

Eriophyoid mites (Acari: Eriophyoidea) occurring on lime trees in ornamental nurseries

GRAŻYNA SOIKA

Research Institute of Pomology and Floriculture, Pomologiczna 18, 96-100 Skierniewice, Poland;
e-mail: gsoika@insad.pl

(Received on 18 January 2006, Accepted on 25 May 2006)

Abstract: Four eriophyoid mite species inducing galls on lime leaves – *Eriophyes tiliae* (Pag.), *E. exilis* (Nal.), *E. nervalis* (Nal.) = *E. leiosoma* (Nal.), and *Phytoptus tetratrichus* (Nal.) – were found in Polish nurseries during the growing season 2005. *Eriophyes tiliae* was the most frequent on *Tilia platyphyllos* (Scop.), *T. caucasica* Rupr. and *T. cordata* Mill. Free-living eriophyoid mites on lime leaves were represented by *Aculus ballei* (Nal.) and *Tetra tiliae* Boczek et Szymkowiak. *Aculus ballei* was the most common. Its largest population was recorded on *Tilia platyphyllos* Scop. ‘Rubra’ (about 150 individuals/leaf). This mite species was not found on *T. insularis* Nakai, *T. americana* L., *T. platyphyllos* Scop. ‘Laciniata’, *T. cordata* Mill. ‘Erecta’, *T. × europaea* L. ‘Pallida’ and *T. × euchlora* Koch ‘Brabant’. *Tetra tiliae* occurred sporadically and it was the most numerous on *T. platyphyllos*.

Key words: Eriophyoidea, *Tilia* spp., nursery, *Eriophyes tiliae*, *Eriophyes exilis*, *Eriophyes nervalis*, *Phytoptus tetratrichus*, *Aculus ballei*, *Tetra tiliae*

INTRODUCTION

Lime trees (*Tilia* spp.) are important components of the Polish landscape. Among phytophagous mites inhabiting limes, eriophyoids are the most abundant (KROPCZYŃSKA 1984).

Up to now, 21 species of eriophyoid mites have been known to live on lime trees (AMRINE & STASNY 1994, BOCZEK & SZYMKOWIAK 1997). Among them, 16 species induce galls or erineae, and only 5 species are vagrants on leaves. Eriophyoids inhabiting limes have been examined mostly on trees in urban areas and natural habitats (ROIVAINEN 1947, LIRO & ROIVAINEN 1951, BOCZEK 1961, FARKAS 1965, VANEČKOVÁ-SKUHRAVÁ 1996a, b, BUCHTA et al. 2005). In the available literature there is no information about eriophyoid mites occurring on young lime trees cultivated in nurseries.

The aim of this investigation was to identify eriophyoid species inhabiting different taxa of limes in nurseries.

MATERIALS AND METHODS

Mites inducing galls on leaves

Field research on the occurrence of eriophyoid mites inducing galls was conducted in 2005. Seven taxa of lime trees were observed in 4 nurseries: (I) Dzieńmierowo near Poznań – 11 June 2005, *Tilia glabra* Vent. f. *fastigiata*, *T. cordata* Mill., *T. platyphyllos* Scop., 5 years old; (II) Klementowice near Puławy – 19 July 2005, *T. caucasica* Rupr., *T. cordata* Greenspire, *T. × euchlora* Koch., *T. 'Komsta'*, *T. platyphyllos* Scop., 2 years old; (III) Pęchcin near Ciechanów – 29 June 2005, *T. platyphyllos* Scop., 2 years old; and (IV) Nowakowo near Elbląg – 30 June 2005, *T. platyphyllos* Scop., 2 years old.

Fifty trees were randomly selected from each taxon and 5-10 shoots of each tree were chosen in order to record the number of leaves with galls or other visible symptoms of infestation by mites. Twenty affected leaves were collected from each tree for more detailed analysis. Ten galls of each sample were examined in the laboratory under a stereomicroscope. Individuals collected from galls were mounted in Heinze medium and then microscopically inspected to identify species.

The degree of infestation was expressed as frequencies (%) of:

- shoots with affected leaves, related to the total number of examined shoots (F_1);
- affected leaves, related to the total number of examined leaves (F_2);
- affected leaves with symptoms induced by one species of eriophyoid mites, related to the total number of affected leaves (F_3).

Mites being vagrants on leaves

Observations of free-living eriophyoid mites on leaves of 17 taxa of limes were carried out in 6 nurseries located in different parts of Poland: (I) Dzieńmierowo – 23 August 2005, *T. americana* L., *T. glabra* Vent. f. *fastigiata*, *T. × euchlora* Koch., *T. cordata* Mill., *T. insularis* Nakai, *T. platyphyllos* Scop. 'Laciniata', *T. × varsaviensis* Kobendza; (II) Klementowice – 9 July 2005, *T. caucasica* Rupr., *T. cordata* Mill. 'Greenspire', *T. 'Komsta'*, *T. × euchlora* Koch., *T. platyphyllos* Scop.; (III) Pęchcin – 29 June 2005, *T. platyphyllos* Scop., *T. × varsaviensis* Kobendza; (Va) Braniewo "A" – 29 June 2005, *T. × euchlora* Koch., *T. platyphyllos* Scop., *T. tomentosa* Moench; (Vb) Braniewo "B" – 29 June 2005, *T. cordata* Mill., *T. tomentosa* Moench; and (VI) Piszowice near Brzeg – 21 July 2005, *T. cordata* Mill., 'Greenspire', 'Erecta', *T. × europaea* L., *T. × europaea*, 'Koningslinde', 'Pallida', *T. platyphyllos* Scop. 'Rubra', *T. tomentosa* Moench 'Brabant', *T. × varsaviensis* Kob.

During the growing season (from July to August), 50 leaves were randomly collected (5 leaves per tree). The leaves were examined in the laboratory according to the procedure described above.

Data were calculated by one-way analysis of variance (ANOVA). Neumann-Keuls test was used to assess the significance of differences between means at $\alpha = 0.05$.

RESULTS

The degree of infestation of limes by eriophyoid mites inducing galls was very low, as the frequency of shoots with affected leaves was lower than 40%. Affected leaves occurred mainly on *Tilia platyphyllos*, *T. caucasica*, and *T. cordata*, whereas the foliage of *T. cordata* 'Greenspire', *T. 'Komsta'*, and *T. glabra* f. *fastigiata* were the least infested. Eriophyoid mites inducing galls (Table 1) did not colonize *T. × euchlora*. Four species of eriophyoid mites inducing galls on lime leaves were found: *Eriophyes tiliae* (Pagenstecher, 1857), *E. exilis* (Nalepa, 1892), *E. nervalis* (Nalepa, 1918) = *E. leiosoma* (Nalepa, 1892) and *Phytoptus tetratrichus* (Nalepa, 1891) (Tables 1 and 2).

Table 1. Degree of infestation of limes in nurseries by eriophyoid mites

Taxon	Frequency (%)	
	shoots with affected leaves (F ₁)	affected leaves (F ₂)
Dzieńmierowo (11 June 2005)		
<i>Tilia cordata</i>	16.6 cd	13.4 b
<i>Tilia platyphyllos</i>	9.3 bc	12.9 b
<i>Tilia glabra</i> f. <i>fastigiata</i>	2.0 ab	3.1 a
Klementowice (19 July 2005)		
<i>Tilia caucasica</i>	35.1 d	27.4 b
<i>Tilia platyphyllos</i>	35.8 d	30.7 b
<i>Tilia cordata</i> 'Greenspire'	0.5 ab	1.1 a
<i>Tilia 'Komsta'</i>	0.1 a	0.1 a
<i>Tilia × euchlora</i>	0.0 a	0.0 a
Pęchcin (29 June 2005)		
<i>Tilia platyphyllos</i>	36.9 d	32.9 b
Nowakowo (30 June 2005)		
<i>Tilia platyphyllos</i>	21.1 cd	25.9 b

Means followed by the same letter within columns are not significantly different in Neumann-Keuls test ($\alpha = 0.05$)

Eriophyes tiliae induced nail galls on the upper surface of the leaf. The galls varied in color from greenish yellow to pink or red. There were significant differences in frequency of that mite between the tested taxa of limes ($F_{8,36} = 6.26$, $P \leq 0.001$) (Table 2). The highest values of frequency were reached on *T. platyphyllos* and *T. caucasica*.

Eriophyes exilis occurred the most numerously on *T. platyphyllos*, on which the frequency of specimens in galls ranged from 81.3 to 99.3%. The remaining individuals inhabiting these galls were identified as *E. nervalis* (Table 3). Interestingly, *E. exilis* attacked also other species of limes, but only on *T. platyphyllos* it induced galls with pubescence on the upper surface of the leaf in vein axils.

Table 2. Frequency (F_3 , %) of leaves with nail galls induced by *Eriophyes tiliae*, related to the total number of affected leaves

Host plant	Nursery			
	I	II	III	IV
<i>Tilia glabra</i> f. <i>fastigiata</i>	90.5 b	-	-	-
<i>Tilia caucasica</i>	-	100.0 b	-	-
<i>Tilia cordata</i>	5.0 a	-	-	-
<i>Tilia cordata</i> 'Greenspire'	-	65.5 ab	-	-
<i>Tilia</i> 'Komsta'	-	9.5 a	-	-
<i>Tilia platyphyllos</i>	52.6 ab	100.0 b	14.7 a	100.0 b

Means followed by the same letter are not significantly different in Neumann-Keuls test ($\alpha = 0.05$). I – Dzieńmierowo; II – Klementowice; III – Pęchcin; IV – Nowakowo

Table 3. Frequency (F_3 , %) of affected leaves (average \pm standard deviation) and species composition of eriophyoid mites on limes

Host plant	Symptoms of infestation	% of affected leaves (F_3)		Eriophyoid species	% of specimens	
		I	III		I	III
<i>Tilia cordata</i>	erineum on leaf underside	40.0 \pm 26.2	-	<i>Eriophyes nervalis</i>	64.3	-
				<i>Eriophyes exilis</i>	35.7	-
	marginal leaf roll	39.4 \pm 38.14	-	<i>Phytoptus tetratrichus</i>	100.0	-
<i>T. platyphyllos</i>	vein axil galls	27.0 \pm 36.5	84.6 \pm 8.1	<i>Eriophyes exilis</i>	81.3	99.3
	with pubescence on upper side of leaf			<i>Eriophyes nervalis</i>	18.7	0.7

I – Dzieńmierowo; III – Pęchcin

Eriophyes nervalis occurred the most numerously on *T. cordata* in a yellow erineum on the lower surface of the leaf (Table 3). It is worth mentioning that in the erineum it was always accompanied by *E. exilis*.

Phytoptus tetratrichus was found only on *T. cordata*, on which it formed tight upward leaf-roll galls along the edges of leaves.

Free-living eriophyoid mites on lime leaves were represented in nurseries by *Aculus ballei* (Nalepa, 1891) and *Tetra tiliae* Boczek et Szymkowiak, 1997.

Aculus ballei was the most common. Significant differences in its density were found between the tested taxa of limes ($F_{16,153} = 52.89$, $P=0.00$). The highest number of individuals was noted on *T. platyphyllos* 'Rubra' (about 150 individuals per leaf). Mites feeding in such a high density caused browning of leaves and noticeable short-

ening of shoots. Density of this species on the other limes was considerably lower. It ranged from 0.1 to 11 individuals per leaf on *T. × varsaviensis* and *T. platyphyllos* (in Braniewo “A”) respectively. No individuals of this mite were found on *T. americana*, *T. cordata* ‘Erecta’, *T. insularis*, *T. platyphyllos* ‘Laciniata’, and *T. × tomentosa* ‘Brabant’.

Tetra tiliae was only noticed in 1 nursery on 3 species of limes. There were significant differences in density of mites between the tested taxa of limes ($F_{2,27}=19.12$, $P<0.01$). The highest number of this mite species was recorded on *T. platyphyllos* (Table 4).

DISCUSSION

The frequency of the eriophyoid mites inducing galls and the density of free-living eriophyoid mites, especially of *Aculus ballei*, varied considerably within lime species, irrespective of nursery location. There occurred distinct trends in preference

Table 4. Density of free-living eriophyoid mites on limes

Host plant	Nursery						
	II	I	II	III	Va	Vb	VI
	Average number of mites per leaf						
	<i>Tetra tiliae</i>	<i>Aculus ballei</i>					
<i>Tilia americana</i>	-	0.0 a	-	-	-	-	-
<i>Tilia caucasica</i>	1.0 a	-	4.1 b	-	-	-	-
<i>Tilia cordata</i>	-	0.0 a	-	-	-	0.1 a	-
<i>Tilia cordata</i> ‘Erecta’	-	-	-	-	-	-	0.0 a
<i>Tilia cordata</i> ‘Greenspire’	0.0 a	-	3.2 b	-	-	-	0.2 a
<i>Tilia × euchlora</i>	0.0 a	0.2 a	0.4 a	-	0.3 a	-	-
<i>Tilia × europaea</i>	-	-	-	-	-	-	0.2 a
<i>Tilia</i> ‘Koningslinde’	-	-	-	-	-	-	0.1 a
<i>Tilia × europaea</i> ‘Pallida’	-	-	-	-	-	-	0.1 a
<i>Tilia</i> ‘Komsta’	3.3 b	-	3.4 b	-	-	-	-
<i>Tilia glabra</i> f. <i>fastigiata</i>	-	0.1 a	-	-	-	-	-
<i>Tilia insularis</i> ‘Nakai’	-	0.0 a	-	-	-	-	-
<i>Tilia platyphyllos</i>	39.9 c	-	0.0 a	1.8 ab	11.0 c	-	-
<i>Tilia platyphyllos</i> ‘Laciniata’	-	0.0	-	-	-	-	-
<i>Tilia platyphyllos</i> ‘Rubra’	-	-	-	-	-	-	153.1 d
<i>Tilia tomentosa</i>	-	-	-	-	0.0 a	0.1a	-
<i>Tilia tomentosa</i> ‘Brabant’	-	-	-	-	-	-	0.0 a
<i>Tilia × varsaviensis</i>	-	0.1 a	-	3.2 b	-	-	0.8 a

Means followed by the same letter are not significantly different in Neumann-Keuls test ($\alpha = 0.05$) I – Dzieńmierowo; II – Klementowice; III – Pęchcin; Va – Braniewo “A”; Vb – Braniewo “B”; VI – Piszczowice.

of some lime species as hosts for eriophyoids. *Tilia platyphyllos* was inhabited both by eriophyoids inducing galls (*Eriophyes tiliae*, *E. exilis*) and by leaf vagrants (*A. ballei*, *T. tiliae*). Probably, an important factor influencing the density of eriophyoid mites on limes in Piszowice and Dzieńmierowo was the use of agrochemicals. Acaricides applied twice as spray treatments in May and June (in Piszowice) destroyed eriophyoids inducing galls and free-living eriophyoids on lime leaves, except *T. platyphyllos* 'Rubra'. An additional spray treatment was necessary due to the high density of *A. ballei* on that lime.

Other factors that determine the occurrence of eriophyoid mites on leaves include the length and density of pubescence on the leaf underside. KOZŁOWSKI (2000) indicated that leaves of apple trees with short pubescence were more numerously inhabited by the apple rust mite (*Aculus schlechtendali*) than leaves with longer pubescence. CZAJKOWSKA and KIELKIEWICZ (2002) showed that *T. platyphyllos* leaves are covered with simple hairs, with the mean number 29.9 per 2 mm² (=1495/1 cm²), whereas on the *T. cordata* and on *T. tomentosa* the hairs are more or less branched with the mean number of hairs per 2 mm² is 0.9 and 29.9, respectively. It seems that simple hairs on leaves of *T. platyphyllos* create favorable conditions for the development of free-living eriophyoid mites. This might explain the greater abundance of free-living eriophyoids on *T. platyphyllos* and 'Rubra' cultivar than on the other tested limes. The differences in mite densities between the studied lime taxa may be also due to differences in chemical composition of leaves, but no data on this subject are available.

The effects of infestation by the same species of eriophyoid mite differed depending on lime species. For instance, galls induced by *Eriophyes tiliae* on *T. cordata* leaves are cone-shaped, up to 5 mm high, while on *T. platyphyllos* the galls are 5–12 mm high, elongated, with a rounded or pointed tip, which may be erect, oblique or curved.

Recently it was also found that *Phytoptus tetratrichus* created warty galls on the upper side and erineae on the underside of *T. tomentosa* leaves, whereas leaf-roll galls along the edges of leaves were induced on *T. cordata* leaves (SOIKA & KIELKIEWICZ 2004).

Among the eriophyoid mite species inhabiting the limes in nurseries, *A. ballei* was the most dangerous. Strong browning of leaves of *T. platyphyllos* 'Rubra' in response to this mite feeding suggested that this species could become an important pest of lime in nurseries, similar to *Aculus schlechtendali* (Nal.) for *Malus* sp. (KOZŁOWSKI 1998) and *Aculus fockeui* (Nal.) for *Prunus* sp. (SUSKI & BADOWSKA-CZUBIK 1995).

CONCLUSIONS

1. Four eriophyoid mite species inducing galls on lime leaves were found in the nurseries: *Eriophyes tiliae*, *E. exilis*, *E. nervalis* and *Phytoptus tetratrichus* (Nal.). *Eriophyes tiliae* was the most common and the most frequent on *T. platyphyllos* and *T. caucasica*.
2. Among free-living eriophyoid mites on leaves of limes, the most common and important was *Aculus ballei*. It was the most numerous on *T. platyphyllos* 'Rubra'. No individuals of this mite were found on *T. insularis*, *T. americana*, *T. platy-*

phyllos 'Laciniata', *T. cordata* 'Erecta', *T. × europaea* 'Pallida', and *T. × tomentosa* 'Brabant'.

Acknowledgments: I wish to thank Prof. G. ŁABANOWSKI for his help during the collection of lime leaves and valuable advice during preparation of manuscript. The study was supported by the Polish Committee for Scientific Research (Grant No. 0709/P06/2003/52).

REFERENCES

- AMRINE J. W., STASNY T. A. JR. 1994. Catalog of the Eriophyoidea (Acarina: Prostigmata) of the world. Indira Publishing House, West Bloomfield, Michigan, USA.
- BOCZEK J. 1961. Badania nad roztocznymi z rodziny Eriophyidae (Szpecielowate) w Polsce I [Studies on mites of family Eriophyidae In Poland I]. Prac. I.O.R. Poznań 3: 5–85.
- BOCZEK J., SZYMKOWIAK P. 1997. Studies on Eriophyoid Mites (Acari: Eriophyoidea). XXIV. Bull. Pol. Acad. Sci. Biol. 45: 35–40.
- BUCHTA I., JANDOVÁ S., KREŠTANPOLOVÁ M., KULA E. 2005. Occurrence variations and spatial distribution of subspecies of *Eriophyes tiliae* (Acari, Eriophyidae) on lime (*Tilia* sp.) in urban environment. www.fle.czu.cz/predmety/uf/presentation//25-26-Buchta.doc.
- CZAJKOWSKA B., KIELKIEWICZ M. 2002. Linden – leaf morphology and the host-plant susceptibility to *Eotetranychus tiliarum* (Herman) (Acarida: Tetranychidae). In: Acarid Phylogeny and Evolution adaptation in mites and ticks (BERNINI F., NANNELLI R., NUZACI G., DE LILLO E., Eds), pp. 435–440, Kluwer Academic Publishers, The Netherlands.
- FARKAS H. 1965. Spinnentiere Eriophyidae (Gallmilben). Die Tierwelt Mitteleuropas 3: 1–155.
- KOZŁOWSKI J. 1998. Czynniki warunkujące wrażliwość odmian jabłoni i reakcja odmian na porzecznicę jabłoniowego – *Aculus schlechtendali* (Nalepa) [Factors determining the sensibility of apple varieties to the apple rust mite – *Aculus schlechtendali* (Nalepa)]. Rozp. Nauk. Inst. Ochr. Roślin Z. 2: 1–199.
- KOZŁOWSKI J. 2000. Morphological features of apple leaves and population size of *Aculus schlenkendali* (Nal) (Acari: Eriophyoidea), In: Materiały XXVI Sympozjum Akarologicznego "Akarologia Polska u Progu Nowego Tysiąclecia, Kazimierz Dolny, 24–26 października 1999 (IGNATOWICZ S., Ed.), pp. 311–315, SGGW, Warszawa.
- KROPCZYŃSKA D. 1984. Rola drapieżnych roztoczy (Phytoseiidae) jako wrogów naturalnych przędziorka lipowca (*Eotetranychus tiliarum* (Hermann)) w warunkach miejskich [The role of predatory mites (Phytoseiidae) as natural enemies of *Eotetranychus tiliarum* (Hermann) in city conditions]. 68 pp., Rozp. Nauk. Monogr. SGGW-AR, Warszawa.
- LIRO J., ROIVAINEN H. 1951. Akamapunkit Eriophyidae – Suomen Elaimet. Anim. Fenn. 6: 1–281.
- ROIVAINEN H. 1947. Eriophyid news from Finland. Acta Entomol. Fenn. 3: 1–49.
- SOIKA G., KIELKIEWICZ M. 2004. Occurrence of *Phytoptus tetratrichus* (Nalepa) (Acari: Eriophyoidea) and differences in the morphology of leaf galls on two linden species. Phytophaga 14: 615–622.
- SUSKI Z. W., BADOWSKA-CZUBIK T. 1995. Population trends of Apple Rust Mite, *Aculus schlechtendali* (Nal.) and Plum Rust Mite, *Aculus fockeui* (Nal.) (Acari: Eriophyoidea) in Poland. In: The Acari. Physiological and Ecological Aspects of Acari-Host Relationships (KROPCZYŃSKA D., BOCZEK J., TOMCZYK A., Eds), pp. 557–579, Dabor, Warszawa.
- VANEČKOVÁ-SKUHRAVÁ I. 1996a. Life cycles of five eriophyid mites species (Eriophyoidea, Acari) developing on trees and shrubs. J. Appl. Ent. 120: 513–517.
- VANEČKOVÁ-SKUHRAVÁ I. 1996b. Harmfulness of eriophyid mites (Eriophyoidea, Acari) causing galls on trees and shrubs in the Czech Republic. Anz. Schädlingsskde, Pflanzenschutz. Umweltschutz 69: 81–83.