doi: 10.17221/167/2016-PPS

Phytoseiid Mites on *Quercus cerris* in an Urban Park – Short Communication

*Jan KABÍČEK**

Department of Plant Protection, Faculty of Agrobiology, Food and Natural Resources, Czech University of Life Sciences in Prague, Prague, Czech Republic

**Corresponding author: kabicek@af.czu.cz*

Abstract

Kabíček J. (2017): Phytoseiid mites on *Quercus cerris* in an urban park – short communication. Plant Protect. Sci., 53: 181–186.

The community of phytoseiid mites on the leaves of non-indigenous *Quercus cerris* was studied in an intensively managed urban park during the years 2012–2014. Five phytoseiid species, namely *Kampimodromus aberrans*, *Typhloseiulus peculiaris*, *Euseius finlandicus*, *Typhlodromus* (*Typhlodromus*) *pyri*, and *Paraseiulus triporus*, were found on the studied oak leaves; three of them are generalist predators. *K. aberrans* and *T. peculiaris* were the dominant species (88.5% of all sampled phytoseiids), of which *K. aberrans* was the significantly most abundant species on the inspected oak leaves. Non-native *Q. cerris* can serve as a favourable host plant and refuge for certain phytoseiid species in environmentally unfriendly urban areas.

Keywords: Phytoseiidae; Acari; turkey oak; species diversity; host plant

Urban and suburban parks and gardens are usually the most heterogeneous green spaces that can retain abundant remnants of sub-natural habitats within a large urban metropolis (Gobster 2001; Shwartz *et al.* 2008). The artificial plant assemblages within the parks vary greatly in character and can range from remnants of natural forest dominated by native species to structurally simple anthropogenically created groups of tree species composed mostly of exotics (LaPaix & Freedman 2010). Plant species diversity is an essential determinant of overall ecosystem biodiversity and markedly influences the composition and abundance of other associated biota (Matson *et al.* 1997; Hope *et al.* 2003). Arthropods as the largest and most diverse faunal group are probably the least studied animals in urban areas, and existing urban invertebrate research has usually focused on obvious or pest species (McIntyre 2000; Scanlon & Petit 2008; Dale & Frank 2014).

Invertebrate natural enemies are an effective means for pest control and can significantly contribute to decreasing the damage caused by phytophagous pests (Hagler 2000; Lazarovits *et al.* 2007). Therefore, the presence of various natural enemies as environmentally friendly biological control agents on plants growing in urban open green spaces is necessary because it is usually impossible and/or hazardous to control diverse urban vegetation pests using toxic pesticides. Many phytoseiid species (Acari: Phytoseiidae) are known as important predators of various small arthropods, especially phytophagous mites living on plants (Gerson *et al.* 2003; McMurtry *et al.* 2013), and diverse wild and cultivated trees and bushes can serve as host plants and refuges for this group of natural enemies (Tixier *et al.* 1998; Papaioannou-Souliotis *et al.* 2000). *Quercus cerris* L. is an important and common oak species in south-eastern Europe and Minor Asia (Bussotti & Grossoni 1997; Şen *et al.* 2010). Several phytoseiid species were recorded on this deciduous tree species in Hungary (Ripka & Szabó 2010, 2011; Ripka *et al.* 2013). *Q. cerris*, as a non-native tree species in Bohemia, is occasionally planted in various park and garden areas (Kubát *et al.* 2002), and data on

doi: 10.17221/167/2016-PPS

the phytoseiid fauna of this oak species are absent in the Czech Republic.

The aim of the present study was to investigate the occurrence and species composition of phytoseiid mites on the leaves of *Q. cerris* growing in an urban park. Knowledge regarding the phytoseiid mites on deciduous trees can contribute to a better understanding of the role of urban vegetation as a potential reservoir for phytoseiids in urban and suburban areas.

MATERIAL AND METHODS

The study was carried out in an urban park in Prague and was aimed at phytoseiid mites inhabiting the leaves of *Q. cerris*. The park, with more than three hundred native and exotic broadleaved tree species and an intense management regime, is located on the northwestern outskirts of the city (50°7.9'N, 14°22.5'E) and lies 280 m a.s.l. Leaf samples were taken from the same 10 randomly selected turkey oak trees (approximately 50 years old) over three seasons. In 2012 and 2013, five collections were performed (28/6, 27/7, 9/8, 24/8, 31/8 and 27/6, 15/7, 29/7, 12/8, 23/8, respectively), and three in 2014 (9/7, 28/7, 25/8). The standard sample size was 10 randomly selected leaves per tree of approximately identical size collected from the proximal part of the shoots. Each sample was directly placed in a plastic bag and stored in a cold-storage box. The sampled leaves were taken to the laboratory, where they were either examined or stored in the refrigerator at 5°C. The entire leaf surface was surveyed under a binocular microscope, and the mites found were separated using insect pins. The numbers of phytoseiid motile stages were recorded. Temporary slide preparations were made in lactic acid for microscopic examination. Immature phytoseiid stages were not determined and were excluded from the analyses. The phytoseiids were classified based on the Kolodochka (1980), Beglyarov (1981a, b), and Chant and Yoshida-Shaul (1982, 1983, 1987) keys. The nomenclature of the phytoseiid species used in this study follows Demite *et al.* (2016). The tree species was determined with the key of Kubát *et al.* (2002).

Dominance (Do) indicates the percentage of specimens of a given taxon based on the total number of mites collected from the oak trees at the study site. The species dominance was characterised by the following scale: eudominant (≥ 10%), dominant (5–9.99%), subdominant (2–4.99%), recedent (1–1.99%), and subrecedent (< 1%) (Tischler 1965). The constancy of occurrence (C) indicates the relationship between the number of samples in which a given species occurred and the number of all samples collected from the oak trees at the study site. The following categories of constancy were used: euconstant (76–100%), constant (51–75%), accessory (26–50%), and accidental (≤ 25%) species (Tischler 1965). The counts of mites per leaf were evaluated among phytoseiid species using analysis of variance (ANOVA) followed by Tukey's HSD test. The statistical significance was tested at $P = 0.05$. Before carrying out an ANOVA, a logarithmic transformation, i.e. log (y + 1), was applied to the data.

RESULTS AND DISCUSSION

All sampled turkey oaks were inhabited by phytoseiid mites. A total of 1257 specimens of phytoseiids belonging to five species, *Kampimodromus aberrans* (Oudemans), *Typhloseiulus peculiaris* (Kolodochka), *Euseius finlandicus* (Oudemans), *Typhlodromus* (*Typhlodromus*) *pyri* Scheuten, and *Paraseiulus triporus* (Chant & Yoshida-Shaul), were found on the undersurfaces of the surveyed oak leaves (Table 1). Six phytoseiid species were found on *Q. cerris* leaves

Table 1. Qualitative and quantitative survey data of the Phytoseiidae on *Quercus cerris* (Prague, 2012–2014)

Phytoseiids	Individuals	Total (%)	Mites/leaf ± SEM	Dominance	Constancy (%)
K. aberrans	642	51.1	0.50 ± 0.18^{a}	ED	80.0
T. peculiaris	471	37.5	0.37 ± 0.17^{b}	ED	71.5
E. finlandicus	64	5.1	0.05 ± 0.06^{c}	D	20.8
T. (*T.*) *pyri*	47	3.7	0.03 ± 0.05^{c}	SD	14.6
P. triporus	33	2.6	0.03 ± 0.03^{c}	SD	16.9

SEM – standard error of the mean; ED – eudominant; D – dominant; SD – subdominant; significant differences among the phytoseiid species are highlighted with small letters (in column) based on Tukey's HSD test (α = 0.05)

doi: 10.17221/167/2016-PPS

Table 2. Phytoseiids (percentage and total number of individuals) collected in Prague on *Quercus cerris*

Year	*K. aberrans*	*T. peculiaris*	*T. (T.) pyri*	*P. triporus*	*E. finlandicus*	Number of individuals
2012	60.1	25.6	9.9	3.7	0.7	434
2013	45.0	46.0	0.2	1.8	6.9	493
2014	48.2	40.3	0.9	2.4	8.2	330

in Hungary (Ripka & Szabó 2011; Ripka *et al.* 2013), of which *K. aberrans*, *T.* (*T.*) *pyri*, and *E. finlandicus* are mentioned above. Two species (*K. aberrans* and *T. peculiaris*) composed the majority of the phytoseiids collected from the inspected oak leaves (88.5% of all sampled phytoseiids). *K. aberrans* occurred on all inspected oak trees and was significantly ($F_{4, 145}$ = 129.65, $P < 0.05$) the most abundant phytoseiid species; it represented 51.1% of the total phytoseiid abundance on the surveyed oak leaves (an average of 0.5 mites per leaf) (Table 1). More specimens of this eudominant and euconstant species were recorded on the examined oaks in 2012 (Table 2). *K. aberrans*, a generalist predator widely distributed in Europe, was collected from *Acer* spp., *Aesculus hippocastanum*, *Corylus avellana*, *C. colurna*, *Malus* sp., *Morus alba*, *Prunus* sp., *Quercus cerris*, *Salix* sp., *Tilia platyphyllos*, *Viburnum opulus*, and many other cultivated and wild plants (Kolodochka 1978; Miedema 1987; McMurtry & Croft 1997; Duso *et al.* 2004; Ripka 2006; Kabíček 2008; McMurtry *et al.* 2013). *K. aberrans* was regularly sampled on vines in productive vineyards (Tixier *et al.* 2000), and it is a common and frequently observed phytoseiid species in apple and hazelnut orchards (Ozman-Sullivan 2006; Tixier *et al.* 2014). The abundant occurrence of *K. aberrans* on the inspected oak trees could indicate that *Q. cerris* is the favoured host plant for this generalist species. *K. aberrans* is frequently found on pubescent leaves (Duso *et al.* 2009; Peverieri *et al.* 2009), and the abaxial surface of *Q. cerris* leaves has stellate trichomes flattened onto the lamina as well as bulbous ones (Bussotti & Grossoni 1997). Therefore, the leaves of *Q. cerris* can constitute favourable microhabitats for *K. aberrans.* According to Tixier *et al.* (2000), *K. aberrans* is able to disperse from surrounding vegetation to crops by aerial dispersal and can probably develop well on vine cultivars with pubescent leaves. Thus, *Q. cerris* could potentially serve as a natural reservoir for *K. aberrans* in various climatically favourable regions where turkey oak is a native and common species and may contribute to the recolonisation of vineyards and orchards by this phytoseiid species under suitable conditions.

Obviously, the eudominant and euconstant *T. peculiaris* was the second most abundant species (an average of 0.4 mites per leaf) in the studied taxocoenosis of phytoseiid mites; it made up 37.5% of the total specimens. This species was detected in many of the leaf samples from all the studied oak trees. More specimens of *T. peculiaris* were found on the examined oak leaves in both 2013 and 2014 (Table 2). *T. peculiaris*, as likely an uncommon species with a limited range, was described by Kolodochka (1980) from the leaves of *Tilia tomentosa* in Moldova and was also found on oaks in Iran and Hungary (Faraji *et al.* 2007; Kontschán *et al.* 2014). Papadoulis and Emmanouel (1993) noted its presence in Greece, and it was recently found in Turkey (Döker *et al.* 2016). According to Kontschán *et al.* (2014), *T. peculiaris*, as a species with probably Mediterranean distribution, colonised also the Carpathian Basin. The present study indicates that *T. peculiaris* can occur and persist well on turkey oaks in the region with a non-Mediterranean climate. Thus, repeated findings of *T. peculiaris* on the surveyed oak leaves can demonstrate the positive role of woody plants as refuges for phytoseiid mites in urban areas and may indicate that *Q. cerris* could serve as favourable host plant for this infrequently reported and little known phytoseiid species.

Accidentally occurring *E. finlandicus* was found on several of the surveyed oak trees; it composed 5.1% of the total number of specimens. More individuals of *E. finlandicus* were detected on the inspected oak leaves in both 2013 and 2014 (Table 2). *E. finlandicus* is a generalist predator that mostly feeds on pollen (McMurtry & Croft 1997; McMurtry *et al.* 2013), but it is also known as a facultative polyphagous predator of eriophyoid and tetranychid mites (Schausberger 1998; Awad *et al.* 2001). *E. finlandicus*, as a generally common phytoseiid species living on many broadleaved trees and shrubs, preferentially resides on glabrous or slightly pubescent leaves (Kolodochka 1978; Papaioannou-Souliotis *et al.* 2000; Seelmann *et al.* 2007). The infrequent occurrence of *E. finlandicus* (an average of 0.05 mites per leaf) could indicate that the observed leaves of *Q. cerris* were a less favourable habitat for this generalist predator.

Subdominant *T.* (*T.*) *pyri* was detected infrequently on several of the inspected oak trees (an average of 0.03 mites per leaf); in total, it represented only 3.7%

doi: 10.17221/167/2016-PPS

of the total number of phytoseiid specimens. *T.* (*T.*) *pyri* is widely used as a biological control agent in commercial orchards and vineyards (Van de Vrie 1985; Duso *et al.* 1991; Gerson *et al.* 2003). This mite is reported from the leaves of various tree and shrub species, e.g. *Acer* spp., *Aesculus hippocastanum*, *Corylus avellana*, *Quercus* sp., *Syringa vulgaris*, *Tilia platyphyllos*, *Viburnum* sp. (Chant & Yoshida-Shaul 1987; Miedema 1987; Papaioannou-Souliotis *et al.* 2000; Duso *et al.* 2004). Similarly to *K. aberrans*, *T.* (*T.*) *pyri* is a generalist predator that is commonly found on pubescent leaves (Roda *et al.* 2003; McMurtry *et al.* 2013). Leaf trichomes may influence intraguild predation (Seelmann *et al.* 2007; Ferreira *et al.* 2011), and the displacement of *T.* (*T.*) *pyri* by *K. aberrans* on pubescent grape and apple leaves is well documented (Duso *et al.* 1991, 2009; Peverieri *et al.* 2009). Therefore, the infrequent occurrence of *T.* (*T.*) *pyri* on the studied oak leaves could be influenced by competitive species interactions.

The accidentally occurring *P. triporus* was recorded only on some of the surveyed oak trees (an average of 0.03 mites per leaf); in total, it represented only 2.6% of the total number of phytoseiid specimens (subdominant representation). This infrequent species on the surveyed oak leaves has been found on various cultivars in apple orchards in Finland and France (Tuovinen & Rokx 1991; Tixier *et al.* 2014). *P. triporus* occurs on miscellaneous plants (e.g. *Acer platanoides*, *Aesculus hippocastanum*, *Citrus* spp., *Corylus avellana*, *Fragaria vesca*, *Juglans regia*, *Prunus avium*, *P. padus*, *Ribes rubrum*, *Rubus fruticosus*, *Sorbus aucuparia*, and *Ulmus glabra*), usually at low densities (Chant & Yoshida-Shaul 1982; Tuovinen & Rokx 1991; Kabíček 2010; Barbar 2013; Tixier *et al.* 2014). Çobanoglu (2004) observed *P. triporus* in association with Tenuipalpidae and Stigmaeidae. According to McMurtry *et al.* (2013), representatives of *Paraseiulus* are specialised predators of tydeoids.

Various alien plant species can serve as host plants for some native arthropod species that commonly occur in urbanized settings (Shapiro 2002). Similarly, the data obtained in this study show that the non-native *Q. cerris* planted in a managed urban park located at the edge of the city can serve as favourable host plant for several phytoseiid species. Three of the recorded phytoseiid species found on the examined oaks are generalist predators; among them, the most common was *K. aberrans*. Therefore, the results suggest that some generalist species can survive well and utilise diversified microhabitats and food resources on *Q. cerris* in urban areas. Various phytoseiid generalists have evolved in response to the conditions associated with the plants they inhabit rather than to any specific prey, and their occurrence on plants is not usually linked to the presence of certain kinds of prey (McMurtry & Croft 1997; Gerson *et al.* 2003; McMurtry *et al.* 2013); nonetheless, all of the generalists found on the studied oaks are known as effective predators of some eriophyoids and tetranychids (Collyer 1964; Schausberger 1991; Gerson *et al.* 2003). The dominance of single phytoseiid species may change in unbalanced ecosystems (McMurtry & Croft 1997); thus, the presence and persistence of several generalist species with different predatory and survival strategies could better mediate the pest control under different changing environmental conditions.

The consistent occurrence of the uncommon *T. peculiaris* on the studied turkey oaks shows that intensively managed urban parks with artificial plant assemblages wholly created by humans can play an important role in landscape biodiversity. Non-indigenous tree species can evidently provide a refuge for certain phytoseiid populations in environmentally unfriendly urban areas and could be considered as favourable habitats with high conservation value.

References

Awad A.A., Zhang Z.Q., Masters G.J., McNeill S. (2001): *Euseius finlandicus* (Acari: Phytoseiidae) as potential biological control agent against *Tetranychus urticae* (Acari: Tetranychidae): life history and feeding habits on three different types of foods. Experimental and Applied Acarology, 25: 833–847.

Barbar Z. (2013): Survey of phytoseiid mite species (Acari: Phytoseiidae) in citrus orchards in Lattakia governorate, Syria. Acarologia, 53: 247–261.

Beglyarov G.A. (1981a): Key to the phytoseiid predatory mites (Parasitiformes, Phytoseiidae) of the fauna of the USSR. Informatsionnyi Byulletin, 2: 1–95. (in Russian)

Beglyarov G.A. (1981b): Key to the phytoseiid predatory mites (Parasitiformes, Phytoseiidae) of the fauna of the USSR. Informatsionnyi Byulletin, 3: 1–45. (in Russian)

Bussotti F., Grossoni P. (1997): European and Mediterranean oaks *(Quercus* L.; Fagaceae): SEM characterization of the micromorphology of the abaxial leaf surface. Botanical Journal of the London Society, 124: 183–199.

Chant D.A., Yoshida-Shaul E. (1982): A world review of the *soleiger* species group in the genus *Typhlodromus*

doi: 10.17221/167/2016-PPS

Scheuten (Acarina: Phytoseiidae). Canadian Journal of Zoology, 60: 3021–3032.

Chant D.A., Yoshida-Shaul E. (1983): A world review of the *simplex* species group in the genus *Typhlodromus* Scheuten (Acarina: Phytoseiidae). Canadian Journal of Zoology, 61: 1142–1151.

Chant D.A., Yoshida-Shaul E. (1987): A world review of the *Pyri* species group in the genus *Typhlodromus* Scheuten (Acari: Phytoseiidae). Canadian Journal of Zoology, 65: 1770–1804.

Çobanoglu S. (2004): Phytoseiid mites (Mesostigmata: Phytoseiidae) of Thrace, Turkey. Israel Journal of Entomology, 34: 83–107.

Collyer E. (1964): A summary of experiments to demonstrate the role of *Typhlodromus pyri* Scheut. in the control of *Panonychus ulmi* (Koch) in England. Acarologia, 6: 363–371.

Dale A.G., Frank S.D. (2014): Urban warming trumps natural enemy regulation of herbivorous pests. Ecological Applications, 24: 1596–1607.

Demite P.R., Moraes G.J. de, McMurtry J.A., Denmark H.A., Castilho R.C. (2016): Phytoseiidae Database. Available at http://www.lea.esalq.usp.br/phytoseiidae (accessed Oct 14, 2016).

Döker I., Kazak C., Karut K. (2016): Contributions to the Phytoseiidae (Acari: Mesostigmata) fauna of Turkey: morphological variations, twelve new records, re-description of some species and a revised key to the Turkish species. Systematic and Applied Acarology, 21: 505–527.

Duso C., Pasqualetto C., Camporese P. (1991): Role of the predatory mites *Amblyseius aberrans* (Oud.), *Typhlodromus pyri* Scheuten and *Amblyseius andersoni* (Chant) (Acari, Phytoseiidae) in vineyards. II. Minimum releases of *A. aberrans* and *T. pyri* to control spider mite populations (Acari, Tetranychidae). Journal of Applied Entomology, 112: 298–308.

Duso C., Fontana P., Malagnini V. (2004): Diversity and abundance of phytoseiid mites (Acari: Phytoseiidae) in vineyards and the surrounding vegetation in northeastern Italy. Acarologia, 44: 31–47.

Duso C., Fanti M., Pozzebon A., Angeli G. (2009): Is the predatory mite *Kampimodromus aberrans* a candidate for the control of phytophagous mites in European apple orchards? BioControl, 54: 369–382.

Faraji F., Hajizadeh J., Ueckermann E.A., Kamali K., McMurtry J.A. (2007): Two new records for Iranian phytoseiid mites with synonymy and keys to the species of *Typhloseiulus* Chant and McMurtry and Phytoseiidae in Iran (Acari: Mesostigmata). International Journal of Acarology, 33: 231–239.

Ferreira J.A., Cunha D.F., Pallini A., Sabelis M.W., Janssen A. (2011): Leaf domatia reduce intraguild predation among predatory mites. Ecological Entomology, 36: 435–441.

Gerson U., Smiley R.L., Ochoa R. (2003): Mites (Acari) for Pest Control. Oxford, Blackwell Science Ltd.

Gobster P.H. (2001): Visions of nature: conflict and compatibility in urban park restoration. Landscape and Urban Planning, 56: 35–51.

Hagler J.R. (2000): Biological control of insects. In: Rechcigl J.E., Rechcigl N.A. (eds): Insect Pest Management. Techniques for Environmental Protection. Boca Raton, London, New York, Washington, D.C., Lewis Publishers: 207–241.

Hope D., Gries C., Zhu W., Fagan W.F., Redman C.L., Grimm N.B., Nelson A.L., Martin C., Kinzig A. (2003): Socioeconomics drive urban plant diversity. Proceedings of the National Academy of Sciences of the United States of America, 100: 8788–9792.

Kabíček J. (2008): Cohabitation and intraleaf distribution of phytoseiid mites (Acari: Phytoseiidae) on leaves of *Corylus avellana*. Plant Protection Science, 44: 32–36.

Kabíček J. (2010): Scarceness of phytoseiid species cooccurrence (Acari: Phytoseiidae) on leaflets of *Juglans regia*. Plant Protection Science, 46: 79–82.

Kolodochka L.A. (1978): A guide to the determination of plant-inhabiting phytoseiid mites. Kiev, Naukova dumka: 1–78. (in Russian)

Kolodochka L.A. (1980): New phytoseiid species (Parasitiformes, Phytoseiidae) of the Moldova. Vestnik Zoologii, 4: 39–45. (in Russian)

Kontschán J., Karap A., Kiss B. (2014): Phytoseiid mites (Acari, Mesostigmata) from the rest areas of Hungarian highways. Opuscula Zoologica Budapest, 45: 25–31.

Kubát K., Hrouda L., Chrtek J., Kaplan Z., Kirschner J., Štěpánek J. (2002): Klíč ke květeně České republiky. Praha, Academia.

LaPaix R., Freedman B. (2010): Vegetation structure and composition within urban parks of Halifax regional municipality, Nova Scotia, Canada. Landscape and Urban Planning, 98: 124–135.

Lazarovits G., Goettel M.S., Vincent C. (2007): Adventures in biocontrol. In: Vincent C., Goettel M.S., Lazarovits G. (eds): Biological Control. A Global Perspective. Wallingford, Oxfordshire, CAB International: 1–6.

Matson P.A., Parton W.J., Power A.G., Swift M.J. (1997): Agricultural intensification and ecosystem. Science, 277: 504.

McIntyre N. (2000): Ecology of urban arthropods: a review and a call to action. Annals of the Entomological Society of America, 93: 825–835.

McMurtry J.A., Croft B.A. (1997): Life-styles of phytoseiid mites and their roles in biological control. Annual Review of Entomology, 42: 291–321.

McMurtry J.A., Moraes G.J. de, Sourassou N.F. (2013): Revision of the lifestyles of phytoseiid mites (Acari: Phytosei-

doi: 10.17221/167/2016-PPS

idae) and implications for biological control strategies. Systematic and Applied Acarology, 18: 297–320.

Miedema E. (1987): Survey of phytoseiid mites (Acari: Phytoseiidae) in orchards and surrounding vegetation of northwestern Europe, especially in the Netherlands. Keys, descriptions and figures. Netherlands Journal of Plant Pathology, 93 (Suppl. 2): 1–64.

Ozman-Sullivan S.K. (2006): Life history of *Kampimodromus aberrans* as a predator of *Phytoptus avellanae* (Acari: Phytoseiidae, Phytoptidae). Experimental and Applied Acarology, 38: 15–23.

Papadoulis G.T., Emmanouel N.G. (1993): New records of phytoseiid mites from Greece with a description of the larva of *Typhlodromus erymanthii* Papadoulis & Emmanouel (Acarina: Phytoseiidae). International Journal of Acarology, 19: 51–56.

Papaioannou-Souliotis P., Markoyiannaki-Printziou D., Zeginis G. (2000): Observations on acarofauna in four apple orchards of central Greece. II. Green cover and hedges as potential sources of phytoseiid mites (Acari: Phytoseiidae). Acarologia, 41: 411–421.

Peverieri G.S., Simoni S., Goggioli D., Liguori M., Castagnoli M. (2009): Effects of variety and management practices on mite species diversity in Italian vineyards. Bulletin of Insectology, 62: 53–60.

Ripka G. (2006): Checklist of the Phytoseiidae of Hungary (Acari: Mesostigmata). Folia Entomologica Hungarica, 67: 229–260.

Ripka G., Szabó Á. (2010): Additional data to the knowledge of the mite fauna of Hungary (Acari: Mesostigmata, Prostigmata and Astigmata). Acta Phytopathologica et Entomologica Hungarica, 45: 373–381.

Ripka G., Szabó Á. (2011): New plant-inhabiting mite records from Hungary (Acari: Mesostigmata, Prostigmata and Astigmata). Acta Phytopathologica et Entomologica Hungarica, 46: 261–266.

Ripka G., Szabó Á., Tempfli B., Varga M. (2013): New plant-inhabiting mite records from Hungary (Acari: Mesostigmata, Prostigmata and Astigmata) II. Acta Phytopathologica et Entomologica Hungarica, 48: 237–244.

Roda A., Nyrop J., English-Loeb G. (2003): Leaf pubescence mediates the abundance of non-prey food and the density of the predatory mite *Typhlodromus pyri*. Experimental and Applied Acarology, 29: 193–211.

Scanlon A.T., Petit S. (2008): Biomass and biodiversity of nocturnal aerial insects in an Adelaide City park and implications for bats (Microchiroptera). Urban Ecosystems, 11: 91–106.

Schausberger P. (1991): Vergleichende untersuchungen zum Lebensverlauf, die Erstellung von Lebenstafeln und die Vermehrungskapazität von *Amblyseius aberrans* Oud. und *Amblyseius finlandicus* Oud. (Acari: Phytoseiidae). Pflanzenschutzberichte, 52: 53–71.

Schausberger P. (1998): Survival, development and fecundity in *Euseius finlandicus*, *Typhlodromus pyri* and *Kampimodromus aberrans* (Acari, Phytoseiidae) feeding on the San José scale *Quadraspidiotus perniciosus* (Coccina, Diaspididae). Journal of Applied Entomology, 122: 53–56.

Seelmann L., Auer A., Hoffmann D., Schausberger P. (2007): Leaf pubescence mediates intraguild predation between predatory mites. Oikos, 116: 807–817.

Şen A., Miranda I., Santos S., Graça J., Pereira H. (2010): The chemical composition of cork and phloem in the rhytidome of *Quercus cerris* bark. Industrial Crops and Products, 31: 417–422.

Shapiro A.M. (2002): The Californian urban butterfly fauna is dependent on alien plants. Diversity and Distributions, 8: 31–40.

Shwartz A., Shirley S., Kark S. (2008): How do habitat variability and management regime shape the spatial heterogeneity of birds within a large Mediterranean urban park? Landscape and Urban Planning, 84: 219–229.

Tischler W. (1965): Agrarökologie. Jena, VEB Gustav Fischer Verlag.

Tixier M.-S., Kreiter S., Auger P., Weber M. (1998): Colonization of Languedoc vineyards by phytoseiid mites (Acari: Phytoseiidae): influence of wind and crop environment. Experimental and Applied Acarology, 22: 523–542.

Tixier M.-S., Kreiter S., Auger P. (2000): Colonization of vineyards by phytoseiid mites: their dispersal patterns in the plot and their fate. Experimental and Applied Acarology, 24: 191–211.

Tixier M.-S., Lopes I., Blanc G., Dedieu J.L., Kreiter S. (2014): Phytoseiid mite diversity (Acari: Mesostigmata) and assessment of their spatial distribution in French apple orchards. Acarologia, 54: 97–111.

Tuovinen T., Rokx J.A.H. (1991): Phytoseiid mites (Acari: Phytoseiidae) on apple trees and in surrounding vegetation in southern Finland. Densities and species composition. Experimental and Applied Acarology, 12: 35–46.

Van de Vrie M. (1985): Apple. In: Helle W., Sabelis M.W. (eds): Spider Mites, Their Biology, Natural Enemies and Control. Vol. 1B. Amsterdam, Oxford, New York, Elsevier: 311–326.

Received: 2016–12–06
Accepted after corrections: 2017–01–31
Published online: 2017–04–16