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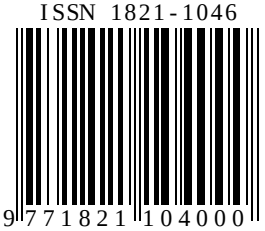

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SPECIES COMPOSITION OF SPIDER MITES AND PREDATORY MITES (Acari: Tetranychidae, Phytoseiidae) OCCURRING ON CRAB APPLE (*Malus silvestris* Mill) IN SERBIA

Katarina MLADENOVIĆ[1], Bojan STOJNIĆ[2], Slobodan MILANOVIĆ[3], Vlado ČOKEŠA[1], Ivan MILENKOVIĆ[1]

Abstract: *New studies of crab apple, Malus silvestris, in Serbia identified the presence of five species of spider mites and nine species of Phytoseiidae. The presence of three spider mite species on this host plant has been identified for the first time in Serbia: Amphitetranychus viennensis, Schizotetranychus schizopus and Tetranychus urticae. The species S. schizopus has been identified on crab apple for the first time ever in the world. Six species of Phytoseiidae*: *Amblyseius andersoni*, *Kampimodromus aberrans*, *Neoseiulella aceri*, *Phytoseius maltshenkovae*, *Typhlodromus* (*Typhlodromus*) *pyri* and *T.* (*Anthoseius*) *rhenanus have been identified for the first time on crab apple in Serbia. Species N. aceri and P. maltshenkovae have been identified on crab apple for the first time ever in the world. Our study increased the total number of spider mite species identified on M. sylvestris to seven and Phytoseiidae to eleven.*

Key terms: Tetranychidae, Phytoseiidae, *Malus silvestris*

PREGLED VRSTA PAUČINARA I PREDATORSKIH GRINJA (Acari: Tetranychidae, Phytoseiidae) NA DIVLJOJ JABUCI (*Malus silvestris* Mill) U SRBIJI

Sažetak: *Novim istraživanjima je u Srbiji na evropskoj divljoj jabuci, Malus silvestris, utvrđeno prisustvo pet vrsta paučinara i devet vrsta fitozeida. Tri vrste paučinara su prvi put nađene na ovom biljnom domaćinu u našoj zemlji: Amphitetranychus viennensis, Schizotetranychus schizopus i Tetranychus urticae. Vrsta S. schizopus je prvi*

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put utvrđena na evropskoj divljoj jabuci u svetu. Šest vrsta fitozeida: Amblyseius andersoni, *Kampimodromus aberrans*, *Neoseiulella aceri*, *Phytoseius maltshenkovae*, *Typhlodromus* (*Typhlodromus*) *pyri i T.* (*Anthoseius*) *rhenanus su novi nalazi na divljoj jabuci u našoj zemlji. Vrste N. aceri i P. maltshenkovae su prvi put identifikovane na evropskoj divljoj jabuci u svetu. Našim istraživanjima ukupan broj vrsta paučinara je povećan na 7 a fitozeida na 11 na M. sylvestris.*

Ključne reči: Tetranychidae, Phytoseiidae, *Malus silvestris*

INTRODUCTION

Spider mites, mites of the Tetranychidae family, are considered the most important harmful group of phytophagous mites in the agriculture and forestry. In natural eco-systems spider mites live mainly in harmony with a host plant, without inflicting significant damage, as a result of the impact of a complex of mites' natural enemies.

Predatory mites of the Phytoseiidae family are natural enemies to a large number of microarthropods; however, they most frequently feed on mites from the Tetranychoidea and Eriophyoidea group; hence, they are important regulators of a population figure of species from these groups of mites in natural habitats (Edland & Evans 1998). Habitats rich in non-cultivated plant species represent a natural reservoir of phytoseiidae (Boller at al. 1988; Duso & Fontana 1996; Tixier at al. 2000 a,b). Certain species of phytoseiidae are successfully used in programmes of biological control of harmful phytophagous mites and insects in plant production (Croft & Barnes, 1971; McMurtry & van de Vrie, 1973; Walter & O'Down, 1992; etc.).

Previous studies of diversity of the spider mite and phytoseiidae fauna in Serbia were mainly focused on agro-ecosystems, while the diversity of the above-mentioned mite groups on wild fruit species in forest ecosystems remained unexplored. Data on presence of spider mites and phytoseiidae in forest plant species in Serbia are presented only fragmentary and in few scientific papers (Tomašević, 1964; Kropczynska & Petanović, 1987; Petanović i Stojnić, 1995; Stojnić i Petanović, 1994; Stojnić, 1993; Stojnić et al., 2002; Mladenović at al., 2010a, 2010b, 2011, 2012, 2013); however, the range of dominant spider mites and Phytoseiidae on most important forest broadleaved species remained virtually unknown. That holds true even more for wild fruit species, on account of the nature of their representation and uneven distribution in forest habitats. On the other hand, their botanical affinity with cultivated fruit species makes them particularly interesting, from the aspect of their role in conservation of those phytoseiidae species that may potentially represent effective agents of biological combat in commercial fruit plantations.

During previous studies of crab apple (*Malus silvestris)* in Serbia, the presence of four spider mite species and five Phytoseiidae species had been established (Stojnić & Petanović, 1994; Mladenović et al., 2013). Out of 1,275 spider mite species recorded worldwide (Migeon & Dorkeld, 2013), 11 species were identified on the European crab apple (Jeppson et al., 1975; Meyer, 1987;

Smith & Roy, 2008; Guanilo et al., 2012). Out of 2,300 recorded species of the family Phytoseiidae (Beaulieu et al. 2011; Chant & McMurtry 2007), 16 species were identified on the European crab apple (Amitai & Swirski, 1978; Jedličková, 1997, 1998; de Moraes et al., 2004; Messelink et al., 2006; Sepúlveda & Carrillo, 2008).

In accordance with the above-mentioned, the results of this study present new data on distribution of spider mites and phytoseiidae on the European crab apple in Serbia and worldwide.

MATERIAL AND WORK METHOD

The collection of crab apple specimens was performed during vegetation period, in the framework of a several-year long study of fruit species in Serbian forest ecosystems. Specimens consisting of 300 leaves each were packed into plastic bags and kept in a refrigerator at the temperature of 5-8^{o}C until mites were extracted. Prior to the mite extraction, leaf specimens were exposed to the effect of ethyl acetate for 20 minutes, which was followed by a shake-off of mites onto a white paper and their extraction under a stereomicroscope. The extracted mites were submersed into a solution of ethanol and lactic acid (Evans & Browing, 1955). After the illumination, permanent slides were made by means of use of the Hoyer's medium (Baker & Wharton, 1964).

For identification of tetranychidae, appropriate keys were used (Prichard & Baker, 1955; Mitrofanov at al., 1987; Manson, 1967; Baker & Tuttle, 1994). For identification of phytoseiidae, appropriate keys were used (Chant, 1959; Begljarov, 1981; Karg 1993), along with an additional taxonomic literature (DeMoraes et al., 1986; 2004; Demite et al., 2012). Permanent slides are kept in the depot of the Entomology and Agricultural Zoology Department of the University of Belgrade's Faculty of Agriculture.

STUDY RESULTS AND DISCUSSION

During the study on *M. silvestris,* the presence of five spider mite species and nine phytoseiidae species has been identified, which doubled the number of species recorded on this plant in Serbia (Table 1).

Table 1: *Species composition of spider mites and predatory mites (Acari: Tetranychidae, Phytoseiidae) on crab apple (Malus silvestris Mill) in Serbia*

	Spider mite species	Collecting data
Fam. Tetranychidae		
1.	***Amphitetranychus viennensis*** (Zacher, 1920)	New data **:** Goč, Cvetna Livada, 28.09.2001(leg. Mladenović); Pančevo, Starčevo, 30.09.2006 (leg. Mladenović); Mali Jastrebac, Prokuplje, 28.06.2011 (leg. Mladenović); Soko Banja, Bovansko Jezero 25.05.2011(leg. Mladenović); Goč, Jezero, 3.7.2013 (leg. Kostić); Goč, Jezero, 3.7.2013 (leg. Kostić); Goč, Brezna, 5.7.2013 (leg.Kostić);
	Bryobia sp. (unidentified)	Zlatibor, motorway, 04.09.2000 (leg. Mladenović) (Mladenović et al.,2013); Goč, 'Dobre Vode' Hotel, ski run, 28.09.2001 (leg. Mladenović) (Mladenović et al.,2013); New data **:** Soko Banja, Bovansko Jezero, 25.05.2011 (leg. Mladenović);

2.	***Bryobia angustisetis*** Jakobashvili, 1958	Veliki Jastrebac, the Lomnička River, 26.06.2001 (Mladenović et al.,2013);
3.	***Bryobia rubrioculus*** (Scheuten 1857)	Mali Jastrebac, Prokuplje, 28.06.2011 (Mladenović et al.,2013); New data : Goč, Jezero, 3.7.2013 (leg.Kostić); Goč, Brezna, 5.7.2013 (leg. Kostić)
4.	***Bryobia ulmophila*** Reck, 1947	Goč, farm and seedling nursery, 28.09.2001 (Mladenović et al.,2013);
5.	***Bryobia vasiljevi*** Reck, 1953	Three-border junction between Serbia, Bulgaria and Macedonia X 4688088 Y 7619070 Altitude 1,015 m, 11.08.2005 (Mladenović et al.,2013);
6.	***Schizotetranychus schizopus*** (Zacher 1913)	New data : Goč, Dobre Vode, 3.7.2013 (leg. Kostić);
7.	***Tetranychus urticae*** Koch 1836	New data : Divčibare, centre-Crni Vrh 02.08.2000 (leg. Mladenović); Divčibare, Pitomine, 11.08.2000 (leg.Mladenović); Zlatibor, motorway, 04.09.2000(leg. Mladenović); Goč, Brezna, 5.7.2013 (leg.Kostić)
Fam. Phytoseiidae		
1.	***Amblyseius andersoni*** (Chant, 1957)	New data : Pančevo, Starčevo, 30.09.2006 (leg. Mladenović);
2.	***Euseius finlandicus*** (Oudemans, 1915)	Goč, 'Dobre Vode' Hotel, ski run, 28.09.2001 (Mladenović et al.,2013); Goč, farm and seedling nursery 28.09.2001 (Mladenović et al.,2013); New data : Divčibare, Beogradsko Naselje 05.08.2000 (leg. Mladenović); Beograd, Vinča, 28.05.2001 (leg. Mladenović); Veliki Jastrebac, the Lomnička River, 26.06.2001 (leg. Mladenović); Goč, Jezero, 3.7.2013 (leg. Kostić); Pančevo, Starčevo, 30.09.2006 (leg. Mladenović); Mali Jastrebac, Prokuplje, 28.06.2011 (leg. Mladenović);
3.	***Kampimodromus aberrans*** (Oudemans, 1930)	New data : Šabac, Gornja Vranjska village, 08.10.2000 (leg. Mladenović); Veliki Jastrebac, the Lomnička River, 03.06.2001 and 26.06.2001 (leg. Mladenović); Goč, farm and seedling nursery, 28.09.2001 (leg. Mladenović); Zlatibor, Gostilje, 03.10.2001 (leg. Mladenović); Mali Jastrebac, Prokuplje, 28.06.2011 (leg. Mladenović); Soko Banja, Bovansko Jezero 25.05.2011(leg. Mladenović);
4.	***Neoseiulella aceri*** (Collyer, 1957)	New data **:** Goč, Jezero, 3.7.2013 (leg. Kostić)
5.	***Phytoseius corniger*** Wainstein, 1959	Zlatibor, motorway, 04.09.2000 (Mladenović et al.,2013);
6.	***Phytoseius echinus*** Wainstein & Arutunjan, 1970	Three-border junction between Serbia, Bulgaria and Macedonia X 4688088 Y 7619070 Altitude 1,015 m, 11.08.2005 (Mladenović et al.,2013);
7.	***Phytoseius juvenis*** Wainstein & Arutunjan, 1970	Kučevo, Ceremošnja, 11.6.1988 (Stojnić & Petanović, 1994); Goč, 'Dobre Vode' Hotel, ski run, 28.09.2001 (Mladenović et al.,2013); New data : Divčibare, Beogradsko Naselje 05.08.2000 (leg. Mladenović); Divčibare, Pitomine, 11.08.2000 (leg. Mladenović);
8.	***Phytoseius macropilis*** (Banks, 1909)	Zlatibor, motorway, 04.09.2000 (Mladenović et al.,2013); Goč, 'Dobre Vode' Hotel, ski run, 28.09.2001 (Mladenović et al.,2013); New data : Goč, Jezero, 3.7.2013 (leg. Kostić);
9.	***Phytoseius maltshenkovae*** Wainstein, 1973	New data : Goč, Jezero, 3.7.2013 (leg. Kostić);
10.	***Typhlodromus* (*Typhlodromus*) *pyri*** Scheuten, 1857	New data : Beograd, Vinča, 28.05.2001 (leg. Mladenović); Bukovik Mountain, 25.06.2001 (leg. Mladenović); Vranje, Koćura, X 4698494; Y 7587431, E W Altitude 1,010 m, 09.08.2005 (Mladenović);
11.	***Typhlodromus* (*Anthoseius*) *rhenanus*** (Oudemans, 1905)	New data **:** Goč, Dobre Vode, 1.7.2013 (leg. Kostić);

During previous studies of crab apple *(Malus silvestris)* in Serbia, four spider mite species had been identified: *Bryobia angustisetis* Jakobashvili, 1958, *B. rubrioculus* (Scheuten, 1857), *B. ulmophila* Reck, 1947 and *Bryobia vasiljevi* Reck, 1953, (Mladenović et al., 2013). By means of this study, another three species have been identified: *Amphitetranychus viennensis* (Zacher, 1920), *Schizotetranychus schizopus* (Zacher 1913) and *Tetranychus urticae* Koch 1836, which increased the total number of spider mite species on crab apple to seven.

During previous studies of crab apple in Serbia, five species of phytoseiidae had been identified: *Euseius finlandicus* (Oudemans, 1915), *Phytoseius corniger* Wainstein, 1959, *P. echinus* Wainstein & Arutunjan, 1970, *P. juvenis* Wainstein & Arutunjan, 1970, and *P. macropilis* (Banks, 1909) (Stojnić & Petanović, 1994; Mladenović et al., 2013). This study increased the number of phytoseiidae species by six - *Amblyseius andersoni* (Chant, 1957), *Kampimodromus aberrans* (Oudemans, 1930), *Neoseiulella aceri* (Collyer, 1957), *Phytoseius maltshenkovae* Wainstein, 1973, *Typhlodromus* (*Typhlodromus*) *pyri* Scheuten, 1857 and *Typhlodromus* (*Anthoseius*) *rhenanus* (Oudemans, 1905), thus increasing the total number of phytoseiidae species on crab apple to eleven.

The current world databases and catalogues do not provide complete records on spider mites identified on *M. silvestris.* For instance, Bolland et al. (1998), along with Migeon and Dorkeld (2013), do not include the European species of crab apple in the list of host plants, while there are individual data on only five Asian species of crab apple; Smith and Roy (2008) presented the data on a group of spider mite species on the European crab apple; however, this study lacked the precise zoogeographic data. In accordance with the above-mentioned, the authors of this study examined the available literature; added new findings made in Serbia, and created a list of 15 spider mite species identified on *M. Silvestris* worldwide (Table 2).

Table 2: *A comparative overview of species composition of spider mites (Acari: Tetranychidae) on crab apple (Malus silvestris Mill) in Serbia and worldwide:*

Species fam. Tetranychidae			
1.	***Amphitetranychus viennensis*** (Zacher, 1920)	Europe (Smith & Roy, 2008)	Serbia
2.	***Bryobia angustisetis*** Jakobashvili, 1958	/	Serbia (Mladenović et al.,2013)
3.	***Bryobia graminum*** (Schrank, 1781)	Europe (Smith & Roy, 2008)	/
4.	***Bryobia rubrioculus*** **(**Scheuten 1857)	Europe (Jeppson et al., 1975), South Africa (Meyer 1987)	Serbia (Mladenović et al.,2013)
5.	***Bryobia ulmophila*** Reck, 1947	/	Serbia (Mladenović et al.,2013)
6.	***Bryobia vasiljevi*** Reck, 1953	/	Serbia (Mladenović et al.,2013)
7.	***Eotetranychus ancora*** Baker & Pritchard, 1960	Mauritius (Meyer 1987)	/
8.	***Eotetranychus carpini*** (Oudemans, 1905)	Europe (Smith & Roy, 2008)	/
9.	***Eotetranychus pruni*** (Oudemans)	Europe (Smith & Roy, 2008)	/
10.	***Eutetranychus africanus*** (Tucker, 1926)	Egypt (Meyer 1987)	/
11.	***Meyernychus emeticae*** (Meyer, 1974)	Angola (Meyer 1987)	/
12.	***Panonychus ulmi*** (Koch, 1836)	South Africa (Meyer 1987) **Europe (Smith & Roy, 2008)**	/
13.	***Petrobia (Petrobia) latens*** (Müller, 1776)	North America (Smith & Roy, 2008)	/
14.	***Schizotetranychus schizopus*** (Zacher 1913)	/	Serbia
15.	***Tetranychus urticae*** Koch, 1836	Peru (Guanilo et al., 2012)	Serbia

Based on the tabular data, it can be concluded that nearly a half of the total number of spider mite species on *M. Silvestris* recorded worldwide have been identified in Serbia; hence, it can be inferred that the current level of research on presence of spider mites on crab apple in Serbia is proportionally higher than in other countries.

The current world databases and catalogues also include only incomplete data on presence of phytoseiidae on *M. silvestris*. De Moraes et al. (1986) listed eleven phytoseiidae species on the European crab apple; however, they were mainly found in the South American countries and Portugal. The authors of this study extended that list by including the data collected by other authors (Amitai &

Swirski, 1978; Jedličková, 1997, 1998; Messelink et al., 2006; Sepúlveda & Carrillo, 2008), as well as by adding the new data collected in Serbia, thus creating a list of 22 phytoseiidae species found on *M. Silvestris* worldwide (Table 3).

Table 3: *A comparative overview of species composition of predatory mites (Acari: Phytoseiidae) on crab apple (Malus silvestris Mill) in Serbia and worldwide*

Species fam. Phytoseiidae			
1.	***Amblyseius andersoni*** (Chant, 1957)	Portugal (de Moraes et al., 1986)	Serbia
2.	***Amblyseius chiapensis*** De Leon, 1961	Brazil – Sao Paulo (de Moraes et al., 1986)	/
3.	***Amblyseius compositus*** Denmark & Muma, 1973	Brazil-Bahia (de Moraes et al., 1986)	/
4.	*Amblyseius impressus* Denmark & Muma, 1973	Brazil – Sao Paulo (de Moraes et al., 1986)	/
5.	*Chileseius camposi* Gonzalez & Schuster, 1962	Chile (Sepúlveda & Carrillo, 2008)	/
6.	***Euseius finlandicus*** (Oudemans, 1915)	/	Serbia (Mladenović et al., 2013)
7.	***Iphiseiodes saopaulus*** (Denmark & Muma, 1973)	Brazil – Sao Paulo (de Moraes et al., 1986)	/
8.	***Kampimodromus aberrans*** (Oudemans, 1930)	Portugal (de Moraes et al., 1986)	Serbia
9.	***Neoseiulella aceri*** (Collyer, 1957)	/	Serbia
10.	***Neoseiulus fallacis*** (Garman, 1948)	Brazil – Sao Paulo (de Moraes et al., 1986)	/
11.	***Metaseiulus* (*Metaseiulus*) *flumenis*** (Chant, 1957)	USA – Arizona (de Moraes et al., 1986)	/
12.	***Phytoseiulus persimilis*** Athias-Henriot, 1957	Izrael (Amitai & Swirski, 1978)	/
13.	***Phytoseius corniger*** Wainstein, 1959	/	Serbia (Mladenović et al.,2013)
14.	***Phytoseius echinus*** Wainstein & Arutunjan, 1970	/	Serbia (Mladenović et al.,2013)
15.	***Phytoseius juvenis*** Wainstein & Arutunjan, 1970	/	Serbia (Stojnić & Petanović, 1994; Mladenović et al.,2013)
16.	***Phytoseius macropilis*** (Banks, 1909)	Portugal (de Moraes et al., 1986)	Serbia (Mladenović et al.,2013)
17.	***Phytoseius maltshenkovae*** Wainstein, 1973	/	Serbia
18.	***Typhlodromips sabaculus*** Denmark & Muma, 1973	Brazil – Sao Paulo (de Moraes et al., 1986)	/
19.	***Typhlodromus* (*Anthoseius*) *rhenanus*** (Oudemans, 1905)	Portugal (de Moraes et al., 1986)	Serbia
20.	***Typhlodromus* (*Anthoseius*) *richteri*** Karg, 1970	Slovakia (Jedličková, 1997)	/
21.	***Typhlodromus* (*Typhlodromus*) *corticis*** Herbert, 1958	Slovakia (Jedličková, 1998)	/
22.	***Typhlodromus* (*Typhlodromus*) *pyri*** Scheuten, 1857	Belgium (Messelink et al., 2006)	Serbia

Based on the tabular data, it can be concluded a half of the total number of phytoseiidae species on *M. Silvestris* recorded worldwide have been identified in Serbia; consequently, it can be inferred that the current level of research of phytoseiidae on crab apple is also more comprehensive than in other countries.

Based on the obtained study results, and given the great diversity of spider mites and phytoseiidae on a proportionally small number of examined specimens and localities, it can be expected that a considerably higher number of spider mite and phytoseiidae species than the currently established, is present on crab apple. In that regard, it is necessary to conduct a more comprehensive research on *M. Silvestris* in future.

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