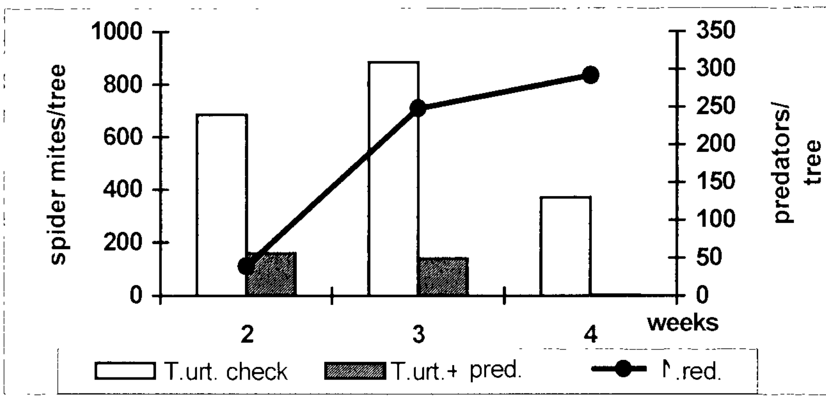

Fig.1. Population dynamics of *T. urticae* and *N. reductus* on apple seedlings when predator/prey ratio was 1:9

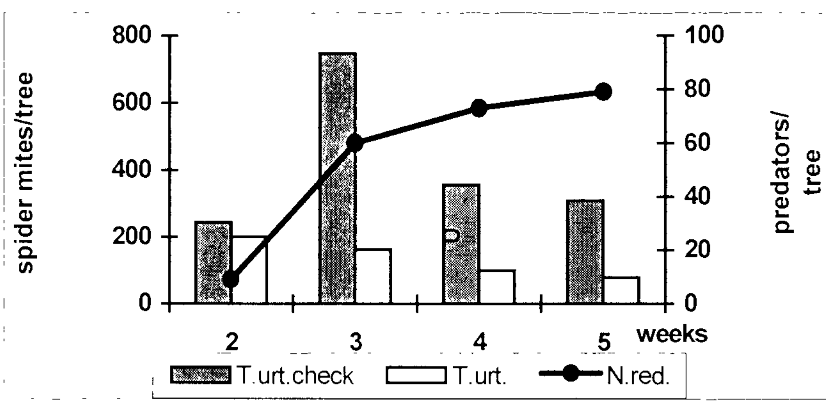

Fig.2. Population dynamics of *T. urticae* and *N. reductus* on apple seedlings when predator/prey ratio was 1:25

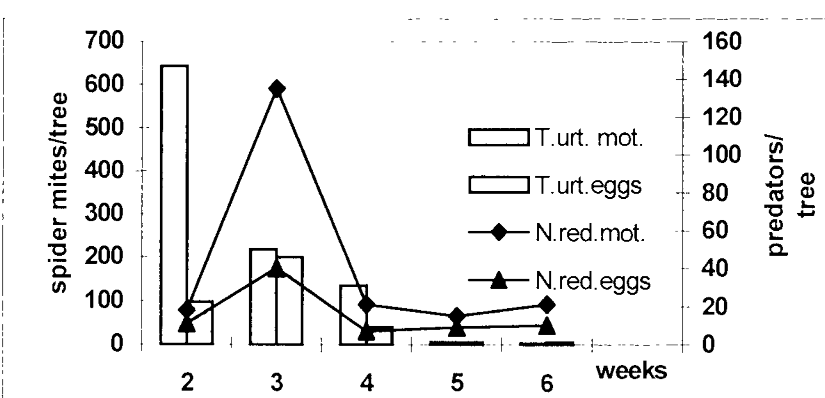

Fig.3. Population dynamics of *T. urticae* and *N. reductus* on apple seedlings when predator/prey ratio was 1:50

In tests which received releases of 1 predator per 9 prey and 1 predator per 25 prey. *Tetranychus urticae* reached a maximum of about 200 motile stages per tree before being controlled. In the variant which had the ratio predator to prey 1:9, population of *T. urticae* was completely eliminated already in the fourth week after predator introduction (Fig.1).

On the trees where a predator was released with a ratio of 1 predator to 25 prey, the effect of introduction was visible in the sixth week. The delay was probably due to the occurrence of *Vasates schlechtendali* on the apple leaves. This mite can be an alternative food source for the predator.

In the variant, which had a predator to prey ratio of 1:50, *T. urticae* reached 600 per plant in the second week of the experiment. Even in such a high population of prey, biological control was achieved in the fifth week of the experiment.

3.2. The influence of predatory mites on population development of *Panonychus ulmi* and *Vasates schlechtendali*

The population development of *P. ulmi* and *V. schlechtendali* on the trees without predators is presented in Fig.4.

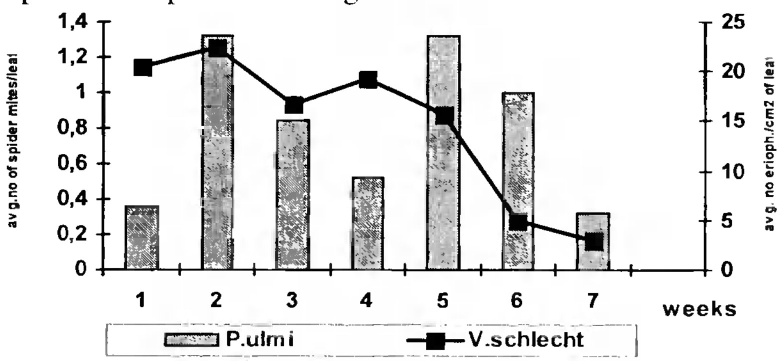

Fig.4. Population dynamics of *P. ulmi* and *V. schlechtendali* on apple seedlings

Density of *P. ulmi* remained at a low level - 0.4-1.4 specimens/leaf during seven weeks of observation. Apple rust mites levels were relatively high - between 15-22 specimens/cm^2. They declined at the end of the experiment because of poor foliage conditions.

On the trees receiving a predator, both phytophagous mites declined in the third week after *N. reductus* introduction. *Panonychus ulmi* was not detectable on the leaves starting from the fourth week after predator introduction. Apple rust mites remained at very low densities - below 1 specimen/cm^2. This density of prey was sufficient to keep the predator population on the trees (Fig.5).

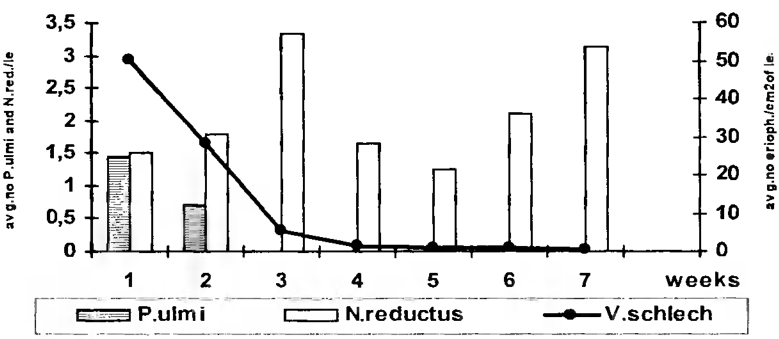

Fig.5. Population dynamics of *P. ulmi*, *V. schlechtendali* and *N. reductus* on apple seedlings

4. CONCLUSIONS

Results of experiments carried out in a very simplified ecosystem provide only an indication for further field research. They prove that *N. reductus* can survive and multiple on 3 species of tested prey. The population of predators can persist on the trees when density of eriophyid mites is low. High efficacy of predator in suppressing of two-spotted spider mites under controlled climatic conditions indicates that this species can be considered as potential candidate for greenhouse releases. The data on the effect of its introduction in the field crops are only restricted to strawberries. Tukonova and Małow [7] and Radetskij and Poliakova [6] showed that the predator can decrease the density of the pest from 22 % to 10 % of the initial population during one growing season

To get a final answer on whether or not this species can be used in apple trees further investigation on the effects of field releases will be conducted.

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EFEKTYWNOŚĆ DRAPIEŻNEGO ROZTOCZA *NEOSEIULUS REDUCTUS* (WAINSTEIN) W ZWALCZANIU ROZTOCZY ROŚLINOŻERNYCH NA JABŁONIACH

Streszczenie

Opracowanie przedstawia wyniki doświadczeń nad skutecznością *N. reductus* w zwalczaniu przędziorka chmielowca, przędziorka owocowca i pordzewiacza jabłoniowego. Doświadczenie prowadzono w fitotronie na siewkach jabłoni. Drzewka doświadczalne podzielono na 6 grup, każda grupa liczyła 10 drzewek. Na 4 grupy drzewek wprowadzono samice przędziorka chmielowca. Po dwóch tygodniach sprawdzono zagęszczenie przędziorków. Następnie na 3 grupy drzewek wprowadzono samice *N. reductus*. Zastosowano 3 warianty doświadczenia różniące się liczebnością drapieżcy. Stosunek liczbowy drapieżcy do ofiary wynosił: 1 wariant 1 : 9, 2 wariant 1 : 25, 3 wariant 1 : 50. Na czwartej grupie drzewek przędziorek chmielowiec rozwijał się bez udziału drapieżcy. Na pozostałe 20 drzewek wprowadzono przędziorka owocowca, znajdował się również na nich szpeciel pordzewiacz jabłoniowy. Po określeniu liczebności obu gatunków na 10 drzewek wprowadzono *N. reductus* w liczbie 10 samic na drzewko. W odstępach tygodniowych z każdego wariantu doświadczenia pobierano próbę 25 liści i liczono wszystkie występujące na liściach roztocze. W kontrolowanych warunkach (fitotron) *N. reductus* okazał się efektywnym drapieżcą przędziorka chmielowca, przędziorka owocowca i pordzewiacza jabłoniowego. Czas, jaki potrzebował drapieżca do zlikwidowania ofiar, zależał od ich zagęszczenia i mieścił się w przedziale 4-7 tygodni.

Słowa kluczowe: *Neoseius reductus*, *Panonychus ulmi*, *Tetranychus urticae*, *Vasates schlechtendali*, efektywność drapieżnictwa

AKADEMIA TECHNICZNO-ROLNICZA IM. JANA I JĘDRZEJA ŚNIADECKICH
W BYDGOSZCZY
ZESZYTY NAUKOWE NR 214 - OCHRONA ŚRODOWISKA 2 (1998) 61-64

MITE CONTROL IN ORCHARDS WITH NEW PESTICIDES

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Synopsis. Mites on plum trees were controlled with Para Sommer based on paraffin oil in 1995-1997 and on apples with Altima 500 SC (fluazinam) in 1993-1994. Para Sommer was applied just before bud break and fluazinam during vegetation. Para Sommer was highly effective, comparable to Apollo 500 SC (clofentezin). The fungicide Altima 500 SC was effective when applied to the population below threshold level. When the population was high even two sprays were unsatisfactory.

Key words: mites, control, Para Sommer, Altima

1. INTRODUCTION

Mites in orchards have been dangerous for a long time. Because they easily get resistant to pesticides [1, 3] there is a need for new, selective compounds enabling to alternate them and apply in integrated pest control method. Para Sommer is a good example. Also, some fungicides, for example Altima 500 SC (fluazinam) or Euparen (dichlofluanid) decrease mite populations [4].

2. MATERIAL AND METHODS

The effectiveness of Para Sommer was tested on plums in 1995-1997 and Altima 500 SC on apples in 1993-1994. The first one was applied in early spring, just before bud break and Altima during growing season. To apply the pesticides a Termit sprayer was used delivering 1000 l of liquid/ha. One combination consisted of one plot 0.2-0.3 ha, with four replicates. Mite counting was executed on leaves sampled from the middle part of the plot. The population density was evaluated with Henderson and McBurnie technique [2] on 50 leaves sampled from each replicate and term. A cumulative Index of Infestation was calculated for each test.

3. RESULTS AND DISCUSSION

The results show high effectiveness of Para Sommer at 3% concentration (Tab.1).

Table 1. The effectiveness of Para Sommer in the control of mites on plums in Nowa Wieś. The treatments were preformed in April just before bud break

Combination	No. of mites/leaf 2-15 weeks after spraying					CH control = 100
	2-4	5-6	8	11	13-15	
1995						
Para Sommer	0.1	0.4	0.2	0.8	3.3	27.3
Apollo 500 S.C.	0.02	0.0	0.01	0.3	1.1	6.8
Control	3.0	3.3	3.0	1.6	7.5	100.0
1996						
Para Sommer	0.0	0.0	0.05	0.5	0.5	5.8
Apollo 500 SC	0.02	0.0	0.02	0.1	0.03	1.3
Control	2.7	4.5	4.6	4.0	8.0	100.0
1997						
Para Sommer	0.1	0.8	0.6	6.0	2.0	23.3
Apollo 500 SC	0.05	1.7	4.3	1.4	3.7	21.7
Control	2.6	8.5	7.7	22.7	29.6	100.0

In the years of experimenting its effectiveness was comparable to Apollo 500 SC (0,4 l/ha). In the years 1995-1996 for thirteen weeks and in 1997 up to eleven weeks after treatment mite population was low - below economic threshold level.

Altima 500 SC, containing fluazinam at the dose one l/ha decreased the number of mites when pest population was low, below economic threshold level. Two or even one treatment gave good results (Tab.2). In the following 7-8 weeks mite population was below economic threshold level. However, when the preparation was applied to a larger population its effectiveness was low even when 2 sprays were executed (Tab.3).

Table 2. The effectiveness of Altima 500 SC in the control of mites on apples in Dąbrowice in 1993. Treatments were made: * 8 June 1993, ** 8 June 1993 i 5 July 1993

Combination and dose/ha	No. of mites/leaf							CH control = 100
	before treatment	1-9 weeks after spraying						
		1	2	3	5	7	9	
Altima 500 SC** 1 l	9.2	3.9	10.2	5.2	11.3	8.6	8.4	43.2
Danirun 110 EC* 0,75 l	4.6	0.1	1.8	0.3	2.5	6.3	10.9	19.5
Peropal 25 WP* 1,5 kg	10.9	0.02	0.08	0.06	0.1	0.7	0.1	1.4
Control	12.7	10.6	13.8	18.0	18.7	32.2	9.5	100.0

Table 3. The effectiveness of Altima 500 SC in mite control on apples in Nowa Wieś. Treatments were made: 9 July 1993, * 30 June 1994, ** 30 June, 14 July 1994, *** 30 June, 14 July, 28 July 1994

Combination and dose/ha	No. of mites/leaf					CH control =100
	before treatment	1-8 weeks after spraying				
		1-2	3-4	5-6	7-8	
1993						
Altima 500 SC - 1 l	1.4	0.05	0.3	1.0	1.4	8.2
Peropal 25 WP - 1.5 kg	2.9	0.0	0.0	0.2	0.4	1.6
Control	7.5	9.9	24.5	2.9	5.4	100.0
1994						
Altima 500 SC** - 1 l	2.7	1.2	0.03	0.1	0.3	14.0
Altima 500 SC*** - 1 l	1.8	0.9	0.01	0.1	0.4	13.6
Peropal 25 WP* - 1.5 kg	2.6	0.4	0.3	1.8	3.4	61.5
Control	2.0	5.3	3.0	3.6	1.4	100.0

4. CONCLUSIONS

1. Para Sommer showed high effectiveness in the control of *Panonychus ulmi* on apples.
2. The fungicide Altima 500SC (fluazinam) was effective against low populations of mites, below economic threshold level. Applied against a large population this fungicide was effective in decreasing its size.

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ZWALCZANIE PRZĘDZIORKÓW W SADACH NOWYMI PREPARATAMI

Streszczenie

Badania nad zwalczaniem przędziorków preparatem Para Sommer prowadzono w latach 1995-97, natomiast preparatem Altima 500 SC w latach 1993-94 w sadach towarowych. W przeprowadzonych badaniach uzyskano wysoką efektywność preparatu Para Sommer w dawce 30 l/ha. Była ona równa skuteczności preparatu Apollo 500 SC w dawce 0.4 l/ha. Przez okres 13-15 tygodni od jego zastosowania liczebność przędziorków była bardzo mała, poniżej progu ekonomicznej szkodliwości. Preparat Altima 500 SC w dawce 1 i 1.5 l/ha ograniczał liczebność przedziorków. Zastosowany na populację poniżej progu zagrożenia wykazał dobre działanie, a na populację powyżej progu ekonomicznej szkodliwości był zbyt mało efektywny nawet wówczas, gdy wykonano dwa opryskiwania.

Słowa kluczowe: przędziorki, zwalczanie, Para Sommer, Altima

AKADEMIA TECHNICZNO-ROLNICZA IM. JANA I JĘDRZEJA ŚNIADECKICH
W BYDGOSZCZY
ZESZYTY NAUKOWE 214 - OCHRONA ŚRODOWISKA 2 (1998) 65-74

EFFECTIVENESS OF PREDATORY MITES (PHYTOSEIIDAE) IN LIMITING POPULATION OF TWO-SPOTTED SPIDER MITES (*TETRANYCHUS URTICAE* KOCH) ON BLACK CURRANTS

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Synopsis. Predatory mites *Typhlodromus pyri*, *Neoseiulus fallacis* and *Phytoseiulus persimilis* (Phytoseiidae) limited populations of the two-spotted spider mite (*Tetranychus urticae*) on 2-year-old potted black currant plants kept either in a net isolator protected from the rain or in an open field. The predators were able to suppress drastically an initial high population of the pests but only after a lag period of 4-6 weeks after their introduction. When the initial population density of the pest was low (about 1 specimen per leaf) the phytoseiids kept it at a low level through several weeks. The black currant variety influenced indirectly the effectiveness of predatory mites. *Neoseiulus fallacis* exhibited higher effectiveness on Titania plants than on Ojebyn and Ben Lomond cultivars.

Key words: Phytoseiidae, spider mites, black currant, effectiveness

1. INTRODUCTION

The two-spotted spider mite (*Tetranychus urticae*) is a common pest of black currants and, in some seasons, may inflict severe economic loses. Therefore it has to be controlled by chemicals applied several times a year. Two-spotted spider mites in apple orchards may be kept to a low level by predatory mites (Phytoseiidae) [1, 3, 4, 6, 9]. Therefore it seems feasible that phytoseiids could effectively control two-spotted spider mite on black currant plantations as well. Such possibility is suggested by field observations (Niemczyk, unpublished data) and by the results of an introductory experiment [8].

At a time when the experiment was initiated, there was no information in literature concerning control of *T. urticae* on black currants by predatory mites. The first data appeared in 1994 [7, 10].

The objective of the presented investigations was to examine the effectiveness of three species of predatory mites (*Typhlodromus pyri* Scheut., *Neoseiulus fallacis* Garman, *Phytoseiulus persimilis* Athias-Heinriot) in controlling two-spotted spider mites on black currant plants. A special emphasis was paid to the role of the first two species because their effectiveness in controlling spider mites in apple orchards is very well documented [1-5, 11].

2. MATERIAL AND METHODS

The experiments were conducted in 1993-1994 at the Research Institute of Pomology and Floriculture in Skierniewice on 2-year-old potted black currant plants kept either in a wire net insectary protected against rain by a roof (experiments 1 and 2) or in an open field (experiment 3). The experimental plants were first infested with two-spotted spider mites and after several days the predatory mites were introduced. *Typhlodromus pyri* and *N. fallacis* were reared in our laboratory and *P. persimilis* was obtained from the local market. The samples of leaves were taken in all experiments at about two week intervals and predators (mites and insects) and phytophagous mites were counted.

a. Experiment 1

The aim of the experiment was to check whether predatory mites *N. fallacis, T. pyri, and P. persimilis* introduced either separately or as a mixed population are able to decrease the number of two-spotted spider mites on black currant in conditions of initial high population density of *T. urticae*. Six treatments were established:

1. *T. urticae* + *T. pyri* (50 individuals per plant)
2. *T. urticae* + *N. fallacis* (50 individuals per plant)
3. *T. urticae* + *P. persimilis* (50 individuals per plant)
4. *T. urticae* + 17 individuals of each predator
5. Check 1 - *T. urticae* - predators not introduced to the plants
6. Check 2 - *T. urticae* - plants kept in an open field, predators not introduced

The experiment (with exception of check 2) was conducted in an insectary over 3 months, from the middle of May to the middle of August. Each treatment consisted of 4 black currant plants. Forty leaves (ten from each plant) were collected to count mites at each sampling term. The plants of each treatment were located at a distance of about 2m from plants treated differently.

b. Experiment 2

The objective of the experiment was to learn whether black currant variety (Ojebyn, Titania and Ben Lomond) may influence the effectiveness of *N. fallacis* in controlling *T. urticae* occurring at the beginning of the trial in a low number. Six treatments were established:

1. Ojebyn cv. + *T. urticae* + 60 individuals of *N. fallacis* per plant
2. Ojebyn cv. + *T. urticae* - without introduction of the predator (check)
3. Titania cv. + *T. urticae* + 60 individuals of *N. fallacis* per plant
4. Titania cv. + *T. urticae* - without introduction of the predator (check)

5. Ben Lomond cv. + *T. urticae* + 60 individuals of *N. fallacis* per plant
6. Ben Lomond cv. + *T. urticae* - without introduction of the predator (check)

The experiment was conducted in wire net insectary over 3.5 months, from the middle of April to the last days of July. Each treatment was represented by 3 black currant plants, and 30 leaves (10 from each plant) were collected at each term. The distance between the plants of each treatment was about 3 m.

c. Experiment 3

The purpose of the trial was to examine whether predatory mites *T. pyri* and *N. fallacis*, introduced on black currant plants lightly infested (about 0.5 individuals per leaf) by two-spotted mites, would be able to keep the pest population at a low level for a long time. Four treatments were established:
1. *T. urticae* + *T. pyri* (30 individuals per plant)
2. *T. urticae* + *N. fallacis* (30 individuals per plant)
3. *T. urticae* without introduction of predatory mites (check 1)
4. *T. urticae* without introduction of predatory mites but some predators occurred naturally in the environment (check 2)

The experiment was conducted in an open field over 4.5 months, from the middle of May to the middle of September. Each treatment consisted of 10 black currant plants and 50 leaves were taken (5 from each plant) at each term for examination. The plants from different treatments were situated at a distance of approximately 50 m from each another.

3. RESULTS

3.1. Experiment 1

All three predatory mites examined (*T. pyri, N. fallacis, P. persimilis*) decreased the population of two-spotted spider mites on black currants. On the plants with *T. pyri* alone or with a mixture of *T. pyri, N. fallacis* and *P. persimilis*, two-spotted spider mites were less numerous than on the plants inhabited by only *P. persimilis* or *N. fallacis*.

The number of phytophagous mites on black currants declined distinctly in all treatments after 4-6 weeks from their introduction of predators (Fig.1). However, the sharp suppression of the *T. urticae* was observed only after 8 weeks since introduction. There was one exception - on plants with *P. persimilis*, the population of two-spotted spider mites decreased dramatically much earlier - after 4 weeks from the introduction of the predator (Fig.1).

The reason the predator´s effectiveness was noticed only after a relatively long lag period was probably connected with a high initial population of two spotted spider mites (18-28 specimens per leaf). After six weeks from their introduction, when the population density of predators increased considerably (the predator/prey ratio reached 1 to 10-50) a sharp decrease of *T. urticae* population was observed during the next two weeks (Fig.1).

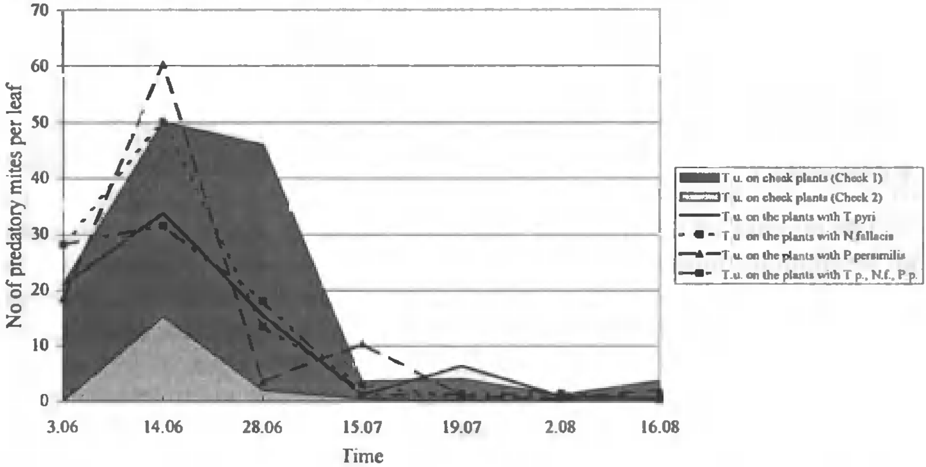

Fig.1. Experiment I: occurrence of *T. urticae* on black currant plants with introduced species of predatory mites

Two-spotted spider mites were the most numerous on control plants kept in the isolator (check 1). The lowest population of phytophagous mites was observed on black currants grown in an open field (check 2), not protected from the rain and infested with "wild" predatory mites and insects (*Oligota flavicornis,* Staphilinidae) occurring naturally in the environment. Thus, the conclusion about the effectiveness of studied predators may be somewhat flawed. First, predatory mites migrated to control plants from neighboring plants of other treatments. And second, *Oligota flavicornis* (Staphylinidae), a predatory insect feeding also on two-spotted spider mites, was noticed on all experimental plants. The presence of predatory mites and *O. flavicornis* could decrease the population of the pest on control plants and thus increase the apparent effectiveness of investigated predatory mites. It should be also mentioned that, as was shown in a special observation, larvae of *O. flavicornis* are not able to feed on predatory mites and thus could not affect the population of predators.

Of the introduced predatory mites, the total number of *N. fallacis* on experimental black currant plants was highest and *P. persimilis* the lowest (Fig.2).

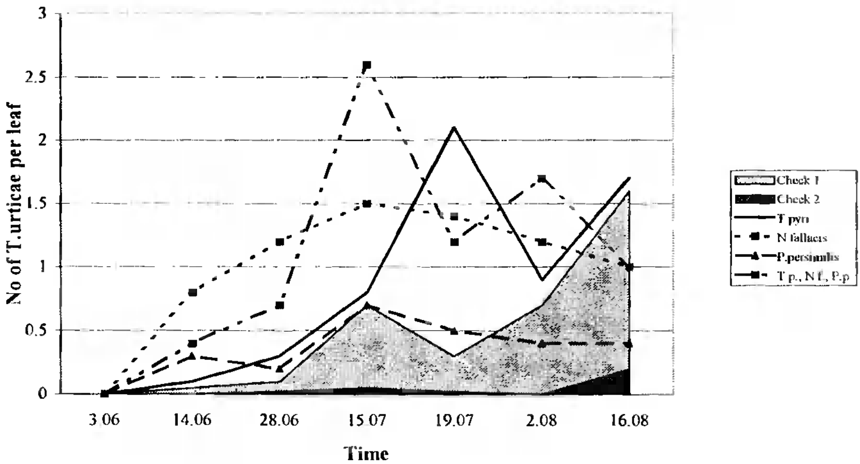

Fig.2. Experiment I: occurrence of 3 species of predatory mites (Phytoseiidae) on black currant plants infested with *T. urticae*

3.2. Experiment 2

The predatory mite *N. fallacis* suppressed the two-spotted spider mite population on black currant plants of all three examined varieties, however, to different degrees (Fig.3).

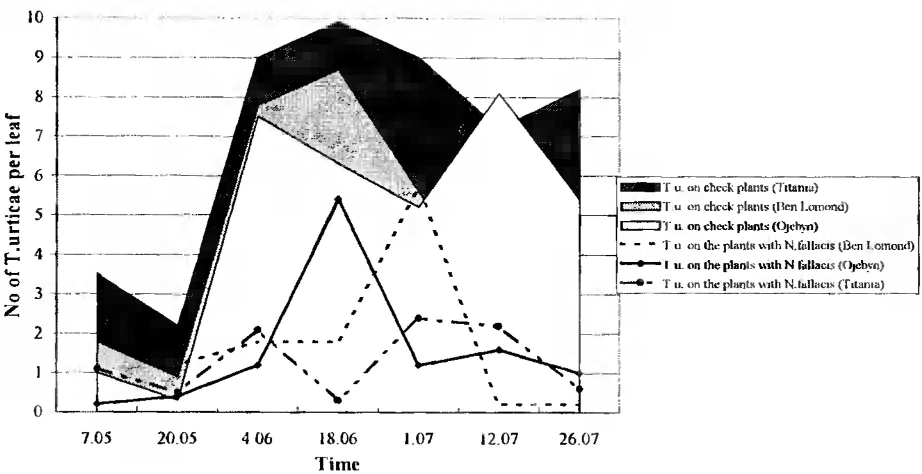

Fig.3. Experiment 2: occurrence of *T. urticae* on 3 varieties of black currant plants with predatory mite (*Neoseiulus fallacis*)

The number of phytophagous mites on plants infested with predators was on average lower by 2 (Ben Lomond), 3 (Ojebyn) or 5 (Titania) times than those on control plants of the same varieties. *Tetranychus urticae* on control plants exceeded threshold level (over 3 mites per leaf) at 3 (Ben Lomond), 5 (Ojebyn) or even 6 (Titania) terms of observations. On the other hand, on plants infested with predatory mites the threshold level two-spotted spider mites was exceeded only once on Ojebyn cv. and twice on Ben Lomond cv. On Titania cv. the phytophagous mites did not reach the threshold level.

These results could have been affected to some extent by the natural occurrence of *N. fallacis* on check plants 4 weeks after the first observation. Also *O. flavicornis,* a predatory insect, was observed on all black currants but especially on check plants. Both facts could increase the apparent effectiveness of predator.

Population density of *N. fallacis* on a particular black currant variety corresponded positively with population density of two-spotted spider mites. The predator occurred in lowest numbers on Titania plants and in highest numbers on Ben Lomond cv. (Figs.3, 4).

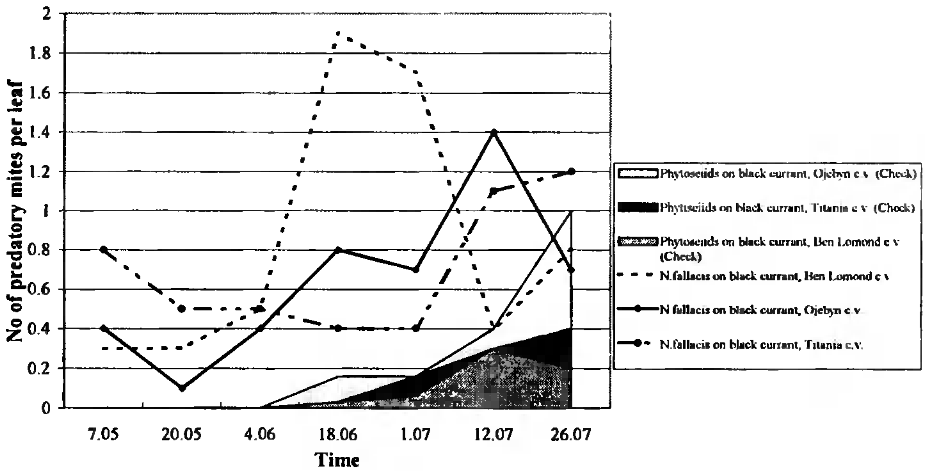

Fig.4. Experiment 2: occurrence of *Neoseiulus fallacis* on 3 varieties of black currant plants infested with *T. urticae*

3.3. Experiment 3

Predatory mites *T. pyri* and *N. fallacis* introduced on black currant plants only moderately infested by two-spotted spider mites were able to keep the pest population on a low level during the entire time of experiment, i.e. longer than 10 weeks.

Population density of *T. urticae* was lowest on control plants (control 2) on which the predatory mites were not released. However, these plants were inhabited naturally by "wild" phytoseiids present in environment.

The population density of two-spotted spider mites on check plants 2 ranged from 0 to 0.9 specimens per leaf during the whole time of the experiment (Fig.5).

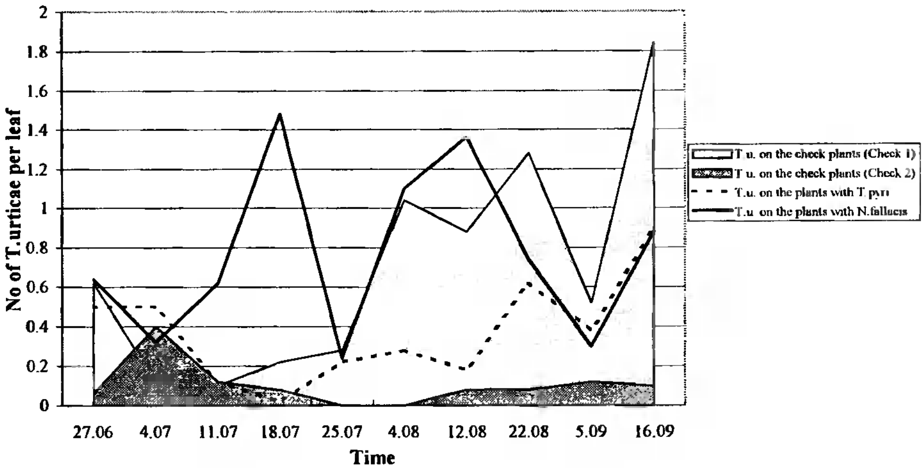

Fig.5. Experiment 3: occurrence of *T. urticae* on black currant plants with 2 species of predatory mites

The population density of predatory mites varied at different sampling times from low (a few specimens per 100 leaves) to moderate (about a dozen specimens per 100 leaves) and rather high (up to 48 specimens per 100 leaves) (Fig.6).

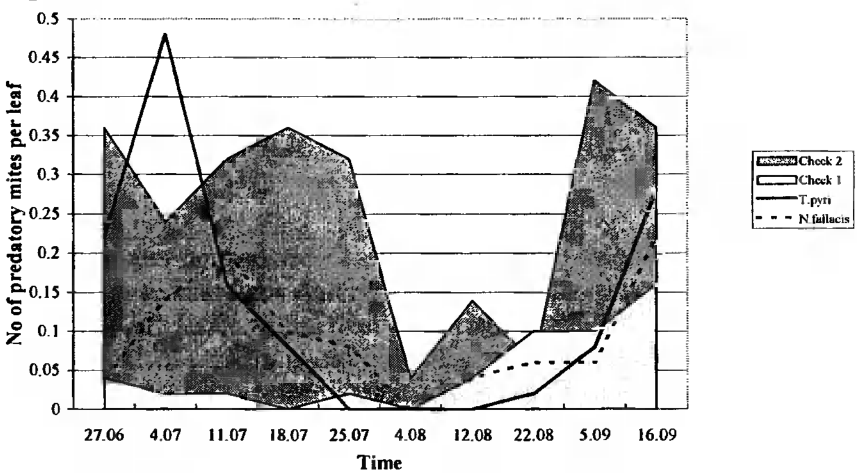

Fig.6. Experiment 3: occurrence of predatory mites on black currant plants infested with *T. urticae*

Predatory mites were the most numerous on "check 2" plants inhabited naturally by "wild" specimens. During first weeks of observations *T. pyri* inhabited black currants in higher numbers than *N. fallacis*.

4. CONCLUSIONS

1. Predatory mites: *Typhlodromus pyri*, *Neoseiulus fallacis* and *Phytoseiulus persimilis* were able to decrease populations of two-spotted spider mites (*Tetranychus urticae*) on black currant plants.
2. The predators introduced on plants heavily infested by two-spotted spider mites (20-30 mites per leaf) drastically suppressed the phytophagous mites but only after a 6-8 week lag period.
3. In the case of a low initial population of phytophagous mites, the examined species of predators (*N. fallacis, T. pyri*) were able to keep pests to a low level over the entire time of the experiment (about 15 weeks).
4. The effectiveness of the predatory mite *N. fallacis* to two-spotted spider mites depended indirectly on the black currant variety. *Neoseiulus fallacis* was more effective on Titania plants, which were infested to a higher degree with phytophagous mites than on Ojebyn and Ben Lomond cv. inhabited with less two spotted spider mites.
5. The most effective of the phytoseiids in controling two-spotted spider mites on black currants grown in an open field indicate the occurrence of the "wild" predatory species occurring naturally (together with *T. pyri* and *N. fallacis* in the environment.
6. Relatively high populations of two-spotted spider mites on black currant plant may be also suppressed by two species of predatory insects: *Oligota flavicornis* (Staphylinidae) and *Stethorus punctillum* (Coccinellidae). The presence of those insects on experimental plants makes difficult an estimation of the real effectiveness of predatory mites.

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EFEKTYWNOŚĆ DRAPIEŻNYCH ROZTOCZY (PHYTOSEIIDAE) W OGRANICZANIU POPULACJI PRZĘDZIORKA CHMIELOWCA (*TETRANYCHUS URTICAE* KOCH) NA CZARNYCH PORZECZKACH

Streszczenie

Doświadczenia prowadzono w latach 1993-1994 na terenie Instytutu Sadownictwa i Kwiaciarstwa w Skierniewicach na dwuletnich roślinach czarnych porzeczek wysadzonych do metalowych wiader, przetrzymywanych bądź w osiatkowanym i zadaszonym insektarium, bądź w warunkach zewnętrznych. Na początku na krzewy doświadczalne nakładano dorosłe osobniki przędziorka chmielowca (*Tetranychus urticae*), a po wzroście liczebności szkodnika wprowadzano dorosłe osobniki drapieżnych roztoczy. Na rośliny kontrolne drapieżców nie wprowadzano. W odstępach około dwutygodniowych sprawdzano pod binokularem liczebność przędziorków i drapieżców na zerwanych liściach.

Stwierdzono, że:

- badane gatunki roztoczy drapieżnych (*Typhlodromus pyri*, *Neoseiulus fallacis*, *Phytoseiulus persimilis*) ograniczały liczebność przędziorka chmielowca na czarnej porzeczce;
- w przypadku wysokiej populacji przędziorków na porzeczkach (około 20-30 osobników na liść) musiało upłynąć dużo czasu (około 6-8 tygodni) od intro-

dukcji, aby wprowadzone drapieżce mogły silnie ograniczyć liczebność przędziorków;

- jeżeli porzeczki były słabo opanowane przez przędziorki, introdukowane drapieżce *T. pyri* i *N. fallacis* utrzymywały populację szkodnika na niskim poziomie przez cały okres trwania doświadczenia (około 3,5 miesiąca);
- odmiana porzeczek czarnych wywierała pośrednio wpływ na efektywność *N. fallacis* w ograniczaniu liczebności przędziorka chmielowca. Na krzewach odmiany Titania, silniej porażonych przez przędziorki, *N. fallacis* wykazywał większą efektywność niż na krzewach odmian Ojebyn i Ben Lomond, słabiej porażonych przez przędziorki.

Słowa kluczowe: Phytoseiidae, przędziorki, czarna porzeczka, efektywność

AKADEMIA TECHNICZNO-ROLNICZA IM. JANA I JĘDRZEJA ŚNIADECKICH
W BYDGOSZCZY
ZESZYTY NAUKOWE NR 214 - OCHRONA ŚRODOWISKA 2 (1998) 75-78

OCCURRENCE OF PREDATORY MITES (PHYTOSEIIDAE) AND THEIR SPECIES COMPOSITION ON BLACK CURRANT PLANTATIONS IN DIFFERENT REGIONS OF POLAND

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Synopsis. The occurrence of predatory mites (Phytoseiidae) was observed in 1992 on 121 black currant plantations located in different parts of Poland. The phytoseiids were found on 48% of the plantations. On inhabited plantations, they occurred in a low or a very low number. Eight phytoseiid species were noted on black currants. The dominant one was *Amblyseius andersoni*. The low population of phytoseiids observed on black currant or their absence was probably due to pesticide treatments.

Key words: Phytoseiidae, black currant, occurrence

1. INTRODUCTION

In 1992, when the experiment started, there was no information on the occurrence and species composition of predatory mites (Phytoseiidae) on black currant plantations in Poland. The objective of the presented observations was to state whether phytoseiids occur commonly on black currants in the country and whether plant protection chemicals used on plantations decreased population density of predatory mites.

2. MATERIAL AND METHODS

The observations were conducted in 1992 at a time of the highest occurrence of phytoseiids, i.e. from a second half of July to the end of August, on 121 plantations located in 11 regions. During that period, samples of 100 leaves taken from 25 randomly selected bushes (4 leaves per bush) were collected from each plantation. The predatory mites, red spider mites and predatory insects associated with the mites were counted under stereomicroscope. The phytoseiids were removed from the leaves and preserved in 70% alcohol for further identification. Black currant varieties, age of plantations, number of chemical treatments and pesticides used were also recorded.

3. RESULTS

3.1. Occurrence of predatory mites (Phytoseiidae)

The predatory mites were observed on 48% of plantations examined. The population of predators on majority of inhabited plantations was low or very low (Tab.1).

Table 1. Number of plantations examined, occurrence of predatory mites (Phytoseiidae) and predatory insects associated with spider mites (*Oligota flavicornis, Stethorus punctillum*)

Region		Number of plantations	Number of plantations with:	
			predatory mites (Phytoseiidae)	predatory insects
nowosądeckie		12	9	0
krakowskie		13	11	0
wrocławskie		15	5	6
lubelskie		11	2	0
radomskie		9	5	4
płockie		6	1	2
rzeszowskie		15	9	0
skierniewickie		35	12	12
opolskie		2	2	0
sieradzkie		2	2	1
konińskie		1	0	0
Total	Number	121	58	25
	%	100	48	20.6

Of 121 plantations checked, only on 16 more then 20 specimens per 100 leaves were found (Tab.2).

Table 2. Occurrence of predatory mites (Phytoseiidae) on black currant plantations*

Black currant plantations	Number of Phytoseiids per 100 leaves		
	>20	about 50	>100
Number	16	3	4
%	13	2.4	3.3

* Number of examined plantations 121 (100%)

The occurrence and population density of predatory mites varied in the regions. In southern part of Poland, in the Nowy Sącz, Rzeszów and Kraków regions, the phytoseiids were the most numerous and occurred commonly on black currants. On the contrary, in the central (Płock) and eastern part of the country (Lublin), the predatory mites were noted only on a few plantations.

3.2. Species composition

Eight species of phytoseiid mites were identified on leaves collected from black currant plantations (Tab.3).

Table 3. Species composition of predatory mites (Phytoseiidae) on black currant plantations located in different parts of Poland

Species	Participation in %	Region
Amblyseius andersoni Chant	70.2	R, O, N, S, W
Amblyseius bryophilus Karg	15.3	N, Rz
Typhlodromus pyri Scheuten	7.6	R, O
Neoseiulus fallacis Garman	4.2	S
Euseius finlandicus Oudemans	1.5	O, N, Rz
Phytoseius macropilis Banks	0.4	R
Typhlodromus rhenanus Oudemans	0.4	W
Amblyseius huron Chant et Chansell	0.4	Rz

Abreviations
R - Radom, O - Opole, S - Skierniewice, N - Nowy Sącz, W - Wrocław, Rz - Rzeszów

Amblyseius andersoni was the most abundant and occurred most commonly. Relatively numerous was also *Amblyseius bryophilus*, but it appeared only in the southern part of the country. *Typhlodromus pyri* was noted only in Radom and Opole, and *Neoseiulus fallacis* only in Skierniewice region. *Euseius finlandicus,* which was reported as the most abundant species on black currants in Finland and in the neighbourhood of Warsaw, was identified in our observations on black currant plantations located in three regions, but was not numerous (Tab.3).

3.3. Occurrence of two-spotted spider mites *(Tetranychus urticae* Koch)

Two-spotted spider mites occurred in almost all examined plantations, but its population was very diversified and varied from several to 17.500 individuals per 100 leaves. The threshold level, which at the observation time was established as 7 mites per leaf, was exceeded on 26 plantations (21.4% of plantations examined). Population density of spider mites varied significantly on different plantations located in the same region.

3.4. Occurrence of predatory insects

Two species of predatory insects associated with spider mites - *Stethorus punctillum* Wse. (Coccinellidae) and *Oligota flavicornis* (Boisd-Lac) (Staphylinidae) - were observed on a few examined plantations in several regions (Tab.1). These predators were observed at highest density (about 20 individuals per 100 leaves) on black currant plantations severely infested with two-spotted spider mites.

3.5. Chemical treatments of black currant plantations

Intensity of the sprayings of black currant plantations varied greatly in different regions. Plantations treated the most often with pesticides were located in the region of Końskowola (Lublin region). The number of sprayings on some plantations located in that region reached as many as 11 per year. As opposite, plantations located in Rzeszów, Nowy Sącz, Skierniewice, Kraków and Rzeszów regions were sprayed much less frequently. Eleven different insecticides - 5 acaricides and 11 fungicides - were applied on examined plantations. Some of them are known to be very toxic to predatory mites and insects, for instance pyrethroids and O-P compounds.

Endosulphan (Thiodan) was the most often applied insecticide and mancozeb (Dithane) was the most often used fungicide on black currant plantations. Both are very toxic to predatory mite *Neoseiulus fallacis* in laboratory tests (Niemczyk - unpublished data). Thus, most probably the low number of phytoseiids observed on examined black currant plantations or their absence was due to used insecticides, mainly endosulphan, pyrethroids (Cymbusz, Danitol, Karate, Talstar) and O-P compounds (fenitrothion, phosalone, dichlorphos) and fungoicide (mancozeb).

WYSTĘPOWANIE DRAPIEŻNYCH ROZTOCZY (PHYTOSEIIDAE) ORAZ ICH SKŁAD GATUNKOWY NA PLANTACJACH CZARNYCH PORZECZEK W RÓŻNYCH REJONACH KRAJU

Streszczenie

W roku 1992 obserwowano występowanie drapieżnych roztoczy z rodziny dobroczynkowatych (Phytoseiidae), naturalnych wrogów przędziorka chmielowca (*Tetranychus urticae*), na 121 plantacjach czarnych porzeczek zlokalizowanych w 11 województwach. Roztocze drapieżne znaleziono na 48% przeglądanych plantacji. Ich liczebność na większości plantacji była jednak mała lub bardzo mała (Tab.1, 2). Znaleziono łącznie 8 gatunków (Tab.3). Dominantem był *Amblyseius andersoni*, który występował najliczniej i najbardziej powszechnie. Oprócz drapieżnych roztoczy na 12 plantacjach znaleziono także 2 gatunki owadów drapieżnych odżywiających się przędziorkami: *Stethorus punctillum* (Coccinellidae) i *Oligota flavicornis* (Staphylinidae) (Tab.1). Niektóre plantacje, szczególnie w okolicy Końskowoli (woj. lubelskie), były intensywnie opryskiwane preparatami chemicznymi. Najczęściej stosowanym insektycydem był Thiodan (endosulfan), a fungicydem Dithane (penkozeb), które w testach laboratoryjnych okazały się bardzo toksyczne dla drapieżnego roztocza *Neoseiulus fallacis*. Najprawdopodobniej mała liczba roztoczy znajdująca się na większości obserwowanych plantacji lub ich całkowity brak, były głównie związane ze stosowaniem pestycydów.

Słowa kluczowe: Phytoseiidae, czarna porzeczka, występowanie

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PRELIMINARY STUDIES ON THE BIOLOGY OF *TETRANYCHUS CINNABARINUS* BOIDS. ON VARIOUS CULTIVARS OF *CODIAEUM VARIEGATUM* SPP.

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Synopsis. The present study reports life-table parameters and the comparison of fecundity, longevity, development time and length of the reproductive period for the carmine spider mite *Tetranychus cinnabarinus* on four cultivars of *Codiaeum variegatum*. Population parameters such as intrinsic rate of natural population increase (r_m), net reproductive rate (R_0), and mean generation time (T) have been used as criteria of croton susceptibility to the carmine spider mite.

Key words: life-tables, *Tetranychus cinnabarinus*, *Codiaeum variegatum*

1. INTRODUCTION

Data concerning bionomy of the carmine spider mite (*Tetranychus cinnabarinus*) which more and more often colonise different glasshouse crops are very scarce and are concentrated mainly on some vegetable crops [1, 4]. The difference in mite development on various host plants should be taken into consideration. The aim of this research was to study the bionomy of *T. cinnabarinus* inhabiting different cultivars of croton plants, commonly cultivated in Poland.

2. MATERIALS AND METHODS

The experiment was carried out on the most popular in Poland croton cultivars (Excellent, Norma, Petra, Golden Finger) under laboratory conditions at 21°C ± 2°, RH 60-70 % and L:D period 16:8. *Tetranychus cinnabarinus* was reared on *Codiaeum* plants cv. Norma at the University greenhouse complex in Ursynów. All material used in the experiments originated from this culture.

Studies on the mite life cycle were conducted on whole croton leaves with petioles. Each leaf was placed on wet cotton in Petri dishes, and than divided by cotton stripes into ten sectors. Single females were isolated and placed in leaf sectors for oviposition. They were removed after 24 h. The mites hatched from the eggs were observed at 24 h intervals. Mite longevity and fecundity of one deutonymph and two males were isolated in leaf sectors and kept there for 2 days to ensure copulation. After that, males were carefully removed. Eggs deposited and female life longevity were recorded daily. Differences were compared using a multiple-range test based on Duncan's test.

Population parameters such as intrinsic rate of natural population increase (r_m), net reproductive rate (R_0), and mean generation time (T) were used as criteria of *Codiaeum* susceptibility to the carmine spider mites.

3. RESULTS AND DISCUSSION

Data on development time and mortality of *T. cinnabarinus* on various cultivars of *Codiaeum variegatum* (L.) are given in Table 1. *Tetranychus cinnabarinus* showed the longest developmental time feeding on leaves of cv. Golden Finger (20.1 days) and the shortest on cv. Excellent (17.6 days). Mortality of *T. cinnabarinus* was related strongly to cultivar and ranged between 27-68 %. The highest mortality was observed on cv. Golden Finger where almost 68 % of the mites died during development. The lowest mortality was found for mites feeding on cv. Norma (27%) and Petra (30%).

The survivorship of eggs is an important parameter influencing the number of adult offspring [5]. Longer duration of the egg stage could result in a longer period of predation by egg feeding predatory phytoseiids [3].

Table 1. Development time and mortality of *T. cinnabarinus* on various croton cultivars. Duncan's test: values with the same letters are not significantly different (P = 0.05)

Cultivar	Developmental time (days)			Mortality (%)	
	egg	egg to adult	egg to egg	larval	total
Excellent	6.89 c	16.3 d	17.6 c	20	32
Norma	8.49 ab	14.6 c	17.9 bc	12	27
Petra	9.13 a	17.2 b	18.3 b	16	30
Golden Finger	8.36 b	18.9 a	20.1 a	43	68

The experimental data on the fecundity of *T. cinnabarinus* are presented in Table 2. Oviposition extended from 9.1 days on cv. Golden Finger to 14.3 days on cv. Petra. The highest fecundity of carmine spider mite females was found on cultivars Petra and Norma; 89.26 and 78.20 eggs per female, respectively.

Daily oviposition rate was similar on three cvs: Excellent, Norma and Petra. It was 22.8 % lower on the cv Golden Finger in comparison with other studied cultivars. Maximum life longevity of carmine spider mite females was noticed on cv. Petra (32.8 days). The lowest rate of mite survival was recorded on cvs. Excellent (28.9) and Golden Finger (29.1).

Table 2. Fecundity and life longevity of *T. cinnabarinus* on various croton cultivars. Duncan's test: values with the same letters are not significantly different (P = 0.05)

Cultivar	Oviposition (days)	Fecundity No.of egg/female	Daily oviposition rate No.of egg/female/day	Life longevity (days)
Excellent	10.6 b	68.41 c	6.45 b	28.9 c
Norma	12.5 b	78.20 b	6.25 b	31.5 b
Petra	14.3 a	89.26 a	6.21 b	32.8 a
Golden Finger	9.1 c	43.91 d	4.82 a	29.1 c

Wrensh and Young [6], based on the study of host quality in relation to *T. cinnabarinus*, indicated that only fecundity was affected by variations in host plant quality. Mite females, feeding on the leaves, which were a good source of food, produced more eggs than on less suitable plants. According to Gerson and Aronowitz, life longevity of mites was a function of the duration of oviposition [2].

The life tables constructed of the results obtained in this experiment are given in Table 3. The mean generation time was different on various croton cultivars and ranged from 2.4 weeks on cv. Norma to 3.41 weeks on cv. Golden Finger. The highest rate of natural population increase (r_m) was found for mites feeding on the leaves of cv. Petra (0.9) and it was 66% higher than on cv. Golden Finger (0.3). The rates of natural increase for mites feeding on cvs. Excellent and Norma were similar: 0.61 and 0.60 respectively. The possible reasons for the lowest rate of natural increase of mite population on cv. Golden Finger were probably very high mortality during development and low mite reproduction rate on plants of this cultivar.

Table 3. Population parameters of *T. cinnabarinus* on various croton cultivars

Cultivars	R_0	r_m	T	λ
Excellent	4.8	0.61	2.78	2.15
Norma	5.2	0.6	2.4	2.96
Petra	7.59	0.9	2.6	3.12
Golden Finger	2.6	0.3	3.41	1.35

4. CONCLUSIONS

Population parameters of *T. cinnabarinus* were related to the cultivar of the host plant. The cv. Petra appeared to be the most attractive host plant for the carmine spider mite *T. cinnabarinus*. Mites feeding on leaves of this cultivar showed the highest fecundity and the highest net reproductive rate. Also the mean generation time was the shortest on this cultivar. On the cultivar Golden Finger all population parameters were the lowest.

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BIONOMIA PRZĘDZIORKA SZKLARNIOWCA (*TETRANYCHUS CINNABARINUS* BOISD.) NA RÓŻNYCH ODMIANACH TRÓJSKRZYNA PSTREGO (*CODIAEUM VARIEGATUM* SPP.)

Streszczenie

Badania prowadzono w warunkach laboratoryjnych na różnych odmianach trójskrzyna pstrego, popularnie zwanego krotonem, (*Codiaeum variegatum*) Excellent, Golden Finger, Norma i Petra. Badano: długość rozwoju, śmiertelność, płodność oraz parametry demograficzne takie jak: tempo reprodukcji netto (R_0), wrodzone tempo wzrostu populacji (r_m), czas rozwoju pokolenia (T) oraz tempo zwielokrotnienia liczebności populacji (λ). Odmiana Petra okazała się najbardziej atrakcyjną rośliną żywicielską dla *T. cinnabarinus*. Na roślinach tej odmiany przędziorki osiągnęły najwyższą całkowitą płodność 89.26 jaj/samicę, najwyższe tempo reprodukcji netto (r_m = 7.6), najwyższe tempo zwielokrotnienia populacji (λ = 3.12) oraz relatywnie krótki czas rozwoju pokolenia (T = 2.6 tygodnia). Obliczone parametry populacyjne były najniższe dla odmiany Golden Finger: R_0 = 2.6, λ = 1.35 oraz T = 3.41, co było najprawdopodobniej związane z niską płodnością (43.9 jaja/samicę) oraz bardzo wysoką (66%) śmiertelnością w czasie rozwoju *T. cinnabarinus* na tej odmianie.

Słowa kluczowe: przędziorek szklarniowy, parametry demograficzne, trójskrzyn pstry - kroton

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ORCHARD ACAROCOMPLEX IN UKRAINE

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Synopsis. The mites in Ukrainian orchards were investigated. In total, 96 species from 32 families were found on apple trees; 24 species are added to the list of orchard mites. Most rich in species were families Phytoseiidae (18 species), Tydeidae (18 species), Stigmaeidae (7 species) and Cheyletidae (5 species). The constancy of *Anthoseius caudiglans*, *Tydeus californicus*, *Amfitetranychus viennensis* and *Lorryia reticulata* increased, perhaps as a result of their tolerance to pesticides. During the last 30 years, the importance of the two bisexual species, *Amphitetranychus viennensis* and *Panonychus ulmi*, increased in apple orchards. Three groups of synthopic species were distinguished: (1) saprophages Oribatida and the family Pygmephoridae, (2) Mesostigmata (Phytoseiidae, Rhodacaridae, Aceosejidae, Laelaptidae, Veigaiaidae, Uropodidae), Bdellidae and Bryobiidae, and (3) a major part of other Prostigmata.

Key words: Ukraine, orchard, apple trees, mites, ecology

1. INTRODUCTION

Orchards are relatively permanent and stabile ecosystems in the agricultural landscape. They are rich in mesofauna, including crown mites. Until now many investigations have been done on orchard mites, but no general concept on the function of orchard acarocomplex have been published yet. This has resulted in improper pest control and losses in harvest.

2. MATERIAL AND METHODS

This paper is based on the material collected in Ukrainian professional orchards in the winter (Wint-89, Wint-90) and summer (3 years, forest-steppe zone, one orchard 150 km south of Kiev) (Tab.1). The mites were extracted and identified to species. The data of A. Vojtenko on the pest (spider mites) distribution on branches in the winter (443 samples from different regions of the Ukraine was also used, including 4-ball estimate (absent, present, usual, pested) and a control of hibernating *P. ulmi* and *P. redikorzevi* eggs and *A. viennensis* adults).

Table 1. Characteristics of samples collected in Ukrainian orchards in different seasons

Season	Regions	Details of method	Number of mites
Wint-89	20 regions	42 samples of tree bark	1625 mites, 54 species, 27 families
Wint-90	20 regions	49 samples of tree bark	1070 mites, 38 species, 21 families
Som	1 region	47 samples, apple tree crown, branches and leaves	839 mites, 34 species, 13 families

3. RESULTS AND DISCUSSION

Orchard mites present different ecological adaptations and life forms like feeding, homing and life cycles. The "acarocomplexes" bases of mite species, which live on apple trees, have comparable sizes and belong to a feeding group [1]. The most important in them are pests like Tetranchoidea. In the Ukraine, *Amphitetranychus viennensis*, *Panonychus ulmi* and *Bryobia redikorzevi* occurs abundantly from time to time, and *Tetranychus urticae* and *Cenopalpus pulcher* can also be important (Tab.2).

Table 2. List of species collected from Ukrainian orchards in different seasons

Family	Species	Win-89	Win-90	Sum
1	2	3	4	5
Tetranychidae	*Amphitetranychus viennensis*	70	82	60
	Tetranychus urticae	25	-	22
	Panonychus ulmi	-	-	7
Bryobiidae	*Bryobia redikorzevi*	11	14	38
Tenuipalpidae	*Cenopalpus pulcher*	-	4	-
Tarsonemidae	*Tarsonemus nodosus*	-	6	11
	Tarsonemus sp.	2	6	-
Pygmephoridae	*Siteroptes* sp.	2	2	-
Eriophyidae	Eriophy gen. sp1.	-	-	2
	Eriophy gen. sp2.	-	-	4
Phytoseiidae	*Phytoseius echinus*	20	24	29
	Phytoseius juvenis	2	4	9
	Amblyseius agrestis	-	4	-
	A. nemorivagus	-	2	-
	A. proximus	-	2	-
	A. andersoni	-	2	16
	A. zwoelferi	2	-	-
	A. herbarius	-	-	2
	A. riparius	-	-	2
	Anthoseius verrucosus	25	18	24
	A. caudiglans	16	18	67
	A. clavatus	5	-	-
	A. inopinatus	-	-	2
	A. halinae	-	2	-
	Typhlodromus rodovae	7	10	2

Table 2 (continued)

1	2	3	4	5
	Metaseius longipilus	-	1	-
	Euseius finlandicus	-	2	11
	Typhloctonus tiliarum	2	-	-
	Paraseiulus soleiger	2	-	-
Rhodacaridae[1/]	*Gamasellodes bicolor*	14	6	-
	Asca nova	-	2	-
Aceosejidae[2/]	*Zerconopsis* sp.	2	-	-
Laelaptidae	*Hypoaspis* sp.	2	-	-
Veigaiaidae	*Veigaia nemorensis*	2	-	-
Uropodidae	*Trichouropoda* sp.	2	-	-
	Oplitis sp.	2	-	-
Eupodidae	*Brotereunetes* sp.	-	2	-
Tydeidae	*Tydeus longisetosus*	-	2	-
	T. electus	-	1	
	T. caudatus	2	2	-
	T. californicus	14	2	16
	T. kochi	11	-	27
	Lorryia reticulata	43	27	-
	L. polygonata	-	2	-
	L. catenulata	2	-	-
	L. armaghensis	-	-	4
	Paralorryia mali	48	20	-
	P. ferula	2	4	-
	P. scabiseta	-	4	-
	P. chapultepecensi	-	-	4
	Paralorryia sp.	9	-	-
	Tydaeolus freguans	-	1	-
	Pronematus sextoni	-	1	-
	Triophtydeus fragarius	1	-	-
	T. immanis	-	-	4
Bdellidae	*Bdella muscorum*	9	-	-
	Biscirus silvaticus	-	-	2
	Cyta latirostris	5	-	-
	Spinibdella cronini	-	-	4
Cunaxidae	*Cunaxa setirostris*	9	-	-
	Cunaxoides biscutum	7	10	9
	Cunaxoides sp.	-	-	2
Stigmaeidae	*Zetzellia mali*	5	12	2
	Mediolata californica	2	-	2
	M. similans	11	-	-
	Mediolata sp.	-	2	-
	Apostigmaeus sp.	2	-	-
	Eryngiopus placidus	5	-	-
	Ledermuelleris sp.	-	-	-
	Stgm. gen. sp.	1	-	-

Table 2 (continued)

1	2	3	4	5
Cheyletidae	*Cheletacarus raptor*	2	-	-
	Paracaropsis strofi	2	-	-
	Paracheyletia samsinaki	2	-	-
	Paracheyletia sp.	-	2	-
	Cheletogenes ornatus	-	-	2
Anystidae	*Anystis baccarum*	-	-	58
Erythraeidae	*Abrolophus* sp.	2	-	4
	Sphaerolophus sp.	-	-	4
	Erythr. gen. sp1.	-	-	2
	Erythr. gen. sp2.	-	-	2
Glycyphagidae	*Glycyphagus domesticus*	7	-	-
Tyroglyphidae	*Tyrophagus humerosus*	5	-	-
Ceratozetidae	*Trichoribates trimaculatus*	73	69	-
	Ceratozetes rostroundulatus	9	6	-
Oribatulidae	*Zygoribatula frisiae*	5	10	-
	Z. exilis	2	-	-
Camisiidae	*Camisia segnis*	7	4	-
Scheloribatidae	*Scheloribates latipes*	9	2	-
	S. laevigatus	2	-	-
	Liebstadia humerata	2	-	-
Astegistidae	*Furcoribula furcillata*	2	-	-
Mycobatidae	*Punctoribates hexagonus*	-	2	-
Oppiidae	*Oppia* sp.	-	2	-
	O. unicarinata	5	-	-
Pelopidae	*Eupelops acromios*	14	-	-
Tectocepheidae	*Tectocepheus velatus*	5	-	-

1/ sensu [2] Bregetova, Shcherbak, 1977; 2/ sensu [3] Evans, 1958

Geographical differences in acarocomplexes between three main orchard mite pests were also observed. *Amphitetranychus viennensis* is sensitive to temperature and its pest level drops down when the humidity/temperature ratio increases. In contrast, *Panonychus ulmi* reacts to humidity positively, rising its pest level. Therefore, the pest level of these two species depends on climate zone (Fig.1). The pest level of *Bryobia redikorzevi* does not depend on climatic conditions and is low in Ukraine.

The pest level depends on pesticide pressure. Two bisexual species *Amphitetranychus viennensis* and *Panonychus ulmi* are more harmful to orchards, which are protected by pesticides, than *Bryobia redikorzevi*. Thus, the modern intensive technologies promote *Panonychus ulmi*. *Tetranychus urticae* also positively reacts to modern orchard technology, and its importance increases in orchards.

The important for acarocomplexes are conservative and stable background species. Ranging by the constancy index, 1/4 to 1/3 of the representatives in the samples have it higher than 10. Background species are generally common in samples, with several exceptions. Summer samples have *Anystis baccarum* and *Panonychus ulmi*, which hibernate egg stage. Most of background species are widely distributed on trees and bushes, and usually appear in all climate zones of the Ukraine. Some of them are connected with Asteracea and are characteristic for orchards. Some species (*Anthoseius caudiglans*, *Tydeus californicus*, *Amfitetranychus viennensis*, *Lorryia reticulata*) react positively to chemical pressure, and their constancy recently increased.

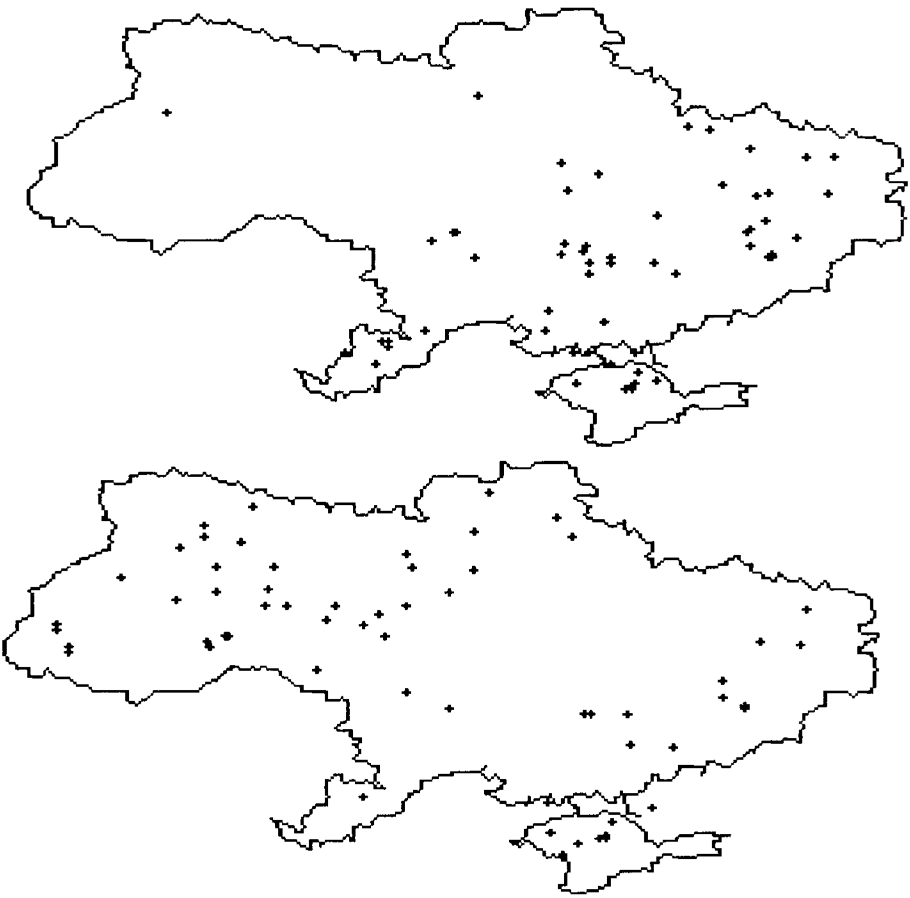

Fig.1. Flares of capacity for two spider mites in Ukrainian orchards (1988-90 years), top - *A. viennensis* (62 points), bottom - *P. ulmi* (70 points)

Based on the constancy index, the background species for orchard are *Amphitetranychus viennensis*, *Bryobia redikorzevi*, *Phytoseius echinus*, *Anthoseius verrucosus* and *A. caudiglans*. Among the families, Ceratozetidae, Tetranychidae, Tydeidae, Phytoseiidae occur more frequently than the others.

Based on the literature, 12 categories of mites are distinguished:

- 4 trophic categories like *ph* (phytophages, leaves-feeding mites), *pr* (stenotrophical and polytrophical predators), *po* (polyphages, species, which need

mixed feeding), *sa* (saprophages, mined Oribatida and Acaroidea),
- 3 strategy categories like *r* (with *r*-strategy), *k* (with *k*-strategy), *c* (*r-k*-intermediate representatives),
- 5 spatial categories for different habitats of mites like *l* (leaves), *v* (branches), *K* (to bark); *kr* (crown), *ko* (on bark).

Based on this material, the most common combination is phytophages, predators and saprophages or polyphages. By cluster analysis, three groups were formed: (1) predators - polyphages - branch gravitated - *k*-strategy, (2) phytophages - leaves gravitated - *r*-strategy, and (3) saprophages bark gravitated - *c*-strategy. The influence of location (leaves-branches) was stronger in summer samples, and strategy in winter samples (Fig.2).

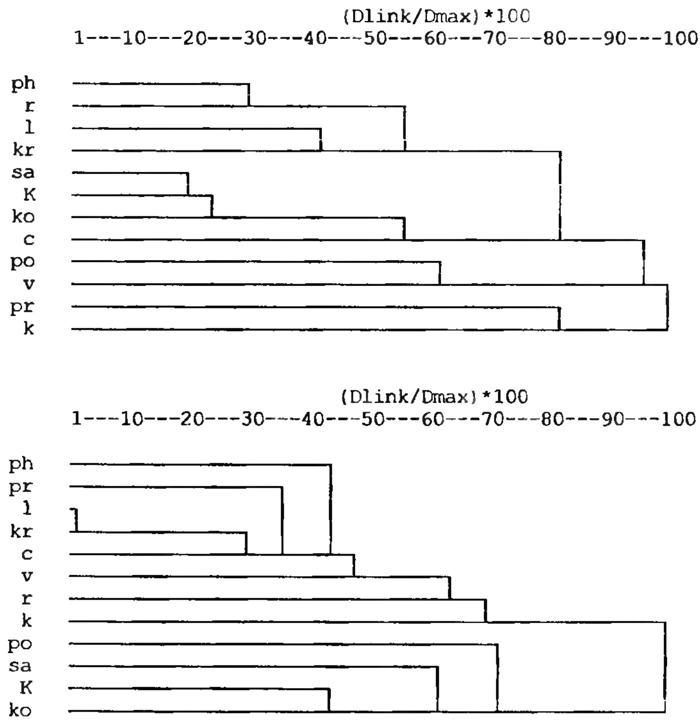

Fig.2. Clusters of ecological groups for samples Wint-90 and Somm. Abbreviations are explained in text

Three-step hierarchic structures by may be recognized in an acarocomplex by: (1) distribution, (2) feeding gravitation and (3) spatial and homing conditions. There are also three groups of species: (1) saprophages Oribatida and Pygmephoridae, (2) Mesostigmata (Phytoseiidae, Rhodacaridae, Aceosejidae, Laelaptidae, Veigaiaidae, Uropodidae), Bdellidae and Bryobiidae, and (3) a major part of other Prostigmata.

4. CONCLUSIONS

In total, 96 species of mites from 32 families were found on apple trees in the Ukraine. Most species belonged to families Phytoseiidae (18 species), Tydeidae (18 species), Stigmaeidae (7 species) and Cheyletidae (5 species). Twenty two species are added to the list of orchard mites:

- *Lorryia catenulata*, *L. polygonata*, *Paralorryia chapultepecensis*, *P. ferula*, *Metalorryia armaghensis* (new species [4]) from the family Tydeidae,
- *Typhlodromus rodovae* and *Amblyseius riparius* from family Phytoseiidae,
- *Cheletacarus raptor*, *Paracaropsis strofi* and *Paracheyletia samsinaki* from the family Cheyletidae,
- *Eryngiopus placidus* from the family Stigmaeidae,
- *Trichoribates trimaculatus*, *Ceratozetes rostroundulatus*, *Zygoribatula frisiae*, *Zygoribatula exilis*, *Camisia segnis*, *Scheloribates latipes*, *S. laevigatus*, *Liebstadia humerata*, *Furcoribula furcillata*, *Punctoribates hexagonus*, *Oppia unicarinata*, *Eupelops acromios* and *Tectocepheus velatus* from the family Oribatida (these mites are only mentioned, not identified).

The constancy of *Anthoseius caudiglans*, *Tydeus californicus*, *Amfitetranychus viennensis* and *Lorryia reticulata* increased, perhaps as a result of their tolerance to pesticides. During the last 30 years, two bisexual species, *Amphitetranychus viennensis* and *Panonychus ulmi*, increased their role in apple orchards. Three groups of synthopic species were distinguished: (1) saprophages Oribatida and the family Pygmephoridae, (2) Mesostigmata (Phytoseiidae, Rhodacaridae, Aceosejidae, Laelaptidae, Veigaiaidae, Uropodidae), Bdellidae and Bryobiidae, and (3) a major part of other Prostigmata.

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AKAROFAUNA SADÓW UKRAINY

Streszczenie

Zbadano roztocze sadów Ukrainy. Stwierdzono występowanie na jabłoniach 96 gatunków z 32 rodzin. Po raz pierwszy stwierdzono w sadach 24 gatunki roztoczy. Najbogatsze w gatunki były rodziny: Phytoseiidae (18 gatunków), Tydeidae (18 gatunków), Stigmaeidae (7 gatunków) i Cheyketidae (5 gatunków). Stałość *Anthoseius caudiglans*, *Tydaeus californicus*, *Amfitetranychus viennensis* i *Lorryia reticulata* wzrosła na skutek ich tolerancji na pestycydy. W okresie ostatnich 30 lat znaczenie dwóch biseksualnych gatunków *Amfitetranychus viennensis* i *Panonychus ulmi* na drzewach owocowych wzrosło. Wyróżniono w sadach trzy grupy gatunków: (1) saprofagiczne Oribatida i rodzina Pygmephoridae, (2) Mesostigmata (Phytoseiidae, Rhodacaridae, Aceosejidae, Laelaptidae, Veigaiaidae, Uropodidae), Bdelllidae i Bryobiidae, oraz (3) inne Postigmata.

Słowa kluczowe: Ukraina, sad, jabłonie, roztocze, ekologia

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W BYDGOSZCZY
ZESZYTY NAUKOWE NR. 214 - OCHRONA ŚRODOWISKA 2 (1998) 91-97

LIFE HISTORY OF THE PREDATORY PHORETIC MITE, *ARCTOSEIUS SEMISCISSUS* (BERLESE) (ACARI, ASCIDAE)

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Synopsis. A life table was constructed for the phoretic, predatory mite: *Arctoseius semiscissus* fed on sciarid eggs with the addition of nematodes. The entire development from egg to adult lasted 7.07 days on average for both sexes with a survival rate of 61 %. The sex ratio was 0.64. Parameter relating to oviposition was total fecundity - 55 eggs/female. Oviposition lasted at most 39 days. Net reproductive rate (R_0) was 21.43, generation time (T) 13.56, intrinsic rate of increase (r_m) 0.23, and finite rate of increase (λ) 1.25.

Key words: Ascidae, phoretic mite, development, mortality, fecundity, mushroom house

1. INTRODUCTION

Mites of the genus *Arctoseius,* like many other ascids, are encountered frequently in soil and humus. They are generally associated with the Collembola and mite species inhabiting the overlying dead and decaying layers of plant material [11, 12].

Typical habitats of *A. semiscissus* were described by Karg [9] and Dziuba [6, 7], who characterised its environment in Poland. In Polish mushroom houses this species was identified by Kropczyńska-Linkiewicz [10].

Arctoseius semiscissus, like the closely related species *A. cetratus* (Sellnick), is phoretic on mushroom sciarid flies: *Lycoriella auripila* Winn. (Diptera, Lycoriidae) [2, 3, 5]. They are predators of sciarid eggs and first larval instar [5].

The purpose of this study was to find if *A. semiscissus* could pass through its entire life cycle under laboratory conditions, feeding on sciarids eggs with addition of nematodes. Life table parameters of this species are also described. This preliminary research on *A. semiscissus* provides the ground for further study, which should define its contribution into sciarids' control in mushroom houses.

2. MATERIAL AND METHODS

2.1. Collection and mass rearing of predatory mites

Flies of *Lycoriella auripila* were collected in November 1996, in a mushroom house situated 35 km from Warsaw, Poland (object of previous sampling by Dmoch [5]). Sciarids infested with mites were placed in Petri dishes (9 cm diam.) filled with moist peat. Simultaneously with egg laying by flies, the mites were leaving sciarids' bodies. Mites were collected and transferred to Petri dishes half-filled with moist peat and covered. The mites were fed on free-living nematodes and kept at 20°C.

For extracting the nematodes, compost samples from a mushroom house were placed in Baermann funnels for 24 h. The extract was added to a Petri dish filled with 2% agar medium where 0.5 cm pieces of cheese were added as food for the nematodes. A Petri dish was left for 1 week at room temperature. Drops containing a nematode-rich mixture were added into the mite rearing dish every other day.

2.2. Biological data

The trial was carried out during November 1996. Mites were kept in glass rearing cages (3 x 4 cm) provided with a 0.5 cm conical opening [4], filter paper on the bottom and covered with microscopic glass. Cages were placed in Petri dishes filled with pasteurised peat and covered with self-shrinking film (preventing moisture loss) and kept at 20°C. Sciarid eggs with addition of nematodes were supplied as nourishment for mites.

To determine the duration of developmental stages, 45 one-day-old eggs were individually placed in rearing cages for daily inspections. The experiment was conducted up to the last moult.

Survival and fecundity test proceeded in the two following steps:

1. 100 eggs of *A. semiscissus* laid by females of different ages were placed using 5 eggs per rearing cage. All cages were checked daily to determine the numbers of hatched larvae, mites at various developmental stages, and emerged adults. Experiment was completed by sex determination.
2. Pairs of adults obtained in the first part of the test were placed separately in rearing cages immediately after emergence. A total of 20 pairs were observed. Eggs laid by each female were counted every other day under a stereoscopic microscope (OLYMPUS - SZ40), until the female died.

2.3. Data analyses

Based on the results obtained from the above experiments, the life table parameters were calculated according to the equations given by Andrewartha and Birch [1]. Data for the duration of developmental stages were analysed using the Kruskal-Wallis test.

3. RESULTS

In this experiment, *A. semiscissus* was fed on sciarid eggs with addition of nematodes. Table 1 shows the duration of various developmental stages of *A. semiscissus*. There was no significant difference ($p > 0.05$) in the total time of juvenile development for females and males (Kruskal-Wallis test). None of the postembryonic stages exceeded on average two days.

Table 1. Duration of different developmental stages of *A. semiscissus* (days), feeding on sciarid eggs and nematodes (laboratory experiment at 20°C)

Developmental stage	Female (n = 32)			Male (n = 13)		
	mean	SE	range	mean	SE	range
Egg	3.16	0.07	(3 - 4)	3.38	0.14	(3 - 4)
Larva	1.34	0.08	(1 - 2)	1.31	0.13	(1 - 2)
Protonymph	1.40	0.09	(1 - 2)	1.15	0.11	(1 - 2)
Deutonymph	1.16	0.07	(1 - 2)	1.23	0.12	(1 - 2)
Total	7.06	0.08	(6 - 8)	7.08	0.16	(6 - 8)

Survival of *A. semiscissus* up to the adult stage was limited (Tab.2), but mortality was observed only for eggs.

Out of 61 mites reaching the adult stage (Tab.2), the females outnumbered the males (39:22).

Table 2. Mortality (%) in developmental stages of *A. semiscissus*

Stage of development	n		Mortality (%)
	initial	final (survive)	
Egg	5	3.05 ± 0.49	39
Larva	3.05	3.05 ± 0.49	0
Nymph (1 & 2)	3.05	3.05 ± 0.49	0
Total	3.05	3.05 ± 0.49	39

Total fecundity of *A. semiscissus* females ranged from 9 to 131 eggs per female and averaged 55 (SE ± 5.23). Between the 9 th and 19 th day of a female's life, a high oviposition was observed (Fig.1).

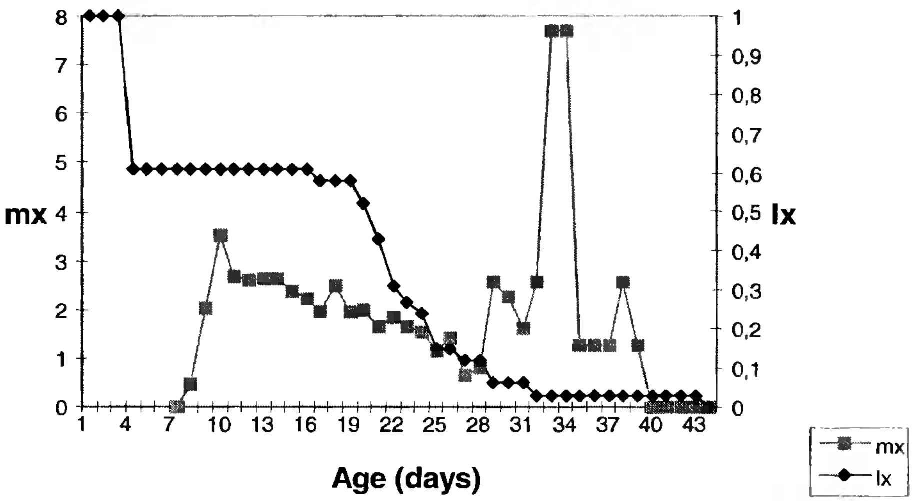

Fig.1. Survival (lx) and fecundity (mx) of *A. semiscissus*

The number of females who survived was quite stable for the first 20 days, followed by its gradual decline to only a single surviving specimen on the 28th day). Average female's life longevity was 24 days (SE ± 1.31), (range: 17-44 days).

Demographic parameters obtained for *A. semiscissus* (Tab.3) show that its high finite rate of increase (λ) results from both short generation time (T) and high net reproductive rate (R_0).

Table 3. Life-history parameters of *A. semiscissus* at 20 °C, feeding on sciarid eggs and nematodes (data for 20 pairs)

Parameter	Worth
Net reproductive rate (R_0)	21.55
Generation time (T) (days)	14.42
Intrinsic rate of increase (r_m) (days)	0.21
Finite rate of increase (λ)	1.24
Sex ratio	0.64

4. DISCUSSION

There are no data in the literature on the development time and bionomics of *A. semiscissus*. Therefore the results obtained for this species are discussed with regard to the relevant records for other soil-associated predators of the Gamasida: *Arctoseius cetratus, Proctolaelaps deleoni* Nawar (Ascidae), *Hypoaspis miles* Berlese (Hypoaspidae).

Binns [3] found that most eggs of *A. cetratus* hatched after 5-6 days at 22°C, but in singular cases - also after 3, 4 and 7 days. It partly corresponds with the results of present research (Tab.1) showing that eggs of *A. semiscissus* hatched after 3-4 days. In some other species, however, larvae could emerge sooner, e.g. *P. deleoni*: 2.9 [13].

Arctoseius semiscissus in a relatively short time completes its development (larva - deutonymph). This process is more advanced as compared to other species: *A. cetratus* [3], *P. deleoni* [13], *Hypoaspis miles* [8].

The sex ratio for *A. semiscissus* corresponds with this parameter established for *H. miles* (0.66) when fed on sciarid larvae [8]. A similar record was obtained for *P. deleoni* by Nawar [13]. Average longevity of *A. semiscissus* females is much lower as compared to *H. miles* [8], but close to that observed for *P. deleoni*, i.e. 19.1 days [13]. Average total fecundity of *P. deleoni* females was five time superior to that of *A. semiscissus*.

The net reproductive rate of increase (R_0) (Tab.3) shows that *A. semiscissus* population can increase about 22 times during one generation, feeding on sciarid eggs and nematodes. Having a similar mean generation time (T) at the same temperature, a population of *P. deleoni* associated with a wide range of terrestrial habitats, can multiply 18 fold, feeding on free-living nematodes. The latter species also shows a lower intrinsic rate of natural increase (r_m).

Experiment shows that *A. semiscissus* is able to pass through its life cycle, feeding on sciarid eggs with the addition of nematodes, but it also accepted nourishment such as larvae of Cecidomyiidae (*Heteropeza pygmea* Winn., *Mycophila speyeri* Barnes), spider mites, and acaroid mites. The multiplying ability of *A. semiscissus* feeding on sciarid eggs with the addition of nematodes is more advantageous as compared with other soil species - *P. deleoni*, when fed on free-living nematodes.

A high finite rate of increase (λ) for *A. semiscissus*, if related to other biological control agents, e.g. *H. miles* - 1.08 [8] reflects a potential use of this species for suppressing sciarid flies in mushroom houses and it should be subject to further study.

5. CONCLUSIONS

1. Development time for *A. semiscissus* is satisfied and compared with that observed for other soil, predatory mites.
2. The net reproductive rate (R_0) shows that *A. semiscissus* population can increase about 22 times during one generation, feeding on sciarid eggs and nematodes.
3. A high finite rate of increase (λ) for *A. semiscissus*, is related to other biological control agents; however, high egg mortality was observed.

4. The obtained results show a potential use of this species for suppressing sciarid flies in mushroom houses.

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TABELA ŻYCIOWA DRAPIEŻNEGO ROZTOCZA FORETYCZNEGO, *ARCTOSEIUS SEMISCISSUS* (BERLESE) (ACARI, ASCIDAE)

Streszczenie

Obiektem badań był drapieżny roztocz glebowy: *Arctoseius semiscissus*, przenoszony foretycznie przez muchówki *Lycoriella aurypila*. W doświadczeniu prowadzonym w listopadzie 1996 r., *A. semiscissus* hodowany był na pokarmie mieszanym, który stanowiły jaja ziemiórek z dodatkiem saprofitycznych nicieni glebowych. Badano, jak podawanie tego typu pokarmu wpływa na kształtowanie się parametrów demograficznych populacji roztocza, długość rozwoju poszczególnych stadiów rozwojowych i ich przeżywalność. Parametry otrzymane ze skonstruowanej tabeli życiowej przedstawiają się następująco: wrodzone tempo wzrostu populacji (r_m) 0.23, tempo reprodukcji netto (R_0) 21.43, czas rozwoju populacji (T) 13.56, tempo zwielokrotnienia liczebności populacji (λ) 1.25. Średni czas rozwoju kolejnych stadiów wynosił (w dniach): jajo - 3.27, larwa - 1.32, protonimfa - 1.28, deutonimfa - 1.20.

Słowa kluczowe: muchówki, roztocze foretyczne, rozwój, śmiertelność, płodność, pieczarkanie

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INFLUENCE OF REDUCING SUGARS AND STARCH UPON THE REPRODUCTION OF SPIDER MITES FROM THE GENUS *TETRANYCHUS* (ACARI, TETRANYCHIDAE) FEEDING ON SCAB-RESISTANT APPLE CULTIVARS

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Synopsis. The apple cvs. Lodel and Freedom were found to have a higher level of reducing sugars in their leaves than the cvs. Novamac and Primula. However, no significant differences between the studied cultivars were found in starch content. The hawthorn spider mite (*Tetranychus viennensis*) and the two-spotted spider mite (*T. urticae*) multiplied best on the cv. Novamac (R_0 = 26.0 and 22.6). The both spider mite species were found to have a negative correlation between the level of reducing sugars and R_0, r_m and λ parameters.

Key words: *Tetranychus*, demographic parameters sugars, apple varieties

1. INTRODUCTION

Studies conducted by many authors showed that the basis of resistance to spider mites, among others, is the biochemical composition of the plant. It is known that the basic plant constituents of leaves, such as carbohydrates, amino acids, proteins or secondary metabolites, have an influence on the fecundity and life longevity of invading mite females, and thereby on the intensity of spider-mite buildup. It was found [4] that a higher content of reducing sugars increases the fecundity of spider mites feeding on beans. That directed the attention of other authors to the role of carbohydrates in spider mite nutrition [2, 3, 8, 13, 14]. Results obtained by many authors mostly concern cases of the two-spotted spider mite (*Tetranychus urticae* Koch) feeding on some horticultural plants, and these results are not always consistent with each other.

In view of the above, these studies were undertaken to find whether carbohydrates have a significant influence on the reproduction of spider mites on the leaves of the chosen apple cultivars.

2. MATERIAL AND METHODS

2.1. Material

Plant material consisted of apple leaves collected from the cvs. Primula, Lodel, Novamac and Freedom. An object of the studies were the hawthorn spider mite (*T. viennensis* Zacher) and the two-spotted spider mite (*T. urticae*).

2.2. Reducing sugars

Reducing sugars were determined according to the method, described by [12]. Apple leaves in the amount of 2 g were collected from the cvs. Primula, Lodel and Freedom on June 15, July 13 and August 13. Ground with quartz sand, they were extracted with 80% ethanol and then added to buffor (citric acid and sodium phosphate). A determination of reducing sugars was made using a "Specol" spectophotometer at a wevelength of 500 nm.

2.3. Starch content

Starch content in the leaves of the above mentioned apple cultivars was determined using a modified iodometrical Stahl method [10] by homogenizing leaf samples in 80% ethanol, by adding, after their drying, NaOH with HCl in addition and by supplementing them with distilled water and leaving them in a water bath for about 30 minutes. After cooling down, the samples were added to I and KI and supplemented with distilled water. Measurements were made on a "Specol" spectophotometer at a wavelength 680 nm. Estimates of starch content were taken from the standard curve for starch.

2.4. Demographic parameters

In research on the longevity, fecundity and development, the method of mite rearings on leaf rings placed on moist cotton in Petri dishes was used. All the experiments were carried out in 3 replications. The following demographic parameters were calculated by the method used by [1].

3. RESULTS AND DISCUSSION

Throughout the growing season, the content of reducing sugars was subjected to fluctuations depending on the apple cultivar and the date of collecting leaf samples. In the cv. Primula the highest level of reducing sugars was observed in June and was followed by a consistent decline until the end of the season. The remaining cultivars were found to have an increase in soluble sugars on July 13 (at date II), followed then by a decline (Tab.1), which is in agreement with other studies [2]. The mean for the season showed significant differences between the cultivars in reducing sugar content which was the highest in the cvs. Lodel and Novamac and the lowest in Primula and Freedom.

The highest starch concentrations at the beginning of the season were found in all the cultivars, except Novamac, where it increased at date II (June 13). Other apple cultivars at date II and III (July 13 and August 13) had a decline in starch content, except the cv. Primula, where a small increase was observed by the end of the season. However, the mean for the whole season showed no significant differences between the studied cultivars in starch content.

Out of the studied apple cultivars, cv. Novamac appeared to have the best conditions for reproduction of the hawthorn spider mite, which increased its population there 26-fold during 27.5 days. Another cultivar with favourable conditions for reproduction of that mite was Freedom, where the pest increased its population 20.6-fold during 27.3 days. The worst conditions for the development of that mite were on the cultivars Primula and Lodel, where it increased its population only 11.1 fold during 24.4 days. The two-spotted mites found the best conditions for itself on the cv. Novamac and increased its population 22.7-fold during 27.4 days. On the cv. Freedom it increased its population 20.3-fold during 27.9 days. The worst cultivars for it were Primula, where its population increased only 10.2-fold during 26.5 days, and Lodel, where its population increased 12.4-fold during 27.2 days (Tab.2).

When comparing demographic parameters of the both spider mite species, it was found that significant differences occurred only in Ro values on the cv. Lodel. No significant differences in other parameters were found between the hawthorn spider mite and two-spotted spider mites living on the same cultivars.

A negative correlation was found between carbohydrates (reducing sugars and starch) and R_0, rm and λ coefficients for the both hawthorn spider mite and two-spotted spider mite, which is in agreement with the studies of [2] for *Panonychus ulmi* Koch on apple trees, [7] and [11] for the two-spotted spider mite on strawberries, [8] for ground nuts and [6] and [9] for *Oligonychus pratensis* living on some sorghum lines. A positive correlation between fecundity of the red spider mite and sugar content in apple leaves was found by [5] and [14].

Table 1. The contents of reducing sugars and starch in the leaves of selected scab-resistant apple cultivars expressed in mg/g of fresh matter

Apple varieties	June		July		August		Average of season	
	reducing sugars	starch	reducing sugars	starch	reducing sugars	starch	reducing sugars	starch
Primula	14.83 c	1.60 c	11.81 a	1.19 a	11.64 a	1.30 b	12.76 a	1.37 a
Lodel	12.86 b	1.65 c	15.44 c	1.58 c	14.79 d	1.23 ab	14.36 b	1.49 a
Novamac	12.16 a	1.42 b	14.07 b	1.63 c	13.11 c	1.22 a	13.11 ab	1.42 a
Freedom	13.14 b	1.34 a	17.79 d	1.33 b	12.53 b	1.26 ab	12.48 a	1.31 a

Table 2. Demographic parameters for the hawthorn spider mite, *T. viennensis* and the two-spotted spider mite, *T. urticae* on 4 scab-resistant apple varieties

Apple varieties	*T. viennensis*				*T. urticae*			
	R_0	T	r_m	λ	R_0	T	r_m	λ
Primula	11.1 a	26.4 a	0.0932 a	1.0978 a	10.2 a	26.5 a	0.0842 a	1.0879 a
Lodel	15.9 b	26.3 a	0.1056 ab	1.1114 ab	12.4 ab	27.2 a	0.0884 ab	1.0924 ab
Novamac	26.0 c	27.5 a	0.1195 b	1.1270 b	22.6 c	27.4 a	0.1138 c	1.1205 c
Freedom	20.6 bc	27.3 a	0.1127 ab	1.1194 ab	20.3 bc	27.9 a	0.1085 bc	1.1146 bc

4. CONCLUSIONS

1. Leaves of the studied apple cultivars were found to have seasonal differences in the content of both reducing sugars and starch.
2. The hawthorn spider mite and two-spotted spider mite found the best conditions for their development on the cv. Novamac ($R_0 = 26$ and 22.6) and the worst on cv. Primula ($R_0 = 11.1$ and 10.2).
3. When comparing demographic parameters of both species of spider mites, no significant differences were found in the reproduction of the studied mite species living on the leaves of the same apple cultivars.
4. A negative correlation was found between the content of reducing sugars and demographic parameters of both mite species.
5. No correlation was found between the starch content and demographic parameters of the hawthorn spider mite and two-spotted spider mite.

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WPŁYW CUKRÓW REDUKUJĄCYCH I SKROBI NA ROZMNAŻANIE SIĘ PRZĘDZIORKÓW Z RODZAJU *TETRANYCHUS* (ACARI, TETRANYCHIDAE) NA PARCHOODPORNYCH ODMIANACH JABŁONI

Streszczenie

Najlepszą odmianą żywicielską dla przędziorka głogowca (*Tetranychus viennensis*) i przędziorka chmielowca (*T. urticae*) okazała się Novamac, gdzie oba gatunki przędziorków pomnażały swoją populację odpowiednio (w ciągu 27.5 dnia - 26 razy i w ciągu 27.4 dnia – 22.7 razy). Najgorszą odmianą żywicielską okazała się Primula, gdzie przędziorki pomnażały swoją populację odpowiednio (w ciągu 26.4 dnia - 11 razy i w ciągu 26.5 dnia - 10 razy). Wiąże się to między innymi z zawartością cukrów redukujących występujących w liściach badanych odmian. Skrobia nie miała istotnego wpływu na rozmnażanie się przędziorków.

Słowa kluczowe: *Tetranychus*, parametry demograficzne, cukry, odmiany jabłoni

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INFLUENCE OF FOLIC ACID, METHIONINE AND RIBOFLAVIN ON POPULATION PARAMETERS OF *TYROPHAGUS PUTRESCENTIAE* (SCHR.)

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Synopsis. The population parameters of the copra mite *Tyrophagus putrescentiae* reared in optimal conditions as well as under the pressure of various concentrations of three different chemosterilants were calculated. Investigation embraced the influence of folic acid (1.0, 2.0, 4.0%), methionine (1.0, 5.0, 10.0%) and riboflavin (0.5, 1.0, 2.0, 4.0%) on fecundity and mortality of mites. Low doses of riboflavin (0.5-2.0%) and folic acid (1.0%) applied in the experiments had a stimulating effect on fecundity. Only methionine at concentrations equal or higher than 5.0% had a negative influence on fecundity and population parameters of treated mites.

Key words: *Tyrophagus putrescentiae*, population parameters, folic acid, methionine, riboflavin

1. INTRODUCTION

Sterilisation is recognised as a powerful method limiting reproductive potential of pests. It may be induced by the use of chemicals or by application of physical methods. Chemosterilants can reduce or eliminate the reproductive capacity of animals [1]. Among examined chemicals, such compounds as riboflavin or methionine caused in *Musca domestica* L. decrease of fecundity and reduction of pupa emergence into adult [5]. The compounds used as chemosterilants in all tests presented in this paper are typical elements of animal diets (vitamins or amino-acids) [7]. Their actions as chemosterilants are induced by the use of abnormal abundances of these compounds in animal's diets, which can disturb the metabolism and influence the development of treated animals.

2. MATERIAL AND METHODS

The copra mite, *Tyrophagus putrescentiae,* was the object of the study. A stock culture of *T. putrescentiae* was reared in special rearing cells. Cells used for experiments were made from glass and had a rectangular shape (4.0 x 3.5 x 0.5 cm). A conical hole of 7-13 mm in diameter was drilled in every cell. Whatman white filter paper was attached on one side of cell using hot wax as an adhesive. The other side of the cell was covered with a microscopic slide coverslip attached to the smooth, glass surface by hot wax. The cells were kept in glass desiccators at a relative humidity of 85% stabilised using saturated solution of potassium chloride, accompanied by an excess of the solid. Temperatures 22 ± 1^0C were maintained by keeping the desiccators in dark cabinets. Mites were fed on a mixture of wheat germ and yeast in ratio a 3:1 by weight.

The mixture of wheat germ and yeast was homogenised in a glass homogeniser with certain amount of chemicals providing the following concentrations of folic acid (1.0, 2.0, 4.0%), methionine (1.0, 5.0, 10.0%) and riboflavin (0.5, 1.0, 2.0, 4.0%).

The mean value of females' longevity and fecundity was statistically compared for various groups of mites fed on various concentrations of tested chemosterilants. ANOVA was used to compare the means. If ANOVA showed a difference, Fisher's least significant difference (LSD) procedure was used to determine which means were significantly different from the others.

3. RESULTS

Time of development and survival rate (lx) of *T. putrescentiae* treated by various doses of chemosterilants during the premature stages are presented in Tables 1A, 1B and 1C.

The fecundity of females treated by various doses of methionine showed that 1.0% methionine had no effect on egg deposition (Tab.2A). Higher applied doses of 5.0 and 10.0% significantly reduced the number of laid eggs (Tab.2A). Females longevity treated by 1.0-5.0% of methionine was the same as those observed for the control group and only the dose of 10.0% significantly reduced females longevity (Tab.3A). Parameters r_m and λ showed the similar tendency of changes like those observed for females fecundity under the pressure of various doses of methionine. Both higher doses of methionine (5.0 and 10.0%) had influence on population parameters, lowering the value of r_m and λ parameters (Tab.4A).

Completely different results were obtained during the tests with B complex vitamin representatives applied as a chemosterilant. Tests conducted with various doses of folic acid failed to show any influence of this compound on females' longevity (Tab.3B). The lowest applied dose of folic acid (1.0%) seemed to have a stimulating effect on fecundity and this value was significantly higher than those noted for control (Tab.2B). Parameters r_m and λ reached their peak also under this concentration of folic acid (Tab.4B). Higher doses had no effect on fecundity of females, keeping it on the same level as the control (Tab.2B).

A more difficult to interpret reaction was observed during the tests with riboflavin. There were no influence of various concentrations of riboflavin on *T. putrescentiae* longevity (Tab.3C). Doses of riboflavin ranged from 0.5% to 2.0% had a stimulating effect on fecundity, and a fecundity peak was recorded after the application the lowest dose (0.5%) of riboflavin (Tab.2C). Demographic parameters r_m and λ also reached the highest value when the dose of 0.5% riboflavin was applied (Tab.4C).

Table 1A. Duration of development and survival rate (lx) of *T. putrescentiae* treated by various doses of methionine during the premature stages

Dose of chemosterilant [%]	Stage*	Duration of development (weeks)	Contribution in total developmental cycle [%]	Survival rate (lx)
0.0%	E*	0.75	28	0.98
	La	0.42	16	0.96
	Lr	0.22	8	0.94
	Pa	0.44	16	0.92
	Pr	0.20	8	0.92
	Da	0.44	16	0.90
	Dr	0.22	8	0.88
Total		2.69	100	
1.0%	E	0.75	28	0.96
	La	0.41	15	0.96
	Lr	0.24	9	0.96
	Pa	0.43	16	0.96
	Pr	0.22	8	0.96
	Da	0.43	16	0.94
	Dr	0.23	8	0.94
Total		2.70	100	
5.0%	E	0.73	25	0.92
	La	0.43	15	0.90
	Lr	0.25	9	0.81
	Pa	0.45	16	0.63
	Pr	0.24	8	0.61
	Da	0.52	18	0.57
	Dr	0.26	9	0.56
Total		2.88	100	
10.0%	E	0.72	24	0.98
	La	0.48	16	0.90
	Lr	0.27	9	0.83
	Pa	0.48	16	0.59
	Pr	0.24	8	0.56
	Da	0.53	18	0.48
	Dr	0.28	9	0.39
Total		3.00	100	

* E - egg, L - larva, P - protonymph, D - deutonymph, a - active stage, r - resting stage.

Table 1B. Duration of development and survival rate (lx) of *T. putrescentiae* treated by various doses of folic acid during the premature stages

Dose of chemosterilant [%]	Stage*	Duration of development (weeks)	Contribution in total developmental cycle [%]	Survival rate (lx)
0.0%	E*	0.75	28	0.98
	La	0.42	16	0.96
	Lr	0.22	8	0.94
	Pa	0.44	16	0.92
	Pr	0.20	8	0.92
	Da	0.44	16	0.90
	Dr	0.22	8	0.88
Total		2.69	100	
1.0%	E	0.78	28	1.00
	La	0.43	16	1.00
	Lr	0.21	8	1.00
	Pa	0.44	16	1.00
	Pr	0.23	8	0.98
	Da	0.44	16	0.98
	Dr	0.21	8	0.98
Total		2.74	100	
2.0%	E	0.78	27	0.98
	La	0.45	16	0.98
	Lr	0.24	8	0.98
	Pa	0.47	16	0.96
	Pr	0.25	9	0.94
	Da	0.46	16	0.94
	Dr	0.24	8	0.94
Total		2.89	100	
4.0%	E	0.81	27	0.98
	La	0.44	15	0.98
	Lr	0.27	9	0.98
	Pa	0.51	17	0.98
	Pr	0.23	8	0.96
	Da	0.46	15	0.96
	Dr	0.28	9	
Total		3.01	100	

* E - egg, L - larva, P - protonymph, D - deutonymph, a - active stage, r - resting stage

Table 1C. Duration of development and survival rate (lx) of *T. putrescentiae* treated by various doses of riboflavin during the premature stages

Dose of chemosterilant [%]	Stage*	Duration of development (weeks)	Contribution in total developmental cycle [%]	Survival rate (lx)
0.0%	E	0.75	28	0.98
	La	0.42	16	0.96
	Lr	0.22	8	0.94
	Pa	0.44	16	0.92
	Pr	0.20	8	0.92
	Da	0.44	16	0.90
	Dr	0.22	8	0.88
Total		2.69	100	
0.5%	E	0.69	25	0.90
	La	0.44	16	0.88
	Lr	0.24	9	0.88
	Pa	0.44	16	0.88
	Pr	0.23	9	0.88
	Da	0.44	16	0.88
	Dr	0.24	9	0.85
Total		2.71	100	
1.0%	E	0.75	25	1.00
	La	0.49	17	0.92
	Lr	0.25	8	0.90
	Pa	0.44	15	0.85
	Pr	0.26	9	0.83
	Da	0.51	17	0.80
	Dr	0.26	9	0.80
Total		2.95	100	
2.0%	E	0.77	25	0.98
	La	0.50	16	0.96
	Lr	0.26	8	0.92
	Pa	0.47	16	0.89
	Pr	0.26	8	0.81
	Da	0.54	18	0.80
	Dr	0.27	9	0.78
Total		3.08	100	
4.0%	E	0.81	26	0.88
	La	0.49	15	0.88
	Lr	0.27	9	0.86
	Pa	0.49	15	0.85
	Pr	0.24	8	0.83
	Da	0.57	17	0.82
	Dr	0.31	10	0.80
Total		3.17	100	

* E - egg, L - larva, P - protonymph, D - deutonymph, a - active stage, r - resting stage

Table 2A. Fecundity of *T. putrescentiae* treated by various doses of methionine

Chemosterilant	No. of replications	Minimum (per week)	Maximum (per week)	Average* (per week)	SD
control	22	145.0	494.0	334.3a	92.5
methionine 1.0%	25	35.0	637.0	361.9a	134.4
methionine 5.0%	23	45.0	573.0	231.5b	123.3
methionine 10.0%	27	11.0	182.0	64.7c	42.7

Table 2B. Fecudity of *T. putrescentiae* treated by various doses of folic acid

Chemosterilant	No. of replications	Minimum (per week)	Maximum (per week)	Average* (per week)	SD
control	22	145.0	494.0	334.3b	92.5
folic acid 1.0%	28	175.0	625.0	413.6a	106.8
folic acid 2.0%	27	66.0	538.0	337.9b	129.2
folic acid 4.0%	27	51.0	561.0	340.7b	113.0

Table 2C. Fecundity of *T. putrescentiae* treated by various doses of riboflavin

Chemosterilant	No. of replications	Minimum (per week)	Maximum (per week)	Average * (per week)	SD
control	22	145.0	494.0	334.3bc	92.5
riboflavin 0.5%	25	219.0	550.0	414.8a	75.3
riboflavin 1.0%	26	121.0	631.0	390.0ab	113.1
riboflavin 2.0%	24	126.0	657.0	364.8abc	143.0
riboflavin 4.0%	27	113.0	647.0	315.3c	122.2

* Means within the same column with the same letter are not significantly different (i.e. $P > 0.05$) (Fisher's least significant difference (LSD) procedure)

Table 3A. Females' longevity of *T. putrescentiae* treated by various doses of methionine

Chemosterilant	No. of replications	Minimum (weeks)	Maximum (weeks)	Average* (weeks)	SD
control	22	6.0	19.0	12.9a	4.0
methionine 1.0%	25	3.0	19.0	11.6a	4.6
methionine 5.0%	23	4.0	18.0	13.2a	3.2
methionine 10.0%	27	7.0	17.0	8.1b	3.9

Table 3B. Females' longevity of *T. putrescentiae* treated by various doses of folic acid

Chemosterilant	No. of replications	Minimum (weeks)	Maximum (weeks)	Average* (weeks)	SD
control	22	6.0	19.0	12.9a	4.0
folic acid 1.0%	28	2.0	29.0	12.5a	6.5
folic acid 2.0%	27	2.0	26.0	12.9a	5.4
folic acid 4.0%	27	1.0	27.0	11.7a	6.8

Table 3C. Females longevity of *T. putrescentiae* treated by various doses of riboflavin

Chemosterilant	No. of replications	Minimum (weeks)	Maximum (weeks)	Average* (weeks)	SD
control	22	6.0	19.0	12.9a	4.0
riboflavin 0.5%	25	5.0	36.0	13.4a	6.5
riboflavin 1.0%	26	3.0	29.0	11.8a	6.2
riboflavin 2.0%	24	2.0	31.0	14.4a	6.4
riboflavin 4.0%	27	2.0	33.0	13.4a	6.1

* Means within the same column with the same letter are not significantly different (i.e. $P > 0.05$) (Fisher's least significant difference (LSD) procedure)

Table 4A. Population parameters (per week) of *T. putrescentiae* treated by various doses of methionine

Concentration (%)	r_m	R_o	T	λ
0.0	1.03495	147.15679	4.82291	2.81497
1.0	1.07395	158.02850	4.71413	2.92693
5.0	0.75095	61.93429	5.49442	2.11902
10.0	0.45996	12.62469	5.51276	1.58401

Table 4B. Population parameters (per week) of *T. putrescentiae* treated by various doses of folic acid

Concentration (%)	r_m	R_o	T	λ
0.0	1.03495	147.15679	4.82291	2.81497
1.0	1.05995	203.18379	5.01351	2.88624
2.0	1.02695	161.83731	4.95308	2.79254
4.0	0.91895	157.28848	5.50417	2.50666

Table 4C. Population parameters (per week) of *T. putrescentiae* treated by various doses of riboflavin

Concentration (%)	r_m	R_o	T	λ
0.0	1.03495	147.15679	4.82291	2.81497
0.5	1.04096	176.36018	4.96902	2.83192
1.0	0.99695	157.52180	5.07502	2.71001
2.0	0.91195	137.25132	5.39699	2.48918
4.0	0.89695	130.36830	5.42988	2.45212

4. DISCUSSION

The idea of chemosterilization gained the top popularity between 1960-1970. This new technique of pest eradication seemed to be very promising and effective. Many substances represented and classified to various groups of chemicals (alkylating agents, antimetabolites, miscellaneous groups [4]) were thoroughly tested for selecting specific, harmless-for-human compounds, which could be used as active pest chemosterilants. The results of the investigations of various chemicals influencing the reproductive potential of arthropods and describing their probable mode of action are described by many authors including: Borkovec [1], Kilgore [4] and LaBrecque and Smith [6]. Unfortunately the method of chemosterilization turned out not to be very safe, efficient or effective as it had been previously expected. So now its application is restricted to some chosen groups of arthropods occurring in specific conditions.

There is a little information found on the influence of folic acid, methionine and riboflavin on insects or other arthropods [2, 3, 5]. The impact of methionine and/or riboflavin on house flies (*Musca domestica*) or screw-worm flies (*Cochliomyia hominivorax* (Coguerel)) is reported by LaBrecque et al. [5] and Gouck et al. [2]. The only information found on the impact of folic acid on the reproductive potential of the plum curculio (*Conotrachelus nenuphar* (Herbst)) is by Hays and Cochran [3]. The results obtained by above mentioned authors indicated that all three tested compounds (riboflavin [5], methionine [2, 5] and folic acid [3]) possess a power to reduce significantly the reproductive potential of house flies [2, 5], screw-worm flies [2] and/or plum curculio [3]. Folic acid applied to a plum curculio adult in Hays and Cochran [3] experiments halted progeny production. House flies were treated with methionine or riboflavin added to the larval medium by LaBrecque et al [5]. As a result of the methionine application, low adult emergence and no oviposition were observed [5]. The hatching rate of eggs and percent of pupation were reduced in experiments where flies were treated by methionine administered by larval dipping, adult feeding and by topical application [2]. When riboflavin was applied as a house fly chemosterilant [5], low adult emergence connected with little oviposition occurred. Another pathological effect reported after riboflavin application was that F_1 larvae of *M. domestica* were stunted [5].

Results presented in this paper, were not so spectacular as those reported for insects, showing that only concentrations equal to or higher than 5.0% of methionine was able to reduce the r_m and λ parameters of tested mites populations fed on a diet containing a chemosterilant. Riboflavin and folic acid applied in doses ranging from 0.5 to 4.0% showed no influence on *T. putrescentiae* longevity, and even in lower doses had stimulating effect on fecundity (riboflavin 0.5-2.0%, folic acid 1.0%). It is possible that the differences observed in insects' and mites' reactions on the same chemosterilant are connected with different techniques of food application.

5. CONCLUSIONS

Methionine at high concentration (5.0-10.0%) was efficient as a chemosterilant. Methionine at concentration equal or higher than 5.0% caused a reduction of *T. putrescentiae* fecundity and the r_m and λ parameters. Low doses of riboflavin (0.5-2.0%) and folic acid (1.0%), applied in mites' diets were insufficient to cause mite sterility and even had a stimulating effect on mites fecundity.

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WPŁYW KWASU FOLIOWEGO, METIONINY I RYBOFLAWINY NA PARAMETRY DEMOGRAFICZNE ROZKRUSZKA DROBNEGO *TYROPHAGUS PUTRESCENTIAE* (SCHR.)

Streszczenie

Obliczono parametry demograficzne charakteryzujące populację rozkruszka drobnego *Tyrophagus putrescentiae* hodowanego w warunkach kontrolnych oraz poddanego działaniu trzech różnych chemosterylantów. W badaniach testowano wpływ różnych stężeń kwasu foliowego (1.0, 2.0, 4.0%), metioniny (1.0, 5.0, 10.0%) i ryboflawiny (0.5, 1.0, 2.0, 4.0%) na płodność roztoczy i ich śmiertelność. Niskie dawki ryboflawiny (0.5-2.0%) i kwasu foliowego (1.0%) miały stymulujący wpływ na płodność roztoczy. Dawki metioniny wynoszące 5.0%

i wyższe wpływały niekorzystnie na rozwój populacji wydłużając czas rozwoju pokolenia (T) i obniżając tempo zwielokrotnienia liczebności populacji (λ).

Słowa kluczowe: *Tyrophagus putrescentiae*, parametry demograficzne, kwas foliowy, metionina, ryboflawina

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CONTENT OF SOME ORGANIC COMPOUNDS IN THE LEAVES OF CUCUMBER IN RELATION TO ITS SUSCEPTIBILITY TO SPIDER MITES

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Synopsis. The reason for differences in the development of *Tetranychus urticae* on selected cultivars of cucumber was studied. For this purpose the chemical analysis of the leaves of 5 cucumber cultivars were conducted to estimate the content of some nutritional substances - proteins, sugars, amino acids - and also the content of secondary plant metabolites - phenols and cucurbitacins. It was found that leaves of highly susceptible to spider mites cv. Corona are richer in most nutritional compounds, excluding amino acids, compared to other studied varieties. They contain more soluble proteins and soluble sugars. In the leaves of cultivar Corona, a higher cucurbitacin content was found in comparison with cultivar Farbio.

Key words: cucumber, *Tetranychus urticae*, susceptibility, organic compounds

1. INTRODUCTION

Cucumber is one of the best host plants for spider mites; however, resistant cultivars are also known. Breeding of cucumbers for resistance to spider mites was successful in many cases [5]. The chemical composition of leaves seems to be the most important factor responsible for the susceptibility of cucumber cultivar to spider mites. Contents of bitter secondary metabolites - cucurbitacines are very often related to spider mite populations on cucumber; however, the resistance is not limited only to "bitter" cultivars [3].

The ratio between basic organic substances such as soluble proteins, carbohydrates, amino acids as well as the ratio between these substances and secondary metabolites can influence the development of spider mite populations [9].

The purpose of study was to test the susceptibility of some cucumber cultivars to spider mites and check which chemical compounds in the leaves can be responsible for the suitability of cucumber for these pests.

2. MATERIAL AND METHODS

Studies were conducted on 5 cultivars of cucumber: Corona, Aramis, Dukat, Farbio and Picobello, cultivated under greenhouse conditions. Suitability of these cultivars for *Tetranychus urticae* Koch was tested.

a. Fecundity of spider mite females and development of mite population

For an estimation of mite fecundity, females of *T. urticae* were transferred to Petri dishes, on leaf discs, taken from different cultivar of cucumber. Number of laid eggs was counted after 3 days. About 100 females were tested on each cultivar. The development of spider mite populations on different cultivars of cucumber (10-14 plants of each variety) was checked in greenhouse. The experiment had been started at the 3-leaf stage of the plants. Spider mites were placed on every plant. Initial mite population was 5 mites per leaf. The number of mites was checked on the plants after every 7-10 days.

b. Chemical analysis of leaves

In the leaves of 4 cucumber cultivars: Corona, Aramis, Dukat and Picobello concentrations of organic substances were measured according to the methods described by other authors:
Total proteins - [2]
Reducing sugars - [8]
Total soluble sugars - [10]
Amino acids - [6]
Total phenols - [4]

In the leaves of cultivars Corona and Farbio the concentration of cucurbitacins was measured according to Metcalf et al. [7]. For all chemical analyses the fresh samples of leaves were taken (0,5-1 g). Analyses for the estimation of concentration of amino acids were conducted in 3 replications, the other compounds in 5-6 replications.

3. RESULTS AND DISCUSSION

The results of tests on female fecundity and development of *T. urticae* populations on chosen cultivars of cucumber are presented in Figures 1 and 2. From the presented data is clear that the best host plants for spider mites are two cucumber cultivars - Corona and Picobello. The lowest fecundity of females as well as the worst development of mite population was observed on plants of cultivar Farbio. Relatively low fecundity of *T. urticae* females was observed after their feeding on the leaves of cultivar Aramis.

The contents of some organic compounds in the leaves of various cucumber cultivars are shown in Table 1 and the ratio between different groups of substances in Table 2.

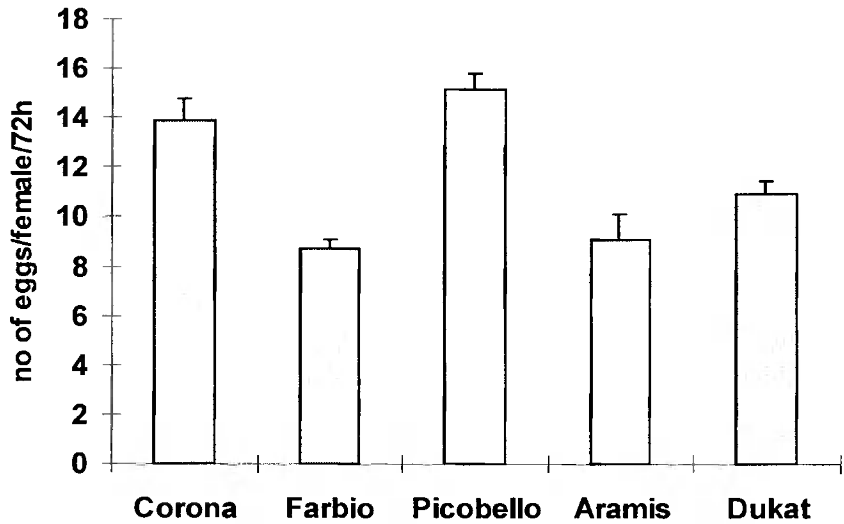

Fig.1. Fecundity of *T. urticae* females on different cultivars of cucumber (in the figure SE are presented)

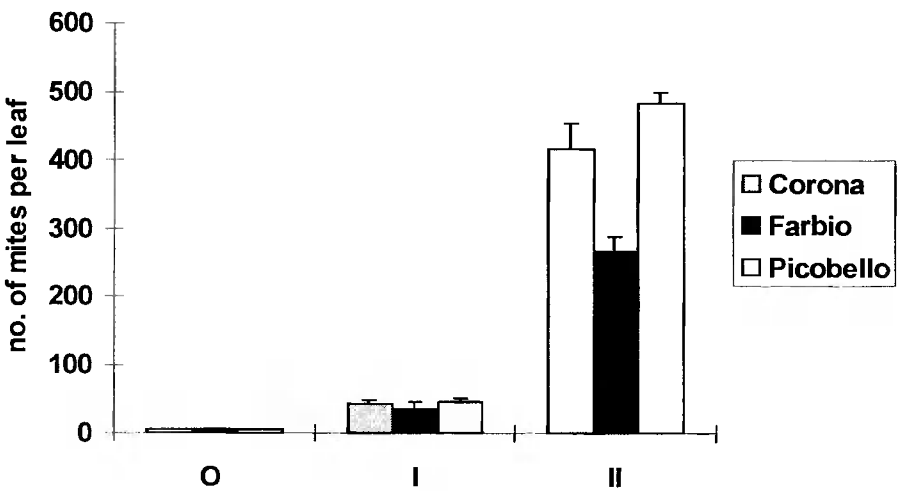

Fig.2. Development of *T. urticae* populations on selected cultivars of cucumber (0 - initial populations, I - after 4 weeks, II - after 7 weeks)

Table 1. Contents of some organic substances in the leaves of different cultivars of cucumber (mg/g.f.w ± SE)

Cultivar	Soluble proteins	Total free amino acids	Protein amino acids	Non protein amino acids	Aromatic amino acids	Soluble sugars	Reducing sugars	Non reducing sugars	Phenols	Cucurbitacins *	
										C	I
Corona	16.1 ± 0.90	1.23 ± 0.018	1.06 ± 0.024	0.17 ± 0.006	0.52 ± 0.016	8.9 ± 0.28	4.8 ± 0.20	4.1 ± 0.32	0.86 ± 0.03	7.5 ± 0.28	5.4 ± 0.24
Aramis	14.2 ± 0.32	1.37 ± 0.030	1.25 ± 0.03	0.12 ± 0.005	0.75 ± 0.010	7.0 ± 0.24	3.3 ± 0.14	3.7 ± 0.19	0.76 ± 0.10	-	-
Dukat	12.1 ± 0.24	1.72 ± 0.005	1.52 ± 0.005	0.20 ± 0.006	0.84 ± 0.008	6.1 ± 0.08	2.9 ± 0.05	3.2 ± 0.12	0.65 ± 0.07	-	-
Picobello	13.4 ± 0.35	1.65 ± 0.008	1.46 ± 0.007	0.19 ± 0.006	0.93 ± 0.010	6.3 ± 0.19	2.4 ± 0.07	3.9 ± 0.24	0.57 ± 0.05	-	-
Farbio	-	-	-	-	-	-	-	-	-	6.7 ± 0.25	6.8 ± 0.20

* C - control plants, I - infested plant

Table 2. Ratio between groups of some organic compounds in the leaves of different cultivar of cucumber

Cultivar	Soluble sugars/ Phenols	Protein amino acids/ Non protein amino acids	Aromatic amino acids/ Total free amino acids	Non reducing sugars/ Total sugars
Corona	10.35	6.08	0.42	0.46
Aramis	9.21	11.29	0.55	0.53
Dukat	9.38	8.50	0.49	0.52
Picobello	11.05	8.60	0.56	0.62

The leaves of cultivar Corona were richer in the most of the organic substances studied than in leaves of other tested cultivars. They had higher concentrations of soluble proteins (12-24%) and a higher content of carbohydrates, both reducing and non-reducing sugars. High contents of these substances can have a positive effect on spider mite population [9]. From the basic organic compounds which are the source of food for spider mites, only free amino acids were found in the leaves of cultivar Corona in lower concentrations than in the leaves of other studied cultivars. A low concentration of free amino acids was, however, connected with a low concentration of aromatic amino acids in the leaves of this sensitive cultivar.

This can be suitable for the development of a spider mite population although the aromatic amino acids can often have the negative influence on populations of herbivores [1]. In the leaves of an other, highly sensitive cultivar for spider mites - Picobello - a high concentration of non-reducing sugars was found. The ratio between non-reducing sugars and the total concentration of sugars was highest in leaf tissue of this variety in comparison with Corona, Dukat and Aramis.

Increased content of cucurbitacins was found in the leaves of cultivar Corona, as compared to Farbio. Higher concentrations of cucurbitacins can be responsible for higher attractivity of cultivar Corona for spider mites; however, the content of cucurbitacins in the leaves of this cultivar is decreased as a result of mite feeding. Cucurbitacins can play an important role in the resistance of cucumber to spider mites [3].

The presented data indicates that the contents and ratio between organic compounds in the leaves of selected cultivars of cucumber have an influence on the susceptibility of these cultivars to spider mites.

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ZAWARTOŚĆ NIEKTÓRYCH SKŁADNIKÓW ORGANICZNYCH W LIŚCIACH OGÓRKA SZKLARNIOWEGO A PODATNOŚĆ TEJ ROŚLINY NA PRZĘDZIORKI

Streszczenie

Badano przyczyny różnic w rozwoju populacji przędziorków na wybranych odmianach ogórków. W tym celu wykonano analizy chemiczne liści 4 odmian ogórków - Corona, Aramis, Dukat i Picobello określając zawartość podstawowych składników pokarmowych - białek rozpuszczalnych, cukrów, aminokwasów oraz wtórnych metabolitów roślinnych - związków fenolowych. Porównywano również zawartość kukurbitacyn w liściach najbardziej wrażliwej na przędziorki odmiany Corona z zawartością tych terpenoidów w liściach najsłabiej porażanej przez te szkodniki odmiany Farbio. Wykazano, że liście wysoce podatnej na przędziorki odmiany Corona są bogatsze od liści innych odmian w większość analizowanych składników organicznych. Zawierają one więcej białek rozpuszczalnych, więcej cukrów zarówno redukujących jak i nieredukujących. Z podstawowych składników organicznych jedynie zawartość wolnych aminokwasów jest niższa w porównaniu z innymi odmianami. W liściach odmiany Corona stwierdzono o kilkanaście procent wyższą zawartość kukurbitacyn niż w liściach odmiany Farbio.

Słowa kluczowe: ogórek, *Tetranychus urticae*, podatność, substancje organiczne

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W BYDGOSZCZY
ZESZYTY NAUKOWE NR 214 – OCHRONA ŚRODOWISKA 2 (1998) 121-127

POPULATION DYNAMICS OF THE TWO-SPOTTED SPIDER MITE (*TETRANYCHUS URTICAE* KOCH) ON BLACK CURRANTS IN THE OLSZTYN REGION

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Synopsis. Plantations of black currant (cvs. Titania, Triton, Ojebyn) were surveyed in 1992-1994 in the Olsztyn region. The heaviest infestation with mites was observed in 1992 and 1993, with spring's warm and dry weather. Cold and rainy weather at the beginning of the growing season in 1994 kept the population of *T. urticae* very low, mite density was below 1 motile form per leaf. During three years of observations Titania cv. was most heavily infested with mites, Triton cv. was less infested and Ojebyn cv. was infested by *T. urticae* the least.

Key words: black currant, *Tetranychus urticae*, weather conditions, mite population

1. INTRODUCTION

Temperature and rainfall are the most important abiotic factors, which determine the development of the mites. Temperature regimes of *T. urticae* given by Mori [5] ranged from 13 to 35^{0}C. Herbert [3] determined that the threshold for development this species was 10^{0}C. Nickel [6] found that *T. urticae* developed faster, with higher egg production, under low humidity (25-30%) rather than high humidity (85-90%). Some authors reported on the effect of rain on mortality of *Panonychus ulmi.* After rainfall the mite population decreased depending from its intensity from 2-50% [7].

The purpose of this paper is to characterise the impact of weather conditions on the population development of the two-spotted spider mite infesting black currant plantations in the northeastern region of Poland. The growing season in this district starts about two weeks later compared to the central region of Poland. The light spring frosts appear often in the end of May or at the beginning of June and it may cause a breakdown of the mite population.

2. MATERIALS AND METHODS

In 1992-1994 observations were carried out in 4 year-old commercial plantation of black currant (Łęgajny - 15 km away from Olsztyn) on cvs. Titania and Triton, and one small experimental field in Olsztyn with Ojebyn cv. In the middle of June 1992 100 specimen females of *T. urticae* per bush of black currant were introduced on experimental field in Olsztyn. The leaf samples were taken from black currant bushes since June (1992, 1994) or May (1993) during the whole growing season in about 2 week intervals, and mobile stages of *T. urticae* were counted under stereomicroscope. Metheorological data were obtained from the Agrometheorology Department - Olsztyn University of Agriculture and Technology. The years of 1992 and 1994 characterised by a warm and dry summer. In 1994 only spring was rather cold (the last ground frost was on 28 and 29 May) and wet. Year 1993 was characterised by a warm spring and very rainy summer (Figs.1, 2).

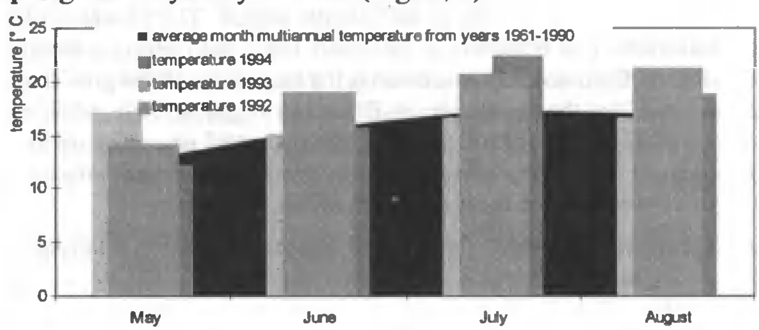

Fig.1. Average month temperatures from years 1992-1994 at the background of multiannual data

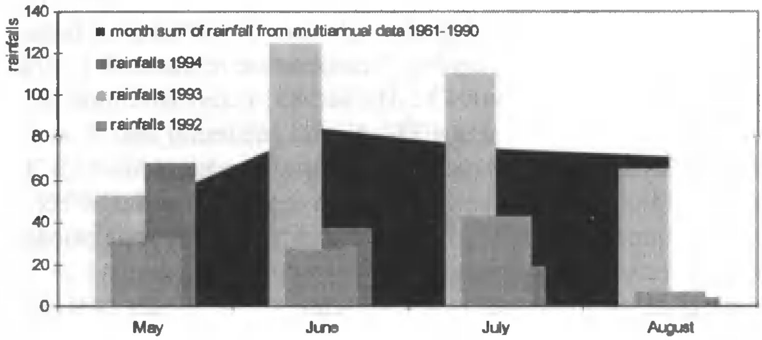

Fig.2. Month sum of rainfalls from years 1992-1994 at the background of multiannual data

3. RESULTS AND DISCUSSION

During the first year of observations (Fig.3b), the infestation level of *T. urticae* on the Łęgajny plantation was very high with a maximum of 150 motile forms /leaf on cv. Titania and 30 16 motile forms/leaf on cv. Triton. Because the economic threshold (in July and August 5-6 motile forms per leaf) was exceeded, after harvest (20 July) a chemical treatment was applied. On cv. Ojebyn (Fig.3c) after introduction the mite population grew till 16 motile forms/leaf in the middle of July and then decreased below the economic threshold in August (Fig.3c). According to Czajkowska and Kropczyńska [1] a high density of the spider mite on cv. Titania can be caused by a high rate of increase of the mite on this cultivar. The cv. Ojebyn, during three years of observations, was the least infested by *T. urticae* compared with cvs. Titania and Triton [2, 4].

In 1993 the pest infestation was very high in the third decade of May and at the begining of June with maximum level of 55 motile forms/leaf on cv. Titania and 38 motile forms/leaf on cv. Triton (Fig.4b). On cv. Ojebyn the population of mites also increased to a maximum in June but it's density had not exceeded the economic threshold (Fig.4c).

In 1994 on all cvs. a very low mite population density was observed. In Łęgajny the *T. urticae* infestation was nearly equal zero till August, when the average number of mites per leaf on cv. Titania reached the maximum level of 0.8 and 0.5 on cv. Triton (Fig.5b, c). This situation could be caused both by late ground frosts and the intensive rainfall in May.

Cold weather at the beginning of the growing season in 1994 kept the population of *T. urticae* to a low level. The long-term rainfalls in June and July 1993 caused the decrease of mite infestation below the economic threshold at the end of July.

The obtained data indicate that the weather conditions in this region seem to be a decisive factor influencing mite population development. In a number of seasons *T. urticae* do not reach the status of an important pest because of unfavourable weather conditions.

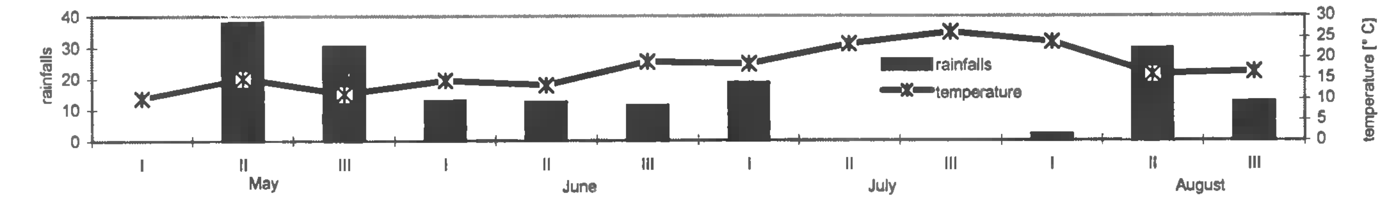

Fig.3a. Weather conditions 1992

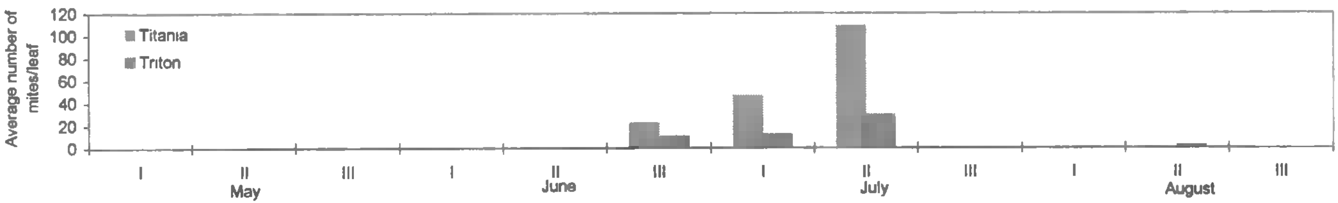

Fig.3b. The intensity of the two-spotted spider mite *T. urticae* infestation on black currant cultivars - Łęgajny 1992

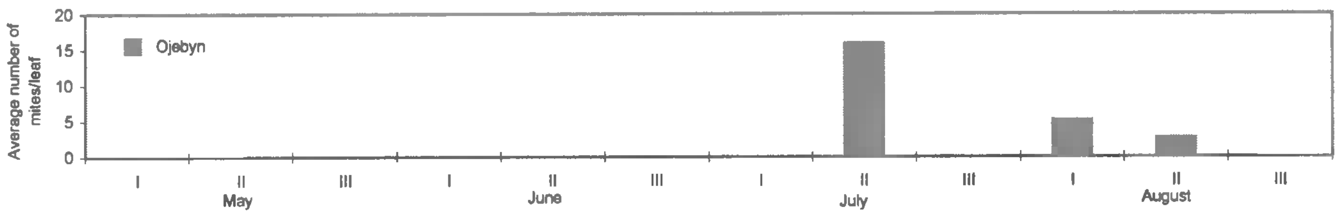

Fig.3c. The intensity of the two-spotted spider mite *T. urticae* infestation on black currant cultivars - Olsztyn - Exp. field 1992

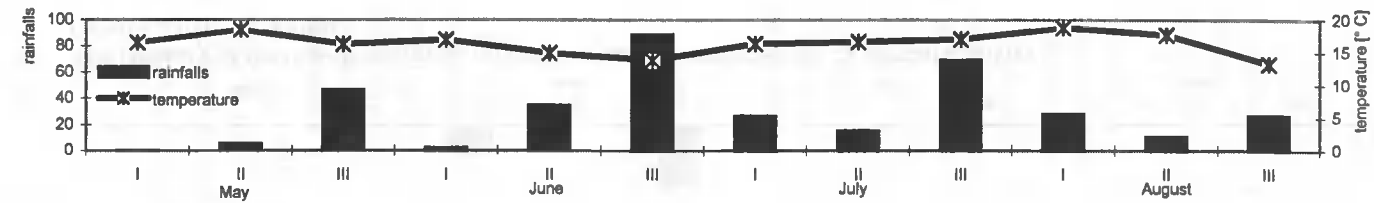

Fig.4a. Weather conditions 1993

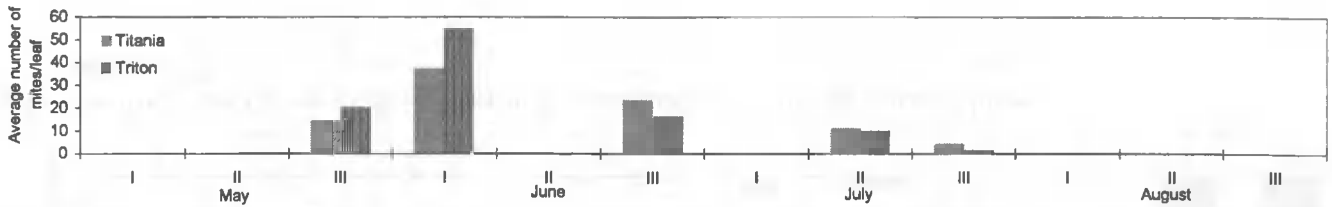

Fig.4b. The intensity of the two-spotted spider mite *T. urticae* infestation on black currant cultivars - Łęgajny 1993

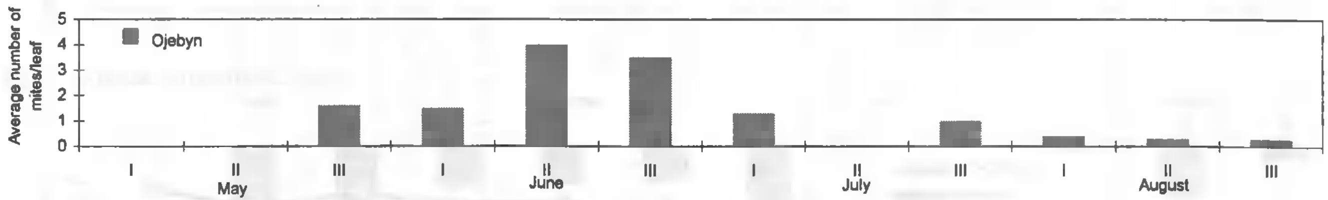

Fig.4c. The intensity of the two-spotted spider mite *T. urticae* infestation on black currant cultivars - Olsztyn - Exp. field 1993

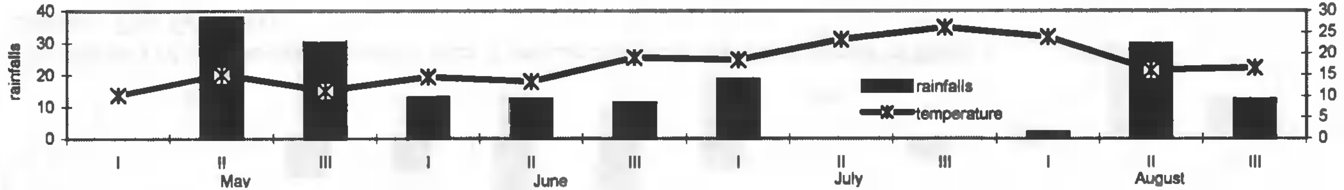

Fig.5a. Weather conditions 1994

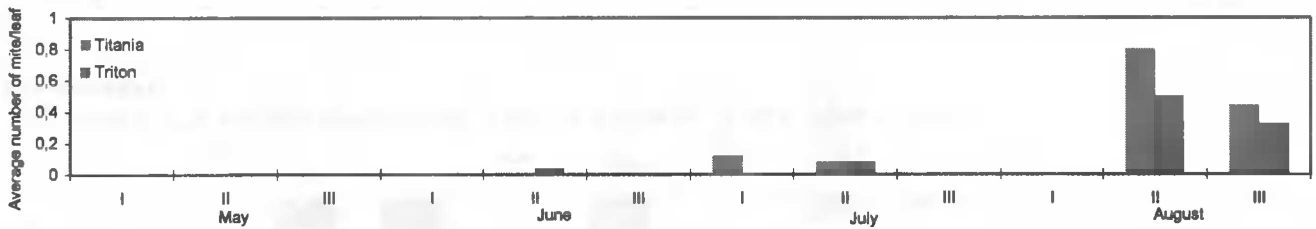

Fig.5b. The intensity of the two-spotted spider mite *T. urticae* infestation on black currant cultivars - Łęgajny 1994

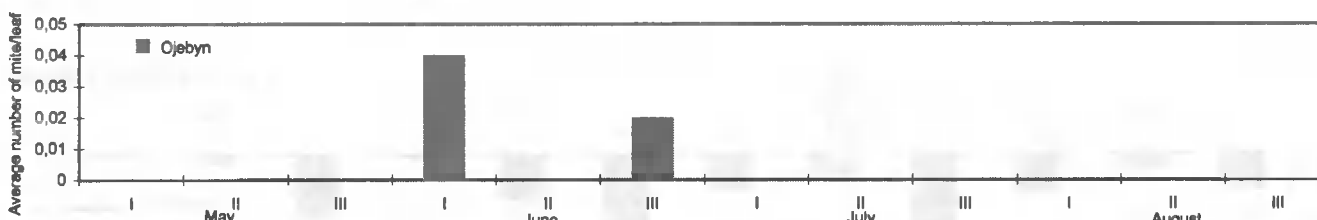

Fig.5c. The intensity of the two-spotted spider mite *T. urticae* infestation on black currant cultivars - Olsztyn - Exp. field 1994

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DYNAMIKA POPULACJI PRZĘDZIORKA CHMIELOWCA (*TETRANYCHUS URTICAE* KOCH) NA CZARNEJ PORZECZCE W WOJEWÓDZTWIE OLSZTYŃSKIM

Streszczenie

Badania prowadzono w latach 1992-1994 na plantacji doświadczalnej Zakładu Entomologii ART w Olsztynie (odm. Ojebyn) i na plantacji produkcyjnej w Łęgajnach (odm. Titania, Triton). Określono dynamikę występowania przędziorka chmielowca w tych sezonach wegetacyjnych. Największe zasiedlenie krzewów czarnej porzeczki przez *T. urticae* zaobserwowano w roku 1992 i 1993 na odmianach Titania i Triton. Lata te charakteryzowały się ciepłą i suchą wiosną. W roku 1994 ze względu na chłodną i wilgotną wiosnę populacja przędziorka chmielowca kształtowała się na bardzo niskim poziomie i nie przekroczyła średnio 1 szt./liść na żadnej z badanych odmian.

Słowa kluczowe: czarna porzeczka, przędziorek chmielowiec, warunki pogodowe

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ZESZYTY NAUKOWE NR 214 - OCHRONA ŚRODOWISKA 2 (1998) 129-133

COMPARISON OF THE CARMINE SPIDER MITE (*TETRANYCHUS CINNABARINUS* BOISD.) AND TWO SPOTTED SPIDER MITE (*TETRANYCHUS URTICAE* KOCH) AS A FOOD FOR *AMBLYSEIUS CALIFORNICUS* MCGREGOR

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Synopsis. This preliminary experimens concerns the food preference of the predatory mites *Amblyseius californicus* to two species of tetranychid mites: *Tetranychus urticae* and *T. cinnabarinus*. The predatory mite's choice between the two mentioned spider mites, served as food, did not depend on prey species but depended on the amount of time the predator was given to select the food.

Key words: *Amblyseius californicus*, food preference, *Tetranychus urticae*, *T. cinnabarinus*

1. INTRODUCTION

Amblyseius californicus is a natural enemy of the spider mite in the Mediterranean area. It is used to control spider mites on citrus, apple and tea [1, 2, 4]. It is also found as an effective predator of two-spotted spider mite *Tetranychus urticae* on strawberries in Spain [3]. Up to now no study has been conducted on control the carmine spider mite *T. cinnabarinus* in Polish glasshouses.

During last few years in the Department of Applied Entomology at the Warsaw Agricultural University, studies of biological control on spider mites using the predatory mite *Phytoseiulus persimilis* Athias-Henriot were conducted. In 1994 on biologically protected gerbera plants, other species of Phytoseiidae predator, *Amblyseius californicus,* have appeared [5], and initiate study using this species as a new pest control agent.

The present study reports the preliminary results of a comparison between two species of tetranychid mites - *T. urticae* and *T. cinnabarinus* - used as food for *A. californicus*.

2. MATERIAL AND METHODS

The colony of spider mites *T. urticae* and *T. cinnabarinus* was maintained on bean plants cv 'Złota Saxa'. *Amblyseius californicus* was obtained from Koppert BV in form of SPICAL product. For preliminary experiments the choice test was conducted using the two mentioned species of spider mites as a food for *A. californicus*.

At the beginning of the experiment two discs of bean leaves were cut for 2 various species of prey mites (*T. urticae* and *T. cinnabarinus*) and placed upside down on wet cotton wool in Petri dishes. Five females representing the same mite species were put on each disc. Mites were allowed to feed on the discs for 3 days, and then all the females were removed. At the same time an additional leaf disc had been inserted on which one female of predatory mite was released to choose freely between the food (eggs of *T. urticae* or *T. cinnabarinus*) (Fig.1).

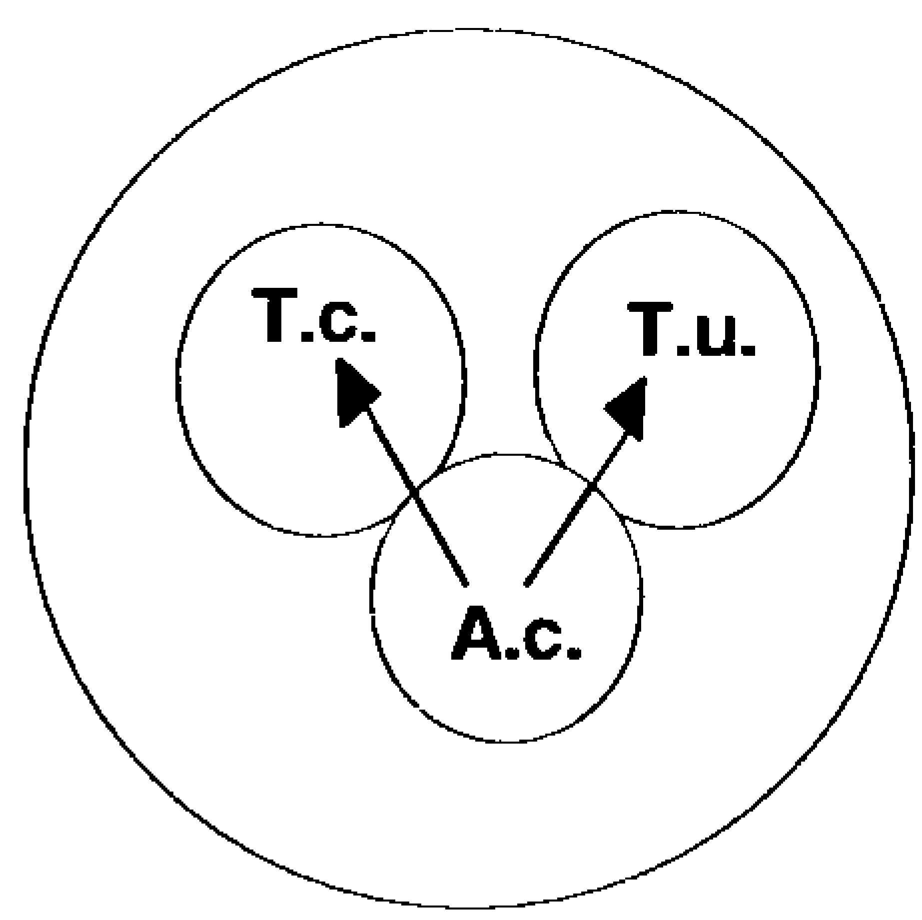

Fig.1. The experimental set up (T.u. – *T. urticae*, T.c. – *T. cinnabarinus*, A.c. – *A. californicus*)

It was noted after 15 min., 2 h and 24 h on which disc the predator was present, and the food preference of predator mite was analysed using the χ^2 test. Then the number of eggs laid by *A. californicus* was counted after 24 h.

The experiment was conducted at 25±2^{0}C, 70-80% RH and a photoperiod of L:D = 16:8.

3. RESULTS AND DISCUSSION

The results of the test are presented on Fig.2. Time has a significant influence on *A. californicus*' food selection. The percentage of predators, which chose either spider mite, increased in the course of time. Fifteen minutes seems to be insufficient to select the proper prey. In experiments lasting longer than 15 min., more predatory mites were found on discs with *T. cinnabarinus* eggs. The χ^2 test showed that proportion of predatory mites, which have chosen *T. urticae* or *T. cinnabarinus* as food was not statistically significant. It can be concluded that predarory mites have no preference of the eggs of these two species.

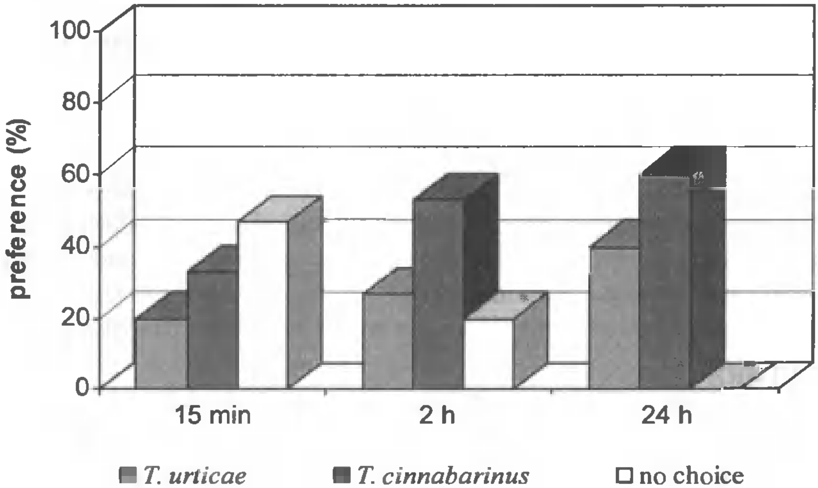

Fig. 2. The *A. californicus* food preference

The number of eggs laid by *A. californicus* was counted on every disc after 24 h (Fig.3). Females of predatory mites laid higher number of eggs when they were feeding on eggs of *T. cinnabarinus* than on eggs of *T. urticae*, but the differences were not statistically significant (Fig.3). Mesa et al. [6] reported that a higher fecundity of *A. californicus* was observed when *T. urticae* was used as a prey. The differences may be caused by the fact that predatory mites originated from various populations (Koppert population and population from Colombia).

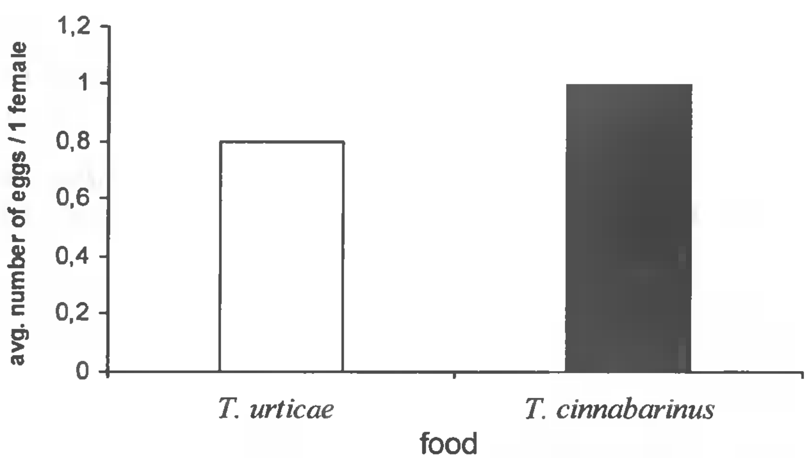

Fig.3. The average number of eggs laid by *A. californicus* after 24h feeding on *T. urticae* and *T. cinnabarinus*

The preliminary study showed evidently that there is no food preference for *A. californicus* when eggs of *T. urticae* or *T. cinnabarinus* are used as a source of prey. Further investigations are needed to learn more about the biology of *A. californicus* including a study on population parameters reared on mentioned spider mite species.

4. CONCLUSIONS

The choice between *T. urticae* and *T. cinnabarinus* as food for *A. californicus* did not depend of the species of prey, but depended on the amount of time the predator was given to select the food.

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PORÓWNANIE WARTOŚCI PRZĘDZIORKA SZKLARNIOWCA (*TETRANYCHUS CINNABARINUS* BOISD.) I PRZĘDZIORKA CHMIELOWCA (*TETRANYCHUS URTICAE* KOCH) JAKO POKARMU DLA DOBROCZYNKA KALIFORNIJSKIEGO (*AMBLYSEIUS CALIFORNICUS* MCGREGOR)

Streszczenie

Porównywano przędziorka chmielowca (*Tetranychus urticae*) i przędziorka szklarniowca (*T. cinnabarinus*) jako pokarm dla dobroczynka kalifornijskiego (*Amblyseius californicus*). Wyniki testu nie wskazały na zależność wyboru przez dobroczynka kalifornijskiego jednego z dwóch gatunków ofiary, natomiast pozwoliły stwierdzić, że wybór ten uzależniony był od czasu danego drapieżcy.

Słowa kluczowe: *Amblyseius californicus*, wybór pokarmu, przędziorek chmielowiec, przędziorek szklarniowiec

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W BYDGOSZCZY
ZESZYTY NAUKOWE NR 214 - OCHRONA ŚRODOWISKA 2 (1998) 135-142

FACTÓRS DISTURBING THE DEVELOPMENT OF TICKS (ACARI, IXODIDA)

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Synopsis. Embryonic development of ticks depends on various factors - temperature and humidity conditions. Temperatures below developmental zero, e.g. 13.1°C in the early period of embryogenesis act most harmfully on eggs, embryos and larvae of *Argas (A.) reflexus* (Fabricius, 1794). At 12°C, during the first seven days of egg incubation as much as 52.9% eggs of this species died. The great disturbances in embryonic development appeared also at different temperatures. The changes of the higher critical temperature of 37°C and 13°C (i.e. the lower threshold of larval development) caused 35.3% egg mortality, 11.5% abnormal egg hatching and 0.9% of larvae with morphological anomalies. High humidity causes the disturbances in embryogenesis of tick species preferring low humidity levels. At 90% r.h. only 42.4% of normal larvae of *Argas reflexus* developed. Under the influence of this humidity a great percentage of abnormally hatched larvae of *Hyalommma marginatum marginatum* Koch, 1844 and larvae with anomalies were observed.

Key words: Ixodida, ticks, development, humidity, temperature

1. INTRODUCTION

The development of ticks is affected both temperature and humidity. Unfavourable conditions disturb the physiological processes in ticks causing developmental anomalies and great mortality of these arthropods. Early developmental stages of ticks are particularly sensitive to changes of environmental factors.

Thus, the aim of this paper is to summarise the available data on the influence of temperature and humidity on the embryonic development of ticks of the families Argasidae and Ixodidae. Most experiments discussed in this study were made in our laboratory. Additional data was obtained from the literature.

2. REVIEW

2.1. Temperature

Various tick species show different temperature tolerances (Table). The lower critical temperatures, below which development does not occur, are low in tick species adapted to temperate climates and higher in tick species living in warm climates. The lower threshold of larval development range between 11.1°C and 20.0°C (Table). Within the range of tolerated constant temperatures, the disturbances in the embryonic development may be caused by the altering temperatures. Egg and embryo mortality depends on the differences between these temperatures.

Table. Humidity and temperature requirements of the larval stage of various tick species

Ticks species	Humidity (%)		Temperature (°C)		The lower thereshold of larval development (°C)	Source of information
	range	optimal	range	optimal		
ARGASIDAE						
Argas (A.) reflexus (Fabricius, 1794)	10-90	30-75	20-30	25	13.1	[2]
Argas (A.) polonicus Siuda, Hoogstraal, Clifford et Wassef, 1979	10-90	50-75	22-37	30	15.7	[23]
Argas (A.) vulgaris Filippova, 1966	10-100	10-55	20-32	28		[20]
Argas (P.) persicus (Oken, 1818)	10-90	30	21-32	30	20.0	[10, 11], Buczek, unpubl.
Argas (P.) arboreus Kaiser, Hoogstraal et Kohls, 1964	0-95	60	21-37	28-34	16.4	[12]
IXODIDAE						
Ixodes ricinus (Linnaeus, 1758)	90-100	90-100	16-33	16-28	15.5	[9] Mc Leod cf. 9, Buczek, unpubl.
Amblyomma americanum (Linnaeus, 1758)	75-95	95	10-35	20		[16]
Dermacentor reticulatus (Fabricius, 1794)	90-100	90-100	20-34	20,27	14.2	[26]
Haemaphysalis longicornis Neumann, 1901	75.5-100	100	18-35	30	11.1	[13, 25]
Hyalomma m. marginatum Koch, 1844	50-90	75	25-35	25		[6]
Rhipicephalus sanguineus Latreille, 1806	2-10 mmHg s.d.	2-8 mmHg s.d.	25-38	35		[13, 14]

Low temperatures in early periods of *Argas reflexus* egg development act most harmfully on embryogenesis. As much as 52.9% egg mortality was obseved when the eggs of this species were kept at 12°C for the first seven days of development at 30% r.h. (Fig.1).

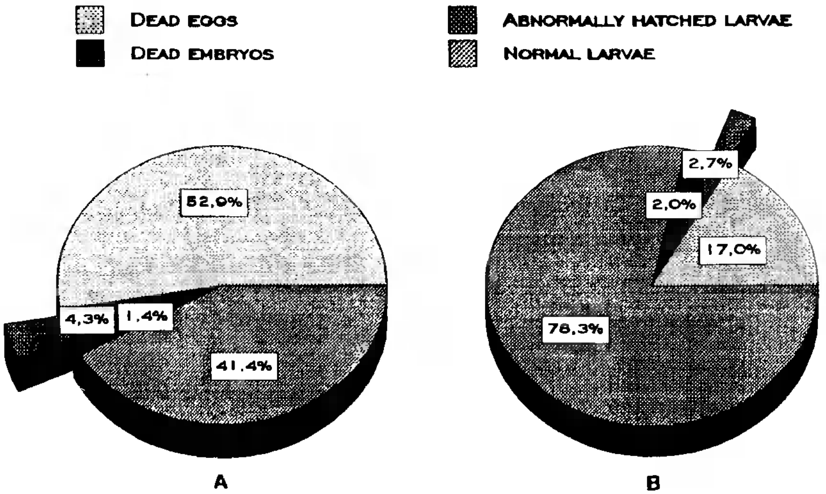

Fig.1. Effect of temperature on the egg development of *Argas (A.) reflexus* at 30% RH; A – 12°C for seven days and then 30°C, B – constant temperature of 30°C

1.4% dead embryos and 4.3% abnormally hatched larvae also appeared under these conditions [5]. Less embryonic death and abnormality occured at 9°C and came later, i.e. after the first seven days of egg incubation (Fig.2).

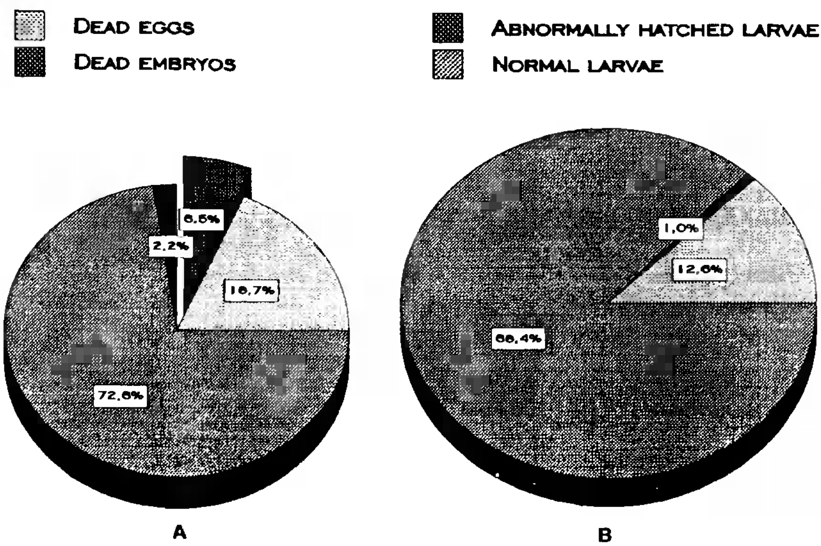

Fig.2. Effect of temperature on the egg development of *Argas (A.) reflexus* at 30% RH; A – 25°C and 9°C changed every seven days, B – 25°C

Great disturbances appeared during frequent changes of temperatures between 9°C (which is below developmental zero) and 30°C (Fig.3) [4].

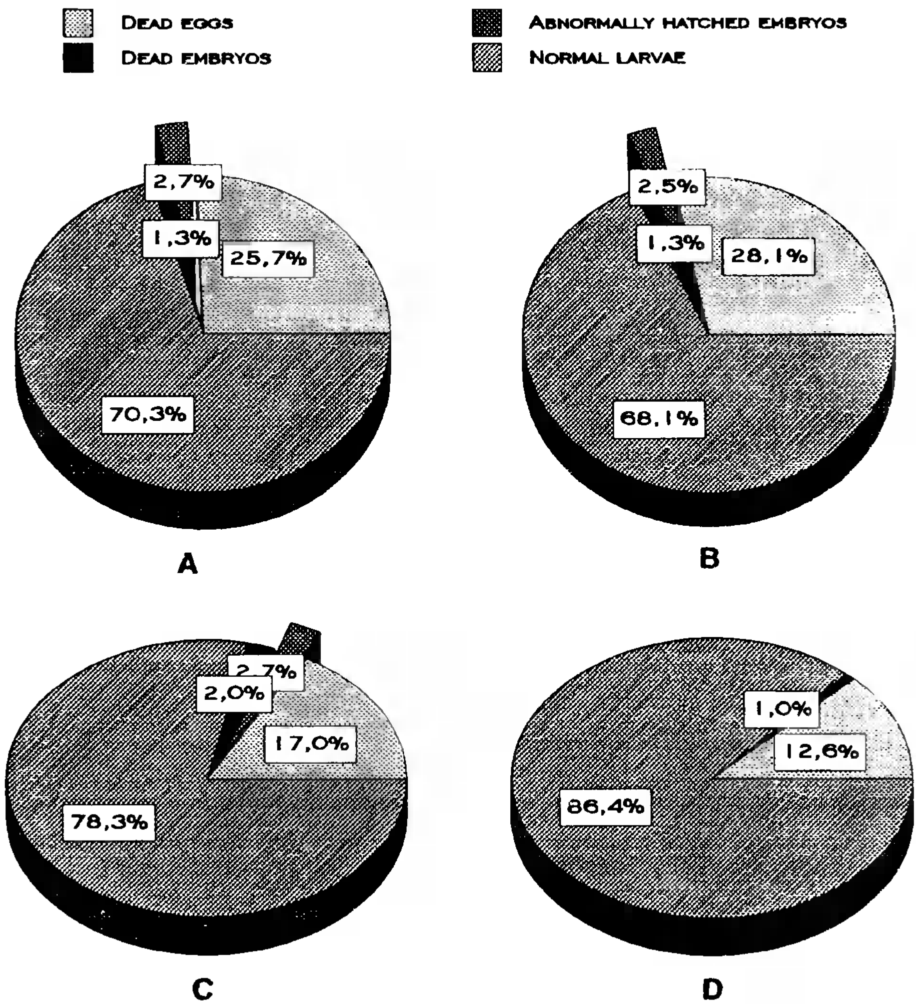

Fig.3. Effect of temperature on the egg development of *Argas (A.) reflexus* at 30% RH; A – temperature changes 9 and 30°C every six hours, B – temperature changes 9 and 30°C every 12 hours, C – constant temperature of 30°C, D – constant temperature of 25°C

Changes in the higher critical temperature of 37°C and of 13°C (i.e. the lower threshold of larval development) caused 35.29% egg mortality, 11.14% abnormally hatched eggs and 0.9% morphological anomalies [8].

2.2. Humidity

There are great differences in the water loss of eggs of different tick species [13] due to the various properties of the waterproof wax on the egg's surface secreted by Gene's organ. Species living in dry habitats can exist for a long period at low humidities; on the other hand, ticks living in moist environments can subsist only in high humidities.

Argasidae ticks may develop in a wide humidity range (from 10 to 90% r.h.) but they prefer low humidities (Table). There is a correlation between the percentage of egg and embryo mortality and the duration of egg incubation of *Argas reflexus* at 90% r.h. [3]. Twenty percent of dead eggs and embryos and 30.1% of abnormally hatched larvae were observed when the eggs developed under the influence of this humidity from the 21st to 25th day of embryonic development, at 25°C.

The humidity requirements of Ixodidae are more differentiated than Argasidae ticks (Table). Generally, they need higher humidity levels for development. Unfavourable humidity conditions cause the egg desiccation or disturbances in formation of the blastoderm, formation and metamerization of the germ band [7, unpubl. data]. Among Ixodidae there are relatively hydrophilous (for example *Hyalomma*) and completely hydrophilous (for example *Ixodes, Dermacentor*) species. The percentage of abnormally hatched larvae of *Hyalomma marginatum marginatum* Koch, 1844 increased at 90% humidity. Under these conditions morphological anomalies in larvae also developed [8]. On the other hand, the developmental disturbances of *Ixodes ricinus* (Linnaeus, 1758) appeared in humidities below 90% [9, Buczek unpubl.].

The susceptibility of the tick´s early developmental stages to humidity and temperature limits the occurrence of ticks in nature as well as rearing in the laboratory.

Apart from the above-mentioned factors, ticks abnormally develop in a laboratory feed on unspecific [15, 17, 19, 24] or immunised host species [22]. Feeding on immunised animals causes the increase of tick mortality [21, Buczek, unpubl.], reduction of number and weight of engorged ticks [18, 21], decrease in egg batches, disturbances in egg hatching [18] and prolongation of engorgement, preoviposition and oviposition [1].

During repeated feeding of ticks on the same host, there appear strong inflammatory changes of the host's skin, which alter the composition of the tick's diet. After repeated feeding of *Hyalomma m. marginatum* on rabbit, scrub specimens develop [7, Buczek, unpubl.].

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CZYNNIKI ZAKŁÓCAJĄCE ROZWÓJ KLESZCZY (ACARI, IXODIDA)

Streszczenie

Rozwój embrionalny kleszczy zależy od różnych czynników środowiskowych, przede wszystkim od warunków temperatury i wilgotności. Najbardziej szkodliwie na *Argas (A.) reflexus* (Fabr.) działają niskie temperatury poniżej zera rozwojowego, tj. 13,1°C we wczesnym okresie embriogenezy. Pod wpływem temperatury 12°C działającej przez pierwszych siedem dni inkubacji jaj obumierało aż 52.9% jaj tego gatunku. Duże zakłócenia w rozwoju embrionalnym pojawiały się również w zmiennych temperaturach. Zmiany najwyższej krytycznej temperatury 37°C i 13°C, tj. dolnego termicznego progu rozwojowego larw powodowały: 35.3% śmiertelność jaj, 11.5% nienormalny wylęg larw i rozwój 0.9% larw z anomaliami morfologicznymi. Wysokie wilgotności powodują zakłócenia w embriogenezie gatunków kleszczy preferujących niskie poziomy wilgotności. W wilgotności względnej 90% wylęgało się tylko 42.4% larw normalnych *Argas reflexus*. Pod wpływem tej wilgotności obserwowano także dużo nieprawidłowo wylęgających się larw *Hyalomma m. marginatum* Koch i wad morfologicznych.

Słowa kluczowe: Ixodida, kleszcze, rozwój, wilgotność, temperatura

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ZESZYTY NAUKOWE NR 214 - OCHRONA ŚRODOWISKA 2 (1998) 143-153

SURFACE STRUCTURES IN DIFFERENT STAGES OF *HYALOMMA MARGINATUM MARGINATUM* KOCH, 1844 (ACARI, IXODIDA, IXODIDAE)

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Synopsis. Surface structures were examined in all developmental stages of *Hyalomma marginatum marginatum* using a light microscope and SEM. Haller's organ and setae on tarsus I, the palpal organ as well as setae and glands on idiosoma were taken in consideration in this study. Wall pore, terminal pore and no pore setae were observed in larvae, nymphs and adults. The anterior pit of Haller's organ of this tick species contains six setae: single porosa seta, two grooved setae (wall pore setae), two fine setae and single conical seta (no pore setae). Terminal pore setae were found in the palpal organ and on the tarsus I of all instars. No pore setae were on the ventral, dorsal, lateral and latero-anterior faces of tarsus I and idiosoma. Small and large glands occur on the surface of the idiosoma. Within each area porosa there are 96 orifices and two setae. The surface structure changes during ontogeny of *Hyalomma m. marginatum*.

Key words: Ixodida, ticks, *Hyalomma marginatum*, surface structures

1. INTRODUCTION

Surface structures have been used as a basis for classification of ticks. Among them setae and non-setal structures are of the greatest importance for tick systematic [8, 11, 16, 20]. These structures vary functionally. Setae on gnathosoma, idiosoma and legs are involved in the reception of environmental cues; on the other hand the glands in the maintance of water balance, in moulting or in secretion of pheromones.

The goal of this paper is to present a study on the surface structures in all developmental stages of *Hyalomma marginatum marginatum*.

2. MATERIAL AND METHODS

Various developmental stages of *Hyalomma m. marginatum,* e.g. larvae, nymphs and adult ticks constitute material for this study. All ticks originated from laboratory cultures of Syrian *Hyalomma m. marginatum.* The ticks were killed in alcohol and then prepared for studies in light and SEM microscope.

Specimens for light microscopic observations were macerated in 5% NaOH and mounted in Hoyer's medium. Ticks for SEM observations were cleared, desiccated and coated with gold.

The following taxonomically important structures were examined in larvae, nymphs and adults: apical palpal segment, Haller's organ and setae of the first pair of legs, setae and glands on scutum and alloscutum. Also the areae porosae in females were taken into account in these investigations.

3. RESULTS AND DISCUSSION

Various kinds of setae occur in all developmental stages of *Hyalomma m. marginatum.* They are wall pore, terminal pore and no pore setae.

The anterior pit of Haller's organ of all instars of this tick species contains six setae: single porosa seta, two grooved setae, two fine setae and single conical seta (Figs.1, 2). These setae differ in their external appearance and length [5]. Among them are setae with numerous pores (porosa seta, grooved setae) and no pore setae (fine setae and conical seta). Wall pore sensilla are also situated in dm_1 group on the tarsi of the first pair of legs.

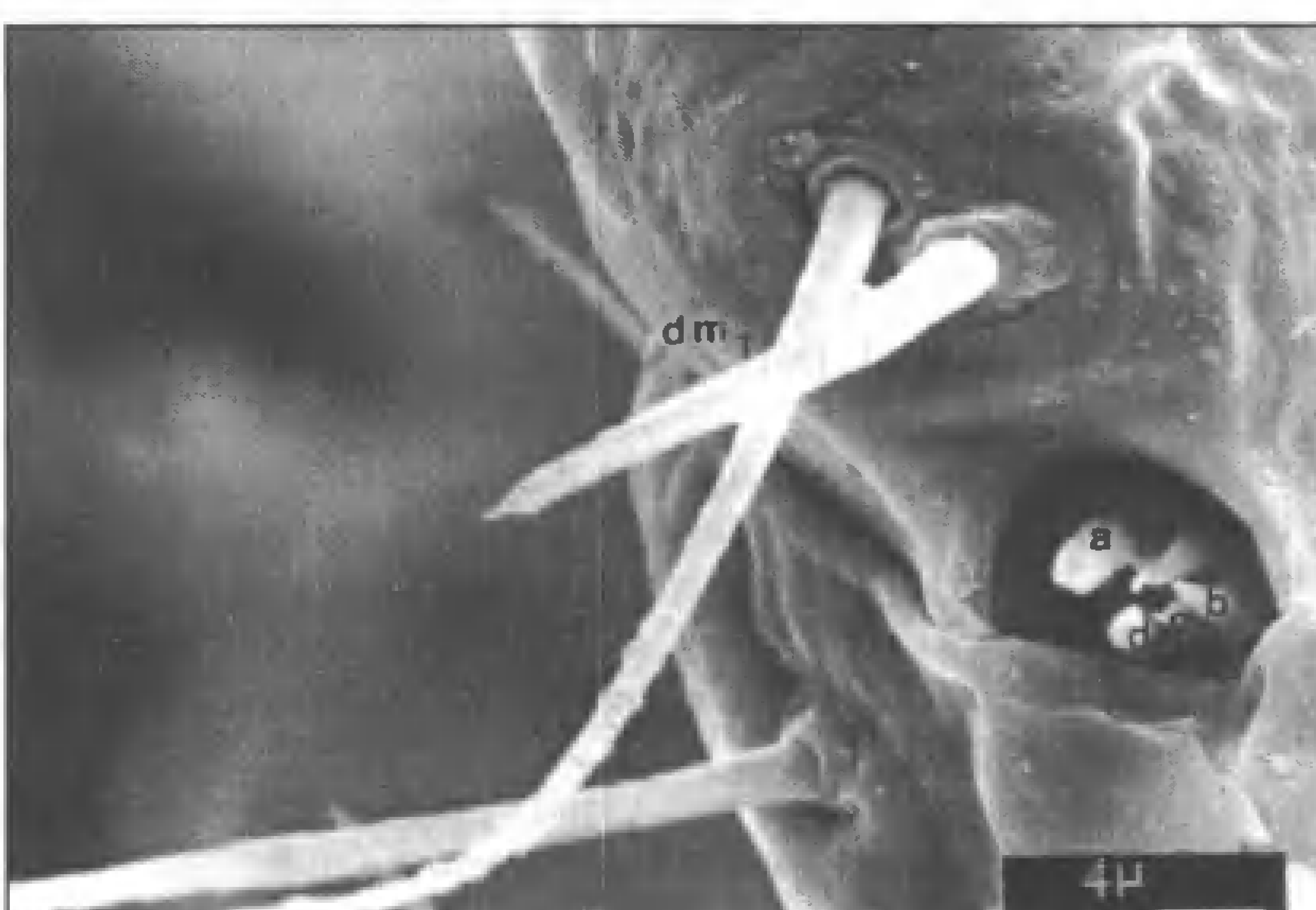


Fig.1. Haller's organ and setae of leg (dm_1) in larva of *Hyalomma m. marginatum*; a - porosa seta, b - grooved setae, c - fine setae, d - conical seta (2500x)

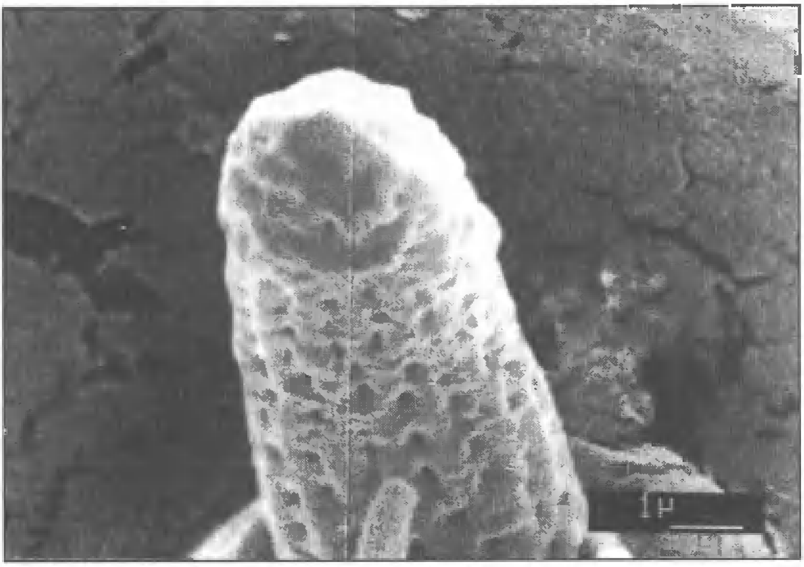


Fig.2. Porosa seta in nymph of *Hyalomma m. marginatum* (1000x)

Hess and Vlimant [18, 19] in TEM studies found different types of wall pore sensilla which differ in the thickness, the structure of the shaft wall and in the mode of innervation. They are wall pore single-walled (wp-sw) sensilla A and B and wall pore double-walled (wp-dw) sensilla A, B and C.

Terminal pore sensilla occur in palpal organ of *Hyalomma m. marginatum* (Fig.3). Seven setae belong to this organ in all stages of development. Similar setae is present on ventral face of the tarsus I. The terminal pore setae were also observed on apical palpal segment of *Hyalomma asiaticum* Schulze et Schlottke, 1929 [2], *Amblyomma americanum* (L., 1758) [14] and on the tarsus I of *Amblyomma americanum* [7, 12, 13] and *Hyalomma asiaticum* [22]. According to Chu-Wang and Axtell [7] and Foelix and Axtell [12] these sensillae are common for other articles of tick legs.

No pore setae are situated on ventral, dorsal, lateral and latero-anterior faces of the first tarsus, in the anterior pit of Haller's organ and on idiosoma of *Hyalomma m. marginatum.* Idiosomal setae differ in length [4]. Transmission electron microscopy studies show the ultrastructural differentiation of no pore setae in *Amblyomma variegatum* Fabricius, 1794 [19].

The same seta may be involved in the detection of the wide range of environmental stimuli [1, 3, 6, 15, 23, 27]. However, setae with pores are chiefly chemoreceptors [17, 27] and hygroreceptors [26]. Terminal pore setae with terminal slit openings contain units reacting to NaCl and water [2]. Their function appears to be the mechano-gustatory reception [18, 26]. No pore setae are the first of all mechanoreceptors [19]. They may also be thermo- and/or hygroreceptors [19].

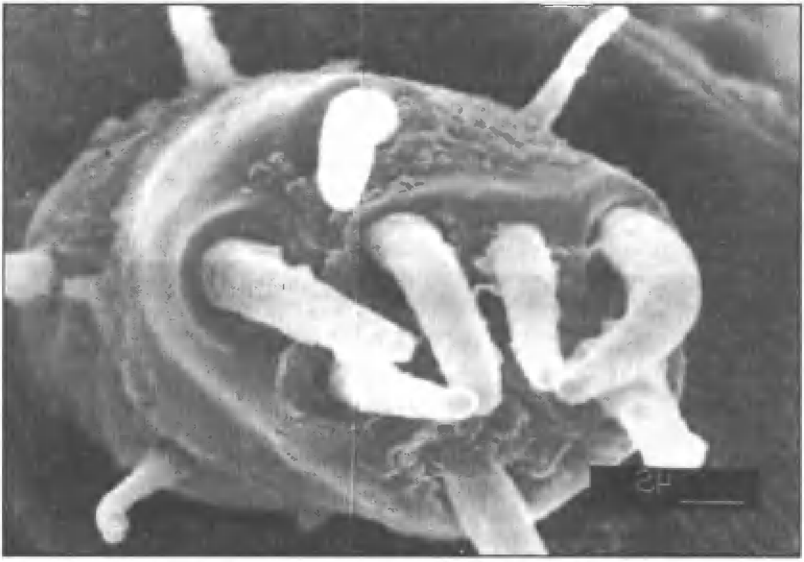


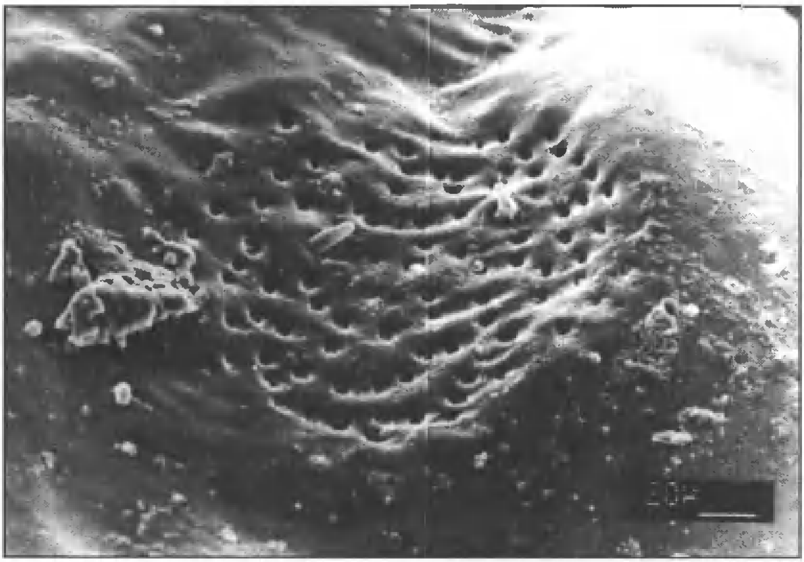
Fig.3. Palpal organ in larva of *Hyalomma m. marginatum* (5000x)

Small and large glands occur on the ventral and dorsal view of idiosoma of *Hyalomma m. marginatum*. The small glands are known in slide-mounted specimens. They are round structures on scutal and alloscutal surface. Aggregation of small glands forms the areae porosae [24] which are situated on the basis of capituli of ixodid females. Ninety-eight orifices of these glands are within each area porosa of *Hyalomma m. marginatum* female. Between them two setae occur (Figs.4A, 4B). The areae porosae produce wax, which coats the eggs deposited by females [10].

Schulze [24] distinguished four non-setal structures in adult ixodid ticks, such as sensilla auriformia, sagittiformia, hastiformia and laterniformia. Three types of them (sensilla auriformia, sagittiformia and hastiformia) were described in larvae of ixodid ticks [9]. Sensilla sagittiformia and hastiformia are glands without innervation [9, 21]. On the alloscutum of *Hyalomma m. marginatum* there are the foveae dorsales. These glands secrete pheromones [25].

The surface structures of idiosoma change during ontogeny of *Hyalomma m. marginatum*. The cuticle is traversed by pore canals (Figs.5, 6, 7). Immature stages are less sclerotized than adults. The synthesis of new cuticle occurs during the feeding of larvae, nymphs and females.

A



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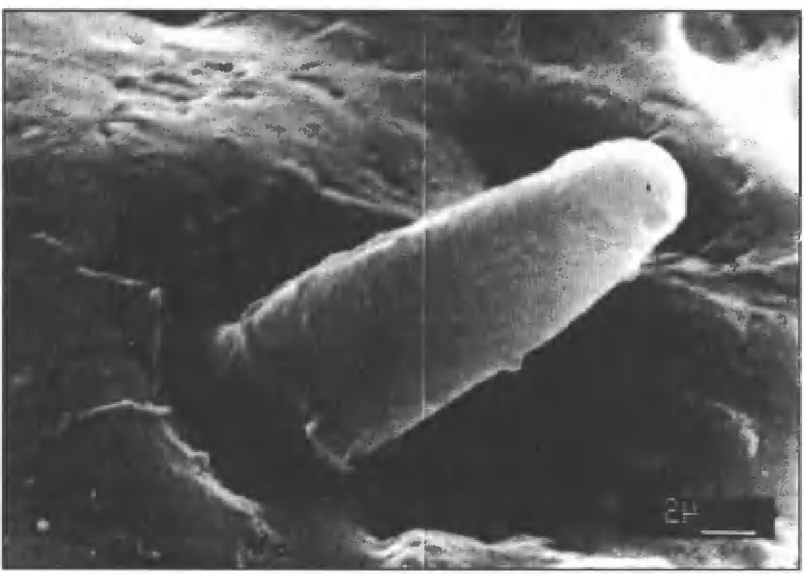
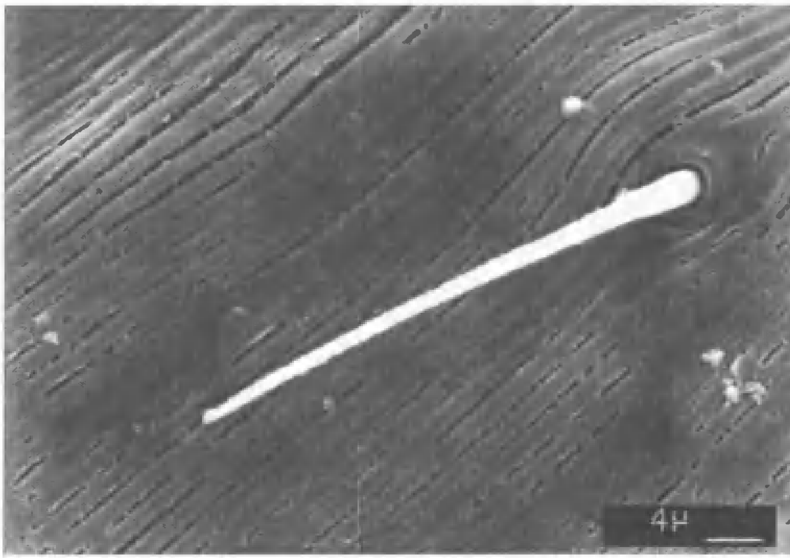


Fig.4. Area porosa on the dorsal side of the basis capituli of *Hyalomma m. marginatum* female: A - area porosa with numerous pores (500x), B - seta (5000x).

A



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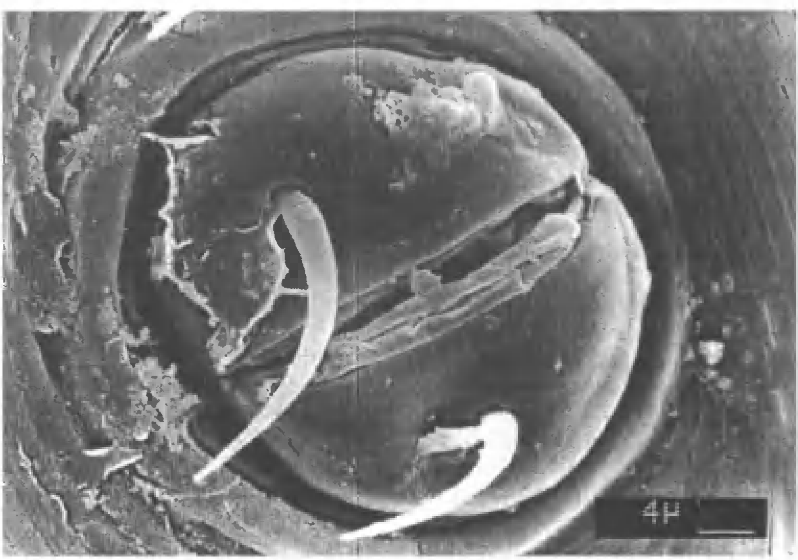
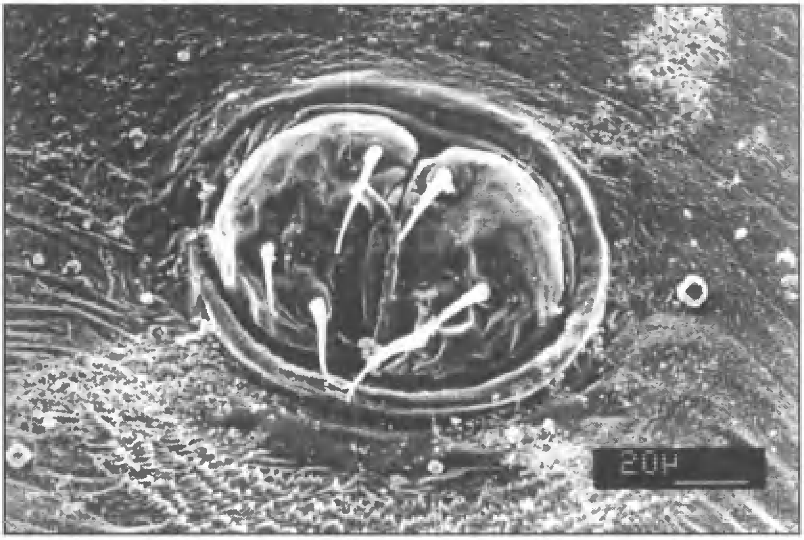


Fig.5. Surface structure of *Hyalomma m. marginatum* larva: A - no pore seta (2500x), B - anus (2500x)

A



B

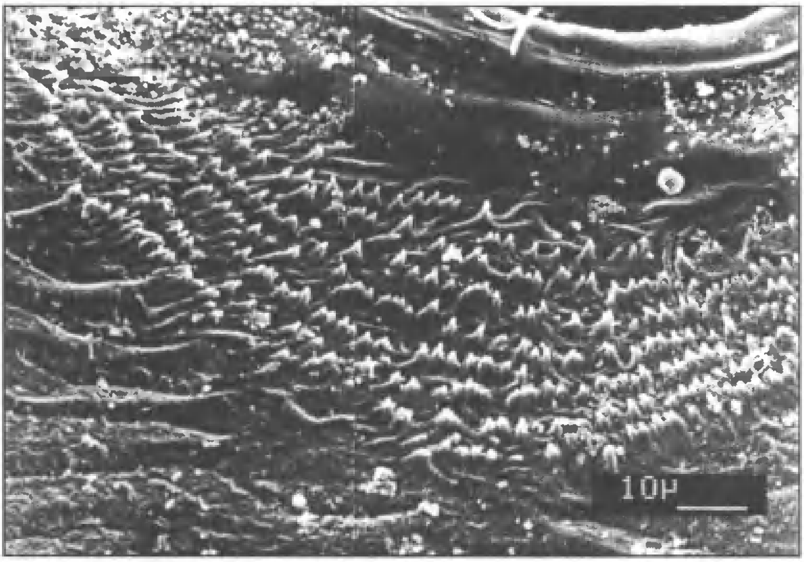


Fig.6. Surface structure on the ventral view of *Hyalomma m. marginatum* nymph (A - 500x, B - 1000x)

A

B

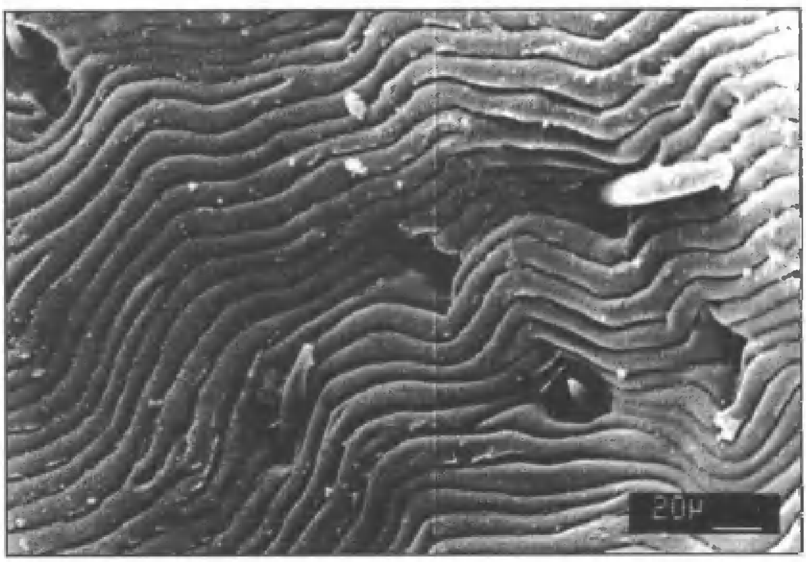


Fig.7. Surface structure of *Hyalomma m. marginatum* female: A - scutum and eye (250x), B - alloscutum with no pore setae (500x)

ACKNOWLEDGMENT

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STRUKTURY POWIERZCHNIOWE RÓŻNYCH STADIÓW ROZWOJOWYCH *HYALOMNA MARGINATUM MARGINATUM* KOCH, 1844 (ACARI, IXODIDA, IXODIDAE)

Streszczenie

Przy użyciu mikroskopu świetlnego i skaningowego badano struktury powierzchniowe u wszystkich stadiów rozwojowych *Hyalomma marginatum marginatum*. Szczególną uwagę zwrócono na budowę organu Hallera i szczecinki na stopie I, budowę organu głaszczkowego, szczecinki i gruczoły idiosomy. U larw, nimf i postaci dorosłych stwierdzono szczecinki z porami na całej powierzchni, szczecinki z porami w części wierzchołkowej i szczecinki pozbawione porów. W grupie przednich szczecinek w organie Hallera występuje sześć szczecinek, tj. pojedyncza szczecinka porowata i dwie bruzdkowane (szczecinki z porami na całej powierzchni) oraz dwie cienkie szczecinki i pojedyncza stożkowata (szczecinki pozbawione porów). Szczecinki z porami w części wierzchołkowej stwierdzono w organie głaszczkowym i na stopie I u wszystkich stadiów rozwojowych. Poza organem Hallera szczecinki bez porów znajdują się na powierzchni brzusznej, grzbietowej, bocznej i przednio-bocznej stopy I i na idiosomie. Małe i duże gruczoły występują na powierzchni idiosomy *Hyalomma m. marginatum*. W obrębie pola porowatego znajduje się 96 otworów i dwie szczecinki. W czasie ontogenezy *Hyalomma m. marginatum* zmienia się struktura powierzchniowa idiosomy.

Słowa kluczowe: Ixodida, kleszcze, *Hyalomma marginatum*, struktury powierzchniowe

AKADEMIA TECHNICZNO-ROLNICZA IM. JANA I JĘDRZEJA ŚNIADECKICH
W BYDGOSZCZY
ZESZYTY NAUKOWE NR 214 - OCHRONA ŚRODOWISKA 2 (1998) 155-160

REVIEW OF DATA ON THE DISTRIBUTION OF THE TICK *DERMACENTOR RETICULATUS* (FABRICIUS, 1794) (ACARI, IXODIDA, IXODIDAE) IN POLAND

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Synopsis. In Poland, the distribution range of *D. reticulatus* covers the North East territories of the country. Already known localities are grouped in the following foci: Masuria, Augustów, Biebrza, Knyszyn, Białowieża, Polesie, Hrubieszów, Bug River Basin. In the years 1994-96 the more western range of the Masuria focus was reported as well as the Roztocze and Stalowa Wola foci. These ticks were collected from host in Bieszczady.

Key words: fauna of Poland, Ixodida, *Dermacentor*, distribution

1. INTRODUCTION

The geographical range of *Dermacentor reticulatus* runs latitudinally from England and Spain to the upper Yenisey basin in Siberia [6, 7, 11, 13, 17, 18, 22 and others]. In Poland this tick occurs mostly in tree-covered river valleys, creeks or drainage ditches in marshy mixed forests, peatbogs, glades and meadows, cut-covers and tree-covered pastures [17, 22]. In its habitats *D. reticulatus* occurs commonly and in great numbers. During its active periods it can be even more numerous than *Ixodes ricinus*. Two periods of activity of adults of unengorged ticks occur during the year in the spring and the autumn [23]. Immature stages have only one activity period in the warm seasons of the year [24].

2. MATERIAL AND METHODS

Data presented in previous publications were review [1, 2, 3, 4, 5, 8, 9, 10, 12, 14, 15, 16, 17, 20, 21, 22] complimented the authors' own research during 1993-1997. Tick flag [17] and host inspections were used to collect ticks in field research. Collection sites in Poland are presented on the map with the UTM System (Fig.1).

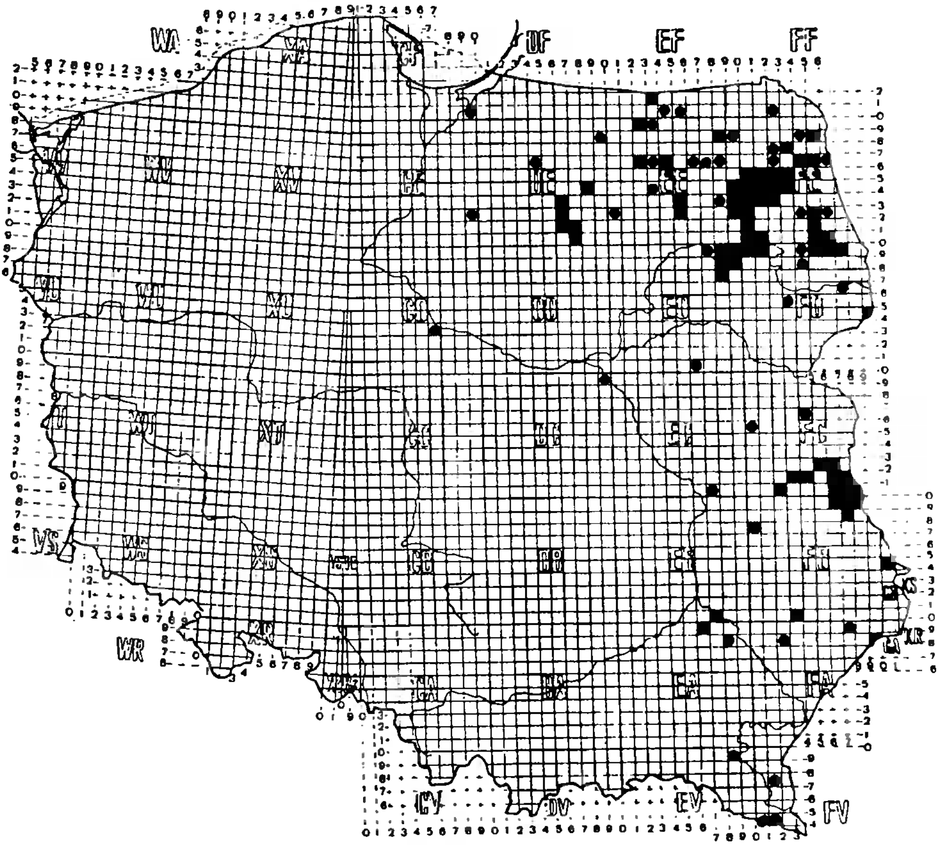

Fig.1. Distribution of *D. reticulatus* in Poland:
ν - ticks collected from grass, λ - ticks collected on animals [in Universal Transverse Marcator system (UTM), each square = 10 x 10 km, adapted by Faunistic Documentation Center, Institute of Zoology, Polish Academy of Sciences]

3. RESULTS AND DISCUSSION

Polish localities of *D. reticulatus* are localized in the Northeast part of Poland (Fig.1) and consist of 10 separate foci. Most localities are connected with elk habitats, which are the main hosts of these ticks [8, 10]. Recently the importance of deers in the distribution of this tick was also reported [3].

Masuria focus. This focus was described quite recently [17, 20]. Its range is not yet completely known. The list of previously know localities is given in [3, 8, 10, 17, 20] - UTM: EE: 26, 29, 34, 45, 52, 53, EF: 31. It is complimented by localities in Napiwoda, Łyna, Marózek, Janowo, Zawada, Pasym, and Urwitałt (G. Karbowiak, written correspondence) and Połom (A. Jasina written correspondence) (UTM respectively: DE: 61, 62, 63, 70, 71, 84, EE: 46, 88), and from dog in Elbląg (leg. Prof. A. Malczewski, UTM: CF: 90).

Six other foci of *D. reticulatus* in Poland were reported and researched by Szymański [21, 22] and are confirmed by this research. They are:
Augustów focus (UTM: FF: 37, 58) in the Augustów Primeval Forest.
Biebrza focus (UTM: ED: 87, 88, 89, 98, 99; EE: 92, 93, 94; FD: 09, 19; FE: 00, 01,02, 03, 04, 05, 10, 13, 14, 15, 23, 24, 25, 34, 35, 45, 46, 55, 56) -the widest area of numerous and dense occurrance of *D. reticulatus* in Poland covering the Biebrza Valley and a part of the Narew valley.
Biebrza focus is the best known in Poland. [1, 2, 4, 21, 22 and others].
Knyszyn focus (UTM: FD: 59, 69, 79; FE: 50, 51, 52, 60) in the Knyszyn Primeval Forest [22].
Białowieża focus (UTM: 94) in the Białowieża Primeval Forest [9, 14, 22].
Polesie focus (UTM: FB: 69, 78, 79, 89; FC: 20, 31, 41, 52, 60, 61, 62, 70, 71, 80) - the second largest focus in Poland, situated in the southern part of Polesie Lubelskie [22]. The list of localities given by Szymański [22] is completed by our collections in Ostrów Lubelski, Okuninka, Tarasiuki and in Sawin-Borek.
Hrubieszów focus (UTM: GB: 04) [22].
Bug River basin focus (UTM: FA: 87) [5, 21, 22]. State border does not allow the full exploration of this focus.

The next two foci are described for the first time:
Roztocze focus (UTM: FB: 30) covering the finding of *D. reticulatus* at the Wieprz river near Zwierzyniec. This focus needs further study.
Stalowa Wola focus (UTM: EB: 70; EA: 69, 88). Ticks were collected in Stalowa Wola and its vicinities (Pysznica, Jastkowice, Przyszów, Jeżowe) on the left and right sides of the lower course of the San river. Actually this is the most western locality of *D. reticulatus* in Eastern Poland

Uncertain localities where ticks were collected from animals and not from vegetation [24], were completed by our findings in the upper basin of San River

(Fig.1): Huzele near Lesko (UTM: EV: 98) and in Bieszczady (Stare Sioło, Ustrzyki Górne, Ustrzyki Dolne - UTM respectively: FV: 04, 14, 17). In Huzele, Stare Sioło and Ustrzyki Dolne ticks were collected from local dogs and in Ustrzyki Górne from rabbit. Untill now ticks were not collected from the vegetation in Bieszczady, therefore we do not separate Bieszczady focus which may be described in the future, after more precise research. It is possible that *D. reticulatus* is spread in the San River basin.

In several cases the collection of *D. reticulatus* from animals was reported in Kotlina near Puławy (UTM: EC: 70) [15] and Warszawa-Bemowo (UTM: DC: 99) [12]. Several dozen (42) localities of *D. reticulatus* in Poland were given by Kadulski [8, 10] and are presented on the UTM map only without the locality names. These localities are listed below without the localities mentioned above in this study. These are (UTM: CD: 63; CE: 92; DE: 46, 98; ED: 60, 79; EE: 02, 36, 39, 66, 76, 83, 86, 98; EF: 40, 50; FA: 28, 79; FB: 07; FC: 15, 46; FD: 35, 48, 49, 76; FE: 26, 27, 42, 48, 62, 66; FF: 20).

Moreover, Siuda et al. [19] reported the collection of adults of *D. reticulatus* from mammals in the Lublin Region. Unfortunately, authors have not had the precise data on the sites of collections. General data on the range of *D. reticulatus* in Poland and Europe are given by Piotrowski [16].

4. CONCLUSIONS

The above review shows that *D. reticulatus* is the widely spreaded species in the East of Poland and its range covers the area between the Vistula river and the San river basin. The recognition of newly discovered foci: Roztocze and Stalowa Wola is fully reasonable. More studies are needed for the Bieszczady focus, which maybe together with Stalowa Wola focus is the one San River Basin focus. Still the appropriate research concerning the occurrence or absence of this species in the central and western parts of our country are lacking.

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STAN WIADOMOŚCI NAD ROZMIESZCZENIEM W POLSCE *DERMACENTOR RECITULATUS* (FABRICIUS, 1794) (ACARI, IXODIDA, IXODIDAE)

Streszczenie

Dotychczasowe badania na terenie Polski wykazały, że *D. reticulatus* występuje w północno-wschodniej części naszego kraju. Na tym obszarze wyróżniono 8 tzw. ognisk występowania tego gatunku, tj.: mazurskie, augustowskie, biebrzańskie, knyszyńskie, białowieskie, poleskie, hrubieszowskie i pobużskie. Znane również były znaleziska tego kleszcza na różnych żywicielach na szerszym obszarze ograniczonym od zachodu rzeką Wisłą i środkowo-dolnym biegiem rzeki San; na ogół znaleziska te uważane są za przypadki zawleczeń.

W niniejszej pracy potwierdzono istnienie ww. ognisk i opisano nieznane wcześniej ogniska: roztoczańskie i stalowowolskie. Stwierdzono występowanie *D. reticulatus* na zwierzętach w Bieszczadach, lecz istnienie ogniska bieszczadzkiego wymaga potwierdzenia w przyszłych badaniach. Do tej pory nie stwierdzono występowania tego gatunku kleszczy na obszarach Polski położonych na zachód od Wisły.

Słowa kluczowe: fauna Polski, Ixodida, *Dermacentor*, rozmieszczenie

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W BYDGOSZCZY
ZESZYTY NAUKOWE NR 214 - OCHRONA ŚRODOWISKA 2 (1998) 161-167

PARASITIC MITES (ACARI) OF NATIVE AND WORLD-WIDE BEES (APOIDEA, *APIS*)

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Synopsis. Review of world-wide Acari, including native species, associated with honeybees was made. Twenty two mite species belonging to ten genera from six families and seven social host-bee species (Apoidea, *Apis*) were listed on the base of results of the author's own observations and world literature. Thirty-four references were cited.

Key words: Acari, mites, parasites, Apoidea, *Apis*, honey bees

1. INTRODUCTION

Social bees are usually accompanied with various arthropods. Some of them, especially mites parasitic on honeybees are interesting to apicultural acarology and apiculture for invasion diseases - acaroses (e.g. acarapidosis, varroasis) of bee colonies. These acaroses belong to heavy bee diseases of veterinary and economic import for beekeeping during recent years. The aim of the present publication is a review of this acarofauna with special reference to the species of real and potential threats to honeybees.

2. MATERIAL AND METHODS

The majority of data were found in native and foreign literature. Results of the author´s own faunistic studies were added. Many years´ observations of bee colonies in native apiaries were conducted. Acarological analyses of bees (imagines, brood), samples of hive debris and bee products were made every year. Mites were picked up from the material, prepared (Berlese, Hoyer, Oudemans mounting media) and determined with obtainable keys and descriptions.

3. RESULTS AND DISCUSSION

The review includes 22 mite species representing 10 genera from 6 families: Erythraeidae (*Leptus* - 1), Laelapidae (*Melittiphis* - 1, *Neocypholaelaps* - 6, *Tropilaelaps* - 2), Pyemotidae (*Pyemotes* - 2), Tarsonemidae (*Acarapis* - 3, *Pseudoacarapis* - 1), Uropodidae (*Urobovella* - 1), Varroidae (*Euvarroa* - 2, *Varroa* - 3) and their hosts (7 bee species of *Apis*). Some (5) of them were registered in Polish acarofauna (Tab., Fig.).

Table. List of 22 mite species (Acari) associated with 7 species of honey bees (*Apis*): *Apis andreniformis* (Smith) - A.a., *A. cerana* F. - A.c., *A. dorsata* F. - A.d., *A. florea* F. - A.f., *A. koschevnikovi* Buttel-Reepen - A.k., *A. laboriosa* Smith - A.l., *A. mellifera* L. - A.m. Data were based on foreign literature and author´s own observations; mite species registered in Poland are marked with asterisk (*)

Mites	Bees:							References
	A.a.	A.c.	A.d.	A.f.	A.k.	A.l.	A.m.	
1	2	3	4	5	6	7	8	9
Acarapis dorsalis Morgenthaller							+	[15]
A. externus Morgenthaller							+	[15]
A. woodi (Rennie)*		+	+				+	[3, 4, 5, 8, 12, 15, 29]
Euvarroa sinhai Delfinado et Baker	+			+			+	[17]
E. wongsirii Lekprayoon et Tangkanasing	+							[26]
Leptus ariel Southcott							+	[30, 32, 33]
Melittiphis alvearius (Berl.)							+	[10, 21, 25]
Neocypholaelaps africana Evans							+	[2]
N. ampullula (Berl.)		+						[2]
N. apicola Delfinado-Baker et Baker		+						[13]
N. favus Ishicava							+	[24]
N indica Evans		+	+	+				[1]
N. novaehollandiae Evans							+	[2]
Pseudoacarapis indoapis (Lindquist)		+						[27]
Pyemotes herfsi Oud.*		+					+	[17, 19, 20]

Table (continued)

1	2	3	4	5	6	7	8	9
Pyemotes ventricosus (Newp.)*							+	[4, 5, 8, 9]
Tropilaelaps clareae Delfinado et Baker		+	+	+		+	+	[3, 11, 18, 34]
T. koenigerum Delfinado-Baker et Baker			+			+		[16]
Urobovella marginata (Koch)*							+	[5, 8, 28]
Varroa jacobsoni Oud.*		+			+		+	[3, 6, 7, 22, 31]
V. rindereri Guzman et Delfinado-Baker					+			[23]
V. underwoodi Delfinado-Baker et Aggarwal		+						[14]

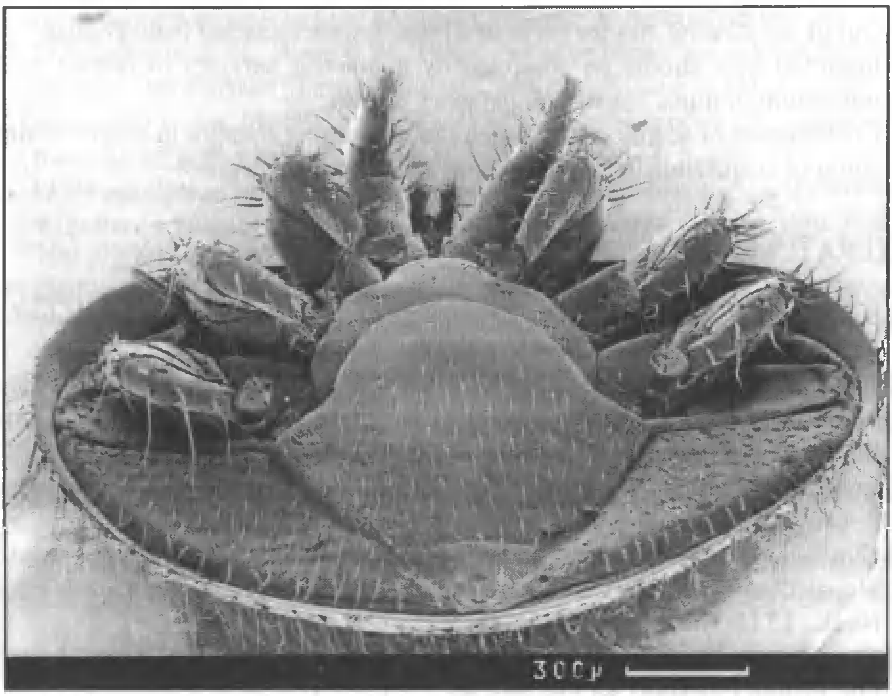

Fig. *V. jacobsoni* - dangerous parasite of honey bees and economic problem for the world apiculture of recent years; female - ventrum, scanning electron microscope (photo: R. A. Baker, Department of Biology, University of Leeds, U.K.)

Varroa jacobsoni Oud. - dangerous ectoparasite of brood and imagines of bees and *Acarapis woodi* (Rennie) - tracheal endoparasite of adult bees, are cosmopolitan and have economic importance for world beekeeping. *Tropilaelaps clareae* Delfinado et Baker is important parasite of bees in South-East Asia. The majority of other mites reviewed here were collected and described for the first time from bees from Asiatic countries. Bees are sometimes accompanied with *Melittiphis alvearius* (Berl.) and some other species (*Neocypholaelaps* spp., *Pseudocacarapis*, *Urobovella*), which are associated with their hosts phoretically; they are rather "pseudoparasites" (transport parasitism) of bees. Parasitism of pyemotids (*Pyemotes* - on bee brood) and erythraeids (*Leptus* - on adult bees) is a rather scarce phenomenon, although it was observed from time to time. The list of mites infesting bees is addressed and recommended to native quarantine services. Imported bee material (bee queens, packets of bees, bumble- and solitary-bees or other polinators) must be carefully examined in respect of presence of parasites and pests of bees as quarantine objects.

4. CONCLUSIONS

1. Out of the 22 mite species presented here, 5 were recorded from Poland.
2. Imported bees should be controled by quarantine services in respect to the infestation of mites - pests and parasites of bees.
3. Continuation of acarological studies and monitoring changes in species composition of acarofauna in Polish apiaries seems to be necessary.

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PASOŻYTNICZE ROZTOCZE (ACARI) PSZCZÓŁ (APOIDEA, *APIS*) W KRAJU I NA ŚWIECIE

Streszczenie

Dane z literatury i wyniki wieloletnich obserwacji własnych stanowiły podstawę do opracowania wykazu gatunków roztoczy (Acarina) spotykanych na pszczołach społecznych (*Apis*). Wykaz obejmuje 22 gatunki (w tym też krajowe) roztoczy pasożytniczych i foretycznie związanych z 7 gatunkami pszczół. Niektóre z tych roztoczy, jak *Acarapis woodi* i *Varroa jacobsoni*, należą do gatunków kosmopolitycznych i mają duże znaczenie gospodarcze jako sprawcy groźnych chorób inwazyjnych pszczół (akarapidoza, warrooza) w skali światowej. Inne, jak np. *Tropilaelaps clareae*, stanowią trudny problem dla pszczelarstwa w krajach Azji południowo-wschodniej. Lokalnie, również głównie w tym rejonie, występuje szereg pokrewnych gatunków roztoczy na kilku azjatyckich gatunkach pszczół. Niektóre pasożytnicze gatunki roztoczy (Erythraeidae, Pyemotidae) mimo że były

obserwowane na pszczołach, nie mają dotychczas większego gospodarczego znaczenia. Inne, jak np. *Melittiphis alvearius, Neocypholaelaps* spp., *Pseudoacarapis* czy *Urobovella*, są foretantami, a ich powiązania z pszczołami, zwłaszcza przy bardzo licznych pojawach tych roztoczy, mogą przyjmować formę pasożytnictwa transportowego, które można określić nie jako pasożytnictwo sensu stricto lecz "pseudopasożytnictwo". Niektóre pospolite gatunki roztoczy pszczół, jak *V. jacobsoni* i *A. woodi*, znane były już od dawna, natomiast inne, jak np. *Euvarroa wongsirii, Tropilaelaps koenigerum, Varroa uderwoodi* i *V. rindereri* zostały odkryte i opisane w ostatnich latach [14, 16, 23, 26]. Służba kwarantannowa powinna zwrócić większą uwagę na dokładne badanie pszczół wwożonych do kraju na obecność szkodników i pasożytów, które stanowią potencjalne zagrożenie dla gospodarki pasiecznej.

Słowa kluczowe: Acari, roztocze, pasożyty, Apoidea, *Apis*, pszczoły miodne

AKADEMIA TECHNICZNO-ROLNICZA IM. JANA I JĘDRZEJA ŚNIADECKICH
W BYDGOSZCZY
ZESZYTY NAUKOWE NR 214 - OCHRONA ŚRODOWISKA 2 (1998) 169-174

DERMATOPHAGOIDES EVANSI FAIN, HUGHES ET JOHNSTON (ACARI, PYROGLYPHIDAE) - BIONOMICS ON BIRD DANDRUFF

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Synopsis. Living mite specimens of *Dermatophagoides evansi* were collected from the dust of a sparrow nest and used as initial material for laboratory monocultures of the species. Mite cultures were kept under a controlled temperature (about +20°C) and RH (85%), with canary dandruff (outer skin scales of birds) as food. Bionomics was studied under the same conditions. The following average results were obtained: embrionic development - 9.5 days; whole developmental cycle - 53.0 days; mortality of juvenile instars - 74.7%; percentage of females - 59.1%; longevity of adults - 44.3 days; fecundity of females - 23.8 eggs over entire life.

Key words: Psoroptoidea, Pyroglyphidae, mites, biology, bird dandruff

1. INTRODUCTION

House dust mites (Pyroglyphidae) are commonly known as factors of sanitary importance and producers of strong allergens causing various human diseases (bronchitis, conjunctivitis, dermatitis, rhinitis). They usually occupy flats, storehouses, birds and even bee nests. Some of them occur also in Poland [4, 5, 6]. Presented here *Dermatophagoides evansi* belongs to this group and was first described in 1967 [12]. It was observed in various habitats of some countries, e.g. houses (bedding, carpets, clothes), soil, birds and their nests. As yet, its geographical distribution included France, Hawaii, Iran, Poland, Portugal, Russia and the U.S.A. [1, 2, 3, 10, 11, 13-20]. The biology of this species is unknown and its recognition was the aim of this study.

2. MATERIAL AND METHODS

Mites were found in a sparrow nest collected from one of the buildings of the State University of Michigan, during the International Congress of Acarology, East Lansing, U.S.A., Aug. 1978. Live specimens isolated from the nest dust material were inoculum for laboratory monocultures of the species. They were kept under controlled conditions: a temperature about 20°C, relative humidity about 85%. Peeled outer skin scales (dandruff) of birds collected from canary nests were used as medium for rearing mites. Biological studies were carried out under the same conditions. Methodological techniques were similar to those used in the case of other related mite species described earlier [7, 8, 9]. An ontogenetic study was based on observations of 400 specimens. Tens adult pregnant females were isolated from mass cultures and placed into cages on food. The next day, freshly deposited one-day-old eggs were picked up from the mothers' cages and put into other cages supplied with some bird skin scales (40 cages x 10 one-day-old eggs). Advances of mite development cycle were observed and registered daily or every second day. Long lives of adult mites and their productivity were examined as follows: resting deutonymphs were taken from cultures and put into cages. After eclosion of adults they were sexed and paired (total 100 pairs). Each pair (female and male) was placed into a separate rearing cage supplied with a small portion of dandruff. The behaviour of mites, their longevity and their laying of eggs were observed every 2-3 days through their whole lives. Newly laid eggs and dead mites were registered and removed.

3. RESULTS AND DISCUSSION

The results of these studies (Table) confirm previous observations of mites, reared on bird dandruff and their acceptance of it as nourishment.

Table. Biological data of *D. evansi* Fain, Hughes et Johnston feeding on bird dandruff at controled conditions: about +20°C, near 85% RH (n – 400 eggs\development\; 100 pairs of adults \longevity, fecundity\)

Parameters	Average	From - to
Life-cycle (days)	53.0	(33-68)
Embryonic development (days)	9.5	(3-24)
Mortality of eggs (%)	17.8	(7-26)
Mortality of all juvenile in stars (%)	74.7	(71-79)
Percentage of females (%)	59.1	(56-66)
Longevity of males (days)	43.0	(14-91)
Longevity of females (days)	45.7	(10-87)
Fecundity per lifetime (eggs)	23.8	(2-72)
Productivity per fecundity day (eggs)	1.4	(1-7)
Oviposition period (days)	17.0	(2-37)
Pre- + postfecundity periods (days)	28.7	(2-68)

Dermatophagoides evansi has strongly developed mouth parts (chelicerae) and is good adapted to this kind of food (Figs.1 and 2).

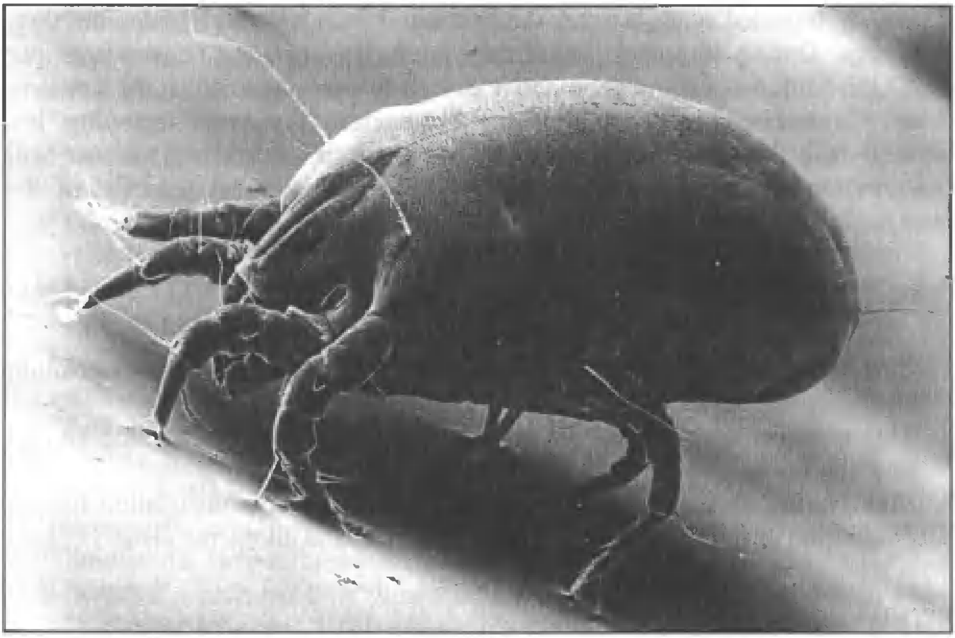

Fig.1. *D. evansi*; material from laboratory culture (W. Chmielewski, Division of Apiculture, Institute of Pomology and Floriculture, Puławy); scanning electron microscopy (photo: M.G. Walzl, Institute of Zoology, University of Vienna)

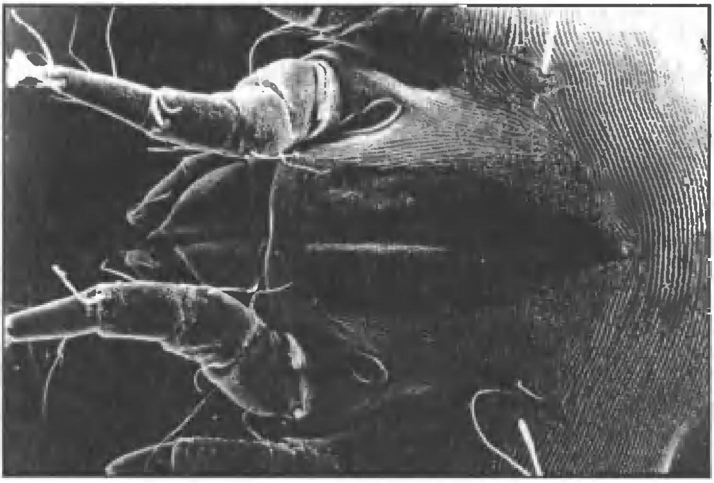

Fig.2. *D. evansi* – female gnathosoma (material: W. Chmielewski; photo: M.G. Walzl)

The sexual behaviour of the species is very characteristic and typical for pyroglyphids. Resting female deutonymphs just before hatching adult females are usually accompanied by adult males. Males are attached to the nymph´s body surface with copulatory succers; just after eclosion of females, adults start to copulate (retroconjugati); copulation is necessary for egg production and usually is repeated many a time. An average 4.7 days later, females lay their first eggs. During fecundity period they produce from one to seven eggs per day. Oviposition is followed by about 24 non fecund days before the female's death. Comparisons of some biological parameters (longevity, fecundity, life history) with the results on other pyroglyphid species, *Hirstia chelidonis* Hull (=*Dermatophagoides passericola* Fain) show that biological potential of the later is slightly higher than *D. evansi* [7].

4. CONCLUSIONS

1. Bird dandruff is attractive nourishment for *D. evansi* securing its oviposition and complete development.
2. This medium might be use for rearing the species under controlled laboratory conditions.
3. Mite rearing by means of this method is worth of recommendation for the production of mites used in acarological studies and allergenic tests.

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DERMATOPHAGOIDES EVANSI FAIN, HUGHES ET JOHNSTON (ACARI, PYROGLYPHIDAE) - BIOLOGIA NA ŁUPIEŻU PTAKÓW

Streszczenie

Dermatophagoides evansi należy do tzw. roztoczy kurzu domowego występujących w pomieszczeniach mieszkalnych i gospodarczych, w gniazdach ptaków synantropijnych, a niekiedy także i pszczół społecznych. Celem badań było poznanie rozwoju, płodności i żywotności tego gatunku w kontrolowanych warunkach, na łupieżu ptaków oraz możliwości zastosowania tego podłoża w hodowli tych roztoczy. Wyjściowy materiał doświadczalny (roztocze dorosłe) pochodził z gniazda wróbli znalezionego w jednym z budynków Uniwersytetu Stanowego w Michigan, a zebrany został przy okazji pobytu autora na Międzynarodowym Kongresie Akarologicznym (East Lansing, USA, 1978). Żywe osobniki wybrane z pyłu gniazdowego wykorzystano do założenia monokultur laboratoryjnych gatunku. Hodowle i doświadczenia biologiczne prowadzono w temperaturze około 20°C, w wilgotności względnej powietrza około 85%; jako pokarm podawano roztoczom martwy, złuszczony naskórek ptasi zbierany w hodowli kanarków. W ich wyniku uzyskano następujące (średnie) dane biologiczne: rozwój zarodkowy – 9.5 dni, pełny cykl rozwojowy – 53.0 dni, śmiertelność naturalna w czasie rozwoju – 74.7%, frekwencja samic – 59.1%, długowieczność osobników dorosłych – 44.3%, płodność samic – 23.8 jaj w ciągu całego życia. Świadczą one o przydatności łupieżu ptaków jako pożywki w hodowli tych roztoczy do doświadczeń i produkcji materiału akarologicznego tą metodą do celów diagnostycznych przy testach alergologicznych.

Słowa kluczowe: Psoroptoidea, Pyroglyphidae, roztocze, biologia, łupież ptasi

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PRELIMINARY STUDIES ON THE INFLUENCE OF FOOD ON THE DEVELOPMENT AND MORPHOLOGY OF *ARCHEGOZETES LONGISETOSUS* AOKI (ACARI, ORIBATIDA) IN LABORATORY CONDITIONS

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Synopsis. The influence of different food on the development and morphology of *Archegozetes longisetosus* in laboratory conditions was studied. Three groups of mites, each consisting of ten freshly moulted females, were kept in the plastic chambers, in controlled climate conditions. Group A was fed algae (*Protococcus* sp.), group B lichens (*Cladonia* sp.) and group C the tree bark (*Prunus padus*). The experiment was continued until all mites of F1 generation became adults. The quality of food affected the time of development, fertility and mortality of mites. In group A the development was the shortest (32.3 days), in group B it was longer (39.8 days) and in group C it was the longest (44.9 days). In group A the fertility of mites was the highest (101.8 mites) and mortality rate the lowest (4.25%) while in groups B and C the fertility was about two times lower and mortality rate was 9.29% and 37.8%, respectively. The influence of different food on some morphological features, such as length and width of the body, length and width of the anal and genital plates, length of sensillus and the setae, and colour of the body, was observed.

Key words: mites, food, time development, morphology

1. INTRODUCTION

Archegozetes longisetosus is a soil saprophagus mite which lives in a tropical climate [1, 2, 5]. It belongs to panphytophages and shows preference to different food. It is known from gut content that in field conditions it mostly fed on fungi and algae, while in the laboratory experiment it accepted moss, decomposed leaves and twigs [7]. In this experiment the influence of algae (*Protococcus* sp.), lichens (*Cladonia* sp.) and tree bark (*Prunus padus* L.) on the development and morphology of *A. longisetosus* in the laboratory conditions was studied.

2. METHODS

Three groups of mites were established for this experiment, each consisted of ten freshly moulted females. Mites were put separately into plastic boxes (2 cm x 7 cm^2), with the bottom filled with a plaster of Paris/charcoal mixture (ratio 9:1) and were kept in controlled climate conditions (temperature 30°C and air humidity 80%). Group A was fed algae (*Protococcus* sp.), group B lichens (*Cladonia* sp.) and group C tree bark (*Prunus padus*). The content of protein, ash and fibre in the foods is given in Table 1.

Table 1. The content of protein, ash, and fibre (in % in dry matter) in the food provided for mites (A - algae, B - lichens, C - tree bark)

Components	A	B	C
Protein	15.51	8.87	4.91
Ash	9.59	5.70	3.61
Fibre	8.52	19.50	14.46

Mites were provided with fresh food every other day, at the same time old food was removed from the boxes and observations concerning the development of the specimens were done. The experiment was continued until all mites of F1 generation became adults. From each group 100 mites were chosen at random, and some of their morphological features were measured: length and width of the body, length and width of the anal and genital plates, length of the sensillus and length of the setae on prodorsum and notogaster. The results were statistically evaluated using the Tukey test.

3. RESULTS

The food quality influenced the time of development of the mites. It was the shortest in group A, fed algae (32.3 days), longer in group B, fed lichens (39.8 days) and the longest in group C, fed tree bark (44.9 days) (Tab.2). This prolonged of development in the groups fed lichens and tree bark, compared to the group fed algae, was especially evident in the active periods of development. For example, in group A the protonymphal stage lasted on average 3.5 days, while in groups B and C it lasted for 4.1 and 6 days, respectively. In group A, the deutonymphal stage lasted on average 2.8 days, and in groups B and C, 5.9 and 6 days. The duration of tritonymphal stage in groups A, B and C was 3.1, 5.7 and 7.2 days, respectively.

Table 2. Average duration of developmental stages, in days (quiescent periods in brackets) and number of mites from one female of *A. longisetosus* in the groups fed: A - algae, B - lichens, C - tree bark

Characteristics	A	B	C
Duration of stages			
Egg	4.7	4.8	5.1
Larvae	5.2 (4.2)	4.8 (3.6)	3.9 (4.2)
Protonymph	3.5 (3.2)	4.1 (3.2)	6.0 (3.5)
Deutonymph	2.8 (3.1)	5.9 (3.9)	6.0 (4.7)
Tritonymph	3.1 (2.5)	5.7 (3.9)	7.2 (4.0)
Total	32.3	39.9	44.6
Mites per 1 female			
Born	101.8	48.4	54.4
Dead (%)	4.2 (4.12%)	4.5 (9.29%)	20.6 (37.87%)
Adults	97.7	43.9	33.8

The quality of food also affected the fertility and mortality of mites, and resulted in different numbers of adults bred from one female. In group A the fertility of females was the highest (101 individuals) and mortality of mites the lowest (4.12%) and the average number of adults bred from one female was 97.7 individuals. In groups B and C the fertility of females was about two times lower than in group A and mortality of mites was much higher (9.29% and 37.87%, respectively) and number of adults in these groups was 43.9 and 33.8, respectively.

The quality of food influenced some morphological features of mites, such as length and width of the body, length and width of the anal and genital plates, length of sensillus and the setae, and the colour of body (Tab.3). Mites fed algae achieved the largest body size (average length and width: 1119 μ and 744 μ); they also had the largest anal and genital plates. Mites fed lichens were smaller (average length and width: 980 μ and 643 μ) and the mites fed tree bark were the smallest (average length and width: 884 μ and 577 μ) The anal and genital plates in those mites were proportionally smaller. The length of some setae also depended on the type of food. It is interesting that the mites from group C, which were the smallest, had he longest most setae (la, c_1, c_2, cp, d_1, d_2, h_2, h_3, p_1), or longer, at least, than mites from group A. Mites from the studied groups differed also in the body colour. Those fed algae were dark brown while those fed lichens were lighter, those fed tree bark were the lightest.

Table 3. Some morphological features of *A. longisetosus* fed: A - algae, B - lichens, C - tree bark; t – calculated between A, B and C

Morphological features		average (μ)			t	
	A	B	C	A-B	A-C	B-C
Body length	1119	980	884	14.5*	19.3*	8.2*
Body width	744	643	577	16.0*	18.3*	7.3*
Length of prodorsum	250	220	194	3.7*	6.9*	3.3*
Length of notogaster	869	761	689	13.8*	19.8*	8.6*
Anal plate length	367	317	280	12.5*	16.7*	7.3*
Anal plate width	89	74	71	8.3*	9.6*	1.7
Genital plate length	205	176	162	13.3*	17.6*	7.4*
Genital plate width	173	143	128	14.1*	20.3*	7.3*
Sensillus length	187	182	182	2.8*	2.2*	-0.1
Setae length: *ro*	134	128	127	3.7*	4.0*	1.1
la	150	153	156	-0.9	-1.8	0.9
in	181	213	212	-7.1*	-7.3*	0.3
c_1	138	141	151	-1.4	-5.0*	-3.7*
c_2	138	141	150	-1.0	-3.9*	-3.6*
c_3	59	57	53	1.5	4.6*	3.4*
cp	143	142	148	0.5	-2.7*	-3.2*
d_1	114	120	129	-3.9*	-9.5*	-4.8*
d_2	104	107	114	-1.5	-6.3*	-4.2*
e_1	93	97	93	-2.2*	0.4	2.8
e_2	91	97	95	-4.5*	-3.4*	1.5
f_2	42	39	40	2.8	2.3	-0.4
h_1	94	102	97	-6.2*	-3.4*	3.4*
h_2	99	108	108	-6.8*	-6.5*	0.0
h_3	92	110	103	-10.8*	-6.7*	4.3*
p_1	103	125	127	-13.6*	-14.1*	-0.9
p_2	113	139	132	-20.1*	-14.5*	3.5*

* Significant differences for p < 0,05

4. DISCUSSION

Algae have been successfully used as the food for oribatid mites by many authors [3, 9, 10]. Sengbush has used *Protococcus* sp. in his laboratory experiments for over 20 years. It is valuable food, rich with protein, vitamins and minerals, and it provided mites with all substances, which are necessary for living. Therefore in this experiment the mites fed algae developed quickly and had high fertility and low mortality.

In the field conditions *A. longisetosus* fed fungi, algae and decomposed leaves [4, 7]. The analyses of gut content showed that this mite avoided wood, although in the laboratory experiment it accepted decomposed twigs. According to Haq [4], starvation may force some animals into accepting unnatural diets. Similarly, in this experiment mites managed to survive on tree bark or lichens, but they were not as successful as those fed algae. This is consistent with Haq's [6] observations, that the type of food evidently influences the development rate of mites; the more nutritious food the shorter the development.

Tree bark and lichens also decreased the fertility of mites, to half of that obtained in the group fed algae. The starvation of the predatory mite *Hypoaspis aculeifer*, Canestrini, which showed a high tolerance to a lack of food, also decreased its fertility [8].

It is interesting that the type of food influenced some morphological features of mites (length and width of their body, length and width of the anal and genital plates, length of sensillus and the setae, colour of the body), which are considered to be diagnostic characters for many species. For example, *A. longisetosus* described by Aoki [1] from Thailand was larger (length 895-973 μ, width 625-675 μ) than that described by Beck [2] from Brazil (length 770-890 μ, width 520-680 μ), but the largest of all were mites fed algae in this experiment. Smaller mites had also smaller genital and anal plates, but some setae were relatively longer, which was observed in the drawings given by Aoki and Beck and in this experiment.

5. CONCLUSIONS

1. The quality of food affected the duration of development of mites; it was the shortest in the group fed algae, longer in the group fed lichens and the longest in the group fed tree bark.
2. The influence of food on the fertility and mortality of mites was observed; the number of adults bred from one female was the highest in the group fed algae and the lowest in the group fed tree bark.
3. The influence of food on such morphological features of mites as length and width of the body, length and width of the anal and genital plates, length of sensillus and the setae, and colour of the body, was observed.

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WSTĘPNE BADANIA NAD WPŁYWEM POKARMU NA ROZWÓJ I MORFOLOGIĘ *ARCHEGOZETES LONGISETOSUS* AOKI (ACARI, ORIBATIDA) W WARUNKACH LABORATORYJNYCH

Streszczenie

Zbadano wpływ różnego rodzaju pokarmu na rozwój i morfologię *A. longisetosus* (Acari, Oribatida) w warunkach laboratoryjnych. Trzy grupy roztoczy, każdą, składającą się z 10 nowo wylęgłych samic, umieszczono w plastikowych komorach, w kontrolowanych warunkach klimatycznych. Grupę A karmiono glonami (*Protococcus* sp.), grupę B porostami (*Cladonia* sp.), a grupę C korą czeremchy (*Prunus padus*). Hodowlę prowadzono do momentu, aż wszystkie roztocze z pokolenia F1 osiągnęły stadium dorosłe. Jakość pokarmu wyraźnie wpłynęła na długość cyklu rozwojowego, płodność i śmiertelność roztoczy. W grupie A rozwój przebiegał najszybciej (32.3 dni), w grupie B trwał 39.9 dni, zaś w grupie C trwał najdłużej (44.6 dni). Zanotowano także różnice w płodności i śmiertelności roztoczy. W grupie A płodność roztoczy była najwyższa (101.8 roztoczy) i wskaźnik śmiertelności najniższy (4.25%), podczas gdy w grupach B i C płodność była dwukrotnie niższa, a wskaźnik śmiertelności wynosił odpowiednio 9.29% i 37.8%. Jakość pokarmu wpłynęła także na niektóre cechy morfologiczne roztoczy, takie jak długość i szerokość ciała, wymiary płytki analnej i genitalnej oraz długość sensillusa i szczecin oraz barwę ciała.

Słowa kluczowe: roztocze, pokarm, czas rozwoju, morfologia

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PRELIMINARY STUDIES ON THE SUCCESSION OF SOIL MITES (ACARI) IN SCOTS PINE FOREST, WITH SPECIFIC ANALYSIS OF ORIBATIDA

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Synopsis. The succession of soil mites in Scots pine forest (plant association *Leucobryo-Pinetum*) was investigated, with specific analysis of Oribatida. This succession was indirectly concluded on the base of 6 Scots pine stands (6-134 years old), which formed different stages of succession of this forest. The density of mites was the lowest in the 6 year-old Scots pine stand and increased to the 79 year-oldie's, while in the 134 year-old stand it decreased, probably due to lower production of forest fall. In mite associations the Oribatida predominated, and the next most abundant were the Actinedida. The species number of Oribatida was the lowest in the 6 year-old Scots pine stand, and increased to the 42 year-olds, along with the increasing number of plant species and thickness of forest litter.

Key words: succession, pine forest, Acari, Oribatida

1. INTRODUCTION

The forest areas in Northern and Central Poland are covered mainly with Scots pine forests planted by men. In these forests Scots 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.

The aim of this investigation was to study the development of soil oribatid mites in the succession of Scots pine forests (plant association *Leucobryo-Pinetum*). On the succession of mites we concluded indirectly on the basis of 6 Scots pine stands (6-134 years old), which formed different stages of succession of this forest.

2. STUDY AREAS

Six Scots pine stands of different ages were chosen in the Zimne Zdroje forest district (inspectorate Osie, Tuchola Forest) for this study. Stands 1-6 of ages 6, 14, 42, 63, 79 and 134 years, respectively, represent different stages of succession of Scots pine forests (plant association *Leucobryo-Pinetum*). In all these stands Scots pine (*Pinus sylvestris* L.) predominated. The crown density of these trees was similar in all stands, while the covering of shrubs slightly increased during the succession (Tab.1).

Table 1. Some characters of plant association and soil mites in Scots pine stands of different ages

Characteristics	Stands					
	I	II	III	IV	V	VI
Age of trees	6	14	42	63	79	134
Density of tree crowns %	60	60	40	50	60	60
Cover of shrubs %	-	-	1	1	5	5
Cover of herbs %	5	20	15	30	30	20
Cover of mosses %	30	90	80	90	90	90
Number of plant species	11	11	19	16	14	18
Density of:						
Acari	10.5	24.3	99.1	203.2	291.1	120.8
Oribatida	8.5	21.9	72.3	163.9	219.3	88.8
Actinedida	0.9	1.2	19.4	30.9	60.4	21.4
Gamasida	1.1	1.2	6.7	7.5	9.2	8.8
Brachychthonius spp.	0.1	1.4	0.5	4.4	30.5	14.8
Liochthonius spp.	0.8	0.1	1.2	1.5	5.2	0.5
Nothrus silvestris Nicolet	-	>0.1	2.2	12.2	6.9	3.7
Oppiella minus Paoli	0.6	13.2	2.4	21.9	36.9	9.6
O. neerlandica Oudemans	2.7	1.2	0.5	0.5	1.4	0.3
O. nova Oudemans	1.8	2.2	20.4	53.3	59.7	19.1
Scheloribates laevigatus C.L.Koch	0.3	0.6	0.1	-	-	-
S. latipes C.L.Koch	0.4	0.1	2.7	2.1	2.2	1.7
Suctobelba spp.	0.3	0.4	10.0	19.6	36.9	15.5
Tectocepheus velatus Michael	>0.1	0.5	19.8	23.8	18.3	11.1
Species number of Oribatida	17	22	33	31	33	32
H for Oribatida	2.07	1.59	2.20	2.15	2.13	2.32

The covering of herbs and mosses increased for 14 years, while in the older stands it did not change much. The number of plant species was the lowest in young Scots pine forests, and increased until 42 years (Tab.1).

The soils belong to the spodic udipsamments soil group. The thickness of the organic layer was the lowest in stand 1 and 2 (2 cm), and increased with the age of trees to 5 cm (stand 3) and 6 cm (the other stands).

3. METHODS

In all investigated plots, samples of 17 cm^2 x 20 cm deep, were taken separately from the organic and mineral horizons, in 20 replicates, in the first ten days of May 1994. Mites were extracted from the material in high gradient Tullgren funnels. The Oribatida were determined to species or genus, including juvenile stages; the other mites were identified to order. The species diversity of Oribatida was characterized with the Shannon *H* index [2].

4. RESULTS

4.1. Density of mites

A total 24.1 thousand mites were extracted. The density of mites was the lowest in the 6 year-old Scots pine forest and increased with the age of trees until 79 years, while in the 134 year-old stand it got distinctly lower (Tab.1). In all investigated stands, Oribatida predominated (73 to 90 % of total Acari), and the next most abundant were Actinedida and Gamasida. Acaridida and Tarsonemida occurred in small densities.

4.2. Species number and structure of oribatid mites

A total 48 taxa of oribatid mites were recorded, and 11 of them were present in all investigated stands. A relatively small number of species lived in the 6 years old Scots pine forest (17 species), and the number of species increased along with the age of trees until 42 years (33 species). In older forests the number of species was similar to the 42 year-old stand .

In the 6 year-old Scots pine forest *Oppiella neerlandica* predominated, and the second most abundant was *O. nova*. In the next succession stage, *O. minus* was the most abundant, while the other species occurred in rather small densities. In older forests (42-134 years old), the most abundant was *O. nova*, and relatively abundant were *Tectocepheus velatus* or the mites from the genera *Suctobelba*.

Interestingly, in young stages of succession (stands 1 and 2), *Scheloribates laevigatus* was present, which is typical for meadows and open areas covered with grasses [3]. In older stages of succession more abundant were *Oppiella* *nova*, *O. minus*, *Tectocepheus velatus* and the mites from the genus *Suctobelba* spp., which are considered to be typical forest species [3, 4]. The *H* index for Oribatida was the lowest in stand 1, and was highest in stand 6.

5. DISCUSSION

During the succession of the Scots pine forest, many factors affect the soil mites, the most important of them seems to be forest litter, which provides the habitat for mites and is eaten by some of them. The thickness of forest litter depends on the amount of forest fall, which generally increases with the height and density of trees. In the investigated stands, the thickness of litter increased to 42 years, which is consistent with Tyszkiewicz and Obmiński [5]. These authors stated that Scots pine trees grow the most intensely for 40 years, and then their growing decreases, and the density of trees gets smaller because of the competition.

In this study, the species number of Oribatida was the lowest in Scots pine stand of 6 year-old, and increased until 42 years, along with the increasing number of plant species and thickness of forest litter. The density of mites increased to 79 years, while in the 134 year-old Scots pine stand it decreased probably due to decreased production of forest fall. The obtained results are partly consistent with those of Niedbała [1], who investigated the succession of oribatid mites in Scots pine forests of 14 and 40 years old in Marcelin near Poznań. He noted that the density and species number of oribatid mites increased with the age of the trees. These forests in Marcelin were planted on arable soil, what resulted in a lower density and different dominance structure of oribatid mites, compared to those in the Tuchola Forest.

6. CONCLUSIONS

1. The density of mites was the lowest in the 6 year-old Scots pine stand and increased until 79 years, while in stand of 134 year-old it decreased, probably due to decreased production of forest fall.
2. In mite associations the Oribatida predominated, and the next most abundant were the Actinedida.
3. The species number of Oribatida was the lowest in the 6 year-old Scots pine stand, and increased until 42 years, along with an increasing number of plant species and thickness of forest litter.

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WSTĘPNE BADANIA NAD SUKCESJĄ ROZTOCZY GLEBOWYCH (ACARI) W BORZE SOSNOWYM, Z GATUNKOWĄ ANALIZĄ MECHOWCÓW (ORIBATIDA)

Streszczenie

Zbadano sukcesję roztoczy glebowych w borze sosnowym (zespół roślinny *Leucobryo-Pinetum*), z gatunkową analizą mechowców. O sukcesji roztoczy wnioskowano na bazie 6 drzewostanów o różnym wieku (6-134 lat), tworzących ciąg sukcesyjny. Liczebność roztoczy była najniższa w 6. letnim młodniku i wzrastała do 79 lat, natomiast w 134. letnim drzewostanie uległa obniżeniu, prawdopodobnie na skutek niższego opadu igliwia. Wśród roztoczy dominowały mechowce, a dalsze z kolei były Actinedida. Liczba gatunków mechowców była najniższa w 6. letnim młodniku i wzrastała do 42 lat, wraz z przyrostem liczby gatunków roślin i miąższości ściółki.

Słowa kluczowe: sukcesja, bór sosnowy, Acari, Oribatida

AKADEMIA TECHNICZNO-ROLNICZA IM. JANA I JĘDRZEJA ŚNIADECKICH
W BYDGOSZCZY
ZESZYTY NAUKOWE NR 214 - OCHRONA ŚRODOWISKA 2 (1998) 187-194

TRICHORIBATES TRIMACULATUS (C.L. KOCH) AS A MOSS MITE (ACARI, ORIBATIDA) WHICH TOLERATES INDUSTRIAL POLLUTION

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Synopsis. The populations of *Trichoribates trimaculatus* in young Scots pine forests polluted by 7 large factories were investigated. The concentration of pollution in epiphytes and Scots pine bark in the investigated regions was the lowest in the control plots and usually increased in the direction of the pollution sources. The densities of *T. trimaculatus* were higher near the pollution source than in the control plots, which suggests that this species tolerated air pollution. It was the most abundant in the lower part of Scots pine stems.

Key words: industrial pollution, Scots pine forest, *Trichoribates trimaculatus*, Acari, Oribatida

1. INTRODUCTION

In the previous papers [1, 9-15, 20, 21] the bioindicative reaction of arboreal mites to different kinds of industrial air pollution in Scots pine forests were investigated. Most oribatid species were sensitive to this pollution, but some tolerated them. The most tolerant to air pollution was *Trichoribates trimaculatus*, which achieved in polluted areas higher densities than in the control plots [1-8, 20, 21].

The aim of this paper was to compare the densities of *T. trimaculatus* in young Scots pine forests polluted by 7 large factories to those in the control plots.

2. STUDY AREAS

The investigated plots were situated in young Scots pine forests, which were under the influence of air pollution produced by 7 large factories, which emitted different kinds of air pollution. The following factories were considered: the "Polchem", "Wistom", "Luboń" and "Police" chemical factories; the

"Włocławek" nitrogen fertilizer factory; the "Kujawy" cement and lime factory, and the "Głogów" and copper smelting works (Fig.1).

Fig.1. The locations of investigated areas in Poland

Air pollution produced by all these factories was rich in sulphur dioxide, and contained other pollutants specific to factories. The "Głogów" copper smelting works, produced carbon oxide and dust, which was rich in heavy metals, especially copper and lead. The "Luboń" chemical factory, produced fluoride and dust (rich in phosphorus), the "Wistom" chemical factory, produced carbon disulphide and sulphur hydrogen. The "Police" chemical factory, and nitrogen fertilizer factory, produced nitrogen compounds, while the "Włocławek" chemical factory, produced nitrogen compounds, dust of Norway saltpetre and vinyl chloride. The "Kujawy" cement and lime factory, produced calcium compounds.

The investigated forests usually represented plant association *Leucobryo-Pinetum*, in which Scots pine (*Pinus sylvestris* L.) predominated. The exception was region polluted by the "Kujawy" cement and lime factory, where the soil was more fertile and all investigated young Scots pine forests formed plant class *Vaccinio-Piceetea*. The soils belong to the spodic udipsamments soil group, with well develop forest litter. More detailed characterizations of the study areas has been given earlier [9-15].

3. MATERIAL AND METHODS

In each investigated region, 3 plots polluted by the factory (plots 1-3) and a control plot (plot 4) were chosen in 20 year old Scots pine forests. Plots 1, 2 and 3 were situated in areas, which were damaged by air pollution to different degrees; this degree increased in the direction of the pollution source.

In every investigated region, the mites were sampled from the trees in the first week of May and October, during two successive years, between 1990 and 1993. In each plot, samples of 1 dm^2 in area were taken from 3 vertical sections of Scots pine stems: lower (10 cm above the soil), middle and upper (above the third terminal whorl of branches), in 10 replicates. Each sample included tree bark with epiphytes around the stem. The percentage of covering epiphytes was assessed, and then the mites were collected together with epiphytes by scraping. Mites were extracted from the material in high gradient Tullgren funnels. The whole population of *Trichoribates trimaculatus* was determined, including juvenile stages. Nearly 4100 mites were investigated.

The concentration of pollutants was determined in epiphytes collected from the section of stems between 110-150 cm above the soil. The concentration of total sulphur in pooled samples was measured using the nephelometry method, while other pollutants were measured using the AAS (copper, lead and calcium), colorimetric (phosphorus and ammonium) and the spectrophotometry (fluoride) methods. A more detailed description of methods has been given earlier [9-15]. In statistical calculations the Tukey test was used.

4. RESULTS

4.1. Species composition of epiphytes and cover

The Scots pine trunks were covered with algae and lichens. In some polluted regions (the "Polchem" and "Wistom" chemical factories, the "Głogów" copper smelting works), the covering of lichens was large. In the regions of the "Włocławek" nitrogen fertilizer factory and the "Police" chemical factory it was medium, while in the other polluted regions (the "Kujawy" cement and lime factory, the "Luboń" chemical factory) it was small (Tab.1). In plot situated nearest the "Kujawy" cement and lime factory and the "Police" chemical factory lichens were absent. The covering of algae generally increased as the covering of lichens decreased.

Table 1. Epiphyte cover (in %) on Scots pine stems polluted by different factories, and in the control plots

Factory	Epiphytes	Plot			
		1	2	3	4
"Polchem" chemical factory	Lichens	25.7	30.8	23.3	24.0
	Algae	22.3	25.1	28.4	29.4
"Wistom" chemical factory	Lichens	26.7	28.0	19.4	23.5
	Algae	34.8	33.4	32.4	30.1
"Luboń" chemical factory	Lichens	15.9	16.5	16.7	18.6
	Algae	33.8	46.8	39.2	34.7
"Włocławek" nitrogen fertilizer factory	Lichens	5.2	32.3	25.9	18.2
	Algae	57.2	41.2	35.0	29.8
"Police" chemical factory	Lichens		19.8	26.3	24.5
	Algae	70.6	44.2	32.5	24.8
"Kujawy" cement and lime factory	Lichens		7.7	9.5	9.5
	Algae	35.9	37.5	44.2	30.6
"Głogów" copper smelting works	Lichens	17.4	27.0	24.9	27.0
	Algae	39.7	32.3	37.7	34.5

4.2. Concentration of pollutants in epiphytes

The concentration of pollution in epiphytes was usually the highest near the pollution source, and it decreased in the direction of the control plots (Tab.2).

Table 2. Concentration of pollutants in epiphytes in ppm

Factory	Pollution	Plot			
		1	2	3	4
"Polchem" chemical factory	Sulphur	2995	2845	2160	1360
"Wistom" chemical factory	Sulphur	4040	3395	3305	2845
"Luboń" chemical factory	Sulphur	2645	2875	2105	1850
	Phosphorus	1064	935	934	794
	Fluorine	183	145	110	94
"Włocławek" nitrogen fertilizer factory	Sulphur	2695	2710	2745	2375
	Ammonium nitrogen	2023	428	103	92
"Police" chemical factory	Sulphur	3450	2600	2685	1960
	Ammonium nitrogen	1661	1046	996	350
"Kujawy" cement and lime factory	Sulphur	4080	2780	2450	2685
	Calcium	34199	9650	2843	1782
"Głogów" copper smelting works	Sulphur	3090	2015	2455	1710
	Copper	807	237	143	34
	Lead	668	213	141	66

These plants accumulated sulphur and other pollutants, which depended on production. Near the "Głogów" copper smelting works they also accumulated copper and lead, near the "Kujawy" lime factory - calcium, near the "Luboń" chemical factory - phosphorus and fluoride, and near the "Włocławek" nitrogen fertilizer factory and the "Police" chemical factory - ammonium nitrate.

4.3. Density of *Trichoribates trimaculatus*

The density of *Trichoribates trimaculatus* in the investigated regions was usually the highest near the pollution source, and decreased in the direction of the control plot (Tab.3).

Table 3. Abundance (*A* in indiv./1dm^2) dominance (*D*) and constancy (*C*) indices of *T. trimaculatus* on Scots pine stems polluted by different factories and in the control plots. Significance level (*) p = 0.05

Factory	Index	Plot 1	Plot 2	Plot 3	Plot 4
"Polchem" chemical factory	*A*	3.03	3.75	1.30	2.15
	D	36.1	29.7	13.5	9.6
	C	68.3	49.2	42.5	49.2
"Wistom" chemical factory	*A*	1.17*	0.05*	0.14	0.48
	D	26.6	1.3	2.4	5.6
	C	57.5	5.0	10.8	25.0
"Luboń" chemical factory	*A*	3.98*	0.03	0.02	0.02
	D	82.1	<1.0	<1.0	<1.0
	C	90.0	1.7	1.7	1.7
"Włocławek" nitrogen fertilizer factory	*A*	4.24*	0.87	1.37*	0.02
	D	54.2	8.7	13.4	<1.0
	C	83.3	44.2	49.2	0.8
"Police" chemical factory	*A*	2.31*	0.04	0.01	0.02
	D	34.4	<1.0	<1.0	<1.0
	C	65.8	0.8	0.8	1.7
"Kujawy" cement and lime factory	*A*	1.59*	5.61*	0.13	0.19
	D	36.1	65.2	2.0	1.9
	C	53.3	70.0	10.8	10.8
"Głogów" copper smelting works	*A*		0.65	0.04*	0.53
	D		16.2	<1.0	8.5
	C		25.0	2.5	21.7

In the highly polluted plots the densities of *T. trimaculatus* were usually significantly higher than those in the control plots what indicates that this species tolerates air pollution. It usually predominated in arboreal oribatid mite associations, except the "Głogów" copper smelting works, where *Cultroribula juncta* (Michael) was more abundant. The dominance and constancy indices of

T. trimaculatus were usually high, with the highest values near the "Luboń" chemical factory (*D* = 82, *C* = 90).

In all investigated Scots pine forests, *T. trimaculatus* was the most abundant in the lower part of Scots pine stems, and its density decreased higher up. In the lower sections 42% of total population occurred, while in middle and upper sections only 33% and 25% of population was present. This species was represented in similar proportions by juvenile stages and adults.

5. DISCUSSION

Trichoribates trimaculatus is considered as a typical arboreal species [17, 19, 21]. It was recorded from trees, shrubs and rocks covered with shrubs. Among trees it inhabited Scots pine, spruce, oak, linden and apple trees. It was abundant in higher sections of trees: in the section of oak between 7.5-15 m [18], and in spruce, 14 m above the soil [17]. This species was also abundant on young Scots pine, larch and spruce trees in plant association *Leucobryo-Pinetum claudonietosum* [19] and on linden [22] and apple trees [16].

Trichoribates trimaculatus accepts as food both algae and lichens, and therefore achieved high densities in many highly contaminated Scots pine forests. This species predominated on trees both covered with lichens (the "Wistom" chemical factory) and covered with algae (the "Police" chemical factory). The tolerance of this species to air pollution was earlier announced from birch trees and juniper in old Scots pine forests polluted by the "Włocławek" nitrogen fertilizer factory [1, 20].

6. CONCLUSIONS

1. The concentration of pollution in epiphytes was usually the lower in the control plots and increased in the direction of the pollution sources.
2. *Trichoribates trimaculatus* tolerated industrial air pollution, achieving in polluted plots higher densities than in the control plots.
3. *Trichoribates trimaculatus* was the most abundant in the lower part of Scots pine stems.

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TRICHORIBATES TRIMACULATUS (C.L. KOCH) JAKO MECHOWIEC (ACARI, ORIBATIDA) TOLERUJĄCY ZANIECZYSZCZENIA PRZEMYSŁOWE

Streszczenie

Zbadano rozmieszczenie mechowca *Trichoribates trimaculatus* na strzałach sosny, w około 20-letnich młodnikach sosnowych, w okolicy 7 dużych zakładów przemysłowych. Wraz ze zbliżaniem się do zakładów w epifitach stwierdzono większe stężenie zanieczyszczeń. *T. trimaculatus* tolerował zanieczyszczenia przemysłowe. Najwięcej osobników tego gatunku odnotowano w sekcji dolnej strzał.

Słowa kluczowe: zanieczyszczenia przemysłowe, młodniki sosnowe, *Trichoribates trimaculatus*, Acari, Oribatida

AKADEMIA TECHNICZNO-ROLNICZA IM. JANA I JĘDRZEJA ŚNIADECKICH
W BYDGOSZCZY
ZESZYTY NAUKOWE NR 214 – OCHRONA ŚRODOWISKA 2 (1998) 195-202

ARBOREAL MITES (ACARI) ASSOCIATED WITH YOUNG SCOTS PINE FORESTS POLLUTED BY THE "WISTOM" CHEMICAL FACTORY, POLAND

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Synopsis. The influence of sulphur pollution, with a large amount of SO_2 and CS_2, on arboreal mites in approximately 20 year-old Scots pine forests (plant association *Leucobryo-Pinetum*), was investigated. The concentration of sulphur in Scots pine bark and epiphytes was the lowest in the control plot and increased towards the pollution source. In polluted plots, the densities of total Acari and Oribatida were significantly lower than in the control plot, while Gamasida tolerated sulphur pollution. In highly and medium polluted plots, the species number of oribatid mites was lower than in the less polluted plot and the control plot. Among oribatid mites, *Carabodes labyrinthicus* and *Diapterobates humeralis* were sensitive to sulphur pollutants, while *Trichoribates trimaculatus* tolerated them.

Key words: sulphur pollution, Scots pine forest, bioindicators, Acari, Oribatida

1. INTRODUCTION

The "Wistom" chemical factory produces sulphur pollution, with a large amount of SO_2 and CS_2. These compounds are toxic to organisms [3, 4, 9], causing damage in ecosystems similarly such as acid rain. In forest ecosystems, acid rain decreases the growth of trees and epiphytes, which are important for arboreal mites. It also influences the pH of tree bark and epiphytes, and, therefore, affects the density and species composition of arboreal mites.

The aim of this research was to document how sulphur pollution, produced by the "Wistom" chemical factory, affected epiphytes and arboreal mites in approximately 20 year-old Scots pine forests.

2. STUDY AREAS

Three polluted plots were chosen at distances of 1.0 km (plot 1), 3.8 km (plot 2) and 9.0 km (plot 3) from the pollution source, and a control plot (4) was chosen 14.0 km from this source (Fig. 1).

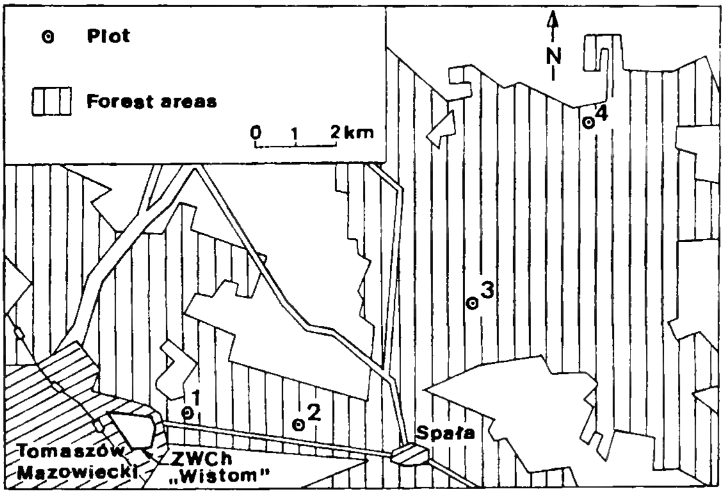

Fig. 1. Situation sketch of investigated plots

The polluted plots were damaged by air pollution to different degrees; this degree increased from plot 3 to plot 1. The investigated forests represented the plant association *Leucobryo-Pinetum*, in which Scots pine (*Pinus sylvestris* L.) predominated, with scarce birch (*Betula pendula* Roth), oak (*Quercus petraea* Liebl. and *Q. robur* L.), mountain-ash (*Sorbus aucuparia* L.), dewberry (*Rubus caesius* L.), alder buckthorn (*Frangula alnus* L.) and juniper (*Juniperus communis* L.). In the control plot and in plot 3, herb and moss layers were well developed, and the covering of plants on the forest floor decreased in the direction of the pollution source. A more detailed characterization of the studied areas has been given earlier [1].

3. METHODS

The mites and epiphytes were investigated in the above plots during the spring and autumn of 1991 and 1992. Samples of 1 dm^2 in area were taken from 3 vertical sections of Scots pine stems: lower, middle and upper section, in 10 replicates. The covering of epiphytes was assessed, and then the mites were scraped together with epiphytes. Mites were extracted from the material in high gradient Tullgren funnels. Nearly 4.9 thousand mites were investigated.

We determined the Oribatida to species or genus, including juvenile stages; the other mites were identified to order. The species diversity of Oribatida was characterized by the Shannon *H* index [5]. In statistical calculations the Tukey test was used.

The concentration of sulphur was determined in the Scots pine bark and epiphytes collected from the middle of the trees. Pooled samples were mineralized, and the total sulphur was measured using the nephelometry method.

4. RESULTS

4.1. Species composition of epiphytes and cover

Epiphytes formed one species of algae, *Chlorococcum infusionum* (Schrank) Menegh., and two species of lichens: *Lecanora conizaeoides* Nyl. ex Cromb. and *Scoliciosporum chlorococcum* (Stenham.) Vezda. In all plots algae covered a larger surface than lichens. In plots 1 and 2, situated near the pollution source, the covering of epiphytes was higher (62% of surface) than in distant plot 3 and the control plot (52-54% of surface) (Fig.2).

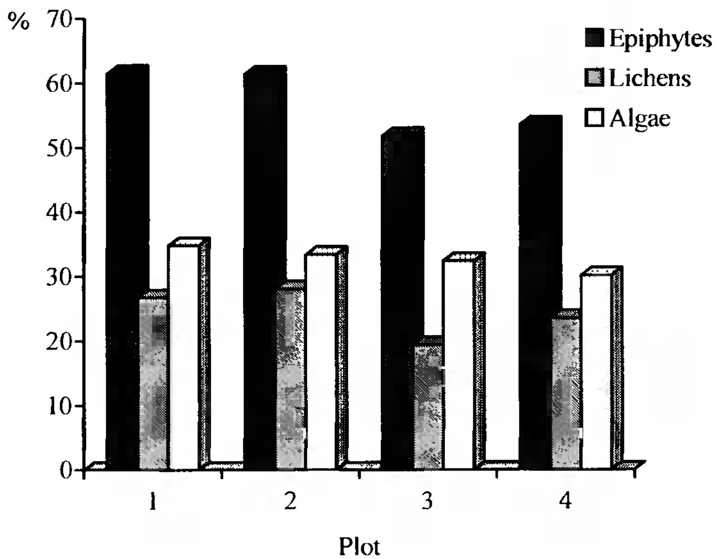

Fig.2. Epiphyte cover on Scots pine stems in the region polluted by the "Wistom" chemical factory

Among lichens, *Lecanora conizaeoides* was more sensitive to air pollution than *Scoliciosporum chlorococcum*. In polluted plots, the thallus of the former species was damaged, probably by sulphur pollution, infected by fungi, and sometimes covered by *S. chlorococcum*.

4.2. Concentration of sulphur in Scots pine bark and epiphytes

The concentration of sulphur in epiphytes and tree bark was lowest in the control plot, and increased in the direction of pollution source (Fig.3).

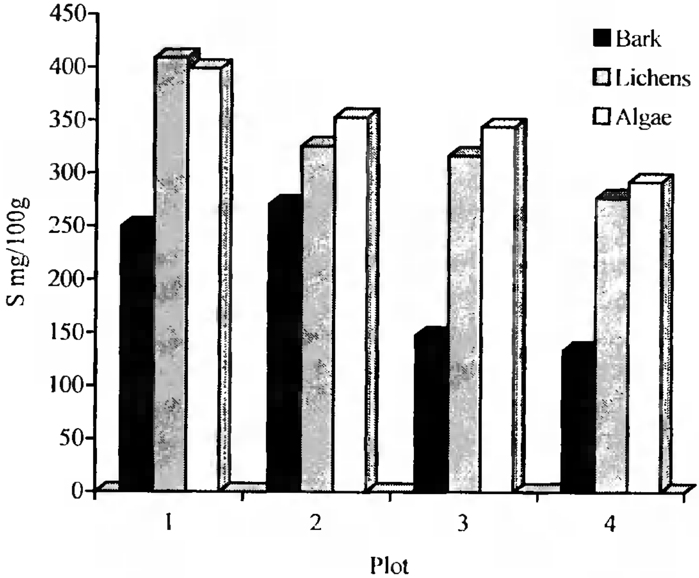

Fig.3. Concentration of sulphur in Scots pine bark and epiphytes in the region polluted by the "Wistom" chemical factory

The concentration was generally higher in epiphytes than in the tree bark, but the increase of concentration was higher in the tree bark than in epiphytes. For example, in plot 1, situated nearest the pollution source, the sulphur concentration was 1.9 times higher in the tree bark and 1.4 times higher in epiphytes, compared to the control plot. In plot 2, the concentration was respectively 2.0 times and 1.2 times higher than in the control plot.

4.3. Density of mites

In all polluted plots, the density of mites was significantly lower than in the control plot (Tab.1). The density was the lowest in plot 2, mainly due to the Oribatida which predominated, and the density of which was reduced to 46% of that in the control plot. In plots 1 and 3, the density of mites was reduced to about 2/3 of that in the control plot. Second most abundant were Actinedida, while Gamasida occurred in small numbers.

Table 1. Some features of arboreal mites in young Scots pine forests polluted by the "Wistom" chemical factory (plots 1-3), and the control plot (4). Abundance in indiv./1dm^2

Characteristics	Plots			
	1	2	3	4
Acari	9.00*	7.96*	9.78*	13.88
Actinedida	3.55	3.23	3.29	4.49
Gamasida	1.04	0.70	0.54	0.68
Oribatida	4.34*	3.96*	5.85*	8.54
C. labyrinthicus (Michael)	0.08*	0.69	0.71	1.26
D. humeralis (Hermann)	0.30*	0.01*	1.32*	2.28
M. brevipes (Michael)	0.47*	0.94	0.35*	1.67
T. trimaculatus (C.L. Koch)	1.17*	0.05*	0.14	0.48
Z. exilis (Nicolet)	1.05	1.05	1.10	1.14
Others Oribatida #	1.27	1.22	2.23	1.71
Species Oribatida	20	20	26	26
H of Oribatida	2.06	1.99	2.44	2.15

* Significance level p = 0.05

Adoristes ovatus (C.L. Koch) (2,4), *Brachychthonius* sp. (1,3), *Camisia biurus* (C.L. Koch) (1,2,3,4), *C. horrida* (Hermann) (1,3), *C. segnis* (Hermann) (1,3,4), *C. spinifer* (C.L. Koch) (3,4), *C. marginatus* (Michael) (4), *C. minusculus* Berlese (3), *C. subarcticus* Trägårdh (2,3,4), *Chamobates schuetzi* (Oudemans) (1,2,4), *Cultroribula juncta* (Michael) (1,2,3,4), *Cymbaeremaeus cymba* (Nicolet) (1,2,3,4), *Damaeus* sp. (2,3,4), *Dometorina plantivaga* (Berlese) (1,3), *Eporibatula rauschenensis* (Sellnick) (2,3,4), *Eremaeus oblongus* C.L. Koch (1,2,3,4), *Eupelops acromios* (Hermann) (1,2,3,4), *Licneremaeus licnophorus* (Michael) (1,3,4), *Liebstadia humerata* Sellnick (3), *L. similis* (Michael) (1,2,4), *Liodes theleproctus* (Hermann) (4), *Metabelba pulverulenta* C.L. Koch (2,3), *Oppiella nova* (Oudemans) (1,3), *Oribatula tibialis* (Nicolet) (4), *Scheloribates laevigatus* (C.L. Koch) (2,4), *S. latipes* (C.L. Koch) (1,2,3,4), *Suctobelba* sp. (3,4), *Tectocepheus velatus* (Michael) (1,2,3,4)

4.4. Species number of oribatid mites and the density of some populations of these mites

In plots 1 and 2, situated near the pollution source, the species number of Oribatida was lower, while in the more distant plot 3 it was similar to that of the control plot (Tab.1). In more polluted plots, 1 and 2, the Shannon *H* index for Oribatida was lower than in plot 3 and in the control plot.

In the most polluted plot 1, *Trichoribates trimaculatus* predominated, and *Zygoribatula exilis* was abundant; the latter species was also abundant in more distant plot 2. In plot 3 and in the control plot, *Diapterobates humeralis* was the most abundant, and *Carabodes labyrinthicus*, *Micreremus brevipes*, and *Zygoribatula exilis* were relatively abundant.

In the highly polluted plot 1, the density of *Trichoribates trimaculatus* was significantly lower than in the control plot, and, therefore, this species is considered to be tolerant to sulphur pollution. In contrast, some other species like *Carabodes labyrinthicus*, *Diapterobates humeralis* and *Micreremus brevipes*, had in plot 1 significantly lower density than in the control plot, so were considered to be sensitive to sulphur pollutants.

5. DISCUSSION

The effect of SO_2 pollution on arboreal mites was discussed in several papers. Kehl and Weigmann [2] and Weigmann and Jung [8] studied the arboreal oribatid mites in different zones of Berlin polluted by various levels of SO_2. In highly polluted areas, the density of mites was reduced, but in medium polluted areas it sometimes increased, compared to other plots. These authors found a negative correlation between the number of oribatid species and the concentration of SO_2. Similar results were obtained by Seniczak and Dąbrowski [7] in young Scots pine forests polluted by the "Polchem" chemical factory in Toruń, with a high amount of SO_2. In the polluted plots, the density of arboreal mites and species number of Oribatida and Gamasida were also lower than in the control plot.

The effect of air pollution produced by the "Wistom" chemical factory on arboreal mites in young Scots pine forests was generally similar to the results reported above. In all polluted plots, the density of mites was significantly reduced, compared to the control plot, and the reduction concerned mainly Oribatida, which predominated. The Gamasida tolerated sulphur pollution and their densities in the most polluted plot were statistically insignificant, compared to the control plot.

In young Scots pine forests polluted by the "Wistom" chemical factory, some species like *Carabodes labyrinthicus* and *Diapterobates humeralis* were sensitive to sulphur pollution, while *Trichoribates trimaculatus* tolerated it. All these species are considered typical arboreal species [6]. They reacted similarly to sulphur pollution produced by the "Polchem" chemical factory in Toruń [7], although the concentration of sulphur near the "Wistom" factory was about 1/3 higher than near the "Polchem" factory.

6. CONCLUSIONS

1. The concentration of sulphur in Scots pine bark and epiphytes was the lowest in the control plot, and increased towards the pollution source.
2. In polluted plots the density of mites was significantly lower, compared to the control plot, mainly due to the Oribatida which predominated and were sensitive to sulphur pollution.

3. Sulphur pollution reduced the species number of Oribatida.
4. Among oribatid mites, *Carabodes labyrinthicus* and *Diapterobates humeralis* were sensitive to sulphur pollutants, while *Trichoribates trimaculatus* tolerated them.

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ROZTOCZE EPIFITOCENOZ MŁODNIKÓW SOSNOWYCH W REJONIE ODDZIAŁYWANIA ZAKŁADÓW WŁÓKIEN CHEMICZNYCH "WISTOM"

Streszczenie

Analizowano akarofaunę nadrzewną w około dwudziestoletnich młodnikach sosnowych w okolicy Zakładów Włókien Chemicznych "Wistom" emitujących do atmosfery duże ilość związków siarki. Wraz ze zbliżaniem się do zakładów zawartość siarki w korze sosny i epifitach wzrastała. Na powierzchniach silnie zanieczyszczonych stwierdzono wyraźny spadek liczebności roztoczy, w tym głównie Oribatida oraz mniejszą liczbę gatunków w porównaniu z powierzchnią kontrolną. Zanieczyszczenia emitowane przez te zakłady spowodowały wyraźny spadek liczebności *Carabodes labyrinthicus* i *Diapterobates humeralis*, a tolerował je *Trichoribates trimaculatus*.

Słowa kluczowe: zanieczyszczenia siarkowe, młodniki sosnowe, bioindykatory, Acari, Oribatida

AKADEMIA TECHNICZNO-ROLNICZA IM. JANA I JĘDRZEJA ŚNIADECKICH
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ZESZYTY NAUKOWE NR 214 - OCHRONA ŚRODOWISKA 2 (1998) 203-206

SOIL GAMASIDA (ACARI) ASSOCIATED WITH YOUNG SCOTS PINE FORESTS POLLUTED BY THE "WISTOM" CHEMICAL FACTORY

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Synopsis. The soil gamasid mites in three young Scots pine forests (*Leucobryo-Pinetum* plant association), polluted by the "Wistom" chemical factory, and in the control plot, were investigated. The concentration of sulphur pollution in these forests increased towards the pollution source. In the most polluted plot, the density, species diversity and species number of Gamasida were lower than in the control area. The pollution affected also the dominance structure of mites. In the control plot, *Zercon peltatus* predominated, while in plots 2 and 3 *Pergamasus runciger* was the most abundant. On the contrary, the strongly polluted plot 1 was predominated by *Rhodacarus coronatus*. Some gamasid mites (*Zercon peltatus* and *Pergamasus misellus*) were sensitive to these pollutants, while *Rhodacarus coronatus* tolerated them. Some species (*Eviphis ostrinus* and *Pergamasus runciger*) were sensitive to a high concentration of sulphur, but tolerated small concentrations.

Key words: pine forest, sulphur pollution, Acari, Gamasida

1. INTRODUCTION

The earlier papers referring to this problem [1, 5] presented the reactions of epiphytes and arboreal and soil mites in young Scots pine forests to pollution emitted by the "Wistom" chemical factory. The concentration of sulphur in the soil increased in the direction of the pollution source. In strongly polluted areas, both the density and species number of Oribatida were significantly lower, compared to the control area.

In this research the soil Gamasida in the same young Scots pine forests, were investigated. All these forests represented plant association *Leucobryo-Pinetum*. More details concerning the study areas have been given earlier [5].

2. MATERIAL AND METHODS

Three young Scots pine forests polluted by the "Wistom" chemical factory, and a control plot, were investigated during the spring and autumn of 1991 and 1992. These forests were situated at distances of 1.0 km (plot 1), 3.8 km (plot 2), 9.0 km (plot 3) and 14.0 km (4 - control plot) from the pollution source. Soil samples were taken from areas covered with dead needles in the way described by Klimek and Seniczak [5].

3. RESULTS AND DISCUSSION

A high concentration of sulphur in the soil significantly reduced the density of mites in young Scots pine forests to about one half of that in the control plot and this reduction also concerned the Gamasida (Tab.1). The pollution also caused changes in the dominance structure of Gamasida. The greatest number of gamasid species occurred in the control area, and here the Shannon's index reached the highest value. The total density, species diversity and species number of Gamasida decreased towards the pollution source, as it did in the saprophagous Oribatida [5].

Table 1. Density (A) of some mites, the H' and J indices and the species number of Gamasida (S) in young Scots pine forest polluted by the "Wistom" chemical factory (plots 1-3) and in the control plot (plot 4). Abundance in thousand indiv./m^2; * significance at p = 0.05

	Characteristics	Plots			
		1	2	3	4
A of:	Acari	89.01*	117.69*	130.22*	162.74
	Gamasida	2.81*	4.97	8.21	7.12
	Zercon peltatus	0.01*	0.44*	1.68	1.63
	Pergamasus misellus	0.10*	0.19*	0.29	0.62
	Rhodacarus coronatus	1.41*	0.36	0.41	0.46
	Pergamasus runciger	0.20	1.09	1.81*	0.93
	Eviphis ostrinus	-	0.14	0.60*	0.15
H'		1.68	2.37	2.39	2.59
J'		0.64	0.81	0.75	0.79
S		14	19	24	26

In the plot strongly polluted by sulphur, *Rhodacarus coronatus* Berlese predominated as a superdominant (Tab.2), and its density was significantly higher than that in the control plot (Tab.1). Therefore, we consider this species as tolerant to sulphur pollution. It also tolerated nitrogen pollution [4] and heavy metals [3]. A high dominance index of *R. coronatus* in the plot strongly polluted by sulphur, low species diversity and a small number of species of Gamasida indicate, according to the biocenotic principles of Thienemann [6] that this area is in the process of degradation. A similar trend was observed in young Scots pine forests polluted by heavy metals [3] and nitrogen compounds [4].

In areas contaminated with a medium levels of sulphur (plots 2 and 3), the most numerous was *Pergamasus runciger* Berlese, while the other species, except for *Veigaia nemorensis* (C.L. Koch), *Prozercon kochi* Sellnick, *Eviphis ostrinus* (C.L. Koch), *Zercon peltatus* (C.L. Koch) and *Z. triangularis* (C.L. Koch), occurred in small numbers.

Table 2. The dominance structure of gamasid species in young Scots pine forests polluted by the "Wistom" chemical factory (plots 1-3), and the control plot, prepared on the base of dominance index

	Plot 1		Plot 2		Plot 3		Control plot	
Sp	*R. coronatus*	50.3						
Ed			*P. runciger*	21.9	*P. runciger* *Z. peltatus*	22.0 20.5	*Z. peltatus*	22.9
Do	*V. nemorensis*	19.1	*V. nemorensis* *Z. triangularis* *P. kochi*	17.6 10.5 10.1	*Z. triangularis* *V. nemorensis*	11.4 11.0	*P. runciger* *V. nemorensis*	13.0 11.4
Sd	2 species		3 species		2 species		3 species	
Re	4 species		6 species		7 species		10 species	
Sr	6 species		6 species		11 species		10 species	

Explanation: Sp - superdominants, Ed - eudominants, Do - dominants, Sd – subdominants, Re - recedents, Sr - subrecedents

In the control area, *Zercon peltatus* predominated as an eudominant. This species was also abundant in the distant plot 3, but in plots 1 and 2, situated near the pollution source, it was significantly reduced, compared to the control plot. A similar reaction to sulphur pollution showed *Pergamasus misellus* Berlese, so we consider these two species as sensitive to sulphur pollution. *Zercon peltatus* was also sensitive to phosphorus-fluorine pollution [2] and heavy metals [3].

4. CONCLUSION

1. A high concentration of sulphur pollution in young Scots pine forests reduced the density, species diversity and the species number of Gamasida.
2. Some gamasid species (*Zercon peltatus* and *Pergamasus misellus*) were sensitive to sulphur pollution, *Rhodacarus coronatus* tolerated it, while *Pergamasus runciger* and *Eviphis ostrinus* were sensitive to a high concentration, but tolerated small concentrations of this pollution.

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GLEBOWE GAMASIDA (ACARI) MŁODNIKÓW SOSNOWYCH ZANIECZYSZCZONYCH PRZEZ ZAKŁADY WŁÓKIEN CHEMICZNYCH „WISTOM"

Streszczenie

W pracy przedstawiono reakcję glebowych Gamasida (Acari) w młodnikach sosnowych, sklasyfikowanych do zespołu roślinnego *Leucobryo-Pinetum* i będących pod wpływem zanieczyszczeń emitowanych przez Zakłady Włókien Chemicznych „Wistom". Wraz ze wzrostem stężenia związków siarki w glebie w kierunku Zakładów, zanotowano obniżanie się liczebności, liczby gatunków i różnorodności gatunkowej Gamasida, a także zmiany w strukturze dominacji gatunków. Na silnie skażonej powierzchni 1 w klasie superdominantów wystąpił *Rhodacarus coronatus*, powierzchnie mniej skażone zdominował *Pergamasus runciger*, natomiast na stanowisku kontrolnym najliczniejszy był *Zercon peltatus*. Niektóre gatunki (*Zercon peltatus* i *Pergamasus misellus*) były wrażliwe na zanieczyszczenia siarkowe, *Rhodacarus coronatus* je tolerował, natomiast *Pergamasus runciger* i *Eviphis ostrinus* tolerowały średnie i małe stężenia, lecz były wrażliwe na wysokie stężenie tych zanieczyszczeń.

Słowa kluczowe: bór sosnowy, zanieczyszczenia siarkowe, Acari, Gamasida

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SOIL GAMASID MITES (ACARI) SETTLING IN THE FOREST LITTER ON THE NATURE RESERVE AREA IN MT. JUMBONG, SOUTH KOREA *

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Synopsis. Studies were carried out in the species composition and the number of soil gamasid mites in the forest litter placed into the soil in the natural deciduous stand in the in Mt. Jumbong Reserve Area. The investigated samples were occupied by 52 species of gamasid mites. Intensive settlement of the forest litter by these mites was recorded in the autumn periods and it decreased in spring and summer. In these periods, the forest litter was penetrated by a small number of species, and the diversity of these group of mites expressed by Shannon's index reached the lowest values. In the successive periods of the growing season, there followed great changes in the structure of species domination. A high number and domination of *Asca aphidioides* and *Holaspina ochraceus* were found in autumn, while in spring and summer these indices decreased. On the other hand, an increase of the number in the spring and summer periods was observed by *Parasitus* sp. 1, *Hypoaspis vacua*, *Asca sculptrata*, *Veigaia tibbetsi* and *Zercon szeptyckii*. The χ^2 analysis revealed a positive connection of *Asca sculptrata*, *Lasioseius* sp. 1, and *Dendrolaelaps fukikoae* with the microhabitat of the south-facing slope, while *Parasitus* sp. 1 was connected with the microhabitat of the north-facing slope.

Key words: Mt. Jumbong, forest litter, Acari, Gamasida

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1. INTRODUCTION

The majority of mite species from the gamasid group belong to predators. In spite of the fact that they do not participate directly in the processes of forest litter degradation, they affect the numerical stabilisation of the soil mezofauna and thereby influence the circulation of matter and energy in the ecosystem [5, 6]. Studies carried out on the settlement of the leaves of different tree species have shown great differences in the domination structure of mite species settling them. The peaks of number of gamasid mites most frequently occurred at the turn of March/April, in June and in September [1, 2, 9, 10]. In the initial period of the decay of the leaves of oak, alder and birch, among gamasid mites, there dominate the representatives of Parasitidae and Veigaiidae families. In summer, there is a frequent increase of *Trachytes aegrota* (C.L. Koch) participation. On the other hand, in autumn, in the strongly decayed leaves, there appear mites from Macrochelidae family, and the Parasitidae and Veigaiidae families appear again [3, 8].

The objective of the studies was the determination of the changes in species composition and in the number of gamasid mites settling in the litter in a natural deciduous forest.

2. MATERIAL AND METHODS

Studies on the settlement of litter by the soil gamasid mites were carried out from October 1994 till September 1995 on the Natural Reserve Area in Mt. Jumbong in South Korea. Bags with litter were placed on the north-facing and south-facing slope of a hill with a natural deciduous forest at 1000 m a.s.l. In the composition of the stand, there dominated *Quercus mongolica*, *Kalopanax pictus*, *Carponus cordata* and *Acer pseudosieboldii*. The undergrowth of the northern slope was dominated by one-year-old herbaceous vegetation, with *Corydalis turtschaninovii* among others, while the southern side was dominated by the evergreen *Sasa borealis*. The detailed botanical characteristics and the soil, meteorological and climatic conditions of this area were reported earlier [4]. On each of the slopes, a total of 40 bags of 400 cm^3 each, were distributed in each investigation terms, 10 bags were collected. The mites were extracted for 3 days in a Tullgren apparatus. A total of, 1104 gamasid mites were obtained. A zoocenological analysis was carried out based on the indices of abundance (*A*), domination (*D*), species diversity (*H'*) and equivaluability (*J'*) [11, 12]. The range of domination classes was accepted according to Seniczak [13], and the connection of the dominating species of gamasid mites in a microhabitat was analysed by the χ^2 test [7].

3. RESULTS AND DISCUSSION

The bags with litter were penetrated by a total of 52 gamasid mites species. In the north-facing slope there occurred 44 species, and in the south-facing slope 41 species of these mites were found (Tab.1).

Table 1. Analysis of gamasid mites associated with the northern facing slope (NFS) and southern facing slope (SFS) of Mt. Jumbong (litter-bags-method)

Index	NFS			
	13.10.94	22.04.95	22.06.95	1.09.95
Indiv. number	368	42	64	108
Species number	35	17	20	21
SD	32.14	4.57	5.40	17.27
H'	2.73	2.52	2.61	2.63
J'	0.77	0.89	0.87	0.87
Index	**SFS**			
	22.10.94	22.04.95	22.06.95	1.09.95
Indiv. number	379	49	26	68
Species number	33	13	11	16
SD	26.99	3.41	4.93	6.75
H'	2.68	2.34	1.64	2.41
J'	0.77	0.91	0.68	0.87

The greatest density, the highest number of species and the highest level of Shannon´s index were recorded on both slopes in the initial period of the studies. Both in spring and summer, the analysed indices decreased, and their drop was more visible on the south-facing slope of the hill than on its north-facing one. In the final period of studies, the numbers of mites, the number of species and the gamasid diversity increased again. It should be stressed that the differences between the obtained values of Shannon´s index for all investigated periods on the south-facing slope were statistically significant, and in reference to the north facing slope such dependences were not found. Similar changes referring to the dynamics of settlement of the forest litter and the diversity of communities were obtained in the same research conditions in reference to saprophagous Oribatida [4]. An intensive penetration by gamasid mites was also observed in the initial period of the decay of the leaves of chestnut, beech, oak, alder and birch [1, 3, 8, 10].

In the initial period of studies, the gamasid mites were predominated by *Asca aphidioides* (L.) that reached the eudominant class on both slopes (Tab.2). In the spring and in the summer, the dominating position on the north-facing slope was taken over by *Parasitus* sp.1, and on the south-facing slope, there dominated *Gamasellus humosus* Ishikawa in the class of eudominants, and *Dendrolaelaps fukikoae* Ishikawa in the class of superdominants (D = 57.7%).

Table 2. The dominance structure of gamasid association for the northern facing slope (NFS) and southern facing slope (SFS) of Mt. Jumbong (litter-bags-method)

NFS											
13.10.1994			22.04.1995			22.06.1995			1.09.1995		
Sp			Sp			Sp			Sp		
Eu	*A. aphidioides*	31.5	Eu			Eu	*Parasitus* sp. 1	25.0	Eu	*H. ochraceus*	19.8
										V. uenoi	18.7
Do			Do	*Parasitus* sp. 1	19.0	Do	*Z. szeptyckij*	11.7	Do		
				V. tibbetsi	16.7						
				Saprolaelaps sp. 1	14.3						
Sd	*V. ashizuriensis*	7.1	Sd	*H. vacua*	7.1	Sd	*H. ochraceus*	8.3	Sd	*D. morikawai*	9.9
	H. ochraceus	6.8					*A. aphidioides*	6.7		*Neogamasus* sp. 1	7.7
	I. corticalis	6.8									
Re	16 species		Re	13 species		Re	16 species		Re	16 species	
Sr	14 species		Sr	-		Sr	-		Sr	-	
SFS											
22.10.1994			22.04.1995			22.06.1995			1.09.1995		
Sp			Sp			Sp	*D. fukikaoe*	57.7	Sp		
Eu	*A. aphidioides*	33.2	Eu			Eu			Eu	*A. aphidioides*	23.5
Do			Do	*G. humosus*	16.3	Do			Do	*V. uenoi*	13.2
				V. ashizuriensis	14.3					*G. humosus*	10.3
				V. uenoi	14.3					*H. ochraceus*	10.3
				A. sculptrata	12.2						
				P. aokii	10.2						
Sd	*A. sculptrata*	7.7	Sd			Sd	*Z. szeptyckii*	7.7	Sd		
	Parasitus sp. 2	5.8									
	Lasioseius sp. 1	5.5									
Re	16 species		Re	7 species		Re	9 species		Re	11 species	
Sr	12 species		Sr	-		Sr	-		Sr	-	

Explanations: Sp – superdominants; Eu – eudominants; Do – dominants; Sd – subdominants; Re – recedents; Sr - subrecedents

It is interesting that during the processes of leaf compost decay, the increase of the participation of another representative of genus *Dendrolaelaps*, i.e. *D. latior* (Leitner) was recorded [3]. In the final period of studies on the north-facing slope, there dominated *Holaspina ochraceus* (Ishikawa) while on the south-facing slope, a high domination index was reached again by *Asca aphidioides* (L.). Generally, the study found that in the autumn periods, in the bags with litter, there predominated representatives of Ascidae and Parholaspididae families, while in spring and summer, the participation of Parasitidae and Veigaiidae families increased.

An analysis of the connection between the dominating gamasid mites species with the microhabitat has revealed a positive dependence between *Asca sculptrata* (Aoki), *Lasioseius* sp. 1 and *Dendrolaelaps fukikoae* Ishikawa and the south-facing slope, as well as a connection between *Parasitus* sp. 1 and the north-facing slope (Tab.3).

Table 3. Association of dominant gamasid species for the northern facing slope (NFS) and southern facing slope (SFS) of Mt. Jumbong (litter-bags-method) (χ^2 analysis)

Name of species	χ^2	NFS	SFS
A. aphidioides	2.80 ns	0	0
A. sculptrata	33.60 ***	–	+
H. ochraceus	3.80 ns	0	0
Parasitus sp.1	17.97***	+	–
V. ashizuriensis	0.02ns	0	0
V. uenoi	3.56ns	0	0
Lasioseius sp.1	8.49**	–	+
D. fukikoae	14.43**	–	+
Z. szeptyckii	2.57ns	0	0

Explanations: + positive association; - negative association; 0 no association; ns - not significant; ** significant at $p = 0.01$; *** significant at $p = 0.001$

Changes of the domination index permitted one to distinguish among the gamasid mites two groups of species. In the first group, there were *Asca aphidioides* (L.) and *Holaspina ochraceus* (Ishikawa) and their participation in the Gamasida reached a high level in autumn and decreased in the period of spring and summer (Figs.1 and 2).

In the second group, there occurred *Asca sculptrata* (Aoki), *Veigaia tibbetsi* Farrier, *Hypoaspis vacua* (Michael), *Parasitus* sp.1 and *Zercon szeptyckii* Błaszak, and their domination distinctly increased in the period of spring and summer, and decreased in autumn. It should be noted that the different dynamics of the population number of *Asca aphidioides* (L.) and *A. sculptrata* (Aoki) during the year decreases the competition between them and permits a better exploitation of convergent ecological niches.

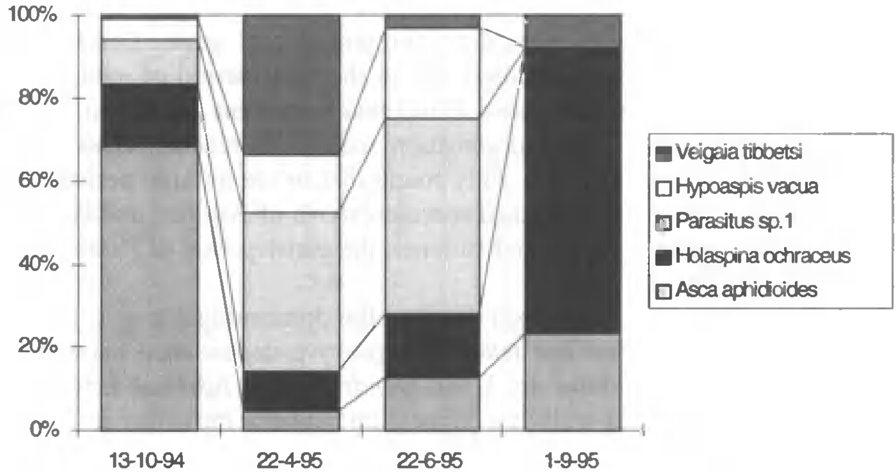

Fig.1. Changes of dominance index of some gamasid species in the following periods of settling forests litter on the northern facing slope of Mt. Jumbong (litter-bags methods)

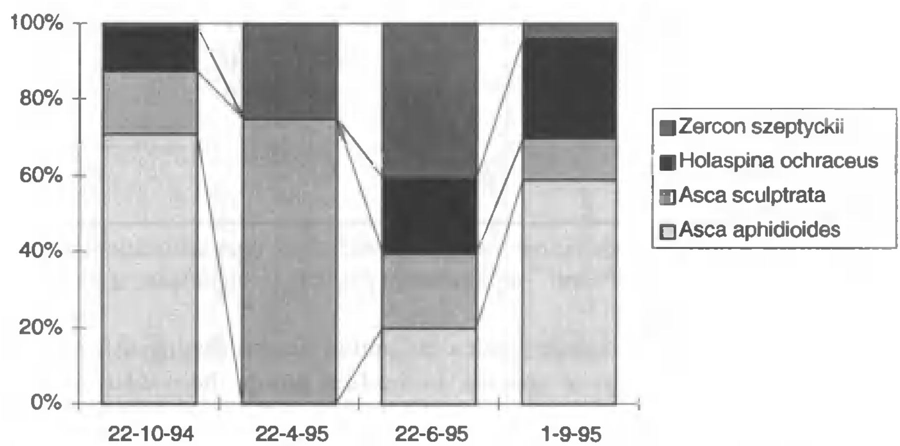

Fig.2. Changes of dominance index of some gamasid species in the following periods of settling forests litter on the southern facing slope iof Mt. Jumbong (litter-bags methods)

4. CONCLUSIONS

1. An intensive settlement of the forest litter by gamasid mites on the north-facing and south-facing slopes was found in autumn seasons and it decreased in the period of spring and summer.
2. In the following periods of studies, significant changes were observed in the domination structure of gamasid mite species on both slopes.
3. The χ^2 analysis has shown a positive connection of *Asca sculptrata* (Aoki), *Lasioseius* sp.1 and *Dendrolaelaps fukikoae* Ishikawa with the microhabitat of the south-facing slope, and a connection of *Parasitus* sp.1 with the microhabitat of the north-facing slope.
4. Among gamasid mites, species were distinguished whose participation in these mites group was increasing in autumn and decreasing in spring and summer but there were also species reaching a low density and participation in autumn and increased these values in spring and summer.

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GLEBOWE GAMASIDA (ACARI) ZASIEDLAJĄCE ŚCIÓŁKĘ LEŚNĄ NA OBSZARZE NATURALNEGO REZERWATU MT. JUMBONG, KOREA POLUDNIOWA

Streszczenie

Przeprowadzono badania nad zmianami składu gatunkowego i liczebności glebowych Gamasida (Acari) w wyłożonej do gleby ściółce leśnej w naturalnym drzewostanie liściastym w Rezerwacie Biosfery Mt. Jumbong w Korei Południowej. W badanych próbach wystąpiły 52 gatunki Gamasida. Intensywne zasiedlanie ściółki leśnej przez te roztocze zanotowano w okresach jesiennych, a zmniejszało się ono wiosną i latem. W okresach tych ściółkę leśną penetrowała mała liczba gatunków Gamasida, a zróżnicowanie zgrupowań tych roztoczy, wyrażone wskaźnikiem Shannona, osiągało najniższe wartości. W kolejnych okresach sezonu wegetacyjnego następowały duże zmiany w strukturze dominacji gatunków Gamasida. Wysoką liczebność i dominację *Asca aphidioides* i *Holaspina ochraceus* stwierdzono jesienią, a wiosną i latem wskaźniki te ulegały obniżeniu. Natomiast wzrost liczebności wiosną i latem wykazano dla *Parasitus* sp.1, *Hypoaspis vacua*, *Asca sculptrata*, *Veigaia tibbetsi* i *Zercon szeptyckii*. Analiza χ^2 ujawniła pozytywny związek *Asca sculptrata*, *Lasioseius* sp.1 i *Dendrolaelaps fukikoae* z mikrosiedliskiem stoku południowego, a *Parasitus* sp.1 z mikrosiedliskiem stoku północnego.

Słowa kluczowe: Mt. Jumbong, ściółka leśna, Acari, Gamasida

AKADEMIA TECHNICZNO-ROLNICZA IM JANA I JĘDRZEJA ŚNIADECKICH
W BYDGOSZCZY
ZESZYTY NAUKOWE NR 214 - OCHRONA ŚRODOWISKA 2 (1998) 215-220

EFFECT OF INDUSTRIAL POLLUTION EMITTED TO THE ATMOSPHERE ON SOIL MITES OF *ZERCON* C.L. KOCH GENUS (ACARI, GAMASIDA) IN YOUNG SCOTS PINE FORESTS

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Synopsis. The article presents the reaction of mites species of *Zercon* genus occurring in the soil of young Scots pine forests polluted by nitrogen, sulphur, phosphorus and fluorine compounds and by heavy metals and calcium dust. The investigated areas were situated in a zone where the soil pollution gradient was increased and the pH value decreased with the decreasing distance from the pollution source. A high sensitivity to the increase of the concentration of sulphur, phosphorus and fluorine compounds and heavy metals in the soil was recorded in *Z. peltatus*. On the other hand, *Z. triangularis* proved to be sensitive to a high level of contamination by nitrogen and calcium dust. In soils contaminated by heavy metals, the reaction of species replacement was found within the genus *Zercon*. *Zercon zelawaiensis*, sensitive to these emissions, was replaced by *Z. peltatus*, while the latter was superseded by *Z. triangularis* being a more resistant one.

Key words: industrial pollution, pine forest, Acari, Gamasida

1. INTRODUCTION

The earlier works [1-5] present the reaction of mites in young Scots pine forests to the pollution of the soil environment by nitrogen, sulphur, phosphorus and fluorine compounds and by heavy metals and calcium dust. In all investigated pine stands, the concentrations of these pollutants in the soil increased in the direction of the emission source. On strongly polluted areas, the mites density, their diversity and the number of Oribatida and Gamasida species were recorded. The objective of the present work was the presentation of the species reaction of genus *Zercon* mites to different types of industrial pollutions penetrating into the soil environment of young Scots pine forests.

2. MATERIAL AND METHODS

Acarological studies were carried out in about 20-year old young Scots pine forests. All investigated areas were covered by *Leucobryo-Pinetum* plant association with common pine (*Pinus silvestris* L.) dominating in the stand. Only the young Scots pine forests subject to a high influence of calcium dust and increased alkalization of soil environment were covered by *Vaccinio-Piceetea* plant association. Samples were taken in spring and autumn periods in the years from 1990 till 1992 from patches of dead needles. In the zones of the activity of five big emitters of industrial pollutions, in each of them, 3 forest plots were assigned in the transect of increasing soil pollution and decreased pH (number 1-3). On the other hand, the control plots (number 4) were lying beyond the zones of direct pollution by the emissions, and on these areas, no distinct morbid changes were found either on single trees or in the whole stands. The detailed characteristics of the soil conditions, the contamination level of the area and the methods of studies were reported earlier [1-5].

3. RESULTS AND DISCUSSION

In the investigated young Scots pine forests, there occurred three mite species belonging to genus *Zercon*: *Z. peltatus*, *Z. triangularis*, and *Z. zelawaiensis*. On the control areas, a high density was most frequently shown by *Z peltatus* or *Z. triangularis*, while the populations of *Z. zelawaiensis* were on these areas comparatively small (Tab.1).

In the zones of high pollution of the young Scots pine forests (plot 1), most frequently no representatives of genus *Zercon* were found at all. A high sensitivity to the increase of the concentration of sulphur, phosphorus and fluorine compounds and heavy metals in the soil was found in *Z. peltatus*. The population density of this mite species in the soil of young Scots pine forests distinctly decreased with the increase of the pollution level. It must be stressed that the recorded differences in the density of *Z. peltatus* on the investigated areas were statistically significant. Between the concentration level of lead and copper in the soil of young forests and the density of *Z. peltatus*, a high value of correlation indices was recorded as well (Figs.1 and 2).

Zercon triangularis was sensitive to high concentrations of nitrogen compounds and calcium dust, and the density of its population on the control plots was distinctly higher than in the zones of an increased activity of the mentioned pollutions. The correlation coefficient calculated on the basis of the density of this species in the zones of young Scots pine forests polluted by calcium dusts indicates a statistically significant linear dependence between the investigated variables (Fig.3). A similar linear dependence was noted between the increasing concentration of sulphur compounds and the total density of mites of *Zercon* genus (Fig.4).

Table 1. The abundance (in thousand indiv./m^2) of *Zercon* mites genus in young Scots pine forest polluted by nitrogen (I), phosphorus and fluorine (II), sulphur (III) compounds and by heavy metals (IV) and calcium dust (V) (plots 1-3) and at the control plots (number 4)

	I	II	III	IV	V
Plot			*Zercon peltatus* C.L. Koch		
1	-	-	0.01*	-	-
2	-	-	0.44*	0.66**	-
3	-	0.24***	1.68	3.04*	-
4	-	2.41	1.63	4.09	-
Plot			*Zercon triangularis* C.L. Koch		
1	2.16*	-	0.02	-	-
2	-	-	0.52	4.65***	0.98**
3	1.07*	0.06	0.93	3.57***	2.15*
4	3.72	-	0.34	0.11	3.77
Plot			*Zercon zelawaiensis* Sellnick		
1	-	-	-	-	-
2	1.74	0.13	-	-	-
3	0.02	-	-	0.02***	-
4	-	-	0.03	1.63	-

Significant at: * p = 0,05; ** p = 0,01; *** p = 0,001

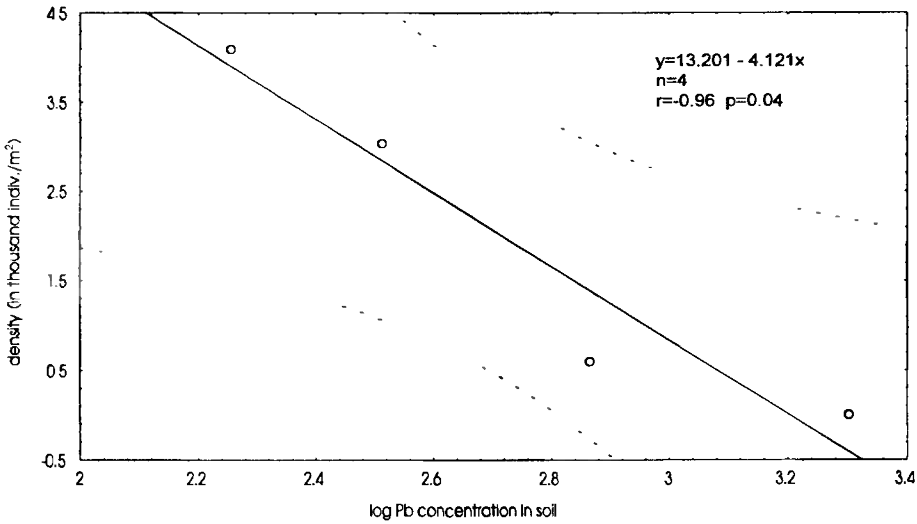

Fig.1. The relationship between lead (Pb) concentration and *Zercon peltatus* density in the soil of young Scots pine forests polluted by copper smelting works „Głogów”

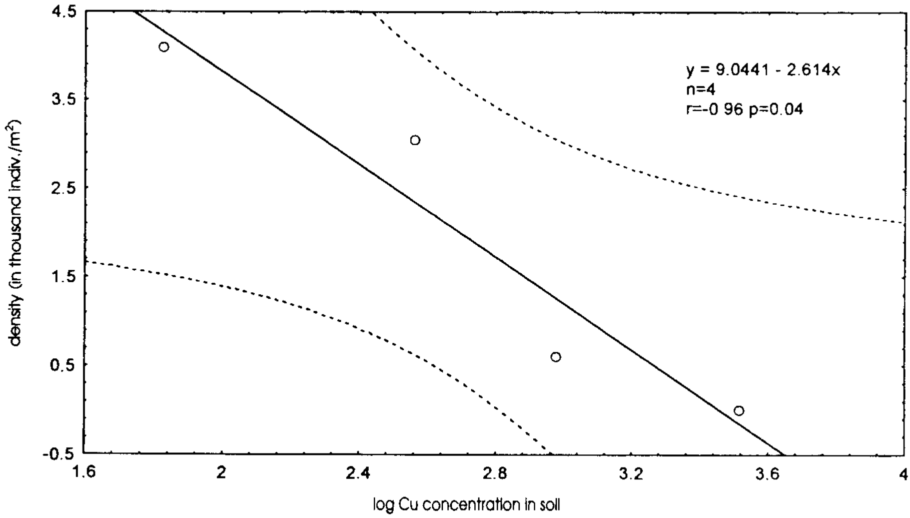

Fig.2. The relationship between copper (Cu) concentration and *Zercon peltatus* density in the soil of young Scots pine forests polluted by copper smelting works „Głogów"

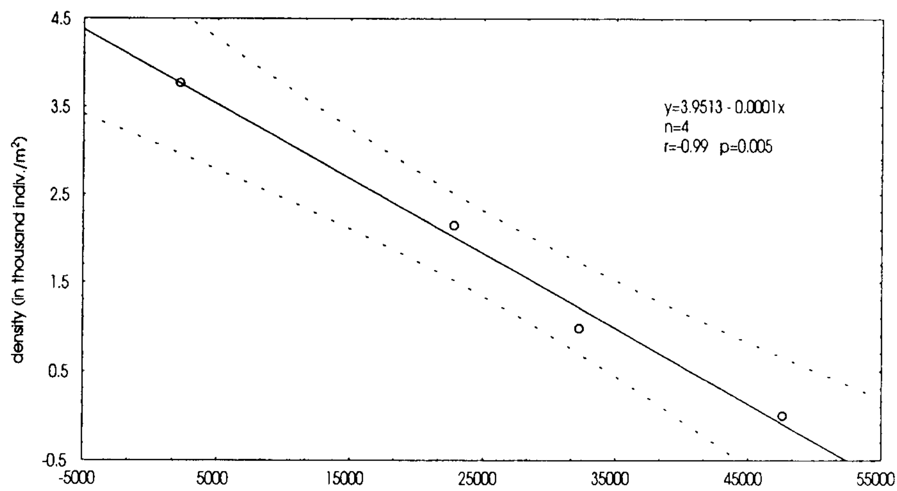

Fig.3. The relationship between calcium (Ca) dust and *Zercon triangularis* density in the soil of young Scots pine forests polluted by „Kujawy" cement factory

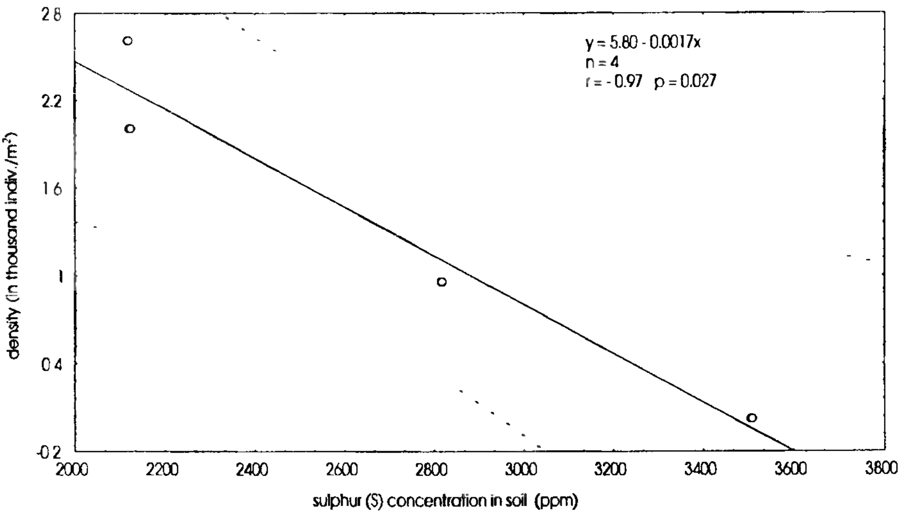

Fig.4. The relationship between sulphur (S) concentration and *Zercon* mites genus density in the soil of young Scots pine forests polluted by „Wistom" chemical factory

This fact shows a high bioindicative value of the investigated mites, both at the species at the genus levels in the conditions of the discussed pollution types acting on young Scots pine forests.

In young forests polluted by emissions of heavy metals, there was observed an interesting phenomenon of species replacement within the *Zercon* genus. On the control area, a high density was reached by *Z.peltatus* and *Z. zelawaiensis*. On the other hand, on plots with a medium and low soil pollution by the emissions, the mentioned species were dominated by the more numerous *Z. triangularis*.

4. CONCLUSIONS

1. High concentrations of calcium and nitrogen compounds in the soil of young Scots pine forests caused a density decrease of *Z. triangularis*, while a similar reaction was shown by *Z. peltatus* to the sulphur and phosphorus compounds and heavy metals.
2. A statistically significant relationship was found between the concentration of calcium dusts in the soil of young Scots pine forests and the density of *Z. triangularis*; and between the concentration of heavy metals and the density of *Z. peltatus*.
3. In the soils contaminated by low and medium doses of heavy metals, a phenomenon of species replacement was found within the genus *Zercon*. *Zercon zelawaiensis* sensitive to these emissions was replaced by *Z. peltatus*, while

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WPŁYW ZANIECZYSZCZEŃ PRZEMYSŁOWYCH EMITOWANYCH DO ATMOSFERY NA ROZTOCZE GLEBOWE Z RODZAJU *ZERCON* C.L. KOCH (ACARI, GAMASIDA) W MŁODNIKACH SOSNOWYCH

Streszczenie

W pracy przedstawiono reakcję gatunkową roztoczy z rodzaju *Zercon* występujących w glebie młodników sosnowych, zaliczonych do zespołu roślinnego *Leucobryo-Pinetum* i *Vaccinio-Piceetea*, skażonych emisjami związków azotu, siarki, fosforu i fluoru, metali ciężkich oraz pyłów wapnia. Powierzchnie badawcze usytuowano we wzrastającym gradiencie skażenia gleby i obniżonego pH wraz ze zmniejszaniem się odległości do źródła zanieczyszczeń. Natomiast powierzchnie kontrolne leżały poza strefami bezpośredniego działania emisji, a na ich obszarze nie zanotowano wyraźnych zmian chorobowych, zarówno na pojedynczych drzewach, jak i w całych drzewostanach. Dużą wrażliwość na wzrost stężenia związków siarki, fosforu i fluoru oraz metali ciężkich w glebie zanotowano dla *Z. peltatus*. Natomiast na wysoki poziom zanieczyszczeń azotowych i pyłów wapnia wrażliwy był *Z. triangularis*. W glebach skażonych metalami ciężkimi stwierdzono reakcję zastępstwa gatunkowego w obrębie rodzaju *Zercon*. Wrażliwy na te emisje *Z. zelawaiensis*, na średnio i mało skażonych powierzchniach (2 i 3) zastępowany był przez *Z. peltatus*, a ten z kolei przez bardziej odporny *Z. triangularis*.

Słowa kluczowe: zanieczyszczenia przemysłowe, bór sosnowy, Acari, Gamasida

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W BYDGOSZCZY
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INFLUENCE OF SULPHUR POLLUTION EMITTED BY THE "WISTOM" CHEMICAL FACTORY ON SOIL MITES (ACARI) IN YOUNG SCOTS PINE FORESTS, WITH SPECIFIC ANALYSIS OF ORIBATIDA

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Synopsis. The influence of sulphur pollution, with a large amount of SO_2 and CS_2, on soil mites in young Scots pine forests (plant association *Leucobryo-Pinetum*) about 20 year-old, was investigated. The concentration of sulphur in the soil was lowest in the control plot and increased towards the pollution source. In polluted plots, the density of mites was significantly lower than in the control plot, mainly due to the Oribatida, which predominated and were sensitive to this pollution. In all polluted plots the species number of mites was lower than in the control plot. Some species were sensitive to pollutants, others tolerated them.

Key words: sulphur pollution, pine forest, bioindication, Acari, Oribatida

1. INTRODUCTION

In the previous papers [1, 2] the effect of air pollution, rich in SO_2 and CS_2 and emitted by the "Wistom" chemical factory, on arboreal mites, was investigated. In polluted plots, the densities of total Acari and Oribatida were significantly lower than in the control plot, while the Gamasida and Actinedida tolerated sulphur pollution. In highly and medium polluted plots, the species number of oribatid mites was lower than in less polluted plot and the control plot. Among oribatid mites, some species were sensitive to sulphur pollutants, while *Trichoribates trimaculatus* tolerated them.

In forest ecosystems sulphur pollution decreases the production of trees such as acid rain. In this way it also decreases the amount of forest fall, which is important for soil animals, including mites. In Scots pine forests, the litter is acidic, so low doses of sulphur do not change the soil pH that much, and sometimes increase the density of mites [4, 8]. Higher concentrations of sulphur are toxic to organisms [6, 7, 9], and reduce the density and species number of mites, causing soil degradation.

In this research the effects of air pollution produced by the "Wistom" chemical factory on soil mites in about 20 year-old Scots pine forests was investigated.

2. STUDY AREAS

Three polluted plots were chosen at distances of 1.0 km (plot 1), 3.8 km (plot 2) and 9.0 km (plot 3) from the pollution source, and a control plot (4) was chosen 14.0 km from this source. The degree of damage of Scots pine trees by air pollution increased from plot 3 to plot 1. The investigated forests represented plant association *Leucobryo-Pinetum*, in which Scots pine (*Pinus sylvestris* L.) predominated, with scarce birch (*Betula pendula* Roth.) and oak (*Quercus petraea* Liebl. and *Q. robur* L.). A more detailed characterisation of the study areas has been given earlier [2].

3. METHODS

The mites were investigated in the above plots during spring and autumn of 1991 and 1992. Samples of 17 cm^2 in area and 20 cm deep were taken in areas of forest floor covered with dead needles, in 10 replicates, and each was further divided into organic and mineral horizons, approximately 5 cm and 15 cm thick, respectively. Mites were extracted from the material in high gradient Tullgren funnels. Nearly 49000 mites were investigated.

We determined the Oribatida to species or genus, including juvenile stages; the other mites were identified to order. The species diversity of Oribatida was characterised by the Shannon *H* index [5].

The concentration of sulphur was determined in organic horizon and mineral soil. Pooled samples were mineralised, and total sulphur was measured using the nephelometry method.

4. RESULTS

4.1. Concentration of sulphur in soil

The concentration of sulphur in soil was lowest in the control plot, and increased in the direction of pollution source (Fig.1). Organic horizon accumulated more pollution than mineral soil. In plots 1 and 2, the concentration in organic horizon was respectively 1.6 and 1.3 times higher than in the control plot, while in the distant plot 3 it was similar as in the control plot. The concentration of sulphur in the mineral soil increased from the control plot to plot 2, but in plot 1 it was lower than in the control plot.

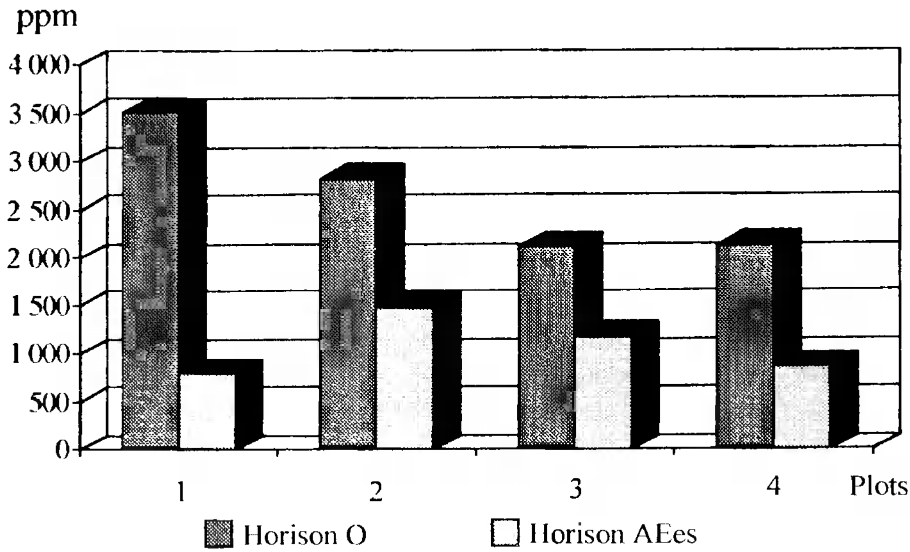

Fig.1. Concentration of sulphur in soil horizons in young Scots pine forests polluted by the "Wistom" chemical factory (plots 1-3), and the control plot (4).

4.2. Density of mites

The density of mites was the highest in the control plot, and decreased in the direction of the source of pollution, along with the increasing concentration of sulphur in the organic horizon (Tab.1).

Table 1. Some features of soil mites in young Scots pine forests polluted by the "Wistom" chemical factory (plots 1-3), and the control plot (4). Abundance in thousand/1 m^2; * $p < 0.05$

Characteristics	Plot 1	Plot 2	Plot 3	Plot 4
Acari total	89.01*	117.69*	130.22*	162.74
Actinedida	22.73	21.15	19.52	22.84
Gamasida	2.81*	4.97	8.21	7.12
Oribatida	62.63*	91.07*	99.78*	131.56
Number of species	38	40	39	50
Index *H*	2.44	2.55	2.65	2.67

In polluted plots 1, 2 and 3 the density was reduced respectively to 55%, 72% and 80% of that in the control plot, being in all plots significantly different from that in the control plot. The reduction concerned mainly the Oribatida and Gamasida, whereas the Actinedida tolerated sulphur pollution.

4.3. Species number of Oribatida and density of some populations of these mites

In all polluted plots, the number of species of Oribatida was lower than in the control plot. The Shannon *H* index for Oribatida was lower only in highly and medium polluted plots, compared to the control plot.

In all plots, *Tectocepheus velatus* predominated, except in highly polluted plot 1 where *Chamobates schuetzi* was more abundant (Tab.2). Relatively abundant were *Scheloribates latipes* in plot 2 and the control plot, and *Suctobelba* spp. in plots 3 and 1. Among oribatid mites, *Adoristes ovatus*, *Carabodes subarcticus*, *Diapterobates humeralis*, *Phthiracarus borealis*, *Scheloribates latipes* and *Tectocepheus velatus* were sensitive to pollutants, while *Chamobates schuetzi* tolerated them.

5. DISCUSSION

Sulphur pollution produced by the "Wistom" chemical factory affect the soil mites in young Scots pine forests probably together with air moisture, like acid rain. In a high concentration it perturbs the soil pH and causes changes in species composition and dominance structure of mites [3, 8]. In the investigated polluted plots, the concentration of sulphur did not change the pH of soil, but it changed the density of mites and species composition of Oribatida. In more polluted plots 1 and 2, situated near the pollution source, the density of mites was reduced, including Oribatida, and the *H* index for the latter group was lower, compared to less polluted plot 3 and the control plot. In all polluted plots, the species number of Oribatida was distinctly lower than in the control plot.

These results are not fully consisted with Hågvar and Amundsen [3] who investigated the effect of artificial acidification in a Norwegian coniferous forest. According to the authors, the density of the soil Acari was reduced, but the density of Oribatida increased after this manipulation; the number of species of Oribatida did not change in this experiment. Also in a Scots pine culture growing on sandy soil in Tuchola Forest (Poland), small doses of sulfuric and nitric acids stimulated the abundance of mites and species diversity of Oribatida [8]. However, higher doses of these acids (500 kg S and 110 kg N/ha per year) reduced the abundance of mites and species diversity of Oribatida, compared to the control plot.

Hågvar and Kjøndal [4] investigated the effects of artificial acidification on several oribatid mites in decomposing birch leaves, and found out that most of them tolerated acidification. In this investigation, some forest taxa like *Adoristes ovatus*, *Carabodes subarcticus*, *Diapterobates humeralis*, *Phthiracarus borealis*, *Scheloribates latipes* and *Tectocepheus velatus* were sensitive to pollutants, at least to a high concentration, while *Chamobates schuetzi* tolerated them.

Table 2. The abundance (*A* in thousand/1m^2) and dominance (*D*) indices of some oribatid mites in young Scots pine forests polluted by the "Wistom" chemical factory (plots 1-3), and the control plot (4); * p < 0.05

Name of species	Plot							
	1		2		3		4	
	A	*D*	*A*	*D*	*A*	*D*	*A*	*D*
Adoristes ovatus (C.L.Koch)	2.77*	4.43	4.26*	4.68	7.83	7.85	6.32	4.81
Brachychthonius spp	0.81	1.29	1.18	1.29	0.98	0.99	1.13	0.86
Camisia biurus (C.L. Koch)	0.17	0.26	0.14	0.15	0.64*	0.64	0.25	0.19
C. spinifer (C.L. Koch)	0.25	0.40	0.05	0.05	1.51	1.51	0.61	0.47
Carabodes forsslundi Sellnick	0.01	0.02	0.05	0.05	0.20	0.20	0.19	0.14
C. labyrinthicus (Michael)	0.01	0.02	1.13*	1.25	0.28	0.28	0.07	0.05
C. subarcticus Tragårdh	0.21*	0.34	1.32*	1.45	2.99*	2.99	7.27	5.53
Chamobates schuetzi (Oudemans)	18.66*	29.79	5.91	6.49	1.32	1.32	6.12	4.65
Cymbaeremaeus cymba (Nicolet)	0.18	0.29	0.08	0.08	0.06	0.06	0.01	0.01
Diapterobates humeralis (Hermann)			0.11*	0.12	2.81	2.81	3.96	3.01
Eremaeus oblongus C.L. Koch	2.75	4.39	1.18*	1.30	1.15*	1.15	5.63	4.28
Eupelops torulosus (C.L. Koch)	2.75*	4.39	0.47	0.51	4.30*	4.31	0.75	0.57
Liochthonius spp.	1.20*	1.92	0.88*	0.97	0.44*	0.44	4.38	3.33
Metabelba pulverulenta C.L. Koch	1.79	2.85	3.32	3.65	2.64	2.65	1.99	1.52
Micreremus brevipes (Michael)	0.09*	0.14	0.31	0.34	0.09*	0.09	0.46	0.35
Oppiella minus (Paoli)	0.72*	1.15	7.10	7.80	0.86*	0.86	10.03	7.62
O. nova (Oudemans)	2.97*	4.74	3.06*	3.36	2.58*	2.58	7.12	5.41
Oribatula tibialis (Nicolet)	4.84*	7.73	5.28*	5.80	4.03*	4.04	0.97	0.74
Pergalumna nervosa (Berlese)	0.06	0.09	0.08	0.09	0.06	0.06	0.18	0.13
Phthiracarus borealis Trägårdh	0.42*	0.67	4.41	4.84	2.06*	2.06	5.07	3.85
Quadroppia quadricarinata (Michael)	1.74	2.77	0.16	0.18	2.93	2.94	0.64	0.49
Scheloribates latipes (C.L. Koch)	1.28*	2.05	10.94	12.01	7.04*	7.05	14.54	11.05
Suctobelba spp.	10.51	16.79	7.68	8.43	15.43	15.46	9.30	7.07
Tectocepheus velatus (Michael)	5.79*	9.24	23.64	25.96	17.50*	17.54	34.81	26.46
Other species	39.26		23.49		54.28		9.76	
Oribatida total	62.63		91.07		99.78		131.56	

Achipteria coleoptrata (L.) - 3, *Atropacarus striculus* (C.L. Koch) - 2,4, *Autogneta traegardhi* Forsslund - 1,2, *Camisia segnis* (Hermann) - 1,3, *Carabodes coriaceus* C.L. Koch - 3,4, *C. femoralis* (Nicolet) - 3,4, *C. marginatus* (Michael) - 2,4, *C. minusculus* Berlese - 4, *Cepheus cepheiformis* (Nicolet) - 3,4, *Ceratoppia quadridentata* (Haller) - 1, *Ceratozetes sellnicki* (Rajski) - 2, *Chamobates cuspidatus* (Michael) - 3, *Cultroribula juncta* (Michael) - 3, *Damaeus clavipes* (Hermann) - 3,4, *D. verticilipes* (Nicolet) - 2,3, *Eporibatula rauschenensis* (Sellnick) - 1, *Eulohmannia ribagai* Berlese - 1,2, *Galumna lanceata* Oudemans - 2,4, *Galumna* 1 - 2,3,4, *Gymnodamaeus bicostatus* (C.L. Koch) - 1, *Hemileius initialis* (Berlese) - 2,4, *Hypochthonius rufulus* C.L. Koch - 4, *Latilamellobates incisellus* (Kramer) - 1, *Liacarus coracinus* (C.L. Koch) - 1,3,4, *Licneremaeus licnophorus* (Michael) - 4, *Licnodamaeus* 1 - 1,2,4, *Microtritia minima* (Berlese) - 1,2,4, *Nanhermannia nanus* (Nicolet) - 3,4, *Nothrus silvestris* Nicolet - 1, *Oppiella neerlandica* (Oudemans) - 3, *O. ornata* (Oudemans) - 2,3,4, *O. subpectinata* (Oudemans) - 4, *O. translamellata* (Willmann) - 1,2,4, *Protoribates* 1 - 4, *Punctoribates* 1 - 4, *Rhysotritia duplicata* (Grandjean) - 1,2,4, *Scheloribates laevigatus* (C.L. Koch) - 2,3,4, *Scheloribates* 1 - 2, *Trichoribates trimaculatus* (C.L. Koch) - 1,4, *Tropacarus carinatus* (C.L. Koch) - 3,4, *Zygoribatula exilis* (Nicolet) - 1,4.

6. CONCLUSIONS

1. The concentration of sulphur in the soil was lowest in the control plot, and increased towards the pollution source.
2. In polluted plots the density of mites was significantly lower, compared to the control plot, mainly due to the Oribatida which predominated and were sensitive to sulphur air pollution.
3. Sulphuric air pollution reduced the species number of Oribatida.
4. Among the mites, the following categories were distinguished:
   - sensitive to pollutants (*Adoristes ovatus*, *Carabodes subarcticus*, *Diapterobates humeralis*, *Phthiracarus borealis*, *Scheloribates latipes* and *Tectocepheus velatus*),
   - tolerant of pollution (*Chamobates schuetzi*).

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WPŁYW ZANIECZYSZCZEŃ EMITOWANYCH PRZEZ ZAKŁADY WŁÓKIEN CHEMICZNYCH "WISTOM" NA ROZTOCZE (ACARI) GLEBOWE MŁODNIKÓW SOSNOWYCH, ZE SZCZEGÓLNYM UWZGLĘDNIENIEM ORIBATIDA

Streszczenie

Badania przeprowadzono w pierwszych dekadach maja i października w latach 1991 i 1992 w okolicach ZWCh "Wistom" w Tomaszowie Mazowieckim. Do badań wybrano około 20-letnie młodniki sosnowe w typie siedliskowym boru świeżego, w których usytuowano 4 powierzchnie doświadczalne. Powierzchnie 1, 2 i 3 były odległe od emitora zanieczyszczeń odpowiednio o 1 km, 3.8 km i 9 km. Powierzchnię kontrolną 4 zlokalizowano w odległości 14 km od zakładów. Przedmiotem analizy było ponad 39 tys. roztoczy, w tym prawie 31 tys. Oribatida. Najwyższą zawartość siarki ogólnej w glebie stwierdzono na leżącej najbliżej emitora zanieczyszczeń powierzchni 1; w miarę oddalania się od ZWCh "Wistom" zawartość tego pierwiastka spadała. Najwyższą liczebność roztoczy stwierdzono na powierzchni kontrolnej i w miarę zbliżania się do emitora zanieczyszczeń liczebność ta wyraźnie malała, a różnice były istotne statystycznie, co wskazuje na negatywny wpływ imisji na te pajęczaki. Najliczniejszą grupą roztoczy były Oribatida, które głównie rzutowały na stosunki liczebności roztoczy. Spadkiem liczebności na zanieczyszczenia reagowały również drapieżne Gamasida, natomiast wyrównane zagęszczenie na badanym terenie zanotowano w przypadku Actinedida. Najliczniejsze gatunkowo zgrupowanie mechowców stwierdzono na powierzchni kontrolnej (50 gatunków), a wskaźnik różnorodności gatunkowej Shannona malał w miarę zbliżania się do emitora zanieczyszczeń. Na leżącej najbliżej emitora powierzchni 1 w zgrupowaniu mechowców dominował *Chamobates schuetzi*, a na pozostałych powierzchniach najliczniejszy był eurytopowy *Tectocepheus velatus*. Wśród Oribatida wrażliwe na imisje zanieczyszczeń ZWCh "Wistom" były *Adoristes ovatus*, *Carabodes subarcticus*, *Diapterobates humeralis*, *Scheloribates latipes* i *Tectocepheus velatus*, a tolerował imisje *Chamobates schuetzi*.

Słowa kluczowe: zanieczyszczenia siarkowe, młodniki sosnowe, bioindykacja, Acari, Oribatida

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GAMASID AND ORIBATID MITES OF ANTHROPOGENICALLY TRANSFORMED GALENA-CALAMINE MINING WASTELANDS

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Synopsis. Mites (Oribatida, Gamasida) of two adjacent, abandoned old galena-calamine mining wastelands with different plant communities were investigated. The differences in species composition and abundance were great. Ninety-five species of mites were recorded from both sites, but only 22 were common to both sites. Different mite communities were found with regard to the type of vegetation. The results indicate that the investigated communities represented the last stage of mite community development.

Key words: Oribatida, Gamasida, community structure, galena-calamine mining wastelands

1. INTRODUCTION

The study of the succession of mite communities in anthropogenic soils is still in the preliminary stages. Little research was been made on the mite succession in postindustrial wastelands [1, 2, 4, 6, 7].

This paper describes the later stages of succession of Oribatida and Gamasida communities in old galena-calamine open cast mining wastelands. Galena-calamine open cast mining wastelands represent a drastically modified and difficult habitat for mites.

This work is a part of the larger study on the structure of mite communities of varying successional ages in industrial wastelands. Few studies described the younger phases of the succession of mite communities on galena-calamine wastelands [4, 7]. The last stage of the development of a mite community in galena-calamine wastelands with pine and beech were also analysed [5, 8].

A comparison of the two adjacent wastelands (afforested and unforested) of identical age, developed on the same soil parent material, is what concerns the present paper.

2. MATERIAL AND METHODS

Soil samples were collected from two adjacent sites on old galena-calamine mining wastelands in Korzeniec near Olkusz. Site I (afforested), was greatly overgrown by Scots pine (*Pinus sylvestris* L. - 60% of cover). Site II (unforested), was situated on the wasteland with *Trifolio-Geranietea Sanguinei* Müller 1962.

The fauna was sampled at monthly intervals from 20 March to 16 October 1989. Samples each of 18 cm^2 in area were taken to the depth of 7.5 cm using a cylindrical core sampler. In total 150 samples were collected. The mites were extracted with a modified Tullgren extractor for 7 days. The mites were preserved in 75% ethyl alcohol. The material was analysed using some of zoocenological indices, e.g. abundance, dominance, frequency of occurrence, species diversity (*H'*) and the Sörensen quotient of similarity species.

3. RESULTS AND DISCUSSION

During the study period 3035 specimens of mites were collected from both sites. They belonged to 95 species. The abundance of Gamasida on the wasteland with pine was low (2777 indiv./m^2). The higher abundance was noted for oribatids (9318 indiv./m^2). The abundances of Gamasida and Oribatida were similar on the unforested wasteland (Oribatida 5674 indiv./m^2, Gamasida 4711 indiv./m^2). The number of oribatid species was only 28 on the unforested wasteland and 38 on the wasteland with pine. A similar number of gamasid mites (25) occurred on both wastelands. The Gamasida fauna from the investigated wastelands appeared to have lower abundance and number of species than the mite fauna from natural habitats and other postindustrial wastelands [5, 8] (Fig.1).

The structure of communities was stable with a high number of dominant species. The species-abundance relationship showed a tendency towards a log-normal distribution.

The Shannon index was similar for the gamasid communities on both sites (H' = 2.33 on unforested wasteland, H' = 2.49 on wasteland with pine) and for the oribatid mites on the afforested wasteland (H' = 2.38). Its value was the lowest on the unforested wasteland (H' =1.76). The frequency of gamasid mite species was very low (Tab.1); this is typical for communities with anthropogenic soil [5].

The mite fauna on the unforested wasteland was different in composition, abundance and diversity than on the wasteland with pine. The communities had only 22 species in common, but they usually occurred in low numbers on each of these sites. The Sörensen quotient of similarity of the oribatid and mesostigmatid mites was 0.46. Small differences in the structure of communities on the adjacent wastelands with pine and beech were observed, however both sites were woodlandlike [5].

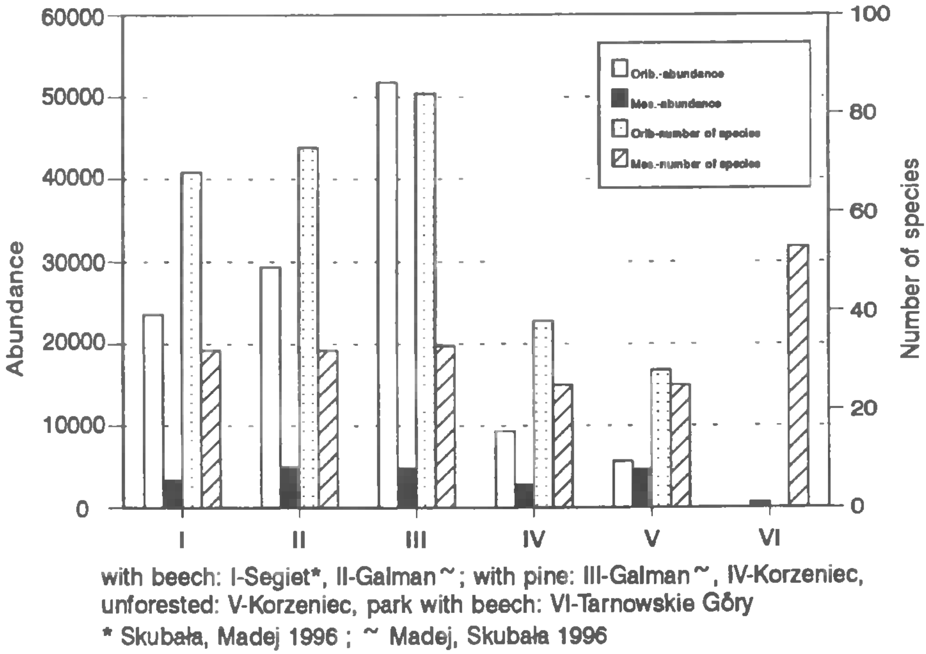

Fig.1. Abundance and number of mite species on different kinds of old galena-calamine mining wastelands

Different species dominated in each community. Among Gamasida on the wasteland with pine *Veigaia nemorensis* (C.L. Koch) and *Trachytes aegrota* (C.L. Koch) dominated (species typical for forest habitats) and on the unforested wasteland: *Rhodacarellus silesiacus* Willmann, *Asca nova* Willmann (small, euedaphic, nematophagous species typical of open habitats). Among oribatid mites panphytophages and eurytopic species dominated (on the unforested wasteland *Tectocepheus velatus* (Michael) and *Protoribates variabilis* Rajski, on the afforested wasteland, *Achipteria coleoptrata* (L.), *Dissorhina ornata* (Oudemans). Among them are the mites which are characteristic of a late stage of succession [6] (Tab.1).

It may be concluded that there is a close relationship between mites and plant communities. This result is in agreement with the recent literature (e.g. [1, 3]). Successional changes in the development of mite communities on the adjacent industrial wastelands with different vegetation cover and microclimate proceeded in two directions. Gamasid and oribatid mites on the afforested wasteland developed into woodlandlike communities, gamasid mites on the unforested wasteland were rather typical of open habitats, whereas most of the oribatid mites were eurytopic (82.6%).

Table 1. The structure of the mite communities: ⊗ - euconstants, ⊕ - constants, ∅ - accesorial species, ↔ -"late" successional species (Parr 1978)

	Unforested wasteland		Afforested wasteland	
Eudominants	*Tectocepheus velatus* 43.5%	⊗	*Achiptera coleoptrata* 23%	⊗↔
	Protoribates variabilis 28.2%	∅	*Dissorhina ornata* 20.5%	⊕
	Rhodacarellus silesiacus 28.6%	∅	*Chamobates voigtsi* 12.9%	⊕
	Asca nova 23.1%		*Adoristes ovatus* 12.1%	⊕
			Trachytes aegrota 29.6%	∅
			Veigaia nemorensis 16.4%	↔
Dominants	*Dissorhina ornata* 6.5%		*Metabelba pulverulenta* 7 %	∅
	Scutovertex sculptus 5.5 %		*Eviphis ostrinus* 7.2%	↔
	Dendroseius reticulatus 7.7 %		*Rhodacarus mandibularis* 7.2%	
	Cheiroseius borealis 7.3%		*Paragamasus runcatellus* 5.9%	
	Amblyseius sp. 6.2%		*Paragamasus misellus* 5.9%	
Subdominants	*Berniniella rafalskii* 4.0%		*Eupelops torulosus* 4.4%	∅
	Trichoribatella baloghi 2.5%		*Punctoribates punctum* 3.8%	∅↔
	Suctobelbella acutideus 2.2%		*Euzetes globulus* 2.8%	
	Hypoaspis aculeifer 2.2%	↔	*Oppiella nova* 2.1%	
	Rhodacarus mandibularis 4%		*Gamasellodes bicolor* 2.6%	
	Minirhodacarellus minimus 2.9%		*Dendroseius reticulatus* 3.9%	
	Dendrolaelaps crassitarsalis 4%		*Veigaia decurtata* 3.3%	
	Veigaia nemorensis 2.1%	↔		
Recedents	*Nothrus biciliatus* 1.1%		*Paradamaeus clavipes* 2%	
	Amblyseius sp. 1.4%		*Quadroopia q.virginalis* 1.7%	
	Hypoaspis praesternalis 1.8%		*Tectocepheus velatus* 1.6%	
			Pachylaelaps furcifer 1.3%	↔
			Amblyseius sp. 1.3%	
			Gamasellodes minor 1.9%	
			Rhodacarellus silesiacus 1.3%	
			Minirhodacarellus minimus 1.3%	
			Veigaia cervus 1.3%	↔
			Paragamasus cambriensis 1.9%	↔
			Trachytes pauperior 1.3%	
			Trachytes sp. 1.3%	
Subrecedents	20 species Oribatida		26 species Oribatida	
	13 species Mesostigmata		7 species Mesostigmata	

4. CONCLUSIONS

1. The abundance and number of species were low on the investigated galena--calamine wastelands.
2. A higher proportion of panphytophages in oribatid communities and lack of mesostigmatid species with high constancy value were typical for anthropogenic soils.
3. The development of the mite communities on two adjacent wastelands undoubtedly depended on the type of vegetation. Mites on the afforested wasteland developed into woodlandlike communities.
4. *Trichoribatella baloghi* Mahunka, 1983, found on the unforested wasteland (15 individuals) is a new species for Polish fauna.

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ROZTOCZE GAMASIDA I ORIBATIDA ANTROPOGENICZNIE PRZEOBRAŻONYCH TERENÓW POGALMANOWYCH

Streszczenie

Na dwóch sąsiadujących ze sobą, różnych pod względem florystycznym starych wyrobiskach galeno-galmanowych, stwierdzono obecność 95 gatunków roztoczy Gamasida i Oribatida. Pod względem jakościowym i ilościowym badane zgrupowania były ubogie, struktura zgrupowania była w pełni wykształcona, aczkolwiek Gamasida charakteryzowały się niską stałością. Zgrupowania roztoczy na warpiach z borem i na warpiach śródpolnych różniły się składem gatunkowym i miały tylko 22 gatunki wspólne.

Słowa kluczowe: Oribatida, Gamasida, struktura zgrupowania, wyrobiska galeno-galmanowe

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W BYDGOSZCZY
ZESZYTY NAUKOWE NR 214 - OCHRONA ŚRODOWISKA 2 (1998) 235-239

PRELIMINARY INVESTIGATIONS ON THE COLONISATION OF A REFUSE DUMP BY MITES WITH SPECIAL REFERENCE TO ASTIGMATA AND MESOSTIGMATA

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Synopsis. This study was done on the communal refuse dump and the adjacent meadow in Bielsko-Biała. A total of 240 samples were taken seasonally from 20 August 1991 to 27 April 1992 (1489 mite specimens were isolated, including 1214 individuals of the Mesostigmata and only 275 individuals from Astigmata). Twenty-four species of Mesostigmata and 2 species of Astigmata were found in the refuse dump whereas 17 species of Mesostigmata and 4 species of Astigmata were found in the meadow. In the refuse dump the mite communities were different than in the examined meadow (*Sö* = 0.38). In the first period of the study, the refuse dump was colonised mainly by mesostigmatid mites, known from a refuse compost and intensive decomposing of the organic matter (*Leptogamasus alstoni, Macrocheles insignitus, Dendrolaelaps stammeri, Hypoaspis aculeifer*). The colonisation of the refuse dump by Astigmata was very slow. The astigmatid mite density was distinctly higher in the meadow than in the refuse dump. Among four species of astigmatid mites found on the meadow (*Rhizoglyphus robini, Schwiebea talpa, S. cavernicola* and *Schwiebea* sp.) only *Rhizoglyphus robini* occurred in the refuse dump. However this species was not numerous (55.5 - 444.4 indiv./m^2). *Tyrophagus palmarum* was also found in the refuse meadow, but in small numbers. Deutonymphal stages (hypopi) of *R. robini* constitued large part of mite community, especially in the meadow (66 - 94.7 %).

Key words: Astigmata, Mesostigmata, colonisation, communal refuse dump, meadow

1. INTRODUCTION

Refuse dump provides a specific habitat both for the soil and parasitic mites [7]. They are good objects for studies on colonisation and succession of mite communities. In literature only a few papers are about this problem. Vlcek and Maca [12] investigated the succession of small mammal communities and their mite ectoparasites, including the Gamasina, on communal refuse dumps of different age. Skubała and Madej [11] described communities of oribatid and mesostigmatid mites colonising a refuse dump and made tried to find the direction of the mite migration.

The actual study is a continuation of previous investigation [11] and a supplement of those data with the species of astigmatid mites, colonising the refuse dump and an adjacent meadow.

2. MATERIAL AND METHODS

The material to studies was collected seasonally: 20th August, 3th November 1991, 2nd March and 27th April 1992 using a sampler of capacity 137 cm^3 (7.5 cm of depth). A total of 240 samples were taken into account. The mites were isolated with the Tullgren's apparatus and conserved in 75% ethanol. In total 1489 mites were collected including 1214 Mesostigmata and 275 Astigmata. The material was analysed using biocenotic parameters, e.g. the mite density and the Sörensen quotient of species similarity.

The study was carried out in the meadow and the refuse dump, which were located 3 km from the centre of Bielsko-Biała. Two sites were chosen for this investigation: a refuse dump and a nearby meadow. From 1960 to the present the refuse dump has been used. Besides communal and productive wastes from neighbouring industrial factors there were many stones. The soil is very weakly formed with pH = 7.6. The refuse dump was feebly covered by *Artemisia vulgaris* L., *Ceratodon purpureus* Brid., *Erigeron canadensis* L., *Lepidium ruderale* L. The adjacent meadow was overgrown by *Agrostis pratensis* L., *Poa pratensis* L., *Dactylis glomerata* L., *Rumex acetosa* L. The pH of the meadow soil was 7.4.

3. RESULTS AND DISCUSSION

Both in the refuse dump and in the meadow during the whole period of the study Mesostigmata and Cryptostigmata mites dominated. The Astigmata colonised the refuse dump and the meadow to a low degree (Tab.1). Values of abundance of Astigmata in this investigation are distinctly lower in comparison with the data reported by Luxton [8]. According to some literature [1, 2, 3, 6] the Astigmata belongs to the pioneer mites, which colonised antropogenic soil.

Table 1. Abundance of the Acari in the meadow and refuse dump (in indiv./m^2)

	20.08.1991	3.11.1991	2.03.1992	27.04.1992
Meadow				
Mesostigmata	4888.8	2166.6	2388.8	1815.0
Astigmata	1444.4	37.0	1018.5	1055.5
Prostigmata	4000.0	92.6	407.4	870.4
Cryptostigmata	4240.7	4911.1	1962.9	6407.4
Refuse dump				
Mesostigmata	5685.2	3574.1	1537.0	425.9
Astigmata	111.1		685.2	148.1
Prostigmata	1111.1	18.5	277.7	685.2
Cryptostigmata	16111.0	3740.7	2129.6	3500.0

In the refuse dump were different communities of mites than those in the meadow (*Sö* = 0.38). Among four species of astigmatid mites, found in the meadow (*Rhizoglyphus robini* Claparéde, *Schwiebea talpa* Oudemans, *Schwiebea cavernicola* Vitzthum and *Schwiebea* sp.), only *Rhizoglyphus robini* occurred in the refuse dump, but was not numerous (55.5 - 444.4 indiv./m^2). *Tyrophagus palmarum* Oudemans was found exclusively in the refuse dump, but sporadically (37 indiv./m^2) (Tab.2).

Table 2. Abundance of dominant species of Mesostigmata and Astigmata in the meadow and refuse dump (in indiv./m^2).

	20.08.1991	3.11.1991	2.03.1992	27.04.1992
Meadow				
Paragamasus physomastax	407.4	1148.1	1222.2	481.4
Rhodacarellus silesiacus	851.8			166.6
Arctoseius cetratus	629.6	18.5	166.6	92.6
Rhizoglyphus robini	1833.0		1222.2	703.7
Schwiebea talpa	203.7		55.5	18.5
Schwiebea cavernicola	222.2		18.5	
Schwiebea sp.	37.0		37.0	
Refuse dump				
Hypoaspis aculeifer	611.0	1296.3	222.2	92.6
Leptogamasus alstoni	444.4	944.4	444.4	
Macrocheles insignitus	518.5	92.6	18.5	
Hypoaspis praesternalis	148.1	407.4		
Dendrolaelaps stammeri	555.5			
Rhizoglyphus robini	55.5		444.4	203.7
Tyrophagus palmarum	37.0			

Despite of phoretic properties of heteromorphic deutonymphs (hypopi) from the genus *Schwiebea* [5], they did not colonise the refuse dump. The mites of the genus *Schwiebea* do not prefer the decomposing organic matter in the refuse dump [10]. *Rhizoglyphus robini* usually prefers living plant material [9]. In spite of that the Astigmata show a great tolerance for oxygen deficiency [2, 4], and therefore during decomposing processes these mites occur in small numbers. A very low density of species of the genus *Schwiebea* was stated in the meadow in relation to Pusching [10]. Deutonymphal stages of *Rhizoglyphus robini* constituted large part of mite community, especially in the meadow (66-94.7%).

The Mesostigmata were represented in the meadow and the refuse dump by 17 and 24 species, respectively. At the beginning of the study, the community of mesostigmatid mites in the refuse dump was dominated by the species known from compost or intensive decomposing organic material (*Leptogamasus alstoni* Bhattacharyya, *Macrocheles insignitus* (Berlese), *Dendrolaelaps stammeri* Hirschmann, *Hypoaspis aculeifer* (Canestrini) [11] (Tab. 2). The Mesostigmata colonising the refuse dump probably did not arise from the adjacent meadow because the species from the refuse dump occurred in the meadow sporadically or were absent there.

As time progressed the density of mesostigmatid mites decreased from 5685 indiv/m^2 to 425.9 indiv./m^2. Such a drastic reduction in mite numbers was not observed in the meadow (Tab.1). This fact indicates an instability of the microhabitats in the refuse dump.

4. CONCLUSIONS

1. Among Astigmata only *Rhizoglyphus robini* and *Tyrophagus palmarum* occurred in examined refuse dump.
2. Hypopi *R. robini* were found as a large part of the mite community in the refuse dump.
3. The Mesostigmata and Astigmata colonising the refuse dump did not arise from the adjacent meadow.

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WSTĘPNE BADANIA NAD ZASIEDLANIEM WYSYPISKA ŚMIECI PRZEZ ROZTOCZE ZE SZCZEGÓLNYM UWZGLĘDNIENIEM ASTIGMATA I MESOSTIGMATA

Streszczenie

Badania prowadzono na wysypisku komunalnym i przylegającej do niego łące. Zasiedlanie wysypiska śmieci przez roztocze Astigmata i Mesostigmata nie następowało drogą migracji z sąsiadującej łąki. Roztocze Astigmata (*Rhizoglyphus robini, Tyrophagus palmarum*) bardzo powoli zasiedlały wysypisko śmieci.

Słowa kluczowe: Astigmata, Mesostigmata, zasiedlanie wysypiska śmieci, łąka

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ZESZYTY NAUKOWE NR 214 - OCHRONA ŚRODOWISKA 2 (1998) 241-244

SOIL MESOSTIGMATA (ACARI) OF 3 EXPERIMENTAL SCOTS PINE STANDS IN THE GUBIN FOREST DISTRICT

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Synopsis. The article contains a list of Mesostigmata species, which were found in a litter of pine stands. In total, 18 species were found.

Key words: mites, Acari, Mesostigmata, Scots pine forest

1. INTRODUCTION

Research on the influence of methods of forest management systems on the stability and productivity of pine stands was carried out on the experimental area of the Department of Silviculture of Poznań University of Agriculture. The area is located in the Gubin Forest District (Poland W). Due to the harmfulness of the clear cutting system, there was initiated an experiment for the scale of changes in the ecosystem under the influence of different management systems. The experimental area of 88.34 ha consists of a complex of Scots pine (*Pinus sylvestris* L.) stands, which are to a large degree co-eval and growing in similar habitats. The complex is divided into three areas: 1. Experimental area, with stands managed without clear cutting (pine 90 year-old, 36.47 ha). 2. Comparative area, excluded from management (pine 70 year-old, 25.45 ha). 3. Traditionally managed area, where regular procedures are implemented in accordance with the current forest management plan (pines 95 year-old, 26.42 ha) [1].

Due to their current plant-composition, the analysed phytocoenoses may be classified as belonging to the group of the sub-oceanic pine forests *Leucobryo-Pinetum*. In places, it contains sometimes thick pine undergrowth. The ground cover of the discussed area provides three forms of *Leucobryo-Pinetum:* a) litter-and-moss-grown, b) fascicular, c) with eagle fern (*Pteridium aquilinum* (L.) Kuhn) involved. The fascicular form is the most widely spread (it covers the entire traditionally managed area), with bilberry (*Vaccinium myrtillus* L.) as the most dominant species. Shrubs of cowberry (*Vaccinium vitis-idaea* L.), bilberry and heather (*Calluna vulgaris* (L.) Salisb.) cover substantial parts of both the comparative and experimental area. The above phytocoenoses are less fecund than those dominated by *Vaccinium myrtillus*. The least fecund litter-and-moss-grown form predominates in the comparative and experimental areas. Growth of the moss-grown layer amounts to 30-70 %. The predominant kind of moss is *Hypnum cupressiforme* Hedw.

2. MATERIAL AND METHODS

The ultimate goal of the research was to determine the species-composition of mites of the order Mesostigmata, inhabiting litter and humus (to the depth of the mineral soil) in three distinct areas in experimental pine stands at the turn of autumn and winter. Material for study was gathered on 22 November 1996. Thirty samples were collected from the joint area of 88.34 ha. The places for collecting samples were selected at random and they were always more than 1 metre away from tree-stumps, but still under the canopy. Moss and other plants together with the layer of humus to the depth of the mineral soil were collected from the area of 100 cm^2. In order to dislodge mites from the gathered material, Tullgren's apparatus was used. All specimens of the order Mesostigmata were selected; then the species and their developmental stages were determined.

3. RESULTS AND DISCUSSION

In total 1671 specimens of Mesostigmata were examined. Eighteen species belonging to 7 families were indicated (Table). One species only, *Veigaia nemorensis* was in all samples. This species was also the most numerous. All samples contained as many as 819 individuals of this species, which amounts to nearly 50% of all mites of this order that had been found. Next in terms of the number of individuals come the following species: *Paragamasus runcatellus* (307), *P. conus* (191), *Veigaia cerva* (99) and *Paragamasus vagabundus* (73).

Individually, areas differ in terms of species-composition and number of mites. The smallest amount of both specimens (425) and species (9) was found on the experimental area. Here, the highest indices of dominance were gained by: *Veigaia nemorensis* (D = 48), *Paragamasus runcatellus* (D = 31), *P. conus* (D = 13) and *Veigaia cerva* (D = 4). Other species constituted 4% of the total number of specimens of Mesostigmata mites. The comparative area provided 515 individuals pertaining to 13 species. In the case of the experimental area, the dominating species were: *Veigaia nemorensis* (D = 53), *Paragamasus runcatellus* (D = 20), *P. conus* (D = 15), and *Veigaia cerva* (D = 4). Other species constituted 7% of the total number of individuals of the order Mesostigmata.

Table. A list of collected species and their developmental stages (f - female, m - male, d - deutonymph, p - protonymph, l - larva) in the litter of three Scots pine stands (E - experimental, M - traditionally managed, C - comparative). The dominance index of an each species is given

Species	Research area		
	E	M	C
Zercon peltatus C.L. Koch, 1836	1(f,d,p)	<1(p)	3(f,d,p,l)
Leptogamasus tectegynellus (Athias-Henriot, 1967)		6(f,m)	
Paragamasus conus (Karg, 1971)	13(f,m)	8(f,m,d)	15(f,m,d)
P. lapponicus (Trägårdh, 1910)	<1(m)		2(f,m)
P. puerilis (Karg, 1971)	2(f,m)	6(f,m)	<1(m)
P. runcatellus (Berlese, 1903)	31(f,m,d)	10(f,m,d)	20(f,m,d)
P. vagabundus (Karg, 1965)		10(f,m)	
Pergamasus crassipes (Linné, 1758)		1(f,m)	1(f,m)
Hypoaspis aculeifer (Canestrini, 1883)		<1(f)	
H. lasiomyrmecophilus Hirschmann, 1969		2(f)	<1(f)
H. procera Karg, 1965	1(f,m)	1(f,m)	
H. vacua (Michael, 1891)			1(f,m,d)
Veigaia cerva (Kramer, 1876)	4(f,d,p)	8(f,m,d)	4(f,d,p)
V. kochi (Trägårdh, 1901)	<1(m)	<1(f)	<1(f)
V. nemorensis (C.L. Koch, 1839)	48(f,d)	47(f,d,p)	53(f,d,p)
Rhodacarellus subterraneus Willmann, 1935			<1(f)
Asca aphidioides (Linné, 1758)		<1(f)	<1(f)
Amblyseius sp.		<1(f)	

The most diversified fauna occurred on the traditionally managed area, where 731 individuals pertaining to 15 species were collected. The highest indices of domination were gained by: *Veigaia nemorensis* ($D = 47$), *Paragamasus runcatellus* ($D = 10$), *Paragamasus vagabundus* ($D = 10$), *Paragamasus conus* ($D = 8$), and *Veigaia cerva* ($D = 8$). In the case of the former areas, individuals of four species constituted over 90% (experimental area = 96%, comparative area = 93%) of the number of other Mesostigmata. In the case of the traditionally managed area individuals of the four predominant species constituted only 75% of the number of all Mesostigmata. Seven species were found in all three areas.

In sum, the research confirmed that the three investigated areas differ not only in terms of undergrowth, but also in the composition of mite species of the order Mesostigmata. Despite the fact that stands are located in close proximity to one another and belong to the same plant association, *Leucobryo-Pinetum*, there are still crucial differences among them. Research on the mite fauna of these areas continues and its main objective is to observe alterations taking place in the mite fauna after different kinds of management.

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GLEBOWE MESOSTIGMATA (ACARI) W 3 DOŚWIADCZALNYCH DRZEWOSTANACH SOSNOWYCH W NADLEŚNICTWIE GUBIN

Streszczenie

Katedra Hodowli Lasu AR w Poznaniu prowadzi badania nad wpływem sposobu zagospodarowania na trwałość i produkcyjność drzewostanów sosnowych na powierzchni doświadczalnej na terenie Nadleśnictwa Gubin. Stanowi ona kompleks drzewostanów sosnowych o powierzchni 88.34 ha, w znacznej części jednowiekowych, rosnących w zbliżonych warunkach siedliskowych, który podzielono na trzy powierzchnie: eksperymentalną, kontrolną i gospodarczą. Celem badań było określenie składu gatunkowego roztoczy z rzędu Mesostigmata występujących na przełomie jesieni i zimy, w ściole i próchnicy (do powierzchni gleby mineralnej) na tych trzech powierzchniach. Łącznie zbadano 1671 okazów roztoczy z tego rzędu. Wykazano 18 gatunków, należących do 7 rodzin. Najliczniejszym gatunkiem jest: *Veigaia nemorensis* (łącznie znaleziono 819 osobników), który jako jedyny wystąpił we wszystkich próbach. Kolejne miejsce pod względem liczby osobników zajmują: *Paragamasus runcatellus* (307), *P. conus* (191), *Veigaia cerva* (99) i *Paragamasus vagabundus* (73). Badane trzy powierzchnie różniące się między sobą warstwą runa leśnego, mają także zróżnicowany skład gatunkowy roztoczy z rzędu Mesostigmata i jedynie 7 gatunków zostało wykazanych na wszystkich trzech powierzchniach.

Słowa kluczowe: roztocze, Acari, Mesostigmata, drzewostany sosnowe

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ZESZYTY NAUKOWE NR 214 - OCHRONA ŚRODOWISKA 2 (1998) 245-249

COMPARISON BETWEEN ADULT ORIBATID MITES IN THREE MOUNTAIN FORESTS IN POLAND. II. ZOOCENOLOGICAL ANALYSIS

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Synopsis. Studies were taken up in the "Pod Rysianką" Reserve (Beskidy Mountains), the remaining part of the Carpathian Primeval Forest. Three different oribatid communities were described in the soil of three adjacent plant associations (beech, mixed and spruce forests). The highest abundance of oribatids was observed in the autumn and winter. The three analysed communities differed in the dominance and constancy structure. A relatively high proportion of panphytophages, eurytopic and cosmopolitan species suggested severe climatic and life conditions for mites in the soils of the Reserve.

Key words: Oribatida, mountain forest, community structure

1. INTRODUCTION

Oribatid mites are the group of soil animals that have made remarkable evolutionary success with regard to species richness, variety of colonized habitats, diversity of feeding habits, different ways of reproduction, and morphological diversity. About several hundred thousand oribatids per m^2 can be found in organic layers in the soil of temperate forests [2].

The aim of the study was to describe oribatid mite communities in the soils of three adjacent mountain forests. Some characteristic features of the communities were discussed previously [7].

2. MATERIAL AND METHODS

The studies were conducted in the "Pod Rysianką" Reserve, with the natural stand of trees belonging to the oldest one in the Beskid Żywiecki. Three study plots were selected in the Reserve. Site I was chosen in the under-part which was covered by the stand of trees of *Luzulo nemorosae-Fagetum* (beech forest). In the highest part of the Reserve, covered by the association *Plagiothecio-Piceetum tatricum* (spruce forest) site III was chosen. Site II was placed in the wide zone between the two associations. The association developed in this zone was *Abieti-Piceetum montanum* (mixed forest). The investigation sites differed in the altitude, amount of organic matter and humidity. More details concerning the site description have been given earlier [7].

Sampling was carried out at monthly intervals during 3 years (1984-87). In total, 1080 soil samples were collected (86534 specimens of Oribatida, representing 117 species). Adults of oribatid mites were identified to species, but juvenile individuals were not assigned to species.

3. RESULTS AND DISCUSSION

The study of oribatid communities in three mountain forests developed on the similar soils allowed to three significantly different mite communities. The highest abundance of mites was observed during the autumn and winter. The abundance observed in spring (usually high in temperate habitats) were medium (Fig.1).

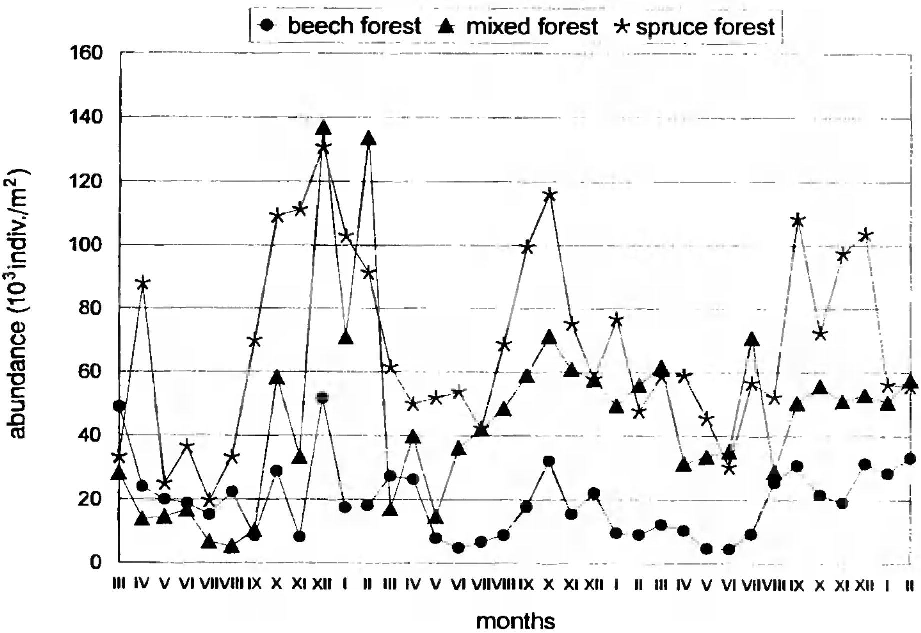

Fig.1. Seasonal variation in the abundance of oribatids in the "Pod Rysianką" Reserve

It was surprising that these soil microarthropods reached the highest abundance when the soil was covered by the thick layer of snow and its temperature was around 0^0C. It was suggested that oribatid species which occurred at higher altitudes may have possessed higher tolerance to the lower temperatures [4]. The high abundance of oribatids in the winter period, and to a lesser extent in the autumn, was a result of the appearance of juvenile stages. During these months the proportion of juveniles in the community was higher than adults. Therefore, it may be concluded that these forms of weak sclerotization may successfully exist at low temperatures.

The structure of oribatid communities was generally stable [7]. However, significant differences were observed in the dominance structure of communities and the constancy (Fig.2).

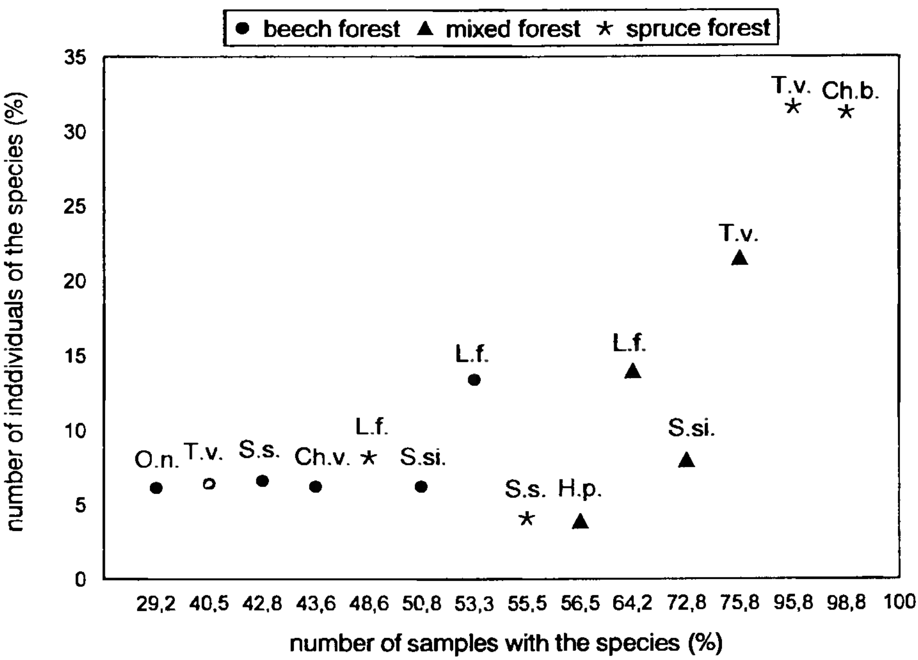

Fig.2. Dominant species in the "Pod Rysianką" Reserve - relation between abundance of individuals and frequency of occurrence:
Ch.b. - *Chamobates borealis* (Trägårdh)
Ch.v. – *C. voigtsi* (Oudemans)
H.p. - *Heminothrus peltifer* (C.L. Koch)
L.f. - *Lauroppia falcata* (Paoli)
O.n. - *Oppiella nova* (Oudemans)
S.s. - *Suctobelbella sarekensis* (Forsslund)
S.si. – *S. similis* (Forsslund)
T.v. - *Tectocepheus velatus* (Michael)

For instance, six species constituted over 5% of the whole community in the beech forest, whereas three such species were noted in the mixed and spruce forests. It is noteworthy, however, that the dominance indices of *Tecto-*

cepheus velatus (Michael) and *Chamobates borealis* (Trägårdh) from the spruce forest were significantly higher. Also, the frequency of occurrence of mites from site III was very high in comparison with the frequency observed on site I. In the fauna most species are known as characteristic of forest biotopes (36, about 42% of the whole number). However, many species were eurytopic (26) and their proportion in the community was the highest in the mixed forest. The number of microphytophages (51) was higher than the number of panphytophages (39); nevertheless, their proportion in oribatid communities was generally the same (about 47%). Usually authors observed a much lower proportion of panphytophages in natural biotopes [1]. A higher proportion of non-specialized species was recorded in highly disturbed environment, e.g. post-industrial wastelands [5, 6]. As for the geographical distribution of mites, most species were of holarctic distribution (43 species, about 30% in general). It is worth mentioning the high share of cosmopolitan species (15% to 36% of all individuals). Investigations carried out in natural biotopes showed a much lower proportion of these species in oribatid communities [3, 8].

4. CONCLUSIONS

1. The structure of oribatid communities in the soil of three adjacent mountain forests was stable; however, differences were observed, e.g. with regard to dominance and frequency of occurrence. The oribatid community in the transition zone (mixed forest) assumed an intermediate position.
2. The highest abundance of oribatids in the autumn and especially winter months (the high proportion of juveniles in the winter was remarkable) suggests a higher tolerance of the mites collected at higher altitudes compared to the lower temperatures.
3. Relatively high proportion of panphytophages, eurytopic and cosmopolitan species in the analysed communities is good evidence of the severe climatic and life conditions for oribatid mites in the Reserve.

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PORÓWNANIE ZGRUPOWAŃ MECHOWCÓW (ACARI, ORIBATIDA) W TRZECH GÓRSKICH LASACH W POLSCE. II. ANALIZA ZOOCENOLOGICZNA

Streszczenie

Badania prowadzono w rezerwacie „Pod Rysianką" (Beskid Żywiecki), który obejmuje ocalały skrawek puszczy karpackiej. W glebie trzech sąsiadujących górskich zespołów roślinnych (buczyna, bór mieszany i bór świerkowy) opisano trzy odmienne zgrupowania mechowców. Najliczniejsze występowanie roztoczy odnotowano w miesiącach jesiennych i zimowych. Struktura zgrupowań (analizowana w oparciu o wskaźnik dominacji oraz stałości występowania) była różna, to jednak w każdym przypadku dość stabilna. Zwraca uwagę stosunkowo wysoki udział w zgrupowaniach gatunków eurytopowych, panfitofagicznych i kosmopolitycznych, co wskazuje na surowe warunki klimatyczne, dość trudne warunki życia dla roztoczy w badanych glebach rezerwatu.

Słowa kluczowe: Oribatida, lasy górskie, struktura zgrupowań

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ACARI AND COLLEMBOLA IN THE "ŻABIE DOŁY" PROTECTED AREA OR HOW NATURE STRUGGLE WITH INDUSTRY

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Synopsis. Studies were undertaken on three dumps of the zinc and lead industry situated in the "Żabie Doły" protected area (Upper Silesia). In the course of the study 4008 individuals of Oribatida, representing 30 species and 18577 specimens of other Acari and Collembola were collected. Actinedida and Acaridida mites reached highest abundance. The oribatid communities on the dumps were in an early stage of development. The community in the youngest non-reclaimed dump (reedy area) was characterised by highest abundance, number of species and most balanced structure.

Key words: Acari, Collembola, post-industrial dumps, pioneer species

1. INTRODUCTION

The process of succession in degraded environments is undoubtedly one of the most interesting problems in environmental biology. The studies of succession in degraded areas refer mainly to vegetation. Soil animals are also an important element of the newly formed biocenoses. Vegetation renewal depends on the diversity and activity of soil fauna, e.g. microarthropods.

The paper gives an account of the structure of oribatid communities developed on reclaimed and non-reclaimed dumps of the zinc and lead industry. Attention was also given to the presence of the other microarthropods.

2. MATERIAL AND METHODS

The research was conducted in the protected area called "Żabie Doły" which is situated between Bytom and Chorzów, in the centre of the Upper Silesian Region. Huge waste-tips, sedimentation tanks and mining land depressions are found in this territory. The "Żabie Doły" is a very specific place where nature shows its ability to overcome the consequences of human industrial activity. The presence of 92 plant species (2 species are under protection) was recorded in this region. Furthermore, the bird fauna is really impressive. One hundred and twenty one species were observed in the "Żabie Doły", some of them are included in the Polish Red Book of Endangered Species.

Three dumps of the "Orzeł Biały" mining-metallurgic works have been chosen in the area differing in age and plant cover. Site I (reedy area) was placed on the dump of washed material. The waste deposition was continued between 1970 and 1988. There was no land reclamation on the dump. The vegetation cover was relatively dense and one species (*Phragmites communis* Trin.) clearly dominated. The amount of decaying organic matter was significantly higher on this site than on the others. Site II (afforested dump) was situated on the dump of floated material. The dump was exploited between 1930-1970. Afterwards, the area was reclaimed. Today single trees, e.g. *Robinia pseudoacacia* L., *Pinus sylvestris* L. and *Acer platanoides* L. grow on the dump. Despite of the presence of trees, the humus layer was very thin. Site III (unforested dump) was located on the other dump of floated material. The storage of waste was stopped in 1970, but land reclamation practices were carried out between 1983-1990. At present only herbaceous plants occurred at the plot, e.g. *Trifolium pratense* L., *Plantago lanceolata* L., *Dactylis glomerata* L. and *Festuca* sp. The surface of the dumps (site II and III) was not covered by soil. Trees were planted into holes with fertile soil and some grass was sown.

The sampling was carried out at approximately monthly intervals from July 1994 to June 1995. In total 310 soil samples were collected using a cylindrical core sampler (18 cm^2, 137 cm^3). Oribatida were identified to species while other mites and springtails to order.

3. RESULTS AND DISCUSSION

During the study period 4008 specimens of Oribatida were collected from three dumps. They were classified into 30 species. Furthermore, 1760 individuals of Gamasida, 12029 of Actinedida and Acaridida and 4788 of Collembola were found.

The abundance of Oribatida on the investigated dumps ranged from 633 indiv./m^2 (site III) to 13383 indiv./m^2 (site I) (Tab.1). The number of species varied from 10 (site III) to 17 (site II) and 18 (site I). The abundance at the reedy area (site I) was relatively high in comparison with the other studies on post-industrial wastelands. As regards the abundance of oribatids on the two other dumps, it was very low. As for the number of species, it was very low on three investigated dumps [2, 12, 14, 18]. It is worth mentioning that the abundance and species richness was much higher on the youngest dump (site I), where there was not any reclaiming practices.

Table 1. Abundance of different groups of Acari, Collembola and dominant species of Oribatida (figures are mean ± S.E. indiv./m^2) on the investigated dumps in the "Żabie Doły"

Taxa	Site I	Site II	Site III
Oribatida – adults	8616 ± 1554	2917 ± 817	278 ± 82
Oribatida – juveniles	4768 ± 791	3994 ± 1271	356 ± 61
Oribatida – total	13384 ± 2087	6911 ± 1721	633 ± 115
Oppiella nova (Oudemans)	**3212 ± 787**		**144 ± 52**
Liochthonius lapponicus (Trägardh)	**2308 ± 661**	55 ± 33	11 ± 7
Liochthonius propinquus Niedbała	**1313 ± 451**	**155 ± 105**	
Tectocepheus velatus (Michael)	**919 ± 211**	**2350 ± 733**	**67 ± 50**
Suctobelbella acutidens (Forsslund)	**606 ± 128**	78 ± 28	
Gamasida	1707 ± 401	4939 ± 1021	2744 ± 661
Actinedida and Acaridida	35767 ± 6437	15600 ± 3450	11883 ± 2637
Collembola	2874 ± 508	13389 ± 6426	10050 ± 2633

Bold typed values indicate dominant species on a particular dump.

The oribatid communities differed with regard to species composition. There were only 3 common species for three communities, and they reached different abundance. For instance, the abundance of *Tectocepheus velatus* (Michael), a numerous species on all sites, ranged from 67 indiv./m^2 (site III) to 2350 indiv./m^2 (site II) (Tab.1). The number of dominant species was also different on the dumps, from 2 (site II, III) to 5 (site I). In general, dominant species reached a very high proportion to the whole number in communities, e.g. *Oppiella nova* (Oudemans) at site I (37.3%) and site III (52%) or *Tectocepheus velatus* (80.6%) at site II. The structure of the mite communities was also examined using the species - abundance relationship (Fig.1). The curves showed generally a tendency towards a logarithmic distribution, however the log abundance declined more sharply in relation to the species rank on the unforested dump (site III). A steep decline of the curves indicates early successional status of the communities [6]. Moreover, the values of the Shannon diversity index were very low on the dumps, from $H' = 0.94$ (site II) to $H' = 1.60$ (site I).

Noteworthy are species dominating on the investigated dumps: *Tectocepheus velatus* (Michael), *Oppiella nova* (Oudemans), *Liochthonius lapponicus* (Trägårdh), *L. propinquus* Niedbała and *Suctobelbella acutidens* (Forsslund). The presence of the above species on zinc and lead dumps indicates their adaptation to difficult life conditions, e.g. low amount of organic matter, low humidity, high concentration of heavy metals. These mites have been usually considered as pioneer species, non-sensitive or tolerant to pollution [1, 7, 10, 12, 14]. Some authors [11] observed *Tectocepheus velatus* and *Liochthonius* sp. as sensitive to a high concentration of heavy metals. However, these species were tolerant of small concentrations of these pollutants and occurred with high abundance on moderately polluted plots in the mentioned investigations. The most numerous species which comprised from 76% (site III) to 97% (site I) of the whole community, are parthenogenetic mites. This way of reproduction may be an important advantage for these species in colonizing dumps [9].

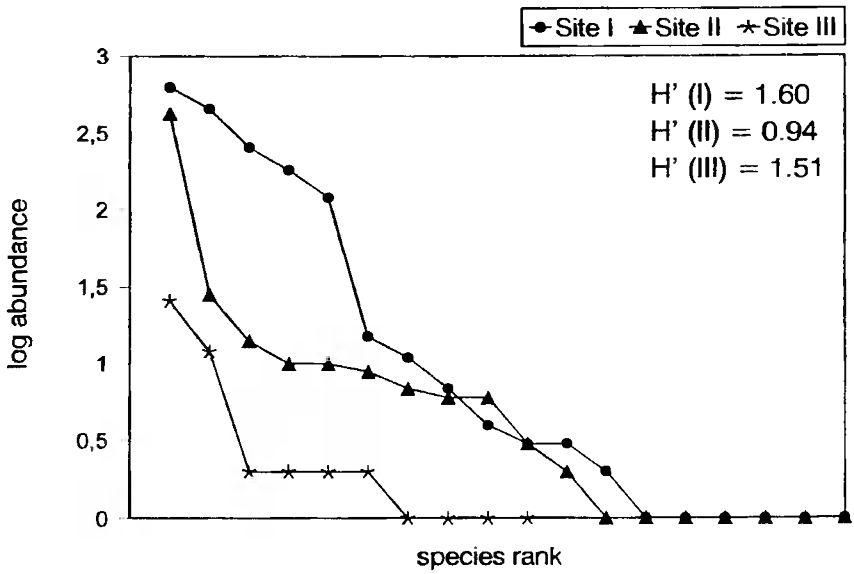

Fig.1. Rank – abundance relationships for Oribatida on the dumps in the "Żabie Doły"

As regards trophic preferences of oribatid mites recorded in the study, the proportion of microphytophages (in general about 53%) was a little higher than panphytophages (46.3%). The tendency of eurytopic and cosmopolitan species to dominate in oribatid communities was very clear. Eurytopic species comprised generally 76%, whereas cosmopolitan ones about 73% of the whole number. Similar results were obtained in other studies on post-industrial dumps [12, 13, 14, 18]. However, the proportion of non-specialised species was much higher than microphytophages in all these studies. Panphytophagy is the most beneficial from the ecological point of view [16]. On the other hand, Whelan [17] suggested that microphytophages colonised new areas much quicker than panphytophages.

The representatives of Actinedida and Acaridida dominated on the dumps (Tab.1). Their proportion in all Acari ranged from 56.8% (site II) to 77.9% (site III). The abundance of oribatid mites was lower and they constituted from only 4.1% (site III) to 26.3% (site I) of the whole number of Acari. Gamasida reached a lower abundance; however their number was significantly higher than Oribatida on site III. The number of springtails was lower than that of mites. Their abundance was 2.5 times lower on site III, and 16 times lower on site I, compared to Acari. Gackowski et al. [4] observed a high sensitivity of mites to a high concentration of heavy metals; however, saprophagous Oribatida and

Actinedida appeared less sensitive to this concentration of heavy metals than predatory Gamasida. Furthermore, Acaridida occurred even in higher numbers on highly contaminated plots than in the control. It partly corresponds with the results obtained on dumps in the "Żabie Doły" area. Oribatid mites usually constitute from 60 to 90% of the total number of Acari in natural biotopes, whereas their proportion becomes lower in the soils under the anthropogenic influence [8, 15]. Oribatids do not participate in early colonisation; however the addition of even a small amount of organic matter accelerates the development of mite communities [3, 5]. It was characteristic that on the youngest dump (site I) where the amount of organic matter was highest, the community was much better developed.

4. CONCLUSIONS

1. Mites of the Actinedida and Acaridida groups prevailed on waste-tips of the zinc and lead industry. The oribatid communities were in an early stage of the development characterised by low abundance, number of species and species diversity.
2. The structure of the oribatid community on the youngest dump (site I), which was not reclaimed, was the most balanced.
3. Some species (*Tectocepheus velatus*, *Oppiella nova*, *Liochthonius lapponicus*, *L. propinquus* and *Suctobelbella acutidens*) may be regarded as pioneer species typical of early stages of succession on post-industrial dumps.
4. An almost equal proportion of microphytophages and panphytophages and the preponderance of species having more ecological plasticity of cosmopolitan distribution, was typical of oribatid communities on the dumps.
5. The oribatid community appeared to be a good indicator of the rate of the colonisation process on post-industrial dumps.

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ROZTOCZE I SKOCZOGONKI NA UŻYTKU EKOLOGICZNYM „ŻABIE DOŁY", CZYLI JAK PRZYRODA ZMAGA SIĘ Z PRZEMYSŁEM

Streszczenie

Badania prowadzono na trzech zwałach przeróbczych przemysłu cynkowo-ołowiowego położonych na obszarze użytku ekologicznego „Żabie Doły" (Górny Śląsk). W okresie badań zebrano 4008 mechowców reprezentowanych przez 30 gatunków, oraz 18577 osobników należących do pozostałych grup roztoczy i skoczogonków. Najwyższe zagęszczenie osiągnęły roztocze z rzędu Actinedida i Acaridida. Zgrupowania mechowców na hałdach były we wczesnej fazie rozwoju. Zgrupowanie roztoczy na najmłodszej hałdzie, nie poddanej procesowi rekultywacji, cechowało się najwyższym zagęszczeniem, liczbą gatunków i najbardziej zrównoważoną strukturą.

Słowa kluczowe: Acari, Collembola, zwały poprzemysłowe, gatunki pionierskie

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SOIL MITES (ACARI, ORIBATIDA, GAMASIDA) UNDER THE INFLUENCE OF SALTY MINE WATER

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Synopsis. Pedozoological investigations were undertaken on the wasteland periodically flooded with salty water from mines. In the course of the study 3034 individuals of Oribatida and Gamasida, representing 116 species, were collected. The communities of mites were not typical of other salty areas. The number of species was relatively high and two species were new to the Polish fauna. However, the structure of communities was not stable, because of the very low frequency of occurrence and unbalanced proportion between oribatid and gamasid mites.

Key words: Oribatida, Gamasida, community structure, salty mine water

1. INTRODUCTION

Coal mining causes the degradation of the natural environment in Poland, especially in Upper Silesia. Large dumps and deformation of vast areas are created as a result of the extraction of hard coal. But mining disposes also a huge amount of salty water, which has the negative influence on the environment. The aim of this project was to describe oribatid and gamasid mites developed in the soil of a wasteland periodically flooded by the salty water from mines.

2. MATERIAL AND METHODS

Soil samples were taken on the bank of the "Goławiecki" stream in Nowy Bieruń (about 30 km south-east of Katowice, Upper Silesia). The stream has lost its natural character and runs water from the "Ziemowit" and "Piast" mines. Underground water is rich in different elements, especially Na^+ and Cl^-. The area was covered with compact herbaceous vegetation (34 species). The plant species were mainly ruderal species; however, many of them occurred in saline soils. The sampling was carried out in monthly intervals from April 1994 to March 1995. Generally, 160 soil samples of 18 cm^2 surface and 7.5 cm depth were taken. During the study period 3034 specimens of Oribatida and Gamasida, representing 116 species, were collected.

3. RESULTS AND DISCUSSION

The abundance of Oribatida on the wasteland flooded by salty water was very low (6167 indiv./m^2). It was considerably lower than the abundance of oribatids in different kinds of open habitats, natural or degraded and also in saline soils (Fig.1) [1, 2, 6, 8, 9]. As for the abundance of Gamasida (4992 indiv./m^2), it was average, much lower than in natural open biotopes but similar to habitats under the influence of human activities (Fig.1) [3, 5, 7, 8, 9].

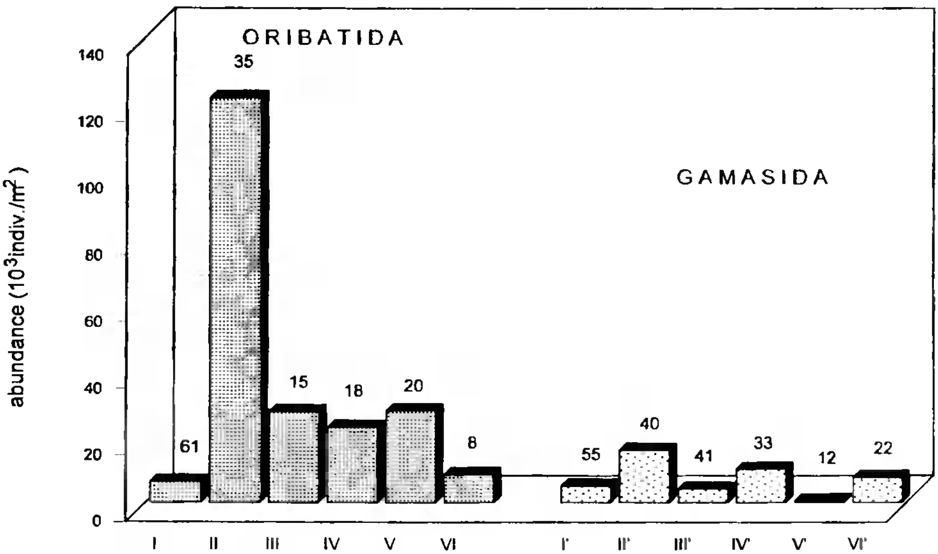

Fig.1. Abundance (column) and number of oribatid and gamasid species (figure) in the investigated wasteland and other open biotopes:

I	- wasteland, Bieruń	I'	- wasteland, Bieruń
II	- sweet meadow, Strzeszynek [6]	II'	- meadow, Germany [7]
III	- meadow, Knurów [1]	III'	- wasteland, Katowice [5]
IV	- wasteland, Kamień [2]	IV'	- salt-marsh, Ciechocinek [3]
V	- halophyte patches, Janikowo [8]	V'	- halophyte patches, Janikowo [8]
VI	- salty meadow, Janikowo [9]	VI'	- salty meadow, Janikowo [9]

Species richness of both groups of mites (Oribatida - 61 species and Gamasida - 55 species) was very high in the investigated area. The number of species was much higher than recorded by many authors in different types of open habitats, even in natural meadows (Fig.1).

Eurytopic species played an important role in oribatid communities (e.g. *Tectocepheus velatus* (Michael), *Scheloribates laevigatus* (C.L. Koch), *Gustavia microcephala* (Nicolet)). Only 3 species from the midst of 12 dominants were mites typical to open habitats (*Punctoribates punctum* (C.L. Koch), *Liebstadia similis* (Michael) and *Eupelops tardus* (C.L. Koch)). There was no species regarded as halophilous. Only some of them (*L. similis*, *Heminothrus peltifer* (C.L. Koch) and *T. velatus*) were recorded in saline soils [8, 9]. Numerous species of Gamasida are known as euedaphic mites, of small sizes, slowly moving, characteristic of open habitats (e.g. *Rhodacarellus silesiacus* Willmann, *Rhodacarus calcarulatus* Berlese, *R. mandibularis* Berlese, *Eviphis ostrinus* (C.L. Koch). Several of the recorded species were observed abundantly in saline soils. They were the following species: *Lysigamasus vagabundus* (Karg), *Hypoaspis aculeifer* (Canestrini), *Veigaia nemorensis* (C.L. Koch), *Macrocheles glaber* (Müller), *Pachylaelaps furcifer* Oudemans, *Arctoseius cetratus* (Sellnick), *Lasioseius berlesei* Oudemans [3, 4, 8, 9]. The first species, of high dominant value (5.5%), is even regarded as an indicator of salt concentration [4].

The structure of oribatid and gamasid communities, based on the dominance index was stable (Tab.1).

Table 1. Abundance and dominance and constancy of occurrence indices of numerous mite species on the wasteland in Bieruń

Species	Abundance (indiv./m^2)	Dominance (%)	Constancy of occurrence (%)
1	2	3	4
ORIBATIDA			
Punctoribates punctum (C.L. Koch)	882	20.8	38.8
Tectocepheus velatus (Michael)	615	14.5	46.9
Phthiracarus globosus (C.L. Koch)	316	7.4	28.1
Liebstadia similis (Michael)	295	7.0	22.5
Eupelops tardus (C.L. Koch)	201	4.7	23.7
Galumna obvia (Berlese)	194	4.6	18.1
Scheloribates laevigatus (C.L. Koch)	194	4.6	20.6
Gustavia microcephala (Nicolet)	146	3.4	14.4
Hermaniella dolosa Grandjean	132	3.1	13.7
Medioppia obsoleta (Paoli)	101	2.4	1.9
Ceratozetes peritus Grandjean	90	2.1	7.5
Oppiella nova (Oudemans)	90	2.1	8.1

Table 1 (continued)

1	2	3	4
GAMASIDA			
Lysigamasus digitulus (Karg)	552	17.3	20.7
Leptogamasus suecisus Trägårdh	357	11.2	17.1
Rhodacarus calcarulatus Berlese	333	10.4	12.8
Rhodacarellus silesiacus Willmann	262	8.2	20.0
Lysigamasus vagabundus (Karg)	175	5.5	15.0
Eviphis ostrinus (C.L. Koch)	171	5.3	11.4
Rhodacarus mandibularis Berlese	163	5.1	13.5
Gamasellodes bicolor (Berlese)	155	4.8	12.1
Prozercon traegardhi (Halbert)	147	4.6	15.7
Hypoaspis aculeifer (Canestrini)	147	4.6	15.0

Several species (four oribatid and seven gamasid species) constituted over 5% of the whole number and their proportions were relatively even. Moreover, the value of the Shannon diversity index was very high, $H' = 3.034$ (Oribatida) and $H' = 3.019$ (Gamasida). However, the frequency of occurrence of mites was very low, especially of Gamasida. The above characteristics and also very high abundance and number of species of Gamasida in comparison with Oribatida, illustrate a different situation from natural conditions. It may be concluded that low salinity can favour the species richness of mites, however the structure of mite communities is not balanced. The positive reaction of mites to low salinity was observed by some authors [9]. However, in some studies an elevated salinity decreases the typical Gamasida fauna, whereas it did not affect much the oribatid species [4].

4 CONCLUSIONS

1. The communities of Oribatida and Gamasida described on the wasteland periodically flooded with salty water were not typical of other salty areas, probably due to the short time of influence of salinity.
2. The mite communities displayed low abundance and low constancy of occurrence and on the other hand high number of species, high diversity and balanced dominance structure. Noteworthy also is the unbalanced proportion between oribatid and gamasid mites in comparison with natural biotopes.
3. Two species recorded in the soil of wasteland in Nowy Bieruń are new to the Polish fauna: *Berniniella inornata* Mihelčič, 1957 and *Epicriopsis palustris* Karg, 1971. Furthermore, the following species were known only from one stand in Poland: *Anomaloppia manifera* (Hammer, 1955), *Cepheus*

brachiatus Sitnikova, 1975, *Sphaerozetes tricuspidatus* Willmann, 1923 and *Trichoribates oxypteus* Berlese, 1910.

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GLEBOWE ROZTOCZE (ACARI, ORIBATIDA, GAMASIDA) W WARUNKACH ODDZIAŁYWANIA ZASOLONYCH WÓD KOPALNIANYCH

Streszczenie

Opisano zgrupowania roztoczy z rzędu Oribatida i Gamasida w glebie nieużytku okresowo zalewanego zasolonymi wodami z kopalń. W okresie badań zebrano 3034 roztoczy należących do 116 gatunków Oribatida i Gamasida. Zgrupowania roztoczy w glebie badanego nieużytku nie były typowe dla zgrupowań solnisk. Liczba gatunków roztoczy była bardzo duża, a dwa gatunki były nowymi dla fauny Polski. Bardzo niska stałość występowania i zaburzone proporcje pomiędzy obu badanymi grupami roztoczy wskazują na niezrównoważoną strukturę zgrupowań roztoczy.

Słowa kluczowe: Oribatida, Gamasida, struktura zgrupowania, zasolone wody kopalniane

AKADEMIA TECHNICZNO-ROLNICZA IM. JANA I JĘDRZEJA ŚNIADECKICH
W BYDGOSZCZY
ZESZYTY NAUKOWE NR 214 OCHRONA ŚRODOWISKA 2 (1998) 265-269

DEVELOPMENT OF MITE COMMUNITIES (ACARI, GAMASIDA) OF THE AREA OF ECOLOGICAL GROUND, "ŻABIE DOŁY"

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Synopsis. The communities of Gamasida of the area of ecological ground, "Żabie Doły", on post-flotation pulps and dumps were analysed. Most Gamasida of both habitats were the species typical for an open environment. These were small mites, poly- and nematophagous (Rhodocaridae, Laelaptidae and Ascidae).

Key words: Gamasida, dump, post-flotation pulp, pioneer species, community structure

1. INTRODUCTION

Industrial and urban processes can cause some changes in the natural environment. In the region of the Upper Silesia and nearby can be seen as an example of these changes. There is not much research on the biological activity of the soil of mining dumps. Little information is available about life in the soil of post-industrial dumps and the succession processes [9, 10].

Studies on mites in postindustrial areas were conducted by several authors (Dunger [3], Hutson [6], Luxton [8]), Bielska [1], Madej [9, 10], Gołda, Madej [4], which support Dunger's [3] idea that dumps are very usable for ecological study.

The aim of this work was to describe the group of Gamasida that inhabited the newly formed soil of the "Żabie Doły" dumps and to assess the degree of advancement in the succession of communities' development.

2. STUDY AREAS

The research was done in the area of ecological ground, "Żabie Doły", which is situated on the border of the towns Bytom and Chorzów. This region has been under the strong antrophogenic pressure for a long time. It is covered with great amount of mining waste. Dumps and post-flotation pulp of ZGH "Orzeł Biały" are covered by the association *Senecioni - Tussila - Ginetum* (it is rarely found on the dump) and groups of *Festuca tenuifolia* which appeared after the recultivation process.

3. METHODS

The research was taken from the post-flotation pulp M/G/70 and the dump M/G/65 between July 1994 and June 1995. Two hundred and twenty samples were collected using a steel cylinder (18 cm^2 and 7,5 cm long). The material was analysed using some zoocenological indices (*Q*) [5], Shannon's species diversity (*H'*), species abundance (*d*) and index of evenness (*e*). To compare the examined groups Sörensen's formula (*Sö*), Kulczyński indices (*Ku*) were used.

4. RESULTS AND DISCUSSION

In the course of the investigation 1226 individuals of Gamasida were collected, which were classified in 8 families and 21 species. The average density of Gamasida on the dumps was 4938.9 indiv./m^2 (8 families, 19 species, 73,5% of individuals belonged to Rhodocaridae). On the post-flotation pulp the average density of Gamasida was 1701.7 indiv./m^2 (4 families, 10 species, the most numerous families were Ascidae and Rhodocaridae). The dominance of Ascidae and Rhodocaridae has shown the pioneer developmental stage of Gamasida mites in these areas [11].

Asca nova achieved the highest dominance in the examined areas (post-flotation pulp - 37.4%, dump - 36.0%), and next most abundant on dump was *Rhodocarellus silesiacus* (33.3%). Some species achieved a high dominance index on the post-flotation pulp (*Arctoseius cetratus* - 32%, *Hypoaspis praesternalis* - 21.7%). Small species inhabit newly shaped areas easily [7]. The value of species diversity of both groups was similar: a low value showed little stability of the group at the beginning of succession (the post-flotation pulp - $H' = 1.4$, $d = 0.67$, $e = 0.6$; the dump - $H' = 1.2$, $d = 0.74$, $e = 0.4$).

The Sörensen's index of similarity was 55.2 %, whereas Kulczyński index *Ku* was 0.34. These values indicate a moderate similarity of the communities. As regards the trophic preferences, the dominant species were poly- and nematophagous mites. These are characteristic for the pioneer succession stage [2]. On the post-flotation pulp, polyphagous mites had a larger contribution (58 : 40,5 %) whereas on the dump nematophagous were dominant (33 : 59 %). Thus the community on the wasteland was better developed. In the region "Żabie Doły" two rare species were found: *Cheiroseius longipes* and *Protogamasellus mica*.

Table. The dominance (*D*), constancy (*C*) and ecological category (*Q*) indices of some gamasid species in the post-flotation pulp and dump

Species	Trophic group	The post–flotation pulp			The dump		
		D (%)	*C* (%)	*Q* (%)	*D* (%)	*C* (%)	*Q* (%)
Amblyseius meridionalis (Berlese, 1914)	A	0.9	1.8	1.33	1.2	8.0	3.1
Amblyseius obtusus (Koch, 1839)	A	0.4	0.9	0.6	0.9	3.0	1.6
Ameroseius corbiculus (Sowerby, 1806)	O	-	-	-	0.5	3.0	1.2
Antennoseius bacatus (Athias-Henriot, 1961)	?	-	-	-	0.1	1.0	0.4
Arctoseius cetratus (Sellnick, 1940)	P	30.5	33.6	32.0	0.1	1.0	0.4
Asca nova (Willmann, 1939)	N	40.5	34.5	37.4	59.2	53.0	56.0
Cheiroseius (Ch.) borealis (Berlese, 1904)	P	0.4	0.9	0.6	0.1	1.0	0.4
Cheiroseius (P.) longipes (Willmann, 1951)	P	5.5	9.1	7.0	0.1	1.0	0.4
Gamasellodes bicolor (Berlese, 1918)	?	-	-	-	4.8	11.0	7.3
Gamasellodes minor (Athias-Henriot, 1961)	P	-	-	-	0.6	1.0	0.8
Hypoaspis (G.) aculeifer (Canestrini, 1885)	P	0.4	0.9	0.6	4.4	19.0	9.1
Hypoaspis (C.) praesternalis (Willmann, 1949)	P	20.0	23.6	21.7	-	-	-
Hypoaspis (C.) vacua (Michael, 1891)	P	-	-	-	0.9	2.0	1.3
Leptogamasus suecicus (Trägardh, 1936)	A	-	-	-	0.3	2.0	0.8
Neojordensia levis (Oudemans et Voight, 1904)	?	0.4	0.9	0.6	-	-	-
Paragamasus (A.) runcatellus (Berlese, 1903)	P	-	-	-	0.1	1.0	0.4
Paragamasus (A.) vagabundus (Karg, 1968)	A	-	-	-	0.1	1.0	0.4
Pergamasus (P.) crassipes (Linne, 1758)	P	-	-	-	0.1	1.0	0.4
Protogamasellus mica (Athias-Henriot, 1961)	P	-	-	-	0.8	4.0	1.7
Rhodocarellus silesiacus (Willmann, 1936)	P	1.4	1.8	1.6	25.2	44.0	33.3
Rhodocarus clavulatus (Athias-Henriot, 1961)	P	-	-	-	0.1	1.0	0.4

P - polyphagous species of the first and secondary category
N - feeders on worm-like prey
A - arthropod feeders
O - omnivorous species feeding on animals and plants
? - unknown

5. CONCLUSIONS

1. The communities of Gamasida on the dump and the post-flotation pulp were at the beginning of their developmental stage. The families Ascidae, Rhodocaridae and Laelaptidae dominated on the investigated area.
2. Pioneer species, like *Asca nova*, *Arctoseius cetratus*, *Hypoaspis praesternalis* and *Rhodocarellus silesiacus* dominated in the dump and post-flotation pulp. These are small size, euedaphic, poly- and nematophagous mites.

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diach sukcesji ekologicznej zwałów kopalnictwa węglowego. Acta Biol. Sil., 6(33): 173-189.

ROZWÓJ ZGRUPOWAŃ ROZTOCZY (ACARI, GAMASIDA) NA TERENIE UŻYTKU EKOLOGICZNEGO "ŻABIE DOŁY"

Streszczenie

Zbadano faunę Gamasida na zwale przeróbczym i w masie poflotacyjnej na użytku ekologicznym „Żabie Doły". Wśród roztoczy przeważały gatunki pionierskie, o małych rozmiarach ciała, poli- i nematofagiczne. Bardziej zaawansowane w rozwoju było zgrupowanie roztoczy na zwale przeróbczym. Zaobserwowano tam większe zagęszczenie osobników Gamasida i większą różnorodność gatunkową.

Słowa kluczowe: Gamasida, zwał przeróbczy, masa poflotacyjna, gatunki pionierskie, struktura zgrupowania

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DEGRADATIVE SUCCESSION OF ACARI IN DECAYING GRASS

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Synopsis. A field experiment concerning the role of saprophagous Acari in the initial stage of the decomposition of *Dactylis glomerata* hay was conducted. Colonisation by mites occurred after a delay, i.e. after decomposition had proceeded to a certain degree. Pioneer colonisers were of the genus *Tyrophagus*, and they dominated on the hay, whereas Oribatida were scarce. Oribatida and also Tarsonemidae dominated in the soil.

Key words: degradative succession, saprophagous Acari, *Tyrophagus*, Oribatida

1. INTRODUCTION

Team research headed by Ostrihanska-Kajak [5] conducted in 1992 and 1993 at Łomna (in the buffer zone around Kampinoski National Park near Warsaw) considered the influence of epigeic macroarthropods on the decomposition of dead organic matter in soil. The work presented here aimed to assess the role of particular groups of mites in the succession associated with the ongoing decomposition of organic matter. For this purpose, the communities of saprophagous Acari of a meadow soil and of decomposing cocksfoot grass *Dactylis glomerata* were compared.

2. STUDY AREA, MATERIAL AND METHODS

The work was done on a long-established *Arrhenatheretalia* meadow on gleyed black earth with pH (in H_2O) of 4.4 [3]. In experiments, two types of isolators were used: open ones penetrable by invertebrates and closed ones inaccessible to these animals. Soil monoliths were placed in the isolators, closed with the stylon nets, and immediately returned to the places from which they had been taken. The containers placed on the surface of the monoliths contained weighed portions of hay formed from the aboveground parts of the grass *Dactylis glomerata*. New portions of hay were put out in the spring of both the first and second year of the experiment. The results presented below relate to communities of saprophagous Acari of the meadow soil and the decomposing hay in the open isolators. The mites were dislodged with the modified Tullgren apparatus. The dates of sampling are given in Table 1, along with the densities of mites.

Table 1. Densities of saprophagous mites (means ± SE) in meadow soil and the experimental hay

Date	Meadow soil	Experimental hay
21.V.1992	1192 ± 262	
4.VI.1992	1201 ± 292	
2.VII.1992	2555 ± 610	0
2.IX.1992	6841 ± 1235	12946 ± 2400
20.X.1992	7330 ± 2447	130275 ± 22936
19.IV.1993	7482 ± 1807	-
10.V.1993	2158 ± 479	227 ± 99
21.VI.1993	3919 ± 768	35767 ± 9198
27.IX.1993	5917 ± 1002	35355 ± 12720

3. RESULTS

3.1. The decomposition of hay and the population dynamics of the mite communities

The decomposition of the *D. glomerata* hay is illustrated in Figure 1A. The general indicator of the process was the declining mass of the hay [8] expressed as a percentage. The decline in mass was presented on the basis of the mass of hay remaining. In 1992, the research lasted between June and October and in 1993 between April and September. Fifty five percent of the hay still remained in an undecomposed state by October 1992 and 46% by September 1993.

In 1993, mites colonised the hay within one month of its exposure, but in 1992 the time taken for colonisation was longer. In 1992 after the 1-month time between September and October a rapid, 10-fold increase in mite density was noted. A similarly abrupt (158-fold) increase within one month occurred in 1993, between May and June, and this density was also sustained in September (Tab.1). The data suggest that the colonisation of the hay only occurred after its initial decomposition - with the intensive population growth following a loss of initial mass of about 20%.

Figure 1B and Table 1 illustrate the population changes of the saprophagous mites in the meadow soil. In 1992, the increase in mite density continued between May and September, with the rapid, almost 3-fold increase between July and September, and a slight growth beyond this period until October.

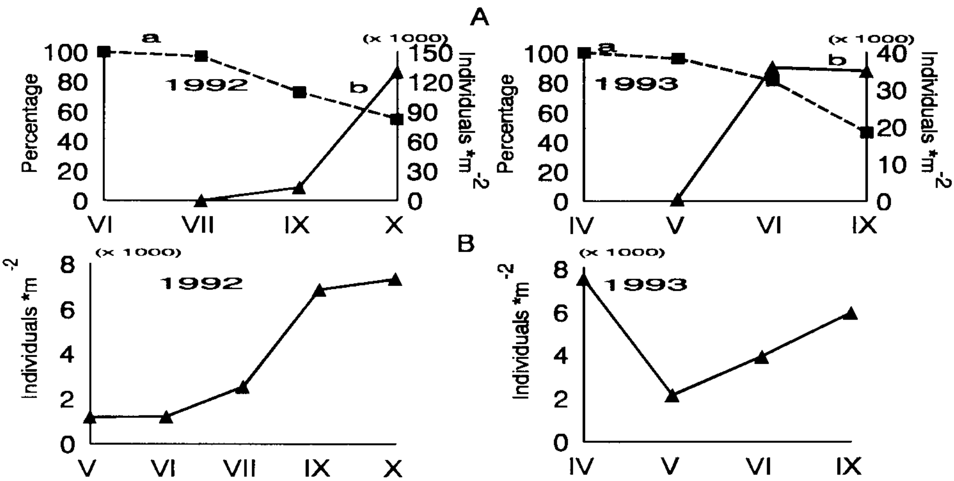

Fig. 1.A. The loss of mass of *Dactylis glomerata* and the colonisation of grass by saprophagous Acari: a - mass of hay remaining, b - mites in the litter layer;
B. The dynamics of the population of saprophagous mites in the meadow soil

In 1993, the peak density of mites was noted in April. This was followed by an abrupt decline in May and then by continuous growth in the remaining months. An intensive, 1.8 fold increase in density characterised the May-June period and a 1.5-fold increase the June to September period.

Mite communities showed a phase of rapid growth in both the experimental hay and the meadow soil. In the former, the increase was achieved within a 1-month period, while in the latter it lasted longer (as, e.g. in 1993).

3.2. The dominance structure of the communities of saprophagous mites

The meadow soil and experimental hay were colonised by almost the same taxa of mites (Fig.2). Individuals of the genera *Schwiebea*, *Scutacarus* and *Imparipes* and of the family Nanorchestidae did not occur in the hay, but their percentage representation in the community of the meadow soil was also very low (usually below 1%). The community colonising the hay included individuals of the genera *Acotyledon* and *Acarus*, which were not noted in the meadow soil. These mites, however, accounted for less than 1% of the community.

The communities of mites in the meadow soil differed from those in the hay in their less acute dominance structure. In 1992, the community in the meadow soil was mostly formed by Oribatida (31% of individuals), Tarsonemidae (39%) and *Tyrophagus* (11%). The respective figures for these groups in 1993 were 58%, only 9% and 14%. In contrast, the communities in the hay were dominated by a single genus *Tyrophagus*. This genus accounted for 91% of the total number of individuals in the community in 1992 and for 94% in 1993. Mites of the family Tarsonemidae accounted for 4% of the total, while

Oribatida did not even reach 1% (Fig.2A). The qualitative composition of taxa in the two environments was similar, although they provided differential living conditions. The hay offered optimal conditions for the development of *Tyrophagus*, but made the existence of Oribatida very difficult. In contrast, the environment of the meadow soil allowed for the development of several taxa, including in particular the Oribatida, Tarsonemidae and to a lesser extent, the mites of the genus *Tyrophagus*.

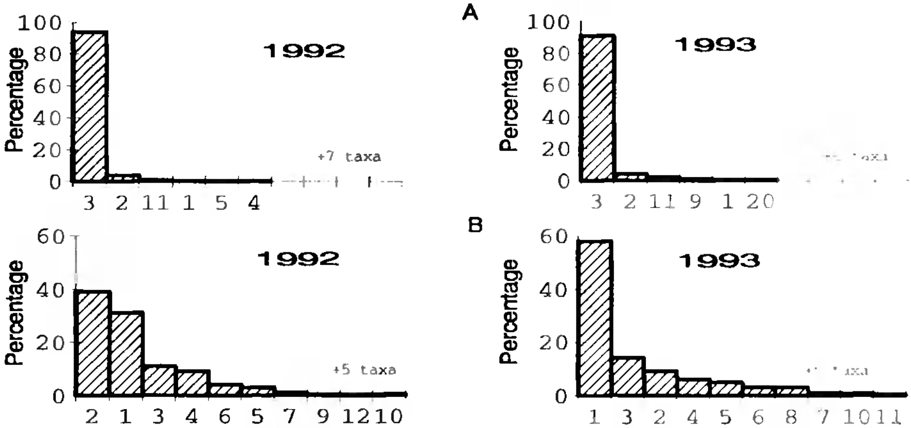

Fig.2. Structure of saprophagous Acari communities in summer 1992 and summer 1993 field experiments: A - in *Dactylis glomerata* hay, B - in the meadow soil.
Nos. of taxa:

1. Oribatida	8. *Schwiebea*	15. Nanorchestidae
2. Tarsonemidae	9. *Siteroptes*	16. *Pediculaster*
3. *Tyrophagus*	10. *Imparipes*	17. Uropodina
4. Tydeide	11. *Ameroseius*	18. Other Mesostigmata
5. Eupodidae	12. *Brennandania*	19. *Acarus*
6. *Bakerdania*	13. *Glycyphagus*	20. Acaridae - hypopi
7. *Scutacarus*	14. Anoetidae	21. *Acotyledon*

4. DISCUSSION

The characteristic phenomenon is the lack of, or at best a very limited, immediate colonisation of the hay by Acari. Only later, after a certain decline in the mass of the hay, did the colonisation proceed. This reflects the fact that saprophagous mites require food that has already been partially decomposed by microorganisms [2, 4]. A similarly characteristic phenomenon is the colonisation of the hay almost exclusively by *Tyrophagus* (accounting for more than 90% of the total numbers). This attests to the unsuitability of hay, at this stage of decomposition, as food for mites of other groups like the Oribatida. The abrupt increase in numbers of mites of the genus *Tyrophagus* within one-month points them to be r-strategists, i.e. characteristic pioneer species. The dev lopment of their populations is correlated with the availability of easily decomposable organic matter (simple carbohydrates, starch and protein). In turn, the Oribatida, which are K-strategists, are associated with the organic matter in hay like cellulose, lignin and waxes, which is very difficult to break down.

Microorganisms are also associated with organic matter decomposed to differing degrees [1, 6, 7]. Mites of the genus *Tyrophagus* have been assigned to indicatory group II, i.e. mites associated with degradative succession [9, 10].

5. CONCLUSIONS

The analysis concerned the participation of saprophagous mites in the first stage of the decomposition of dead organic matter (*Dactylis glomerata* hay). It was found that:

a) the colonisation of hay by mites followed the exposure of weighed portions after a certain delay; the process was correlated with a reduction in the mass of the hay, i.e. with its microbial decomposition,
b) the predominant and pioneer group was the mite genus *Tyrophagus*, with the other taxa from the meadow soil (e.g. Oribatida) being less represented.

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ROZKŁAD TRAWY I SUKCESJA DEGRADACYJNA ACARI

Streszczenie

W latach 1992 i 1993 w otulinie Kampinoskiego Parku Narodowego (Łomna), prowadzono zespołowe badania nad wpływem epigeicznych makrostawonogów na rozkład martwej substancji organicznej gleby. Celem niniejszej pracy była ocena poszczególnych grup roztoczy w sukcesji związanej z postępującym rozkładem substancji organicznej gleby. W tym celu porównano zespoły saprofagicznych Acari gleby łąkowej z zespołami roztoczy rozkładającej się trawy *Dactylis glomerata*. Siano tej trawy wkładano do specjalnego pojemnika, którego dno stanowiła siatka nylonowa umożliwiająca wnikanie roztoczy do rozkładającej się trawy. Pojemniki z trawą umieszczone zostały na powierzchni uprzednio wyciętych i ponownie umieszczonych w te same miejsca monolitach glebowych. Same monolity zostały zapakowane w siatki nylonowe zamykane u góry. W siatkach wycięto okienka umożliwiające wnikanie do tych prób makrofauny (izolatory otwarte). Wiosną pierwszego i drugiego roku doświadczeń wstawiano nowe naważki siana. Ustalono, że w ciągu obydwu lat roztocze *Tyrophagus* zasiedlały trawę po określonym zmniejszeniu się ciężaru trawy. Wynika to z faktu, że saprofagiczne Acari odżywiają się pokarmem częściowo rozłożonym przez mikroorganizmy. Badane siano zostało zasiedlone prawie wyłącznie przez roztocze z rodzaju *Tyrophagus* (ponad 90% liczebności roztoczy). Świadczy to o nieprzydatności pokarmowej siana na tym etapie rozkładu dla innych grup roztoczy, np. Oribatida. Roztocze z rodzaju *Tyrophagus*, w środowisku doświadczalnego siana, w ciągu miesiąca zwiększały swoją liczebność od 10 do 158 razy. Wskazuje to na ich strategię rozwoju typu r, charakterystyczną dla gatunków pionierskich. Ich rozwój skorelowany jest z łatwo rozkładalną substancją organiczną siana (proste węglowodany, skrobia, białko). Roztocze z rodzaju *Tyrophagus* zostały zaliczone do II grupy wskaźnikowej Acari związanych z sukcesją degradacyjną.

Słowa kluczowe: sukcesja degradacyjna, saprofagiczne Acari, *Tyrophagus*, Oribatida

AKADEMIA TECHNICZNO-ROLNICZA IM. JANA I JĘDRZEJA ŚNIADECKICH
W BYDGOSZCZY
ZESZYTY NAUKOWE NR 214 – OCHRONA ŚRODOWISKA 2 (1998) 277-279

COMMUNITIES OF SAPROPHAGIC MITES (ACARI, ORIBATIDA) IN KRAKÓW'S RECLAIMED AND INITIAL SOILS

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Synopsis. Communities of oribatid mites from reclaimed Jurassic limestone quarry soil and initial soil in a partially reclaimed sedimentation tank were studied. The quarry mites have a higher density and greater species diversity (2200 individuals per sq m., 41 species) than the sedimentation tank mites (1522 individuals per sq m., 17 species). In both communities parthenogenetic species belonging to Oppiidae, Brachychthoniidae, Trhypochthonidae contributed significantly to the community formation.

Key words: oribatid soil mites, succession

1. INTRODUCTION

Some of Kraków's waste sites were created by the quarrying and industrial processing of local deposits of Upper Jurassic limestone. Most of these sites have been or are being reclaimed, others owe their transformation to climatic factors and natural ecological succession. The present paper on mite communities in Kraków's reclaimed and initial soils is a continuation of the earlier research on the role of mites in soil-forming processes, conducted in Kraków [2] and Silesia [1, 5, 6].

2. MATERIAL AND METHODS

Two sites in the Podgórze district of Kraków were chosen for this study. Reclaimed scarps of the disused Zakrzówek quarry constituted site I, which was grown with flora *Tanaceto-Artemisietum vulgaris* with soil pH between 7.2 and 8.7. Site II was located in the partially reclaimed sedimentation tank of Solvay (Kraków Soda Works, closed down in 1990). The site of sampling was transformed to a small extent. Pioneer grass species (*Agrostris vulgaris* With., *Calamagrostris epigeios* L.) occurred on the site, pH of the soil was between 7.2-8.3.

Samples were collected in a 36 cm^2 auger, inserted to the depth of 7.5 cm. Forty-nine soil samples were taken in the spring and autumn of 1996. Mites were extracted from the soil using a Tullgren apparatus. Mite communities were characterised on the basis of zoocenological indices: density, dominance (*D*), species diversity (*H*) and evenness (*e*).

3. RESULTS AND DISCUSSION

The mean density of Oribatida in the reclaimed soil of the quarry was 2200 individuals per sq m. Two species dominated in the community: *Ctenobelba obsoleta* (C.L. Koch) (22.3%) and *Tectocepheus velatus* (Michael) (12.2%). Changes have been observed in the group of dominant species in comparison to the previous research [2]. Xerotermophilic species *Scutovertex sculptus* Michael, *Liacarus coracinus* C.L. Koch have been superseded by such species as *Oppiella nova* (Oudemans) (7.7%), *Liochthonius sellnicki* (Thor) (5.9%) and *Trhypochthonius* sp. (5.6%). This may indicate a progressive development of the community and increased moisture of the reclaimed quarry soil. Dominant species constituted 53.7% of the total mite population.

In the soil of the sedimentation tank Oribatida constituted a less developed community. The mean density of the mites was 1522 individuals per sq m. Species from the Oppiidae family were the most numerous and constituted 60% of the total mites population. *Tectocepheus velatus* (8.4%) also occurred in high numbers.

The values of species diversity and evenness were higher for the quarry mites (*H* – 2.8612, *e* – 0.7704). A less balanced distribution of species dominance was recorded for the tank Oribatida (*H* – 2.0583, *e* – 0.7263). The results indicate a progressive development of the Oribatida community on site I. Forty-one species were found in the quarry soil whereas earlier studies recorded only 19 [2].

The development of the community is also indicated by a decreased number of Mesostigmata, which constituted only 30% of the total mite population.

The species diversity of the sedimentation tank mites was low: 17 species were identified. Observation of the transformations in this community will be continued and reported in another study.

Among the mites collected on both sites, parthenogenetic species belonging to Oppiidae, Brachychthoniidae and Trhypochthoniidae appear to play an important role in the community formation. The role of these species in soil mite succession is mentioned in the literature [3, 4].

4. CONCLUSIONS

1. The communities of saprophagic oribatid mites colonising site I from site II differ by higher species diversity and more balanced dominance. In both communities parthenogenetic species play an important role.
2. In the developing community on site I (quarry) changes have occurred in the group of dominant species since the stage situation described in an earlier study.

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ZGRUPOWANIA SAPROFAGICZNYCH ROZTOCZY GLEBOWYCH (ACARI, ORIBATIDA) GLEB REKULTYWOWANYCH I INICJALNYCH W KRAKOWIE

Streszczenie

W pracy została przedstawiona analiza zgrupowania roztoczy z rzędu Oribatida w glebie rekultywowanego kamieniołomu wapienia jurajskiego oraz w inicjalnej glebie otaczającej osadnik sedymentacyjny nieczynnych zakładów sodowych. Roztocze kamieniołomu miały większe zagęszczenie i dużą różnorodność gatunkową (2200 osob./m^2, 41 gatunków), w porównaniu do roztoczy osadnika (1522 osob./m^2, 17 gatunków). W zgrupowaniach dużą rolę odgrywały gatunki partenogenetyczne z rodzin: Oppiidae, Brachychthoniidae, Trhypochthoniidae.

Słowa kluczowe: roztocze glebowe Oribatida, sukcesja

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W BYDGOSZCZY
ZESZYTY NAUKOWE NR 214 OCHRONA ŚRODOWISKA 2 (1998) 281-285

ANTENNOPHORINA, MICROGYNIINA, SEJINA (ACARI, GAMASIDA) OF THE BIAŁOWIEŻA NATIONAL PARK

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Synopsis. Since 1992 the Białowieża National Park has been the site of research on the mite fauna of the order Gamasida. This paper presents initial results concerning the fauna Antennophorina, Microgyniina and Sejina. Research in the area of the Białowieża National Park confirmed the occurrence of 3 species of the suborder Antennophorina, 2 species of the suborder Microgyniina, and 5 species of the suborder Sejina. A new species of mite of the genus *Schizocyrtillus* was found. It is the first time in Europe presence of this genus was discovered. In the Białowieża National Park the new species *Sejus hinangensis* and developmental stages of *Sejus rafalskii* were described.

Key words: mites, Acari, Gamasida, Białowieża National Park

1. INTRODUCTION

Research on the mite fauna of the order Gamasida of the Białowieża National Park was initiated in 1992. Fieldwork resulted in the compilation of 384 samples from various microhabitats, such as litter, anthills, dry rot, bark-beetle feedings, etc. Research was fauna-oriented and its ultimate goal was to set up an inventory of the mite species in the Park's area with the focus on Antennophorina, Microgyniina and Sejina, which are evidently less known than such suborders as Gamasina or Uropodina.

2. LIST OF SPECIES

Antennophorina, Celaenopsidae

Celaenopsis badius C.L. Koch, 1836

Microhabitat: moss, litter, under tree bark [2].
This species was found in the BNP in the habitats of *Ips typographus* L. [5, 6]. In this study it was found in 33 samples: sifted contents of a slit in lime (compartment 398G) and hornbeam (comp. 398B), bore dust and dry rot from a slit in spruce (comp. 399A), litter from among hornbeam's root burls (comp. 400A), dry rot from a hollow in maple (comp. 285B, 400A) and hornbeam (comp. 317D, 371C, 398F, 400A), bore dust from a hollow in alder (comp. 399C) and lime (comp. 340B), sifted litter (comp. 371B), bore dust underneath the bark of birch (comp. 317A, 342B), sifted litter at the base of ash (comp. 315D), litter and moss from among roots of fallen spruce (comp. 344D), bracket fungus (comp. 284D, 369B), dry rot underneath the bark of moss-covered oak (comp. 256A), moss on the bark of lime (comp. 344B), ants underneath moss on maple (comp. 318D), lichen-covered bark of withered spruce (comp. 224B), bore dust underneath the bark of spruce (comp. 224D, 228D, 286D), bore dust underneath the bark of withered spruce (comp. 317A, 340D, 401A), bark of withered spruce (comp. 288C, 2 x 315A), bark with chips (comp. 286D).

Pleuronectocelaeno austriaca (Vitzthum, 1926)

Microhabitat: insect feedings, bark's underneath, at times phoretically on bark beetles of the genera *Ips* and *Scolytus* [2].
In the BNP it was found in the habitats of *Ips typographus* L. [5, 6], and in bore dust underneath bark (comp. 286C, 286D).

Schizocyrtillus sp. n.

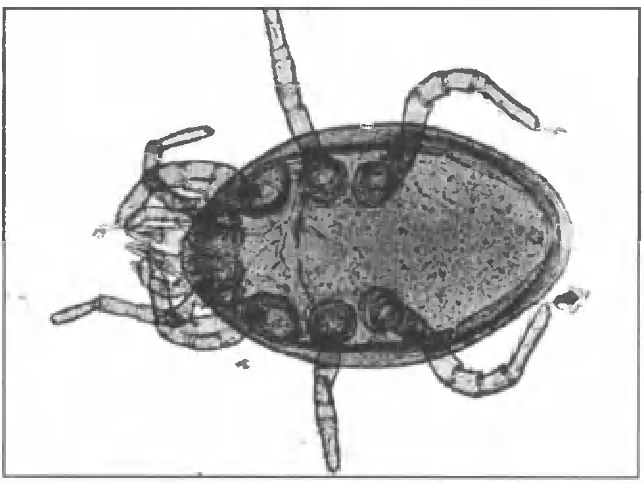

Fig.1. *Schizocyrtillus* sp. n. - female

In the BNP it was found in the sifted nest of the group *Formica rufa* ant (comp. 256C) and in bore dust underneath the bark of withered pine (comp. 256F).

Microgyniina, Microgyniidae

Microgynium rectangulatum Trägårdh, 1942

Microhabitat: rotting wood, old roots [1].
In the BNP it was found in sifted nest of the *Formica rufa* group ant (comp. 256C), bore dust underneath the bark of withered pine (comp. 256A, 318B) and spruce (comp. 317B, 371A), pieces of spruce bark (comp. 369B), bore dust underneath the bark of spruce (comp. 288D).

Microsejus truncicola Trägårdh, 1942

Microhabitat: rotting wood [1].
In the BNP it was found in sifted nest of the *Formica rufa* group ant (comp. 256C), bore dust and dry rot underneath the bark of birch (comp. 256B), dry rot from a stump (comp. 256D), dry rot underneath moss (comp. 255D), bore dust underneath the bark of spruce (comp. 288D).

Sejina, Ichthystomatogasteridae

Asternolaelaps querci Wiśniewski et Hirschmann, 1984

Microhabitat: oak's dry rot [8].
In the BNP it was found in fine dry rot from a hollow in oak (comp. 286B, 318D, 369F), dry rot from hollows in spruce (comp. 369F) and pine (comp. 287D), chips underneath the barks of oak (comp. 318D) and birch (comp. 317A), bore dust and dry rot from an old stump (comp. 284D).

Sejidae

Sejus hinangensis Hirschmann et Kaczmarek, 1991

Microhabitat: found in the paths of the bark beetle *Ips typographus* (L.) and in pine's dry rot [4].
This species was described on the example of species found in rotten spruce in the area of the BNP [4]. It also occurred in chips under the bark of withered spruce (comp. 373B) as well as in moss containing rotten bark of spruce (comp. 316A).

Sejus rafalskii Wiśniewski et Hirschmann, 1991

Microhabitat: oak's dry rot [4].
In the BNP it was found in bore dust and dry rot from a hollow in maple (comp. 285B, 398C, 399A, 400A). Material gathered in the close-protection area was used to describe one male individual and two deutonymph forms of the species [3].

Sejus sejiformis (Balogh, 1938)

Microhabitat: dry rot and soil from a hollow in spruce [7].
In the BNP it was found in sifted contents of a hollow in maple (comp. 398B, 398C).

Sejus togatus C.L. Koch, 1836

Microhabitat: a species with a broad range of occurrence, encountered in soil, litter, dry rot of: pine, spruce, oak, alder; underneath the bark of beech and spruce and in the stumps of pine, spruce, fir, oak [4].
In the BNP it was found in dry rot from a hollow in withered spruce (comp. 318A, 373B, 399C), litter (comp. 370C, 398B), bore dust underneath the bark of spruce (comp. 342D), bore dust from a hollow in oak (comp. 399B), bore dust underneath the bark of withered spruce (comp. 286D, 317A, 343C, 373D, 401A), bore dust from a hollow in lime (comp. 340B), bore dust underneath moss on oak (comp. 371D, 399B), litter at the base of pine (comp. 255C) and withered birch (comp. 284B), bore dust underneath the bark of withered pine (comp. 318B), dry rot from a stump of oak (comp. 288D), sifted nest of the *Formica rufa* group ant (comp. 256B), bore dust underneath moss-covered bark (comp. 342B), bark of withered spruce (comp. 224B, 255C, 315A), bark of birch with bracket fungus (comp. 318B), moss with bark and bore dust of spruce (comp. 316B), bore dust underneath the bark of birch (comp. 315A), bison's (*Bison bonasus* L.) excrements mixed with soil (comp. 315B), dry rot from a hollow in pine (comp. 287D).

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ANTENNOPHORINA, MICROGYNIINA, SEJINA (ACARI, GAMASIDA) BIAŁOWIESKIEGO PARKU NARODOWEGO

Streszczenie

W 1992 roku rozpoczęto badania nad fauną roztoczy z rzędu Gamasida Białowieskiego Parku Narodowego. W wyniku prac terenowych zebrano 384 próby z różnych mikrośrodowisk takich jak ściola, kopce mrówek, zmurszałe drewno, żerowiska korników i inne. Praca miała charakter faunistyczny, a jej celem było sporządzenie listy gatunków roztoczy występujących na terenie parku. Szczególną uwagę zwrócono na przedstawicieli Antennophorina, Microgyniina i Sejina, na temat których jest zdecydowanie mniej informacji w porównaniu z takimi grupami jak Gamasina czy Uropodina.

1. Z terenu Białowieskiego Parku Narodowego wykazano: 3 gatunki należące do Antennophorina, 2 gatunki należące do Microgyniina i 5 gatunków z grupy Sejina.
2. Stwierdzono występowanie nowego dla nauki gatunku z rodzaju *Schizocyrtillus*. Jest to pierwsze stwierdzenie przedstawicieli z tego rodzaju w Europie.
3. Na podstawie okazów zebranych na terenie Białowieskiego Parku Narodowego opisano nowy dla nauki gatunek *Sejus hinangensis* oraz nieznane stadia rozwojowe *Sejus rafalskii*.

Słowa kluczowe: roztocze, Acari, Gamasida, Białowieski Park Narodowy

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MITES OF THE FAMILY PARASITIDAE (ACARI, MESOSTIGMATA) OF THE DRAWNO NATIONAL PARK, GÓRY STOŁOWE NATIONAL PARK AND MAGURA NATIONAL PARK

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Synopsis. This article contains a list of mites of the family Parasitidae, found in three Polish national parks: the Drawno National Park, Góry Stołowe National Park and Magura National Park. Thirty-four species were found. Fauna of mites of the subfamily Pergamasine seems to be very specific, and none of the mite species had been found in all three parks.

Key words: mites, Acari, Mesostigmata, Parasitidae, Polish national parks

1. INTRODUCTION

The above-mentioned national parks belong to a group of newly established Polish national parks and no comprehensive research on the fauna of Mesostigmata has yet been conducted there.

The Drawno National Park (NW) was set up in 1990. Until now, research has proved the presence of 5 mite species of the order Mesostigmata with no individuals of the Parasitidae family among them [1, 3]. The Góry Stołowe National Park (SW) was established in 1993. Previous research in the park indicated 7 species of the order Mesostigmata [1, 3], with 3 of them of the Parasitidae family: *Paragamsus insertus* (Micherdziński, 1969), *P. neoruncatellus* (Schweizer, 1961) s. Micherdziński 1969 and *Leptogamasus cristulifer* (Athias-Henriot, 1967) [2]. There has yet been no research on the mite fauna of Mesostigmata in the Magura National Park (SE) [1, 3], established in 1995.

2. MATERIALS AND METHODS

Collections were carried out over the period 1994-1996, and samples were taken from various microhabitats, mainly leaf-litter, moss, soil and rotting wood. The weight and capacity of samples were different. Places of collection (20 in an each park) were selected at random.

3. RESULTS

Inventory of species of the Parasitidae family, indicated in the area of the Drawno National Park (DNP), Góry Stołowe National Park (GSNP) and Magura National Park (MNP)

Subfamily: Parasitinae

Porrhostaspis lunulata Müller, 1859 - GSNP, MNP
Vulgarogamasus kraepelini (Berlese, 1905) - DNP, GSNP, MNP

Subfamily: Pergamasinae

Holoparasitus caesus Micherdziński, 1969 - MNP
H. calcaratus (C. L. Koch, 1839) - DNP
H. quadratus Witaliński, 1972 - MNP
H. tirolensis (Sellnick, 1968) - DNP, GSNP
Leptogamasus anoxygenellus (Micherdziński, 1969) - GSNP, MNP
L. carpaticus (Micherdziński, 1969) - MNP
L. cristulifer (Athias-Henriot, 1967) - GSNP
L. cuneoliger (Athias-Henriot, 1967) - GSNP
L. decoratus Witaliński, 1973 - MNP
L. facetus Witaliński, 1973 - MNP
L. lobatus (Willmann, 1951) - GSNP
L. obesus (Holzman, 1955) - GSNP
L. suecicus (Trägårdh, 1936) - DNP, GSNP
Paragamasus alpestris (Berlese, 1904) - GSNP
P. conus (Karg, 1971) - DNP
P. crassicornutus (Willmann, 1954) - MNP
P. holzmannae (Micherdziński, 1969) - MNP
P. insertus (Micherdziński, 1969) - GSNP
P. lapponicus (Trägårdh, 1910) - DNP
P. misellus (Berlese, 1903) s. Karg 1971 - DNP, MNP
P. neoruncatellus (Schweizer, 1961) s. Micherdziński 1969 - GSNP
P. puerilis (Karg, 1963) - DNP, GSNP
P. runcatellus (Berlese, 1904) - DNP, MNP
P. runciger (Berlese, 1904) - DNP
P. truncellus (Athias-Henriot, 1967) - GSNP

P. vagabundus (Karg, 1968) - DNP, GSNP
Pergamasus barbarus Berlese, 1904 - GSNP, MNP
P. brevicornis Berlese, 1903 - DNP, MNP
P. laminarius Witaliński, 1971 - MNP
P. mediocris Berlese, 1904 - GSNP, MNP
P. quisquiliarum (G. et R. Canestrini, 1882) - DNP
P. septentrionalis (Oudemans, 1902) s. Bhattacharyya 1963 - DNP

The number of indicated species totals up to 34, with 32 of them belonging to the subfamily Pergamasinae. The mite fauna of this subfamily seems to be very specific and no species were encountered in all three national parks, while as many as 22 species were found in one of these parks. Particularly interesting is the indication of occurrence of species *Paragamasus insertus*, previously found in Góry Stołowe Mts. and described by Micherdziński [2]. Another interesting species from this area is *Leptogamasus lobatus*, which the one specimen (male) is the only recorded in Poland (Fig.1).

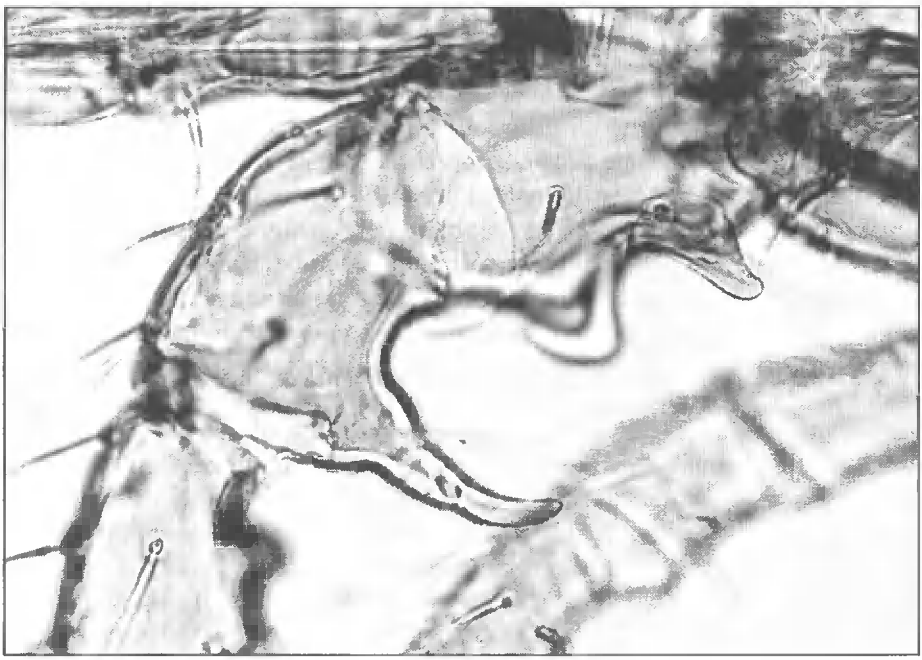

Fig.1. L. *lobatus*, male, leg II

The species *Pergamasus laminarius* from Cergowa Góra (Beskid Niski Mts), located close to the Magura National Park which was described by Witaliński [4], and not encountered elsewhere, was also found.

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ROZTOCZE Z RODZINY PARASITIDAE (ACARI, MESOSTIGMATA) DRAWIEŃSKIEGO PARKU NARODOWEGO, PARKU NARODOWEGO GÓR STOŁOWYCH I MAGURSKIEGO PARKU NARODOWEGO

Streszczenie

Badania na terenie wymienionych parków narodowych prowadzono w latach 1994-1996. Należą one do grupy niedawno utworzonych parków narodowych Polski i dotychczas nie prowadzono tam kompleksowych badań na temat fauny roztoczy z rzędu Mesostigmata. Łącznie wykazano 34 gatunki roztoczy z rodziny Parasitidae, z czego aż 32 należą do podrodziny Pergamasinae. Fauna roztoczy z tej właśnie podrodziny wydaje się być bardzo specyficzną i dotychczas nie znaleziono gatunku, który wystąpił na terenie wszystkich trzech parków narodowych, a aż 22 gatunki wykazano wyłącznie w jednym z nich.

Słowa kluczowe: roztocze, Acari, Mesostigmata, Parasitidae, polskie parki narodowe

AKADEMIA TECHNICZNO-ROLNICZA IM. JANA I JĘDRZEJA ŚNIADECKICH
W BYDGOSZCZY
ZESZYTY NAUKOWE NR 214 OCHRONA ŚRODOWISKA 2 (1998) 291-298

SOIL GAMASINA (ACARI, GAMASIDA) OF THE FERTILE CARPATIAN BEECH FOREST IN THE GORCE NATIONAL PARK

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Synopsis. The composition of species and zoocenological structure of soil Gamasina communities of Carpatian beech forest in the Gorce National Park were analysed. Five thousand eight hundred and seven specimens, representing 53 species, were identified. The most common species were: *Veigaia nemorensis*, *Leptogamasus decoratus*, *Zercon triangularis* and *Geholaspis pauperior*. *Iphidosoma physogastris*, *Veigaia perinsolita*, and *Epicriopsis rivus* were recorded for the first time in Poland.

Key words: Gamasina, community structure, Carpatian beech forest, Gorce National Park

1. INTRODUCTION

Even a brief analysis of the data on the soil Gamasina mites suffices to reveal that the information about this suborder in Poland is rather far from complete. There are a few papers, which analysed this group of mites in some interesting ecosystems in nature reserves or national parks. Some faunistic data can be found in monographs on particular families, systematic works such as revisions, descriptions of new species, and in some brief comments on the sites of the species of mites, which are rare in our fauna. Some data on the occurrence and distribution of particular species can also be found in papers on selected problems of coexistence, including parasitism in various groups of invertebrates and vertebrates. Few attempts have been made to characterise the Gamasina soil fauna in protected areas by [1, 2, 3, 4, 20] and [21]. Recently, a through analysis of the sites of some Gamasida mites in national parks was made [9]. From the Gorce National Park area 21 species were reported, and three were qualified to the genus level.

2. STUDY AREA

The Gorce National Park extends over the Gorce Mountains range and occupies the area of 7019 hectares. It has been established mainly to protect the remains of the old Carpatian forests and preserve the great variety of abundant forest communities in the area. The largest area of the park covers a low-subalpine beech forest (60%), which includes different sub-associations and humidity variants [6]. The communities there belong to the complex of Carpatian beech forests (*Dentario glandulosae-Fagetum*) and cover almost entirely the slopes from the intermediate zone ranging from 600 to 1150 m above sea level [13]. The edaphic and climatic conditions are diversified. In marshland areas with fertile humus, the undergrowth zone includes: *Allium ursinum*, *Chrysosplenium alternifolium*, *Stellaria nemorum* and *Corydalis cava*. The slopes are covered with typical beech forest with rich undergrowth [13] where one can spot *Dentaria glandulosa*, *Symphytum cordatum* and *Polystichum Braunii*. In the places covered with sparse forest, the dominant vegetation, are ferns such as *Athyrium filix-femina*, *Dryopteris filix-mas* and *Aspidium lonchitis*. The upper slopes and ridges are covered with the poorest in plant species variant of beech forest with *Oxalis acetosella*, *Vaccinium myrtillus*, *Luzula nemorosa* and *Majanthemum bifolium*. As far as the forestation is concerned in the zone at lower altitudes (600–700 m), there is a significant contribution of fir trees, in the zone of the intermediate altitudes beech trees are dominant and at the higher altitudes of 1000–1150 m, spruce trees are evident.

3. MATERIAL AND METHODS

The mites were collected from 133 monitoring plots (178 samples) in the Gorce National Park between 1992 and 1995. Samples were sieved from leaf litter and soil (qualitative sample) and some of them were taken using a cylindrical core sampler – each of 100 cm^2 x 10 cm deep (qualitative sample). One or two samples were taken from each monitoring plot. The fauna was not sampled at constant intervals. The mites were extracted with a modified Tullgren extractor. All samples were preserved in 75% ethyl alcohol. Each specimen was slide mounted in Faure's medium. Immatures of mites were not assigned to species (except *Iphidosoma physogastris*). The majority of species were determined after [8] and [10], referring to the works giving the description of the typical material only in the case of doubts.

The material was analysed using zoocenological indices such as: abundance, dominance, frequency of occurrence [16] and species diversity using the Shannon-Wienner index [11]. Data on mite species distribution and preferences of particular habitats were taken from [8, 10].

The aim of this study was to recognise the structure of the soil Gamasina mites and give zoocenological characteristics of their groups in the area of the low subalpine Carpatian beech forest in the Gorce National Park.

4. RESULTS

4.1. Composition of species

The results presented in this paper are based on analysis of 5807 specimens repesenting 53 species (Tab.1) of soil Gamasina, including 3610 adults and 2197 juveniles.

Table 1. The dominance and constancy indices of some gamasid mites in the fertile Carpatian beech forest

Species	Dominance in %	Constancy in %	Variants
1	2	3	4
Ameroseius longitrichus Hirschmann, 1963	0.0	1.1	DgFz
A. plumigerus (Oudemans, 1930)	0.5	3.9	DgFz/DgFu
Arctoseius magnanalis Evans, 1958	0.2	3.4	DgFz/DgFu
A. semiscissus (Berlese, 1892)	0.0	0.6	DgFz
Epicriopsis rivus Karg, 1971*	0.2	2.8	DgFz/DgFu
Epicrius resinae Karg, 1971	1.0	14.0	DgFz/DgFu
Eugamasus cavernicola Trägårdh, 1912	0.0	0.6	DgFz
Eviphis ostrinus (C.L.Koch, 1836)	0.8	12.9	DgFz/DgFu
Gamasellus montanus (Wilmann, 1936)	1.2	7.9	DgFz/DgFu
Geholaspis longispinosus (Kramer, 1876)	2.0	18.0	DgFz/DgFu
G. mandibularis (Berlese, 1904)	0.2	4.5	DgFz/DgFu
G. pauperior (Berlese, 1918)	9.1	32.0	DgFz/DgFu
Holoparasitus ampullaris Witaliński, 1994	1.2	12.4	DgFz/DgFu
Holostaspella exornata Filliponi & Pegazzano, 1967	0.0	0.6	DgFu
Hypoaspis aculeifer (Canestrini, 1883)	0.0	0.6	DgFz
Iphidosoma physogastris Karg, 1971*	0.0	0.6	DgFu
Leptogamasus bicorniger Witaliński, 1977	0.8	10.7	DgFz/DgFu
L. decoratus Witaliński, 1973	19.8	48.3	DgFz/DgFu
L. facetus Witaliński, 1973	0.1	1.1	DgFz/DgFu
Macrocheles glaber (Müller, 1860)	0.0	0.6	DgFz
M. montanus (Willmann, 1951)	0.4	5.1	DgFz/DgFu
Pachylaelaps furcifer Oudemans, 1903	0.0	1.1	DgFz
P. ineptus Hirschmann & Krauss, 1965	1.2	8.9	DgFz/DgFu
P. laeuchlii Schweizer, 1922	0.1	2.2	DgFz/DgFu
P. magnus Halbert, 1915	0.2	2.8	DgFz/DgFu
P. undulatus Evans et Hyatt, 1956	0.9	9.0	DgFz/DgFu
P. vexillifer Willmann, 1956	2.1	18.5	DgFz/DgFu
Paragamasus cambriensis Bhattacharyya, 1963	0.3	5.1	DgFz
P. holzmannae (Micherdziński, 1969)	0.4	4.5	DgFz/DgFu
P. runcatellus (Berlese, 1903)	0.2	0.6	DgFz
Parazercon radiatus (Berlese, 1914)	0.5	5.6	DgFz/DgFu
Pergamasus barbarus (Berlese, 1904)	1.6	16.3	DgFz/DgFu
P. brevicornis Berlese, 1903	2.1	18.8	DgFz/DgFu
P. mediocris Berlese, 1904	1.2	13.5	DgFz/DgFu
Prozercon fimbriatus (C.L. Koch, 1839)	0.0	0.6	DgFz/DgFu
P. kochi Sellnick, 1943	3.0	16.3	DgFz/DgFu
P. kunsti Halaškova, 1963	0.5	1.1	DgFz/DgFu
P. sellnicki Halaškova 1963	0.2	2.2	DgFz/DgFu
P. traegardhi (Halbert, 1923)	0.0	1.1	DgFz/DgFu

Table 1 (continued)

1	2	3	4
Veigaia cervus (Kramer, 1876)	0.2	3.9	DgFz/DgFu
V. exigua (Berlese, 1916)	0.1	0.6	DgFz
V. kochi (Trägårdh, 1901)	0.3	2.8	DgFz/DgFu
V. nemorensis (C.L.Koch, 1839)	30.2	67.4	DgFz/DgFu
V. perinsolita Athias-Henriot, 1961*	0.1	2.2	DgFz/DgFu
V. transisalae (Oudemans, 1902)	0.1	2.2	DgFz/DgFu
Vulgarogamasus kraepelini (Berlese, 1904)	5.0	34.8	DgFz/DgFu
V. remberti (Oudemans, 1912)	0.0	0.6	DgFu
Zercon arcuatus Trägårdh, 1931	0.0	0.6	DgFz
Z. curiosus Trägårdh, 1910	0.0	0.6	DgFu
Z. peltatus peltatoides Halašková, 1969	0.0	0.6	DgFz
Z. romagniolus Sellnick, 1944	1.0	8.4	DgFz/DgFu
Z. triangularis C.L.Koch, 1836	10.6	28.6	DgFz/DgFu
Zerconopsis remiger (Kramer, 1876)	0.0	0.6	DgFz

DgFz - fertile variant of *Dentario glandulolosae-Fagetum*
DgFu - poor variant of *Dentario glandulosae-Fagetum*
* - new species to Polish fauna

The species new to Poland were the following: *Iphidosoma physogastris*, *Veigaia perinsolita*, and *Epicriopsis rivus*. *Geholaspis pauperior* and *Pachylaelaps undulatus* are very rare and were found for only the second time in Poland.

Iphidosoma physogastris is found in deciduous, mixed and coniferous forests, in highly and moderately humid litter, frequently in moss and humus. It has been reported from Lithuania, Latvia and Western Europe. In the area of study a single deutonymph was found at the altitude of 1080 m.

Veigaia perinsolita is known from beech forests in Spain. In the Gorce National Park 4 females were found at four sites. This species occurs here in brown soils at altitudes of 790 to 1010 m.

Epicriopsis rivus is found rarely in mixed forests, humid spruce forests, in the soil of wet meadows, moss near streams (stream sources) and in rotting straw. It has been reported from central Europe. In the area of study it was found at five sites (5 females and 1 male), at altitudes of 770-940 m.

Geholaspis pauperior occurs in deciduous and coniferous litter, decomposing wood and moss in the hilly and mountainous terrains. It has been reported from Italy and Czech Republic. In the study area it was very abundant (328 female specimens) and was classified as a dominant (D_4 - 9.1%). It was uniformly distributed as is indicated by a high value of constancy (C_3 - 32%). Among the species found it was the fourth most abundant, determined by the values of these two indices.

Pachylaelaps undulatus, was described from rotting wood and refuse heaps near a pond [7]. It was also reported from the Central and Northern Europe from coniferous litter in mixed forest and in plants thrown by the sea. Thirty females of this species were found in Carpatian beech forest.

4.2. Zoocenological structure

The most abundant species in the studied environment (eudominants) were *Veigaia nemorensis*, *Leptogamasus decoratus* and *Zercon triangularis*. The class of dominants included *Geholaspis pauperior* and *Vulgarogamasus kraepelini*. The subdominants included 2 species, recedents – 6 and subrecedents – 39 species. As far as the constancy of occurrence is concerned, no species could be classified as euconstants. The class of constants included only *Veigaia nemorensis*, and the class of accessorial species included: *Leptogamasus decoratus*, *Vulgarogamasus kraepelini* and *Zercon triangularis*. The most abundant species were also the most frequent ones (Fig.1).

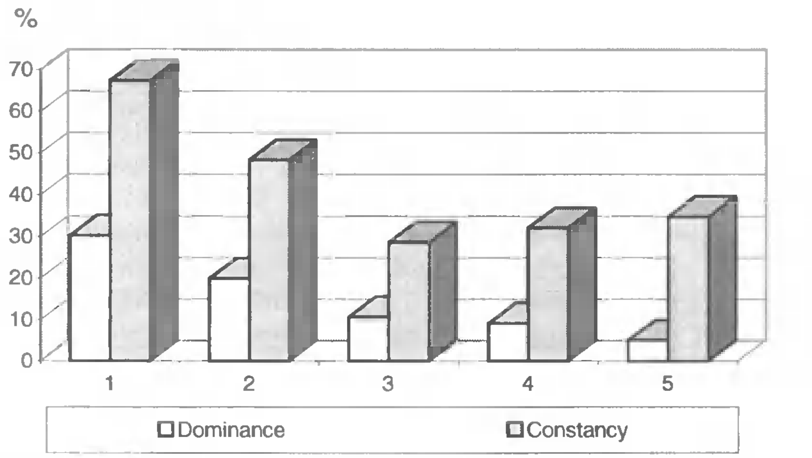

Fig.1. Zoocenological structure of the five the most abundant species:
1 – *Veigaia nemorensis*
2 – *Leptogamasus decoratus*
3 – *Zercon triangularis*
4 – *Geholaspis pauperior*
5 – *Vulgarogamasus kraepelini*

Detailed analysis of the species structure in the fertile (typical) and poor variant of Carpathian beech forest revealed small differences (Tab.1). The abundance of soil mite populations was 1716 and 1250 indiv./m^2 in the fertile and poor variant, respectively, while the mean abundance in the whole area studied was 1506 indiv./m^2. The Shannon-Wiener coefficient, describing diversity of species (H), was 3.56 and 3.38 in the fertile and poor variant, respectively.

5. DISCUSSION AND CONCLUSIONS

Mites from the Gamasida order consist of a few to about 20% of the whole of mites [15]. Gamasina, the richest in species suborder of Gamasida, includes both parasite and free-living species. The majority of Gamasina families living in soil are predators. In lowland beech forests their density varies from 2620 to 10800 indiv./m^2 [12, 14, 17, 18]. In the form of subalpine beech forest of the Sudety Mountains (*Fagetum sudeticum*) the density was 3483 indiv./m^2 [5]. In the Carpatian type of beech forest this index is lowered to 1506 indiv./m^2. The density of Uropodina in the same area is 624 indiv./m^2, [Błoszyk, unpublished]. Gamasina and Uropodina are the two most abundant groups among Gamasida, so the density of Gamasida in the area of the Carpatian beech forest in the Gorce National Park is about 2150 indiv./m^2.

The species characterised by the highest values of the dominance and constancy indices in the area of study is *Veigaia nemorensis*, which is known for its wide ecological range and dominates in many diverse environments. Interestingly, the species rare in Poland, *Leptogamasus decoratus* and *Geholaspis pauperior* were relatively abundant. The most abundantly represented families proved to be Parasitidae (32.8%), Veigaiidae (31.1%), Zerconidae (15.9%) and Macrochelidae (11.7%) (Fig.2).

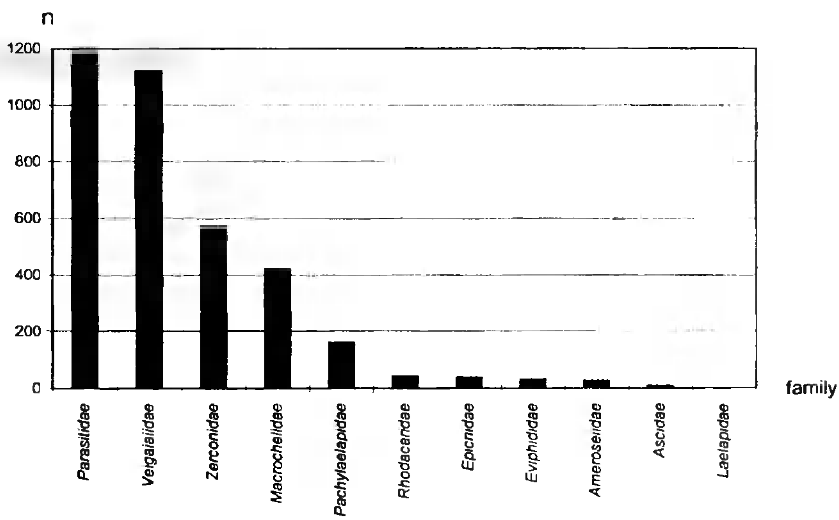

Fig.2. The specimen contribution in the families studied; n – number of specimens

A high percentage of Parasitidae and Veigaiidae has been confirmed by studies in beech forests in wastelands [12]. The species composition and zoocenotic indices point to a greater richness of species in fertile Carpatian beech forestand than in its poor variant. High indices of the species diversity testify to the state of relative biocenotic equilibrium in the communities and their stability, and indirectly to a complexity of habitats [19]. In the fertile variant the index of the species diversity is a bit higher which may indicate a greater stability and better organisation of soil mite communities in the environment studied.

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ROZTOCZE GLEBOWE GAMASINA (ACARI, GAMASIDA) W ŻYZNEJ BUCZYNIE KARPACKIEJ NA OBSZARZE GORCZAŃSKIEGO PARKU NARODOWEGO

Streszczenie

Autor zanalizował skład gatunkowy i strukturę zoocenologiczną zgrupowań roztoczy glebowych Gamasina w żyznej buczynie karpackiej (*Dentario glandulosae-Fagetum*) na obszarze Gorczańskiego Parku Narodowego. Wykazano 53 gatunki roztoczy. Najliczniejszymi gatunkami były: *Veigaia nemorensis*, *Leptogamasus decoratus*, *Zercon triangularis* i *Geholaspis pauperior*. *Iphidosoma physogastris*, *Veigaia perinsolita* oraz *Epicriopsis rivus* to gatunki nowe dla fauny Polski.

Słowa kluczowe: Gamasina, struktura zgrupowań, buczyna karpacka, Gorczański Park Narodowy

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W BYDGOSZCZY
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EUPTYCTIMOUS (ACARI, ORIBATIDA) MITES FROM THE BERMUDA ISLANDS

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At 20 different localities of Bermuda Islands, 17 species of euptyctimous mites have been found. The majority of them are widespread, 4 are semicosmopolitan and 4 are Gondwanan, two originate from Central America, one from North America, one from the Neotropical region, one has probably been introduced from Europe. Of the four endemic species one is of Neotropical origin, one of North American origin, one of central American origin. The origin of fourth species is enigmatic. In general, it can be said that the euptyctimous mites fauna of Bermuda Island is of mixed character, with contributions from all parts of the American continent.

AKADEMIA TECHNICZNO-ROLNICZA IM. JANA I JĘDRZEJA ŚNIADECKICH
W BYDGOSZCZY
ZESZYTY NAUKOWE NR 214 - OCHRONA ŚRODOWISKA 2 (1998) 301

PTYCTIMOUS MITES (ACARI, ORIBATIDA) FROM THE PHILIPPINES

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The fauna of ptyctimous mites of the Philippine Islands encompasses 28 species found in 122 soil samples collected at different localities. Four species had already been known in the Philippines (Corpuz-Raros 1979), they are *Apoplophora pantotrema, Plonaphacarus kugohi, Antropacarus (Hoplophorella) andrei* and *Rhysotritia lucida* determined as *Rhysotritia otaheitensis*. The other 24 species are new for the Philippines, among them one belongs to Protoplophoroidea, three to Mesoplophoroidea, fifteen (over a half of the species) belong to Euphthiracaroidea, nine to Phthiracaroidea. Eight of all species are widespread, among them semicosmopolitan species *R. ardua, P. kugohi* and *A.(H.) cucullatus*, and pantropical species *A. glomerata, I. krakatauensis, M. tropica, A.(H.) andrei, A.(H.) glaucus*. The fauna of ptyctimous mites of the Philippines shows a strong regionalism as half of the species found there are of definitive Oriental origin, and six species which most probably are endemites. It is interesting to note that the majority of Oriental species are Euphthiracaroidea as well as all Mesoplophoroidea. From among 14 species of Oriental origin, six spread on to the Pacific Islands, these are *S. corneri, A. lebronneci, R. anchistea, R. lucida, R. refracta* and *R. spiculifera*, while two species - *A. robusta* and *A. pantotrema* - belong also to the Australian region. All these species belong to Euphthiracaroidea (with the exception of *A. pantotrema*). Totally unexpected was the finding *Aedoplophora glomerata* - a species known so far only from the Neotropical region. The locality in the Philippines significantly extends the zoogeographical range of this species.

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W BYDGOSZCZY
ZESZYTY NAUKOWE NR 214 - OCHRONA ŚRODOWISKA 2 (1998) 303-304

EUPHTHIRACAROIDEA (ACARI, ORIBATIDA) FROM ETHIOPIAN REGION

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The fauna of Euphthiracaroidea of the Ethiopian region has not been sufficiently well recognised; the hitherto collected data are fragmentary, so it seems too early to draw conclusions about the zoogeography of the region. The conclusions presented here are rather hypothetical.

From among 30 species of Euphthiracaroidea known from the Ethiopian region, only five are widespread and most probably introduced. They are semi-cosmopolitic *Rhysotritia ardua*, species which was found at the sites in central Africa, and three pantropical species: *I. krakatauensis* occurring in Tanzania and on a few islands, *Rhysotritia anchistea* found in central Africa, *M. tropica* occurring on the Comoro Islands and Seychelles and *Rhysotritia spiculifera* probably oriental origin and significantly disjunctive, found on in Ivory Coast and on Comoro.

From the remainder 25 species whose occurrence is limited to the Ethiopian region, 12 are widespread on Africa and 13 have been classified as endemites (five of them, so nearly a half, belong to the subgenus *Pocsia*, they were found mostly in Tanzania). The species classified to the two groups occur both on the continent of Africa and on the islands near it. Nineteen of these species occur only in continental Africa, including six more or less extensive (*O. africana, M. ruwenzorii, I. (A.) compacta, E. (P.) disparilis, E. (P.) heterotrichus, R. rustica*), eleven occur in the restricted area of one country in central Africa, and they are: *O. solitaria, M. australis, I. (I.) breviseta, I. (I.) nuda, E. (P.) africanus, E. (P.) bicarinatus, E. (P.) inopinatus, E. (P.) kunsti, E. (P.) secundus, E. (P.) trentus, R.. reticulata*.

From among another group of 8 species found only on the islands, three were found on a few islands (*O. spinosa, M. hauseri, M. tropica*) while the occurrence of 5 was limited to only one island (*O. succinata, I. (I.) clavata, I. (I.) paulyi, I. (I.) tripartita, A. herenessica*). Only three species were found to occur both on the continent and on the islands, these are: *O. tiwi, I. (I.) krakatauensis* and *R. spiculifera*.

The Ethiopian fauna of euphthiracaroid mites is assumed to be very old, dating back to the time before the division of Gondwanaland, which is indicated by the presence of 7 species (almost 25%) of the two very primitive genera *Oribotritia* and *Mesotritia*. Also phylogenetically the youngest genera such as *Rhysotritia* and *Microtritia* are represented. No correlation was established between the geographical distribution of the species and phylogenetic hypotheses of Euphthiracaroidea.

The specific environmental conditions favoured adaptive radiation leading to the appearance of subgenera specific of this region like *Afrotritia* and *Pocsia*. The adaptive radiation of the *Pocsia* species was particularly strong, it is represented by 8 species which makes over 25% of the Euphthiracaroidea found. Genus *Pocsia* is a vicariant of the genus *Euphthiracarus*, which is rather commonly found in the Nearctic Region.

In concluding, the fauna of Euphthiracaroidea in the Ethiopian region has developed a strong regionalism and reveals either distant or no relationship with the faunas of other zoogeographical regions. Moreover, the fauna of Euphthiracaroidea shows very limited affinity to the Oriental fauna, despite the supposed contact with India in the remote past. The presence of the species *I. (I.) krakatauensis*, *R. spiculifera* and perhaps *R. anchistea* support the only evidenced relationship with the Oriental fauna. These data are confirmed by results of studies on other kinds of animal groups.

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