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OCCURRENCE OF SPIDER MITES (Prostigmata: Tetrnaychidae) AND PHYTOSEIID MITES (Mesostigmata: Phytoseiidae) AS THEIR POTENTIAL ENEMIES, ON NORWAY SPRUCE (*Picea abies* (L.)) AND ITS CULTIVARS GROWN IN ORNAMENTAL PLANT NURSERIES IN POLAND

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Abstract. despite intensive chemical plant protection conducted in ornamental nurseries in Poland, spider mites are still one of problematic pests. In view of increasing resistance of spider mites on acaricides, searching for alternative methods of nursery plants protection against those pests, seems to be reasonable. In this work it was important to find out which cultivars of Norway spruce grown in nurseries are threaten by infestation by large amounts of spider mites and to verified if and which species of phytoseiid mites occur on spruces grown in chemical protected nurseries. Density and species composition of tetranychid and phytoseiid mites were also investigated on Norway spruces growing in forests. Our investigations showed that, almost all cultivars of Norway spruce that are offered for sale in nurseries are inhabited by spider mites. Cultivars 'Inversa', 'Remontii', 'Waldbrund', 'Nidiformis' or 'Pumila Glauca' were identified as especially threatened with massive infestation by those pests. Also some predatory mites, such as *Typhlodromus tiliae* Oudemans, were observed in nurseries, but their density was several times lower than on spruces growing in natural conditions. Additionally in forests we observed also *Anthoseius bakeri* (Garman) and *Amblyseius andersoni* (Chant).

Key words: predatory mites, species association, co-occurrence, coniferous plants

INTRODUCTION

Over the past few years the nursery production of ornamental conifers in Poland has been observed to develop dynamically. The success of such production, equivalent to its profitability, largely depends on the quality of the plant material offered. Only the plants

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remaining in good condition present their full decorative and commercial value. Apart from abiotic factors (climate, soil), plant health is greatly determined by pests and disease-causing pathogens. Among the first, these especially dangerous are pests of small body size (difficult to spot with the naked eye), short life cycle and high fertility, such as spider mites and eriophyoids. Such life parameters make them difficult to detect, before the pest population reaches the size threatening the plant's proper development.

While the occurrence and distribution of eriophyoid mites on coniferous trees have been thoroughly examined [Lewandowski and Kozak 2008, Castagnoli et al. 2010], the information on tetranychid mites of ornamental and forest coniferous plants is found scattered in many taxonomic and faunistic papers [Jeppson et al. 1975, Marshall 1986, Lehman 1998]. Only Przygoda [2001] present an evaluation of threat posed by spider mites to coniferous plants growing in botanical gardens. Puchalska et al. [2006] reported that even the trees in the same genus may differ in susceptibility to the same pest, among others due to very specific biochemical composition of plants [Puchalska et al. 2006, 2008]. Therefore it is important to select those species or varieties that are particularly vulnerable to the pest feeding.

In Poland, the pest management on nursery plant material commonly bases on chemical pesticides. However, the EU directive no. 2009/128/EC, effective as of January 1, 2014, imposes an obligation of integrated plant protection against pests on producers of its member countries, including Poland. Seeking an alternative to chemical methods of ornamental plant protection against spider mites is justified also in the case of urban greenery. Due to the presence of people in places such as parks, public gardens, botanical gardens the safe conduct of the procedure with the use of pesticides is hindered. Engaging entomophages may be in this case the safest method to plant protection. The most important among the natural enemies of spider mites are phytoseiid mites. Nevertheless biological control of spider mites with the use of predatory mites from the family of phytoseiids bases mainly on the introduction of exotic species into greehouses [Naher and Haque 2007, Oliveira et al. 2009]. So far, there is only few attempts to apply introduction of phytoseiids on ornamental plants in the field [West and DeAngelis 1993, Kaźmierczak 2004]. In such a case introducing indigenous species of predators gives better results in pest control [Kreiter et al. 2000, Tuovinen et al. 2000].

Recent bibliography sources on spider mites and phytoseiid mites of conifers indicate that our knowledge on those pests is less than sufficient. Therefore the aim of the study was: 1) preliminary assessment of risk of massive infestation by Tetranychidae on particular cultivars of Norway spruce in nurseries; 2) determination of the species composition and abundance of Phytoseiidae occurring on *P. abies* and its cultivars in ornamental plant nurseries and their comparison with those observed on spruce trees in natural conditions (forests).

MATERIALS AND METHODS

Plant material. The object of our research was Norway spruce (*Picea abies* (L.) Krast) and its cultivars grown in ornamental plant nurseries. As we were informed by producers, these cultivars are very popular among clients, but they require intensive pest

management. Plant material was collected in June and July from eight nurseries within Central Poland (Mazovian province) (tab. 1). All of them had a long history of using chemical plant protection involving acaricides. The studies involved 17 cultivars of the Norway spruce (4–8 years old) such as: 'Barryii', 'Pygmaea', 'Maxwellii', 'Nidiformis', 'Pumila Glauca', 'Acrocona', 'Echiniformis', 'Cupressina', 'Procumbens', 'Ohlendorffii', 'Wills Zwerg', 'Virgata', 'Pumila Nigra', 'Waldbrund', 'Remontii', 'Inversa', 'Little Gem', growing in plastic containers (pots or rings). From each plant taxon 30 shoots, a 15 cm long each, were collected. Shoots were taken randomly from different parts of each cultivar (one shoot from a plant = simple sample). Samples were also collected from older trees of Norway spruce do not offered for sale but growing at nurseries as soliters, as a part of exemplary plant arrangements, or in one case forming a hedge adjacent to commercial spruce cultivars (we named that trees associate spruces). Such plants were of interest due to a potential source of pests or their natural enemies. In addition, samples were also collected from Norway spruce trees growing in forests of the Mazovian province (tab. 1). Thirty shoots of mature trees, a 15 cm long each, were collected from different parts of the plants' crowns, up to a height of eight meters.

Table 1. List of sampling localities

Locality	Stand	GPS coordinates	
Wola Prażmowska	nursery	N 51° 56' 40.2335"	E 20° 59' 28.3733"
Wola Mrokowska	nursery	N 52° 1' 47.8682"	E 20° 51' 3.909"
Józefosław	nursery	N 52° 5' 37.504"	E 21° 2' 14.3844"
Piaseczno	nursery	N 52° 3' 19.1329"	E 21° 3' 13.8575"
Henryków	nursery	N 52° 0' 6.5826"	E 20° 56' 10.3848"
Ciechanów	nursery	N 52° 53' 18.1824"	E 20° 34' 43.3999"
Ożarów Mazowiecki	nursery	N 52° 12' 7.4534"	E 20° 48' 27.1274"
Grodzisk Mazowiecki	nursery	N 52° 5' 54.5564"	E 20° 34' 54.4202"
Żebry Kolonia	forest	N 52° 40' 26.7321"	E 22° 22' 1.2965"
Łomianki	forest	N 52° 19' 31.2492"	E 20° 52' 37.299"
Piotrowe Pole	forest	N 51° 11' 10.9324"	E 21° 14' 8.9286"
Wyszków	forest	N52° 34' 32.2309"	E 21° 30' 5.8227"
Kabaty	forest	N 52° 7' 17.8765"	E 21° 4' 43.1177"
Powsin	forest	N 52° 7' 6.6354"	E 21° 5' 23.1319"

Determination of the abundance and species composition of spider mites and phytoseiids. Density of phytoseiids was expressed by mean number of the mites per 15 cm of shoot. Species identification of phytoseiids was carried out according to the keys of Kropczyńska-Linkiewicz [2001] and Beglyarov [1981], and then the share of particular phytoseiid species in the collected samples was established.

The rate of plant colonization by spider mites was determined for each taxon of the plant studied, by using such parameters as: density, intensity and prevalence [Bush et al. 1997, Lewandowski and Kozak 2008]. Tetranychid species were identified using identification keys by Pritchard and Baker [1955], Reeves [1963] and Kropczyńska [1999].

The density of phytoseiids and spider mites on plant shoots had a specific pattern, connected with a large number of zero values in a sample. For this reason, analysis of that parameter with statistical methods would be imprecise. However, it was possible to use separate statistical analyses for prevalence and intensity of spider mites occuring on the plants. Differentiation of the studied cultivars in terms of the intensity and prevalence was studied using generalized linear mixed effects models with binomial distribution and logit link function. As the error homogeneity assumption of the linear model was violated, the estimation was made using generalized least squares with the power function of a variance covariate [Pinheiro and Bates 2000]. Pair-wise comparisons were conducted according to Tukey's contrasts for the corresponding generalized linear mixed effects model [Hothorn et al. 2008], without adjustment for multiple testing (according to Webster's [2007] recommendation). The significance level for all analyses was 0.05. The analyses were conducted in R environment [R Development Core Team 2013].

Occurrence and co-occurrence coefficient of the predators and their preys. On the basis of the collected data, occurrence coefficient which is the measure of frequency of species in the collected samples was established after Kasprzak and Niedbała [1981]. For interpretation of the results, values are usually divided into four classes: (C_4) 75.1–100.0% euconstant; (C_3) 50.1–75.0% constant; (C_2) 25.1–50.0% accessory species and (C_1) ≤ 25.0% accidental species.

Agrell's index (co-occurrence coefficient) [Kasprzak and Niedbała 1981] was calculated to determine the association between the studied species. In order to compare the values of Agrell's index for particular species, analysis of variance was performed. To normalize the data distribution, the data were transformed according to the formula $y = x^3$. The significance of differences between the means was assessed using Fisher's test at confidence level $p = 0.05$.

RESULTS

Despite the use of acaricides, spider mites were found to occur on fifteen out of seventeen cultivars sampled in nurseries. In all samples, one spider mite species, i.e., *Oligonychus ununguis* (Jacobi) occurred.

Despite the lack of statistical elaboration of spider mites density, the data are shown in table 2 because the economic injury level for mites feeding on spruces bases on this value [Bogatko et al. 1987]. It was observed that this threshold (establish as 2 mob. st./20 cm of shoot) was exceeded for associate spruces and such cultivars as: 'Inversa', 'Remontii', 'Waldbrund', 'Nidiformis', 'Pumila Glauca', 'Pumila Nigra', 'Echiniformis' and 'Wills Zwerg' (tab. 2).

A comparison of the population intensity on particular cultivars of Norway spruce showed that the highest number of tetranychid mobile stages (over 10 st./15 cm of shoot) occurred on *P. abies* 'Inversa', 'Remontii', 'Pumila Glauca', 'Echiniformis' and 'Pygmaea' (tab. 2). It is worth to notice that shoots of *P. abies* 'Pygmaea' were populated with a relatively high intensity (avg. 10.5 mobile st./15 cm of shoot), while the density of spider mites on shoots of that cultivar did not exceed the economic injury level. The intensity was less than 2 mobile stages per shoot only for *P. abies* 'Cupressina' and

P. abies 'Barryii' (tab. 2). Associate spruces (exhibition plants, hedges) were almost twice as intensely populated by Tetranychidae as cv. 'Inversa' (tab. 2).

Over the last few years it has been observed that the spruce shoots sampled at the peak of growing season (especially from the trees growing under natural conditions) were not inhabited by the motile stages of tetranychids despite visible symptoms of their feeding. However, there were found more or less numerous deposits of the pest's eggs and on this basis it one might predict the further population development and thus the plant exploitation.

For this reason, the average number of eggs of Tetranychidae found on shoots during the study was also taken into account at the assessment of the risk to outbreaks of these mites on spruce varieties. On two cultivars ('Cupersina' and 'Barryii') we observed that despite very low density and intensity of mobile sages the values of these parameters for eggs were several times higher (tab. 2).

Among spruces with the highest intensity of all developmental stages together were *P. abies* 'Inversa' with avg. over 40 st./15 cm of shoot, and *P. abies* 'Remontii' 'Waldbrund', 'Pumila Glauca' and 'Echiniformis' with over 20 st./15 cm of shoot. Still the highest intensity (avg. 165 st./15 cm of shoot) was observed on associate spruces (tab. 2).

Statistical analysis revealed significant differences in the prevalence of population of particular cultivars of the Norway spruce, both by mobile specimens, eggs and all developmental stages of spider mites in total. Only in the case of associate spruces, the population of spider mites (all variants, i.e., mobile stages, eggs and all stages in total) exceeded 80% (tab.2). Mobile stages of the pest inhabited from 5% (cv. 'Cupressina') to 50% (cv. 'Inversa') shoots of spruces offered for sale. On cv. 'Waldbrund', mobile stages of tetranychids were observed only on 28% of shoots, although that cultivar was very intensively populated. Eggs of spider mites were found on 50% of shoots in the case of samples collected from *P. abies* 'Inversa' and 'Remontii'. On 'Pumila Glauca' and 'Waldbrund', egg clusters were recorded on about 40% of shoots, and on 'Virgata' and 'Wills Zwerg' on about 30% of shoots, while the cultivars: 'Barryii', 'Procumbens', 'Cupressina', 'Echiniformis', 'Acrocona', 'Pumila Glauca' and 'Nidiformis' had egg clusters on about 20% of shoots in a sample. The highest and lowest values of prevalence of all stages of spider mites together were recorded on the same cultivars of spruce as in the case of Tetranychidae eggs (tab. 2).

In all forests where samples were taken, *P. abies* trees were infested by tetranychid mites. Like in the nurseries, also in natural conditions only one species of Tetranychidae, i.e. the spruce spider mite, occurred on spruce trees. The density of mobile specimens of the mite amounted to avg. 3.87 individuals/15 cm of shoot, and together with eggs, 6 st./15 cm of shoot (tab. 2). This value was more than 10 times lower than on associate spruces growing in soil in the area of the nurseries. In terms of density of all mite stages together, the avg. number of mites per *P. abies* shoot was over 20 times lower in natural conditions than on associate spruces in nurseries. In natural sites, spruce shoots were inhabited at the intensity of 7.63 individuals/15 cm of shoot, and avg. of 44% shoots were populated. This means that 2 times more shoots, and at 5 times higher intensity, were infested by spider mites trees of *P. abies* (associate spruces) in ornamental plant nurseries than in natural conditions (tab. 2).

Table 2. Density, intensity and prevalence of *Oligonychus ununguis* mobile stages, eggs, and all stages together, on shoots of studied species and cultivars of Norway spruce, grown in nurseries and forests

Cultivar	Density (±SE)						Intensity			Prevalence		
	mobile st.		eggs		total		mobile st.	eggs	total	mobile st.	eggs	total
'Nidiformis'	3.20	(0.5)	0.94	(0.26)	4.14	(0.64)	9.34 def*	5.18 a*	14.53 bcd*	31.9 cde*	18.1 ad*	32.4 cd*
'Ohlendorffii'	0.00	–	0.00	–	0.00	–	0.00	0.00	0.00	0.00	0.00	0.00
'Cupressina'	0.12	(0.08)	1.85	(0.52)	1.97	(0.55)	0.58 a	9.25 abcd	9.83 b	5.0 b	20.0 bcde	20 bc
'Acrocona'	0.88	(0.21)	1.97	(0.55)	2.84	(0.63)	2.06 abc	10.41 bcd	12.47 bcd	28.9 cd	18.9 ac	35.6 de
'Inversa'	10.85	(2.12)	10.80	(2.55)	21.65	(4.35)	20.97 gh	20.9 e	41.87 e	50 e	51.7 bf	53.3 ef
'Procumbens'	0.58	(0.26)	1.17	(0.37)	1.75	(0.59)	2.69 abcd	5.38 ab	8.08 a	13.3 abc	21.7 bde	21.7 bcd
'Wills Zwerg'	2.15	(0.51)	1.22	(0.36)	3.37	(0.79)	6.82 def	4.29 a	11.12 b	31.7 cde	28.3 be	31.7 cd
'Echiniformis'	2.60	(1.12)	1.60	(0.7)	4.20	(1.58)	12.33 defg	8 abcd	20.33 bcde	30.0 cd	20.0 ac	30.0 cd
'Maxwellii'	0.77	(0.37)	1.13	(0.42)	1.90	(0.63)	4.60 bcde	6.8 abcd	11.40 bcd	8.3 ab	16.7 ab	16.7 ab
'Little Gem'	0.00	–	0.00	–	0.00	–	0.00	0.00	0.00	0.00	0.00	0.00
'Barryii'	0.37	(0.17)	1.65	(0.43)	2.02	(0.54)	1.57 ab	7.07 abcd	8.64 b	11.7 ab	23.3 bde	23.3 bcd
'Pumila Nigra'	2.75	(0.85)	3.82	(0.8)	6.57	(1.44)	7.17 def	9.96 cd	17.13 bcd	26.7 bcd	18.3 bcd	26.7 bcd
'Pumila Glauca'	2.88	(0.79)	1.67	(0.53)	4.55	(1.19)	12.91 fg	9.09 abcd	22.00 cde	25.0 bcd	38.3 ef	38.3 de
'Pygmaea'	1.62	(0.58)	0.53	(0.32)	2.15	(0.73)	10.50 defg	8 abcd	18.50 bcde	15.0 abc	6.7 a	15.0 ab
'Remontii'	7.07	(1.86)	6.73	(1.46)	13.80	(3.03)	14.13 fg	13.47 de	27.60 de	43 e	50.0 fg	50 ef
'Virgata'	1.63	(0.65)	1.73	(0.40)	3.37	(0.92)	4.90 cde	5.2 a	10.10 b	18.3 abc	33.3 be	33.3 cd
'Waldbrund'	6.27	(1.85)	2.55	(0.55)	8.82	(2.13)	16.35 g	6.65 abc	23.00 de	28.3 bcd	38.3 bf	38.3 de
Associate spruces	41.67	(5.62)	98.63	(25.72)	140.30	(29.09)	51.02 h	116.04 f	165 f	82 f	85 g	85 g
P. abies (forests)	3.87	(1.47)	2.13	(1.08)	6.00	(2.32)	7.63	5.70	11.01	43.90	31.05	46.67

* Means in columns followed by different letters are significantly different. Pair-wise comparisons, according to Tukey's contrasts for the corresponding generalized linear mixed effects model ($p = 0.05$)

Phytoseiids were identified in samples collected from spruces in six out of eight nurseries, where the observations were conducted. The number of those mites ranged from avg 0.03 individuals/15 cm of shoot ('Acrocona') to avg. 0.37 in individuals/15 cm of shoot ('Wills Zwerg') (tab. 3). In samples collected from spruces growing in natural conditions, the density of the Phytoseiids amounted 0.78 individuals/15 cm of shoot, and it was twice higher than the one of 'Willis Zwerg' (tab. 3).

Table. 3. Density and frequency coefficient (C) of *Phytoseiidae* on particular cultivars of *P. abies*

Cultivar	No. of phytoseiids/15 cm of shoot (±SE)	Phytoseiid species		
		T. tiliae	*A. bakeri*	*A. andersoni*
'Procumbens'	0.07 (0.05)	C1	not found	not found
'Nidiformis'	0.27 (0.08)	C2	not found	not found
'Acrocona'	0.03 (0.03)	C1	not found	not found
'Pumila Glauca'	0.20 (0.10)	C1	not found	not found
'Waldbrund'	0.03 (0.03)	C1	not found	not found
'Wills Zwerg'	0.37 (0.12)	C2	not found	not found
'Pumila Nigra'	0.13 (0.06)	C1	not found	not found
'Inversa'	0.03 (0.03)	C1	not found	not found
'Barryii'	0.03 (0.03)	C1	not found	not found
Associate spruces	0.17 (0.07)	C1	not found	not found
P. abies (forests)	0.78 (0.29)	C3	C1	C1

In all ornamental plant nurseries, where Phytoseiids occurred, *Typhlodromus tiliae* Oudemans was identified. On the other hand, phytoseiids in forests occurred in assemblages of two or three species. In all such assemblages, *T. tiliae* occurred, accompanied by *Anthoseius bakeri* (Garman) or *Amblyseius andersoni* (Chant), or both those species together. Calculations of percentage of phytoseiid mites species in assemblages revealed distinct domination of *T. tiliae* (80%); *A. bakeri* made 18% of the collected specimens, and *A. andersoni* only 2%. In ornamental plant nurseries, *T. tilia*e occurred on spruces accidentally or as an accessory species (tab. 3). In forests *T. tilae* was highly associated with the habitat (constant) while *A. andersoni* and *A. bakeri* occurred only accidentally (tab. 3).

The only spider mite species observed, i.e., *O. ununguis*, was accompanied at significantly various constancy ($p = 0.0005$) by particular species of phytoseiids. The highest co-occurrence coefficient was found between *O. ununguis* and *T. tiliae* (Ag = 0.51), on spruces growing in forest. The two remaining species of predatory mites (*A. andersoni* and *A. bakeri*) occurred together with *O. ununguis* at similar frequence (respectively Ag = 0.14 and 0.04) and much rarer than *T. tiliae*.

DISCUSSION

Oligonychus ununguis, which we identified in the collected samples, is known to be a dangerous pest of spruce, and especially of its dwarf cultivars grown in ornamental plant nurseries [Lehman 1998]. Feeding of that pest cause significant changes in the chemical composition of a host plant [Kiełkiewicz et al. 2005] and interfere its physiological processes [Puchalska 2006]. Needles of infested coniferous plants become discoloured and deformed, and their shoots show an inhibited growth rate [Bogatko et al. 1987], which in the case of ornamental plants makes them commercially invaluable.

The presence of *O. ununguis* on most of the sampled plants indicates its wide range of diet, and the threat that it poses to most of ornamental spruces offered for sale in nurseries. Massive infestation by the spruce spider mite is especially likely on the cultivars 'Inversa', 'Remontii', 'Waldbrund', 'Pumila Glauca' or 'Echiniformis', which were most intensively colonized by the pest.

Very numerous populations of *O. ununguis*, which we found on older *P. abies* trees growing in the area of the nurseries (associated spruces) indicate a possible role of those trees as a source of the mite, and the necessity of the pest control or plants removal.

As shown above, *P. abies* cultivars grown in nurseries were usually infested at low prevalence, which may indicate that the spruce spider mite occurs only in spots. However, infestation of several shoots at high intensity (that we noticed) will sooner damage the shoots and needles than a more dispersed population of the pest having the similar density at the plant. For this reason, the intensity and prevalence coefficients seem to be useful for evaluation of threat of pest infestation on ornamental plants. They allow to obtain more precise information on the size of a pest population feeding on an area unit of a plant, which is important if damage caused by pest makes the plants lose their aesthetic value.

Our investigations on spruce trees grown in nurseries showed that, in spite of use of acaricides, the plants were still inhabited by a predatory mite of the family Phytoseiidae, *Typhlodromus tiliae.* It was not numerous in the plant material from the nurseries; however, its very presence indicates its adaptive abilities. In samples collected in forests, we found two other phytoseiid species, *Amblyseius andersoni* and *Anthoseius bakeri* apart of *T. tiliae*. All those species were recorded on Norway spruce trees growing in different forests in Poland also by Kaźmierczak and Lewandowski [2006].

Using indigenous species of natural enemies for protection of crops in field usual gives better effect and is safer for the environment than introducing alien species [Ragusa Di Chiara 1991, Lenteren 2006]. The attempt of biological control of spider mites on coniferous plants was made in the United States. As a non-chemical method of protection of *Abies fraseri* (Pursh) against spruce spider mite, natural enemies of the family Phytoseiidae: *Typhlodromus americanus* (Chant), *Amblyseius andersoni* (Chant), *Neoseiulus fallacis* (Garman), or *N. collegae* (DeLeon) were introduced [Boyne 1980, Mizell and Schiffhauer 1991, West and DeAngelis 1993]. The conclusion was that *N. fallacis* effectively limits the population of the spruce spider mite [Boyne and Hain 1983]. Works by Niemczyk et al. [1996], Niemczyk and Sekrecka [1998] also confirm that, in field production, local species of Phytoseiidae may become an alternative for phytoseiid mites used in mite control in greenhouses.

CONCLUSIONS

Because of clumped distribution of spruce spider mite observed on ornamental spruces grown in nurseries, and because of the ornamental character of these plants, the intensity and prevalence parameters seem to be more measurable than density in economic injury level estimation. Further investigations to determine such a threshold are recommended.

Numerous occurrence of spider mites on almost all spruce varieties offered for sale in nurseries, despite the use of acaricides, points to the need for alternative methods of the pest control. Especially cultivars 'Inversa', 'Remontii', 'Waldbrund', 'Pumila Glauca' and 'Echiniformis' are threatened by heavy infestation of *O. ununguis.*

Occurring *T. tiliae* in chemical protected nurseries may indicate on its resistance or tolerance of pesticides, using there. In addition, due to its dominating role in the assemblage of phytoseiids inhabiting spruces in natural conditions, and its strongest co-occurrence with *O. ununguis* among the phytoseiid species, *T. tiliae* seems promising and useful species in biological control of *O. ununguis* on spruces.

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WYSTĘPOWANIE PRZĘDZIORKÓW (Prostigmata: Tetrnaychidae) ORAZ ICH POTENCJALNYCH WROGÓW NATURALNYCH Z RODZINY DOBROCZYNKOWATYCH (Mesostigmata: Phytoseiidae) NA ŚWIERKU POSPOLITYM I JEGO ODMIANACH UPRAWIANYCH W SZKÓŁKACH ROŚLIN OZDOBNYCH W POLSCE

Streszczenie. Pomimo prowadzonej w szkółkach roślin ozdobnych w Polsce intensywnej ochrony chemicznej przed szkodnikami, przędziorki wciąż znajdują się w grupie fitofagów, które szczególnie trudno zwalczyć. Ze względu na tworzenie się ras odpornych na akarycydy, uzasadnione wydaje się poszukiwanie alternatywnych do chemicznej metod walki z przędziorkami, także w szkółkach roślin ozdobnych. Celem niniejszej pracy było wytypowanie szczególnie narażonych na żerowanie dużych populacji przędziorków odmian świerka pospolitego oraz ustalenie, jakie gatunki Phytoseiidae zasiedlają poszcze-

gólne odmiany *Picea abies* uprawiane w chronionych chemicznie szkółkach roślin ozdobnych. Zbadano także liczebność i skład gatunkowy przędziorków i dobroczynków zasiedlających drzewa świerka pospolitego rosnące w lasach. Jak wykazały badania, niemal wszystkie odmiany świerka pospolitego oferowane do sprzedaży w szkółkach były zasiedlone przez przędziorki. Spośród badanych świerków największą liczebność Tetranychidae stwierdzono na odmianach: 'Inversa', 'Remontii', 'Waldbrund', 'Nidiformis' i 'Pumila Glauca'. W szkółkach na badanych roślinach stwierdzono drapieżnego roztocza *Typhlodromus tiliae* Oudemans, niemniej jego liczebność była znacznie niższa niż na świerkach rosnących w warunkach naturalnych. Dodatkowo w lasach na świerku pospolitym stwierdzono dwa inne gatunki dobroczynków: *Anthoseius bakeri* (Garman) i *Amblyseius andersoni* (Chant).

Słowa kluczowe: drapieżne roztocze, współwystępowanie, rośliny iglaste

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