Acta Biologica Sibirica
Journal of Biology
Founded in 2015

Altai State University

www.asu.ru

ISSN 2412-1908

OPEN ACCESS

Acta Biologica Sibirica, 2019, 5(1), 161–166

RESEARCH ARTICLE

Diversity structure of phytoseiid mites in urban plant habitats

Grabovska S.L., Mykolaiko I.I., Mykolaiko V.P., Myronyuk T.M.

Pavlo Tychyna Uman State Pedagogical University
E-mail: irinamikolaiko@i.ua

We founded that *E. finlandicus* and *K. aberrans* formed the nucleus of Phytoseiidae community on the plants of urbanized environment in the result of study of 93 plant species (55 species of tree-and-shrub (58.9%) and 38 species of herbaceous plants (41.1%). Our research was carried out in plantations along the main and secondary municipal highways, near residential area and industrial buildings, on private plots of the private building area, in city parks and squares of Kyiv, Uman, Brovary, and Vasylkiv (Ukraine). The peculiarities of their distribution among urban plant associations, which differ from each other by different characteristics (population, area, degree of urbanization) were determined. Both species - *E. finlandicus* and *K. aberrans* have a rather extended range of indicators of relative biotope contiguity (-0.91<Fij<0.43 and -0.93Fij<0.96) that indicated their property to inhabit large number of plants. The indicator of *K. aberrans* occurrence, which was the highest in the city with the smallest degree of urbanization (Vasylkiv), decreased in the city with the maximum possible degree of urbanization (Kyiv). This indicator of *E. finlandicus* on the contrary increased along the gradient from a smaller city to the metropolitan city. *K. aberrans* inhabit a large number of plant species (33 species), while preferred plants from Rosacea family. *E. finlandicus* dominated by number of urban plant species it inhabited (75 species, 79.78%), absolute number of individuals in collected samples of predatory mites (504), occurrences index (Is = 74.49%), and by index of Palii-Kovnatsi (Di = 51.42%). The dominance of *E. finlandicus* species was registered in both groups of plants. The distribution of Phytoseiidae's was primarily connected with the possibility of their movement along the surface of the substrate. Speed of mites moving was not the same in different species and depended on their morphology and plant morphology. Both species lived and laid eggs on the underside of the leaf. *K. aberrans* was more commonly found near the central vein of the leaf, while *E. finlandicus* was observed more evenly on the leaf plate, which can be explained by it higher vagility. *K. aberrans* could inhabit high number on fruit varieties of plants with pubescence leaves. Morphological features of plant leaves did not affect the spread of *E. finlandicus* species, therefore, they could be considered more "universal". However, it reached a higher quantity on the plants with a smooth surface of a leaf plate. Certain temperature, illumination regime, air and soil humidity caused the differences in mites spreading at various habitats.

Key words: phytoseiid mites; Phytoseiidae; Kyiv city; Uman city; Vasylkiv town; Brovary town; Ukraine

Introduction

With the development of society, science, technology, functions of green zones have become increasingly important. The main ones are microclimate formation, cleaning of ground air from dust, heavy metals and gases, noise pollution reduction, providing recreational needs of the city residents, promoting comfort and aesthetics of residential areas, etc. Green plantations in urban areas occupy from 1 to 98%. The smallest assortment of urban green plantations are in Polissia, the middle one – in the Forest-Steppe, Steppe, Prykarpattia and Transcarpathia, and the richest one is on the Southern coast of Crimea.

The intensive functioning of towns has a significant impact on the centers of the living organisms' existence – forest parks, islands, reservoirs, valleys of small rivers, coastal zones, objects of the natural reserve fund. It causes the biological diversity impoverishment and integral habitat degradation, or their complete destruction. Among the causes of plants inhibition in urban areas are physical, chemical and anthropogenic factors. Some of them have an influence on plants root system: depletion of soil with nutrients or, conversely, their excess (in bulk soils), soil compaction, changed acidity, etc. Other factors influence the aboveground part: smoke, tailpipe pollution, dust concentration, and therefore the change in temperature, radiation modes and illumination intensity, mechanical damage. Sustainability and durability of

urban plantations is possible based on the biotic factor study – complexes of mites, and especially predatory mites – phytoseiids.

Phytoseiid mites (Parasitiformes, Phytoseiidae) are free-living gamasid mites, existing in various habitats. A large number of species are contingent upon plants; they inhabit vegetative parts and feed on herbivorous mites, insect eggs and larvae, plants pollen and juice, as well as some insects' excretion (Murtry et al., 2013; Walzer & Schausberger, 2011; Farazmand et al., 2012; Murtry et al., 2015).

The variety of Phytoseiid mites (more than 1000 species, in Ukraine - up to 100 species) determines the degree of plant protection from various pests. They can control the development of local outbreaks of imported pests-phytophages (Akimov et al, 2007; Kolodochka & Omeri, 2011). The use of predatory phytoseiid mites in integrated protection is based on biological indicators of the specific acaroid community dynamic and the specificity of the prevalence of phytophages' populations. Regarding the species composition formation and dynamics of the modern cohabitation of mites, the distribution of individual taxa and environmental processes are established. One of the main characteristics of the phytoseiid mites' community on plants of secondary phytocenosis of the Forest-Steppe of Ukraine is the status of each species in the community (Broufas et al., 2000; Grabovska, 2017).

Thus, it is extremely important to study the various aspects of the Phytoseiidae life. We intended to study the peculiarities of the predaceous phytoseiid mites' distribution in urban plant habitats. We selected several towns, differed by human population, urban area, and degree of urbanization: Kyiv, Brovary, Vasylkiv (Kyiv region), and Uman (Cherkasy region).

Material and methods

The study of phytoseiid mites was carried out in green plantations within the urban strip of the towns of the Forest-steppe zone (Kyiv, Uman, Brovary, and Vasylkiv). 93 species of plants have been observed (55 species of woody shrubs (58.9%) and 38 species (41.1%) of straw plants) in plantations along main and secondary highways of towns, near residential and industrial buildings, on private plots of inner suburbs, in urban parks and squares. The collection of phytoseiid mites was carried in accordance with well-known methods (Kolodochka, Omeri, 2011) by shaking on black paper (herbaceous plants) or by the method of direct collection from the leaves (mostly from tree-shrub plants). To identify the mites' species we made some micro preparations. The mites' taxonomy was determined by means of several field guides (Kolodochka & Omeri 2011; Kolodochka, 2006). We used occurrence index, I_s (%) and Paliy-Kovnatsky domination index, D_i (Shytykov et al., 2003) in our study.

Results

It has been established that *E. finlandicus* and *K. aberrans* form the majority of a phytoseiid species community in urban tree and shrubbery plantations (Grabovska et al., 2017). The diversity of the species composition of the Phytoseiidae mites depends on the flora diversity - the food base of phytoseiids and often confined to certain species of plants. Both species, *E. finlandicus* and *K. aberrans*, have a rather extended range of indicators of relative habitat relationships (-0.91 <Fij <0.43 and -0.93Fij <0.96), which indicates their trait to inhabit a sufficiently large number of plants.

Euseius finlandicus (Oudemans, 1915) has been found on common apricot *Armeniaca vulgaris, Prunus divaricata, Cydonia oblonga, Sambucus nigra, Ulmus carpinifolia, Vitis sp., Cerasus vulgaris , Centaurea sp., Berteroa Incan, Carpinus betulus, Poligonum persicaria, C. Sanguine, Juglans regia, J . nigra, Sorbus aucuparia, Carpinus betulus, Pyrus communis, Achilla setacea, Dryopteris filix-mas, Qvercus palustris, Qvercu s robur, Echinacea purpurea, Jasminus sp., Aeculus hippocastanum, Viburnum opulus, Catalpa sp., Clematis sp., Acer tataricum, A. platanoides, A. campestre, A. saccharinum, A. negundo, T. pratense, Leucanthemum vulgare, Urtica urens, U. dioica, T. officinale, Poligonum aviculare, Tilia tomentosa, T. argentea, T. cordata, Corylus avellana, Chenopodium album, Arcticum lappa, Malva crispa, Pulmonaria angustifolia, Daucus carata, Saponaria officinalis, Setaria glauca, Hippophae rhamnoides, Solanum nigrum, Tanacetum vulgare, Plantago major, Artemisia, Echium vulgare, Prunus domestica, Helianthus tuberosus, Rosa sp., Thuja occidentalis, Humulus lupulus, Cichorum intybus, Cerasus avium, Chelidoni ummajus, Morus nigra, Rosa canina, Rumex confertus, Amaranthus retroflexus, Malus domestica , Malus baccata, Juniperus sabina, Fraxinus americana.*

Kampimodromus aberrans (Ouderman, 1930) has been found on quince tree *Cydonia oblonga, Prunus cerasifera, Ulmus carpinifolia, Salix carpea, Vitis sp., Cerasus vulgaris, Prunus tomentosa, Juglans regia, Carpinus betulus, Jasmínum sp, Viburnum opulus, Catalpa sp., Aeculus hippocastanum, A. platanoides, A. saccharinum, A. negundo, U. dioica, T. officinale, Tilia tomentosa, T. cordata, T. argentea, Corylus avellana, Echium vulgare, Prunus sp., Helianthus tuberosus, Ríbes sp., Rubus caesius, Stáchys sylvática, Rosa canina, Morus nigra, Rumex confertus, Malus sp., Mallus baccata.*

E. finlandicus dominates in the specific community of phytoseiid mites of plant association according to the number of plant species (75 species, 79.78%), the absolute number of individuals in samples of predatory mites (5043 pieces), the occurrence index (I_s = 74.49 %) and the Paliy-Kovnatsky domination index (D_i = 51.417%) (Table 1).

Table 1. Ecological and qualitative characteristics of *E. Finlandicus*

Studied territory	Number/ratio (%) of inhabited plant species	Absolute number/ratio (%) of individuals per sample	Occurrence index, I_s (%)	Paliy-Kovnatsky index, D_i (%)
Kyiv	60 (83.33)	3037 (68.48)	75.42	51.63
Brovary	16 (64.00)	161 (55.13)	61.11	33.90
Vasylkiv	16 (61.53)	184 (36.07)	43.28	15.65
Uman	28 (82.35)	1298 (80.77)	91.00	60.32
Total	75 (79.78)	5043 (69.02)	74.49	51.42

These data indicate a low level of disposition of these mites to the plant species they inhabit, its eutrophication, which, in the conditions of other species' competitiveness reduction, allows them to occupy empty space; it is reflected in the list of plants available for the most accessible population. If we take into consideration the fact, that the food for these

predaceous mites is multiplicative microscopic eriophyid mites, it is easier to explain the breadth of its eutrophication. It is possible that an increased tolerance of this species (in comparison with other species of phytoseiids) to the influence of negative factors plays a certain role in the growth of the percentage of this species in urban plantations in the direction of the suburbs-center. Finally, the presence of this pattern of mites' expansion in urban area can be assumed as a manifestation of species pre-adaptation towards the existence in urbanized environment.

The analysis of distribution of *E. finlandicus* shows that this species populate the largest amount of plants in Kyiv (60 species) and Uman (28 species). In Vasylkiv and Brovary *E. finlandicus* was found on 16 plant species. In general, *E. finlandicus* inhabit 75 species out of 93 planted in the area. *E. finlandicus* has the highest value of occurrence index in Uman (91.00) and Kiev (75.42), a bit lower in Brovary (61.11), and the lowest value was calculated for Vasylkiv (43.28). The analysis of Paliy-Kovnatsky domination index of phytoseiid mites at green plantations was calculated separately for tree/shrubbery plants and for herbaceous plants. It confirms the domination of *E. finlandicus* in both groups of plants.

In Table 1 we presented a low level of meticulousness of this mite species to inhabited plants as well as high tolerance to the negative factors in the urbanized environment. Thus, we consider *E. finlandicus* is the most enduring species, i.e. the general-predator.

The obtained data on the dominance of the species *E. finlandicus* in natural plantation associations correspond well to data obtained for fruit gardens, arboretums, and botanical gardens of the Ukrainian forest-steppe; for 10 urban parks in 4 regions of the Central Forest-steppe of Ukraine (Kolodochka & Omeri 2011); cotton fields of Uzbekistan and urban parks of Latvia (Baltics) (Demite et al., 2014); cherry orchards and blueberries crops of Poland (Sekrecka & Olszak, 2006); Prague (Czech Republic) (Kabiček & Řeháková, 2004) and Berlin (Germany) (Hasselmann, 2003). The range of environmental factors of the mentioned territories is optimal and promotes this species' spatial distribution and dominant position in the phytoseiid community. According to the previous data (Abdallah et al., 2001; Puchalska & Kozak, 2016) the species *E. finlandicus* is considered an important predator of phytophages in European gardens and vineyards.

One more species that forms the majority of the phytoseiid community in urban plantations is *K. aberrans*, with the occurrence index 16.55% and Paliy-Kovnatsky index 2.36 (Table 2).

Table 2. Ecological and qualitative characteristics of *K. aberrans*

Studied territory	Number/ratio (%) of inhabited plant species	Absolute number/ratio (%) of individuals per sample	Occurrence index, I_s (%)	Paliy-Kovnatsky index, D_i (%)
Kyiv	32 (44.44)	448	19.08	2.99
Brovary	3 (12.0)	88	20.37	5.30
Vasylkiv	7 (26.92)	265	35.82	15.52
Uman	6 (17.64)	240	4.90	0.06
Total	33 (35.10)	1041	16.55	2.36

According to J. Kontschan (Kontschan, 2013), *E. finlandicus* can always be found along with *K. aberrans* placed on abaxial leave sides.

Comparison of the two most common species, *E. finlandicus* and *K. aberrans*, allowed tracing the tendencies of changes in the occurrence indexes and the proportion of their presence in phytoseiid communities on the studied territories. The degree of urbanization usually grows from suburbs to the center. The influence of the community of negative anthropogenic factors undoubtedly affects both urban plants and their animal population. Although this effect can be reduced by plant life (local lowering of temperature, increase of humidity in plantations, etc.), but it cannot be totally decreased even if the size of the urban plantations is of considerable size (for example, an area of a few hectares). Under these conditions, a comparative study of the changes in the occurrence indexes of the two most common phytoseiid species at the studied urban plantations ranging from the smallest to the largest in size and population can be observed as a pattern.

The occurrence index of *K. aberrans*, which turned out to be the largest in the town with the lowest degree of urbanization, Vasylkiv, in general, decreases in the direction of Kyiv city. On the contrary, for *E. finlandicus* this index increases in the direction from the smallest of the explored towns to the metropolis. With a high probability, it can be assumed that this fact indicates a relatively less stability of *K. aberrans* species in the urban environment and shows the high stability of *E. finlandicus* in countering negative factors while inhabiting urban areas. However, it should be mentioned that *K. aberrans*, despite a large number of plants inhabited (33 species), prefers rose family, which in the towns of Ukraine, meanwhile, makes up a significant proportion as well as in the cities. The list includes fruit or decorative tree and shrubbery plants (apple, plum, cherry, two species of linden, hornbeam, elm, jasmine, etc.).

Thus, the tendency to decrease the occurrence frequency of the most of the studied phytoseiid species is directly proportional to the increase of the degree of urbanization in the direction from towns to the metropolis in general retains its essence despite of some fluctuations, which can be explained by the peculiarities of habitat relationships of different species. Only one species, *E. finlandicus*, has the opposite strategy, which allows it to dominate in all urban phytoseiid communities.

The extension of phytoseiids is possible due to their moving over the surface of the substrate. The speed of the mites is uneven in different species and depends on their morphology and morphology of plants. It is known that mites with relatively long limbs (*Amblyseius* and *Euseius* families) choose plants that are less pubescent, while less mobile species with short limbs choose plants with thick hair of various shapes or even a pannose surface.

Both species live and lay eggs on the underside of the leaf like most phytoseiid species (Fig. 1, 2). The *K. aberrans* mites can reach high numbers on the fruit plants with pubescent leaves.

Fig. 1. *K. aberrans*: a – on the leaf of a Norway maple; b - on the leaf of a horse chestnut

Morphological traits of plant leaves, apparently, do not affect the spread of the species *E. finlandicus* so much, therefore, in this sense, it can be considered more "universal". However, on plants with a smooth surface of the leaf plate, it reaches a higher number.

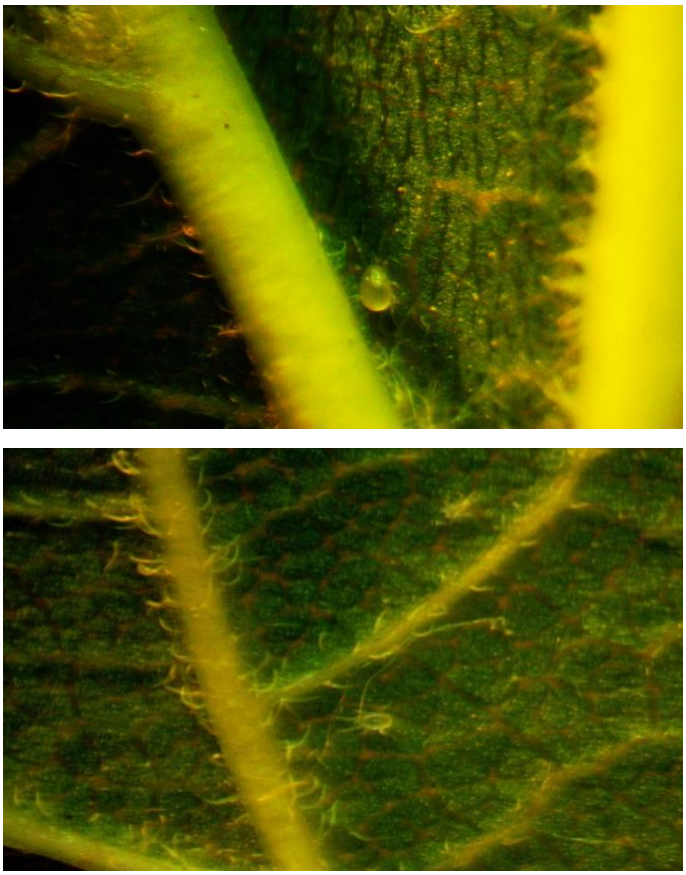

Fig. 2. *E. finlandicus*: a – on the leaf of a small-leaved linden, b – a larva on a small-leaved linden

а б

Fig. 3. The placement of *K. aberrans* (a) and *E. finlandicus* (b) on the leaf surface

The *K. aberrans* mites are the most frequently found near the central vein of the leaf (Fig. 3a), but *E. finlandicus* is placed more evenly on the leaf surface (Fig. 3b), which is likely to be associated with a greater movement of the latter one. In our opinion, temperature, illumination regime, air and soil humidity can cause differences in mites' distribution at different places of habitation.

Conclusion

The species structure of predatory mites in a particular territory depends on zonal distribution, thus we can suppose the different species composition at urban plantations in other natural zones. However, it is expected that the species characteristics we observed would be the same. In this case, an invasive *E. finlandicus* must be the dominant species of phytoseiid community in temperate zone of Europe.

References

Abdallah A.A., Zhang Z.Q., Masters G.J., Neill S. (2001). *Euseius finlandicus* (Acari: Phytoseiidae) as a potential biocontrol agent against *Tetranychus urticae* (Acari: Tetranychidae): life history and feeding habits on three different types of food. Exp Appl Acarol, 25, 833–847. doi.org/10.1023/A:1020431531446

Akimov, Y.A. Kolodochka, L.A., Zhovnerchuk, O.V., Omeri, I.D., Samojlova, T.P. (2007). Vydovoj sostav y ekologycheskye osobennosty kleshhej nadsemejstva Tetranychoidea (Acariformes, Trombidiformes) y semejstva Phytoseiidae (Parasitiformes, Gamasina), obytayushhyx na rastenyyax botanycheskyx sadov Kyeva (Ukrayna) (Species Composition and ecological perculiarities of mites of the superfamily Tetranychoidea (Acariformes, Trombidiformes) and family Phytoseiidae (Parasitiformes, Gamasina), inhabiting plants in botanical gardens of Kiev (Ukraine). Vestnik zoologii, 41(6), 521–534. (in Russian).

Broufas, G.D. & Koveos D.S. (2000). Effect of Different Pollens on Development, Survivorship and Reproduction of *Euseius finlandicus* (Acari: Phytoseiidae). Environmental Entomology, 29(4), 743–749. doi.org/10.1603/0046-225X-29.4.743

Demite, P. R., McMurtry, J. A., & Moraes, G. D. (2014). Phytoseiidae Database: a website for taxonomic and distributional information on phytoseiid mites (Acari). *Zootaxa*, *3795*(5), 571-577. doi.org/10.11646/zootaxa.3795.5.6

Farazmand, A., Fathipour, Y., Kamali, K. (2012). Functional response and mutual interference of Neoseiulus californicus and Typhlodromus bagdasarjani (Acari: Phytoseiidae) on Tetranychus urticae (Acari: Tetranychidae). International Journal of Acarology, 38(5), 369–376. doi.org/10.1080/01647954.2012.655310

Grabovska, S. L. (2017). Species diversity of predacious phytoseiidae mites (Parasitiformes, Phytoseiidae) in vegetative plantations. Scientific Bulletin of UNFU, 27(5), 72–76. doi.org/10.15421/40270515

Grabovska, S.L., Mykolaiko, I.I., Mykolaiko, V.P. (2017). Structure patterns of phytoseiid mite communities in urban plant associations. Ukrainian Journal of Ecology, 7(4), 179–186. doi.org:/10.15421/2017_103

Hasselmann, K. *(*2003). Zur Bedeutung rauberischer Antagonisten fur die Populationsdynamik der Lindenspinnmilbe *Eotetranychus tiliarium* Hermann im stadtischen Grun. Thesis of Doctoral Dissertation. Doktors der Gartenbauwissenschaften. Hannover (in German).

Kabiček, J., Povondrova, K. (2004). Rhytoseiid mite communities on urban deciduous trees. Acta fitotechnica et zootechnica, 7, 119–121.

Kolodochka, L.A. (2006). Kleshchy–fytoseydy Palearktyky (Parasitiformes, Phytoseiidae) (faunystyka, systematyka, ekolohyya, evolyutsyya) (Phytoseiid mites of Palearctic (Parasitiformes, Phytoseiidae) (faunistics, taxonomy, ecology, evolution)). Vestnik zoologii, 21, 250 (in Russian).

Kolodochka, L.A. & Omeri, I.D. (2011). Khyshnye kleshchi semejstva Phytoseiidae (Parasitiformes, Mesostigmata) dendrologicheskikh parkov i botanicheskikh sadov Lesostepi Ukrainy (Predatory mites of the family Phytoseiidae

(Parasitiformes, Mesostigmata) of dendrological parks and botanic gardens of the Forest-Steppe of Ukraine). Kyev (in Russian).
Kontschán, J. (2013). First recorded Phytoseiidae mites (Acari, Mesostigmata) from Albania Opusc. Zool. Budapest, 44 (suppl. 1), 133–137.
Murtry, J.A., Moraes, G.J., Sourassou N.F. (2013). Revision of the lifestyles of phytoseiid mites (Acari: Phytoseiidae) and implications for biological control strategies. Systematic and Applied Acarology, 18 (4), 297–320. doi.org/10.11158/saa.18.4.1
Murtry, J.A., Sourassou, N.F., Demite, P.R. (2015). The Phytoseiidae (Acari: Mesostigmata) as Biological Control Agents. Prospects for Biological Control of Plant Feeding Mites and Other Harmful Organisms. Progress in Biological Control, 19, 133–149. doi.org/10.1007/978-3-319-15042-0_5
Pesenko, Yu. A. (1982). Principy i metody kolichestvennogo analiza v faunisticheskih issledovaniyah [Principles and methods of quantitative analysis in faunistic studies]. Nauka, Moskva (in Russian).
Puchalska, E.K. & Kozak, M. (2016). *Typhlodromus pyri* and *Euseius finlandicus* (Acari: Phytoseiidae) as potential biocontrol agents against spider mites (Acari: Tetranychidae) inhabiting willows: laboratory studies on predator development and reproduction on four diets. Exp Appl Acarol. 68, 39. doi.org/10.1007/s10493-015-9973-5
Sekrecka, M., Olszak, R. (2006). Species composition of phytoseiid mites in cherry orchards and blueberry plantations. Biol. Lett., 43 (2), 361–365.
Shytykov, V.K., Rozenberg, G.S., Zynchenko, T.D. (2003) Koly`chestvennaya gydroekologyya: metody systemnoj ydentyfykacyy` (Quantitative hydroecology: methods of system identification). Tolyatty: IEVB RAN (Russian).
Walzer, A., Schausberger, P. (2011). Sex-specific developmental plasticity of generalist and specialist predatory mites (Acari: Phytoseiidae) in response to food stress. Biological Journal of the Linnean Society, 102(3, 1), 650–660. doi.org/10.1111/j.1095-8312.2010.01593.x

Citation:
Grabovska, S.L., Mykolaiko, I.I., Mykolaiko, V.P., Myronyuk, T.M. (2019). Diversity structure of phytoseiid mites in urban plant habitats. *Acta Biologica Sibirica, 5* (1), 161-166.
Submitted: 15.12.2018. **Accepted:** 15.03.2019
crossref http://dx.doi.org/10.14258/abs.v5.i1.5378