Occurrence variations and spatial distribution patterns of *Eriophyes tiliae* (Pgst.) (Acari, Eriophyidae) subspecies in the urban environment

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ABSTRACT: The occurrence of *Eriophyes tiliae* (Pgst.) subspecies was observed in lime trees in the urban area of Brno. Mites presence was assessed in relation to the lime species, its age and health conditions. Analysis of the occurrence of *liosoma*, *tiliae* and *nervalis* subspecies was carried out on leaves of 3,245 lime trees from the viewpoint of the host preference and spatial distribution of attack in the area of the city and potential effects of air pollution. Subspecies *liosoma* and *tiliae* occurred in 13% of lime trees, the subspecies of *nervalis* was found only in 4 limes. Eudominant subspecies of *E. tiliae* preferred mature trees and young trees reaching height of mature trees in good health conditions. The distribution of *Eriophyes tiliae* on lime trees in the area of Brno depended on the distribution of suitable host trees and was not affected by air pollution.

Keywords: *Eriophyes tiliae*; *Tilia* sp.; distribution patterns; urban environment; host trees; air pollution; gall-forming mites

Most phytophagous mites of the family Eriophyidae create species-specific leaf distortions (galls, erinea etc.) on broadleaved trees, shrubs and herbs by sucking on leaf tissues (Westphal, Manson 1996). Subspecies of the species *Eriophyes* (=*Phytoptus*) *tiliae* (Pgst.) are feeding specialists on lime (*Tilia* sp.) where they create distinctive galls (Fig. 1). Vaněčková-Skuhravá (1996) found three subspecies documented by Keifer et al. (1982) and Schnaider (1991) on lime trees in the Czech Republic. These varieties are often classified as separate species. Biology and feeding behaviour of *E. tiliae tiliae* (Pgst.) were described by Thomsen (1976, 1988). In Poland, Skrzypczynska (1999) noted the occurrence of 6 gall-forming insects and mites on *T. cordata* Mill. Most abundant species were *E. leiosoma* (Nal.) and *Phytoptus tetratrichus tetratrichus* Nal.

The occurrence and distribution of *Eriophyes* species are affected by a number of ecological factors. The most important of them are climate, food supply and anthropogenic effects (air pollution). Detailed knowledge on the distribution of gall-forming mites *Acalitus rudis* (Can.) and *Phyllocoptes lionotus* (Nal.) (Acari: Eriophyidae) on birch was obtained by Kula et al. (1999, 2000) who noted the dependence of occurrence on altitude. Their occurrence could be also affected by the age of trees, provenance and other traits (Kula et al. 2003). The dispersion of mites in the birch crown profile was described by Buchta et al. (2004) who noted the highest occurrence of galls in the lower part of crowns.

According to Fernandes et al. (1994), it was noted in a gall-forming fly *Aciurina trixa* Curr. (Diptera: Tephritidae) that the distribution of galling insects is related to habitat harshness. Most of galls were observed on extremely unfavourable xeric sites. Air pollution load can be a stress factor as well. Koricheva et al. (1996) found that the number of

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Fig. 1. Galls of *E. tiliae* v. *tiliae* (left), v. *liosoma* (in the middle) and v. *nervalis* (right)

galls of birch-bound *Acalitus rudis* (Can.) decreased with a distance from the source of emissions of heavy metals while the occurrence of mite *Phyllocoptes lionotus* (Nal.) forming closed globular galls was not dependent on a distance from the source of air pollution. Price et al. (1987) and Fernandes and Price (1992) confirmed the higher tolerance of phytophagous arthropods living in galls to unfavourable conditions as against to free-living organisms.

In urban environment, where the majority of potential host plants grows in man-influenced environment and where there is no distinct altitudinal gradient, abundance of gall mites is supposed to be driven by different mechanisms. Spatial distribution of host plants was regarded as a serious factor affecting the presence of Microlepidoptera in the agglomeration of St. Petersburg. It was stated that migration potential of particular species was important for spreading and colonization of available habitats (Kozlov 1996). Gall mites are capable of travelling on long distances passively by means of wind (Sabelis, Bruin 1996). Spacing of lime trees in Brno does not exceed spacing of 3 km, thus forming relatively homogenous habitat. Hence the host trees have similar chance of catching travelling mites.

The performance pattern of Eriophyidae depending on stress factors affecting a host can, however, show higher importance in the urban environment. According to Larsson (1989), performance of guilds of gall-forming phytophagous arthropods decreases with the increasing level of stress.

Table 1. Classification of the degree of attack of leaves by gall-forming mites

Category of attack	Degree of attack (%)	Coefficient of infestation
No attack	0	–
Weak	1–10	0.05
Medium	11–50	0.35
Heavy	51–100	0.70

The aim of the paper is to evaluate the occurrence of galls of Eriophyidae attacking lime trees in the urban area of Brno (Czech Republic) in relation to the species of lime, its age, health condition and air pollution stress.

MATERIAL AND METHODS

Description of research area and characteristics of host trees

The occurrence of mites was assessed in the group of 3,245 lime trees (*Tilia* sp.) growing in the urban area of Brno (49°12´N and 16°34´E; altitude 180–300 m a.s.l.) in 2004. Limes are distributed irregularly. The highest proportion of lime trees taken into study is situated in a dense build-up area up to 4 km from the city centre. Generally, the trees form alleys of one species, 5% limes grow as solitaires or in small groups of no more than 10 trees.

In addition to eudominant *T. euchlora* Koch (50.3%), *T. platyphyllos* Scop. (23.2%) and *T. cordata* Mill. (21.1%) also *Tilia tomentosa* Moench, *Tilia × europaea*, *Tilia cordata* Greenspire and *Tilia americana* L. occur there. *T. tomentosa* Moench appears mainly in new plantings.

Data on the air pollution load (SO_2, NO_x, PM_{10}, benzene, O_3, Pb, Cd, As, Ni, Hg, benzo-a-pyrene, carbon monoxide) came from the model calculation of a dispersion study for the city of Brno determined on the basis of up-to-date emission sources according to SYMOS methodology (Bucek 2004).

Kolařík (2002) characterized vitality and physiological age in all lime trees (Table 2). Vitality was expressed as a general characteristic to summarize tree defoliation, leaf size, occurrence of branch malformations, development of secondary shoots, drying up and the growth of shoots and sprouts. Regarding the host age, mature trees with manifestations of the stagnation of growth (degree 4 of physiological age) predominated in the studied group. Concerning host vitality, most represented were the trees with slightly

Table 2. Categorization of the physiological age and vigour (Kolařík 2002)

Level	Description
Physiological age	
1	Planting in the stage of acclimation
2	Acclimated planting, plants in the period of dynamic growth
3	A young tree reaching dimensions of a mature tree
4	A mature tree with symptoms of growth stagnation
5	An old tree, the decline of a crown
Vigour*	
0	A vigorous tree without evident symptoms of decreased vitality and with good conditions to preserve the state
1	Slightly disturbed vigour, conditions of a short-term variation with the high probability of return to Group 0 after disappearing external negative effects
2	Vigour markedly disturbed (growth stagnation), however, preservation of a tree is not immediately disturbed. In young and medium-aged trees, improvement is supposed in larger or smaller extent after the restriction or removal of external negative factors
3	Markedly decreased vigour, the remedy of the condition is not virtually probable
4	Residual vigour
5	A dead dry tree

*Vigour was derived from the degree of foliage, damage to stem and crown, presence of pathogens and other symptoms of the health condition deterioration

or evidently disturbed vitality (vitality degrees 1 and 2). Younger trees with various degrees of vitality were situated mainly north of the city centre (Královo Pole, Ponava and Veveří town districts) and in occasional places of the urban greenery regeneration.

Evaluation of the occurrence of mites and the statistical analysis of data

The attack of lime trees by *E. tiliae* (Pgst.) was classified as the proportion of leaf area with galls (Table 1) in the group of 50 randomly chosen leaves from a single branch sampled from the lower part of the tree crown of each tree.

The infestation coefficient for each of the trees was determined as a sum of the number of leaves in particular categories of attack multiplied by the coefficient of attack. The coefficient of attack expresses the estimated mean value of the proportion of an area with galls in the given category of attack (Table 1). The coefficient of infestation by particular species was visualized in ArcView GIS.

Data sets did not correspond to normal distribution according to the Shapiro-Wilk test of normal distribution. The data are characterized by the high proportion of zero values which caused their considerable skewness. The highest frequency of damaged leaves was noted in attacks by 10% leaf area. To compare the dependence of attack of particular species of lime, their physiological age and vigour by subspecies of *E. tiliae* (Pgst.) a non-parametric Kruskal-Wallis ANOVA with Bonferroni correction *p*-values was used.

The occurrence of galls of *E. tiliae tiliae* and *E. tiliae liosoma* was assessed only in eudominant species *Tilia euchlora*, *Tilia platyphyllos*, *Tilia cordata*. Zero hypotheses of the proposed tests determined that there were no significant differences in the attack by particular subspecies of *E. tiliae* (Pgst.) in relation to categories of physiological age, vigour and lime species. The statistical analysis was carried out by means of Statistica 6.0 software package.

RESULTS

On lime trees in the urban area of Brno, three subspecies of *Eriophyes tiliae* (Pgst.) were found: *tiliae*, *liosoma* and *nervalis* (Schnaider 1991). Galls were found on 436 limes of the total number of 3,245 trees. Most of trees were attacked by subspecies of *liosoma* (249) and *tiliae* (228). *E. tiliae nervalis* was found only on 4 trees. Its presence was not regarded as significant in the area of Brno. The highest frequency in the occurrence of mites was in *T. cordata* Mill. (6.5%) and *T. platyphyllos* Scop. (5.1%). In *T. euchlora* Koch 1.4% trees were attacked; number of attacked lime trees of others species did not exceed 1%.

The proportion of attacked lime species by varieties of *E. tiliae* (Pgst.) is given in Table 3. Generally abundant subspecies *tiliae* was not detected in *T. × europaea*, subspecies *liosoma* attacked *T. americana* L. and *T. cordata* Greenspire. A subspecies *nervalis*

Table 3. The number of lime trees and the occurrence of trees with galls of *E. tiliae* (Pgst.) subspecies

Species	Number of trees	Attacked trees (%)		
		tiliae	*liosoma*	*nervalis*
T. americana L.	11	9.1	0.0	0.0
T. cordata Mill.	686	8.9	25.7	0.4
T. cordata Greenspire	22	4.5	0.0	0.0
T. euchlora Koch	1,632	1.9	1.5	0.0
T. platyphyllos Scop.	753	16.7	5.8	0.1
T. tomentosa Moench	92	3.3	2.2	0.0
T. × *europaea*	41	0.0	7.3	0.0
Tilia sp.	8	62.5	0.0	0.0
Total	3,245	7.0	7.7	0.1

occurred only on *T. cordata* Mill. and *T. platyphyllos* Scop. Statistical evaluation of the rate of attack by subspecies of *tiliae* and *liosoma* was possible in *T. euchlora* Koch, *T. cordata* Mill. and *T. platyphyllos* Scop.

Host preference of both eudominant subspecies was different (Table 3), which was confirmed by results of the Kruskal-Wallis analysis of variance (for both subspecies $p < 0.001$). The *E. tiliae tiliae* preferred *T. platyphyllos* Scop. whereas the subspecies *liosoma* was most abundant on *T. cordata* Mill. (Fig. 2). In the subspecies *tiliae*, the lower degree of leaf attack was observed (Fig. 3).

The simultaneous occurrence of several subspecies of *E. tiliae* (Pgst.) was noted only in 1.35% of lime trees. Subspecies *tiliae* and *liosoma* attacked simultaneously *T. cordata* Mill. (0.8%), *T. euchlora* Koch (0.27%), *T. platyphyllos* Scop. (0.18%) and *T. tomentosa* Moench (0.03%). Subspecies *nervalis* occurred on two trees accompanied by remaining subspecies.

Significant difference in the occurrence by the physiological age of trees was proved in both eudominant subspecies by the Kruskal-Wallis test ($p < 0.0001$). Mature full-grown trees (4th age category) were attacked most independently of the subspecies of *Eriophyes tiliae* and the *Tilia* species. Difference from other age classes was approved by post-hoc multiple comparison of *p*-values at $\alpha = 0.05$. Only exception was the higher attack of young acclimated planting (2nd category) of *T. platyphyllos* by *E. tiliae liosoma* (Fig. 3).

Differences in infestation in relation to the host class vigour were confirmed by Kruskal-Wallis ANOVA for *liosoma* and *tiliae* subspecies ($p < 0.0001$). The highest values of the index of attack were found on sound lime trees or on trees with slightly decreased vigour (Fig. 3). Differences were also determined by the post-hoc multiple comparison of *p*-values ($\alpha = 0.05$). The highest values were usually concentrated in the group of trees with slightly decreased vigour (Fig. 3). On the contrary, highest attack by subspecies *liosoma* on *T. platyphyllos* Scop. was noted in the class of healthy trees.

Although frequency of the occurrence of both dominant subspecies of *E. tiliae* was similar in *T. cordata*, *T. platyphyllos* Scop. and *T. euchlora* Koch, the higher level of leaf area attack by the subspecies *liosoma* creating a typical patchy erinea in some groups of lime trees was noted. According to the index of attack, mature trees of *T. cordata* Mill. with slightly disturbed vigour (weighted mean 48.6%) and young growing-up trees were most threatened (Fig. 3). Same was observed in case of subspecies *tiliae*, but the

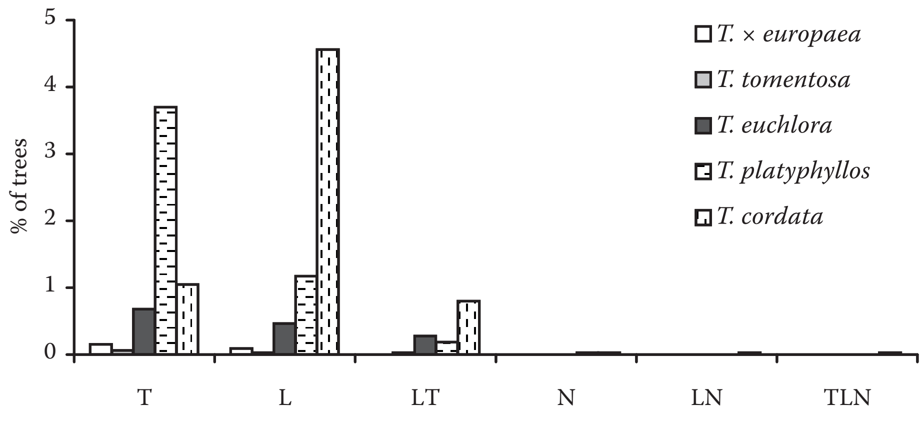


Fig. 2. The occurrence of *E. tiliae* (Pgst.) subspecies according to a nutritive species (T – subspecies *tiliae*, L – subspecies *liosoma*, LT – subspecies *tiliae* + *liosoma*, N – subspecies *nervalis*, LN – subspecies *liosoma* + *nervalis,* TLN – subspecies *tiliae* + *liosoma* + *nervalis*)

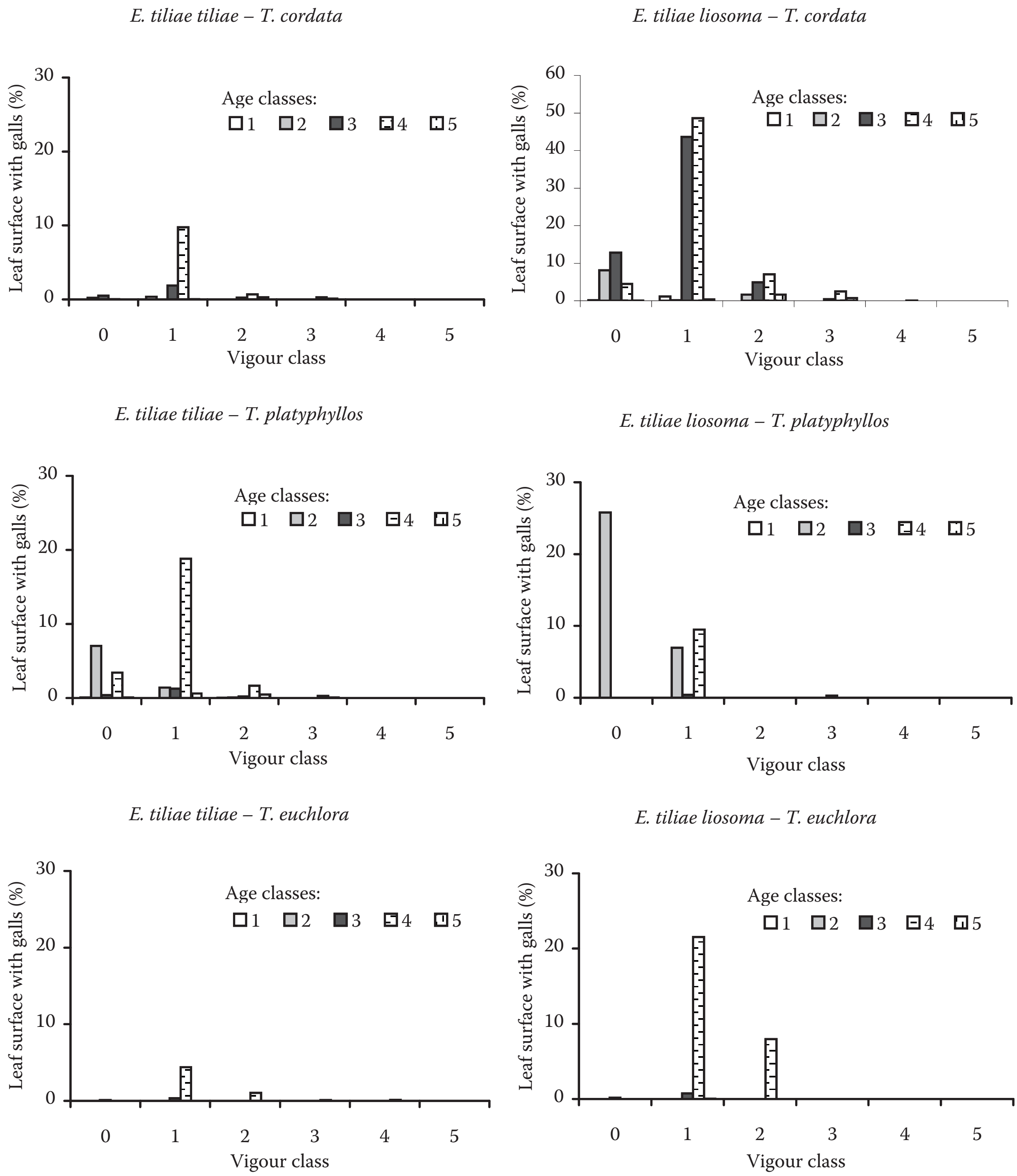
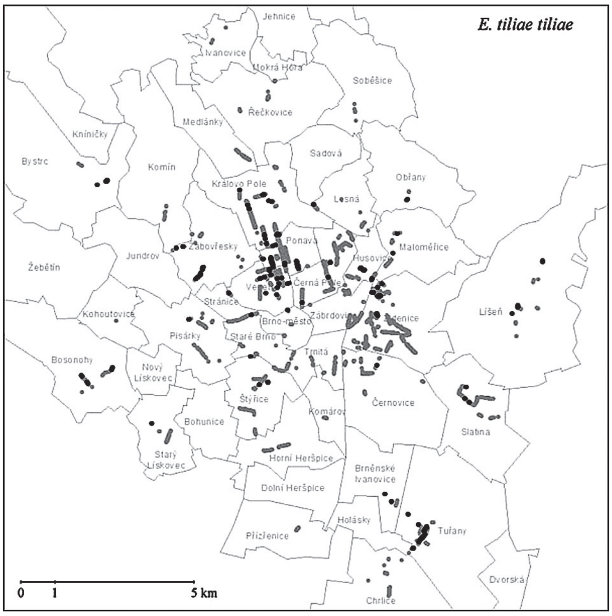


Fig. 3. Index of the attack of lime trees by subspecies *tiliae* and *liosoma* according to vigour and age classes

index of attack did not exceed 10%. The subspecies *liosoma* (index of attack 25.8%) preferred younger trees of *T. platyphyllos* Scop. A species *T. euchlora* Koch, which was most numerous in the urban area of Brno, showed the lowest occurrence of Eriophyidae and the low index of attack. Galls of the subspecies *liosoma* occurred most frequently (21.5%) on mature trees of slightly disturbed vigour. The subspecies *tiliae* with weighted mean of the index of attack 4.4% can be characterized in the same way.

No significant differences were observed in the spatial distribution of Eriophyidae on lime trees in the region of Brno. *E. tiliae tiliae* (Pgst.) was most abundant in an area with high concentration of limes north of the city centre; however, the species commonly occured throughout the city including the suburban districts (Fig. 4). The presence of subspecies *liosoma* was recorded in the large number of trees north of the centre, in southwestern and western parts of the city as well as in more remote alleys in southeastern parts of



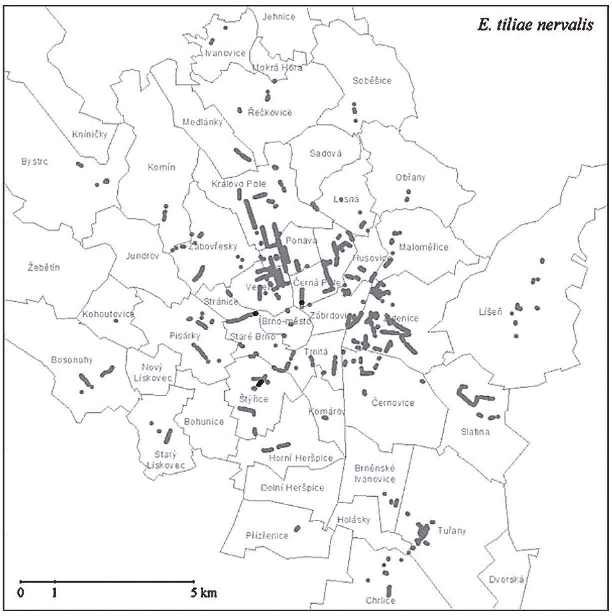


Fig. 4. The occurrence of *E. tiliae* (Pgst.) subspecies in the area of Brno. Black points – presence, light points – absence

Brno. Subspecies *nervalis* was found only in the vicinity of the city centre on trees at least 1.3 km apart.

Eriophyidae nearly did not occur in the potentially rich group of street alleys east of the centre (town districts Židenice, Černovice, Trnitá). Of 700 lime trees only 12 trees were attacked in the margin of the area. Galls of *E. tiliae* were not found even on sporadically growing limes in northern parts of Brno and several extensive alleys in Horní Heršpice and Štýřice town districts south of the centre were also without any attack (Fig. 4).

A hypothesis has not been confirmed that the occurrence of Eriophyidae is correlated with air pollution. In the dispersal model, air pollution load was low. Higher levels of pollutants from road traffic exceeding the set limits were modelled only in the close vicinity of a motorway. However, the occurrence of Eriophyidae was not related to the level of air pollution in case of not a single model harmful pollutant. Correlation coefficients R^2 of linear regression of the index of attack in relation to the air pollution concentration did not exceed a value of 0.2.

DISCUSSION

Properties of host species were the most important factor affecting the occurrence of gall-forming mites in the region of Brno. Spatial distribution and air pollution load did not demonstrate any effect on the occurrence of Eriophyidae. Accidental spatial distribution of attack confirms present findings on the spread of mites mentioned by Sabelis and Bruin (1996). As demonstrated by the presence of Eriophyidae even in relatively remote locations (Fig. 4), *E. tiliae* could spread throughout the studied region.

Form of galls along with imission effects did not influence the attack pattern, although the subspecies *liosoma* was supposed be more sensitive to impacts of the environment due to its felt-like open galls (Koricheva et al. 1996). As compared with measurements in selected reference points the dispersion study provided the overestimated level of air pollution concentrations (Henelová et al. 2005). Therefore, it is possible to state that the occurrence of Eriophyidae was not differentiated by the actual air pollution situation. Although the local air pollution situation could affect health conditions of lime, differentiation probably did not occur due to lack of acute imission loads (Bucek 2004; Henelová et al. 2005).

According to KOZLOV (1996), the limited spread of Eriophyidae can occur towards remote isolated groups of host plants whereby it is not possible to explain the absence of Eriophyidae in the northern part of the city. Groups of available limes were 0.7 to 2 km apart, but the real distance could be further decreased by the occurrence of limes not recorded in the list of urban greenery. A fact that of a large number of lime trees in Židenice and Černovice was not attacked in spite of their sufficient number refers to other effects. Increased abundance of *E. tiliae* (Pgst.) occurred in localities with the frequent regeneration of green vegetation. It is not possible to entirely exclude the introduction of Eriophyidae with planting stock. From the planting stock, Eriophyidae spread to more suitable hosts as described by SABELIS and BRUIN (1996).

The interpretation of above-mentioned mechanisms resulting in the start of migration is closely related to the quality of host which is substantial factor for the performance of phytophagous species (LARSSON 1989; FERNANDES et al. 1994; DE BRUYN et al. 2002). The life pattern of gall-forming organisms conditions the preference of non-stressed trees (LARSSON 1989) which corresponds with the results achieved. The nutritional value of the host leaves is probably related to preferences to mature stabilized trees as against overmature trees or new plantations (FERNANDES et al. 1994). The low occurrence of *E. tiliae* (Pgst.) on *T. euchlora* Koch. is of particular interest. Food specialization on the level of the nutrient plant genus is characteristic for Eriophyidae (WESTPHAL, MANSON 1996). Our studies have demonstrated that there are differences in the degree of attack on the level of subspecies *tiliae* and *liosoma.*

CONCLUSION

On lime trees in Brno, 3 subspecies of *E. tiliae* (Pgst.) were noted in 2004. Subspecies *liosoma* and *tiliae* occurred most frequently. The occurrence of the subspecies *nervalis* was insignificant. Rate of attack by dominant subspecies of the mite was different in eudominant species of *T. euchlora* Koch, *T. cordata* Mill. and *T. platyphyllos* Scop.

A difference was confirmed in the attack of lime trees by Eriophyidae according to the degree of physiological age. Particularly young trees reaching the height of mature individuals and mature trees were preferred. The effect was noted of the health condition (the degree of vigour) of a nutrient species on the occurrence of both subspecies of *E. tiliae tiliae* (Pgst.) and *E. tiliae liosoma* (Pgst.) which attacked most healthy trees or trees with slightly disturbed vitality. These results are related to the life pattern of mites in galls and their preference of a food-quality host.

The spatial distribution of attack was affected by the position of attractive hosts which occurred irregularly in the studied area. Attacked trees were concentrated in a region with the high number of available lime trees situated on the north not far from the city centre. Reduced attack could appear in limited rate of remote less numerous groups of limes in the northern part of the region as the reflection of passive forms of spread. The spatial distribution of mites was not affected by air pollution under conditions of low concentrations of pollutants without the impact of acute air pollution stress. The species of lime, its age and health conditions were a critical factor for the occurrence of Eriophyidae in Brno.

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Výskyt poddruhů roztoče *Eriophyes tiliae* (Pgst.) (Acari, Eriophyidae) na lípách v městském prostředí

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ABSTRAKT: Na lípách v intravilánu města Brna byl sledován výskyt poddruhů vlnovníka *Eriophyes tiliae* (Pgst.) v závislosti na druhu lípy, jejím stáří a zdravotním stavu. Byla provedena analýza výskytu poddruhů *liosoma*, *tiliae* a *nervalis* na listech 3 245 lip z hlediska preference hostitele a prostorové distribuce napadení v území města a možného ovlivnění imisemi. Poddruhy *liosoma* a *tiliae* byly přítomny na 13 % lip, poddruh *nervalis* byl zjištěn pouze na čtyřech lípách. Eudominantní poddruh *E. tiliae* preferoval dospělé stromy a mladé stromy dorůstající velikosti dospělých jedinců v dobrém zdravotním stavu. Rozložení vlnovníků na lípách na území města Brna bylo závislé na rozmístění atraktivních stromů a nebylo ovlivněno imisemi.

Klíčová slova: *Eriophyes tiliae*; *Tilia* sp.; schéma rozšíření; městské prostředí; hostitelské stromy; znečištění ovzduší; hálkotvorní roztoči

Fytofágní roztoči čeledi Eriophyidae vytvářejí sáním na listnatých dřevinách, keřích nebo bylinách druhově specifické novotvary (hálky, zplstnatění apod.) (Westphal, Manson 1996). Poddruhy druhu *Eriophyes* (=*Phytoptus*) *tiliae* (Pgst.) jsou potravně specializovány na lípu (*Tilia* sp.).

Napadení lip roztočem *E. tiliae* bylo klasifikováno (tab. 1) jako podíl listové plochy s hálkami v souboru padesáti náhodně vybraných listů z jednotkové větve, odebrané ze spodní části koruny. Index napadení (suma součinů napadení jednotlivých listů a koeficientu napadení) byl pro jednotlivé druhy vyjádřen prostorově v prostředí ArcView GIS. Pro porovnání závislosti napadení poddruhy roztoče *E. tiliae* jednotlivých druhů lip, jejich fyziologického stáří a vitality byla užita neparametrická Kruskal-Wallisova ANOVA. Výskyt roztočů byl hodnocen v souboru 3 245 lip (*Tilia* sp.), rostoucích v intravilánu města Brna. Lípy jsou rozmístěny nepravidelně, přičemž nejvyššího zastoupení dosahují v husté zástavbě do 4 km od centra města. Vytvářejí zpravidla aleje jednoho druhu, 5 % lip roste solitérně nebo v malých skupinách do deseti jedinců. Kromě eudominantních druhů *Tilia euchlora* Koch. (50,3 %), *Tilia platyphyllos* Scop. (23,2 %) a *Tilia cordata* Mill. (21,1 %) se zde vyskytuje několik dalších druhů. Údaje o imisní zátěži pocházely z modelového výpočtu rozptylové studie pro město Brno (Bucek 2004).

Na lípách v intravilánu Brna byly nalezeny tři poddruhy vlnovníka *Eriophyes tiliae*: *E. tiliae tiliae*, *E. tiliae liosoma* a *E. tiliae nervalis* (Schnaider 1991). Hálky byly nalezeny na 436 lípách z celkového počtu 3 245 jedinců. Nejvíce stromů bylo napadeno poddruhem *liosoma* (249 jedinců) a *tiliae* (228 jedinců). Poddruh *nervalis* byl nalezen pouze na čtyřech jedincích a není v oblasti Brna významný. Podíl napadení druhů lip podruhy *E. tiliae* uvádí tab. 3. U dvou dominantních poddruhů se projevila odlišná preference druhu hostitele (tab. 3), potvrzená výsledky Kruskal-Wallisovy analýzy rozptylů (pro oba poddruhy $p < 0{,}001$ při $\alpha = 0{,}05$). Poddruh *tiliae* preferoval *T. platyphyllos*, zatímco poddruh *liosoma T. cordata* (obr. 2). Souběžný výskyt několika poddruhů vlnovníka *E. tiliae* byl zaznamenán pouze u 1,35 % lip. Signifikantní rozdíl ve výskytu podle fyziologického stáří a vitality stromu byl prokázán Kruskal-Wallisovým testem ($p = 0{,}0001$, $\alpha = 0{,}05$) u obou dominantních poddruhů. Nejvíce byly napadány dospělé plně vzrostlé stromy (4. kategorie) nezávisle na varietě vlnovníka a druhu lípy, nejvyšší hodnoty indexu napadení byly nalezeny u lip bez patrného narušení zdravotního stavu nebo pouze s jeho mírným zhoršením (obr. 3). Disperze vlnovníků na lípách na území města Brna se výrazně neprojevila. *E. tiliae tiliae* byla nejvíce zastoupena v oblasti s vysokou koncentrací lip severně od centra, ale běžně se vyskytovala po celém městě včetně jižního předměstí (obr. 4). Poddruh *liosoma* se vyskytoval na velkém počtu stromů na sever od centra, v jihozápadních a západních částech města i ve vzdálenějších alejích na jihovýchodě (obr. 4). Nebyla potvrzena hypotéza, že výskyt vlnovníků bude korelován s imisemi. Imisní zátěž byla v rozptylovém modelu nízká; lze konstatovat, že výskyt vlnovníků aktuální imisní situace nediferencovala.

Nejvýznamnějšími faktory ovlivňujícími výskyt hálkotvorných roztočů na území Brna byly vlastnosti hostitelské dřeviny, což potvrdily dosavadní poznatky o potravních preferencích vlnovníků (Larsson 1989), prostorové rozmístění a imisní zátěž neměly na výskyt vlnovníků vliv. V podmínkách bez akutního imisního stresu (Buček 2004; Henelová et al. 2005) nedošlo k diferenciaci vlivem imisí. Disperzi vlnovníků mohly ovlivnit i mechanismy popsané Sabelisem a Bruinem (1996), které souvisejí s kvalitou hostitele, jež je určujícím faktorem pro vývoj fytofágů (Larsson 1989; Fernandes et al. 1994; De Bruyn et al. 2002). Odlišná úroveň výskytu poddruhů *tiliae*, *liosoma* na různých druzích lip a nízký výskyt *E. tiliae* na *T. euchlora* byl způsoben diferencovanou potravní atraktivitou hostitele.

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