



HAL
open science

Phytoseiid mites (Acari: Mesostigmata) of Tunisian citrus orchards: Catalogue, biogeography and key for identification

Hajer Sahraoui, Kaouthar Lebdi Grissa, Serge Kreiter, Martial Douin,
Marie-Stéphane Tixier

► To cite this version:

Hajer Sahraoui, Kaouthar Lebdi Grissa, Serge Kreiter, Martial Douin, Marie-Stéphane Tixier. Phytoseiid mites (Acari: Mesostigmata) of Tunisian citrus orchards: Catalogue, biogeography and key for identification. *Acarologia*, 2012, 52 (4), pp.433-452. 10.1051/acarologia/20122072 . hal-01189925

HAL Id: hal-01189925

<https://hal.science/hal-01189925>

Submitted on 1 Sep 2015

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

PHYTOSEIID MITES (ACARI: MESOSTIGMATA) OF TUNISIAN CITRUS ORCHARDS: CATALOGUE, BIOGEOGRAPHY AND KEY FOR IDENTIFICATION

Hajer SAHRAOUI^{1,2*}, Kaouthar LEBDI GRISSA¹, Serge KREITER², Martial DOUIN² and
Marie-Stéphane TIXIER²

(Received 01 February 2012; accepted 29 August 2012; published online 21 December 2012)

¹ Institut National Agronomique de Tunisie, Laboratoire de protection des plantes. 43, Avenue Charles Nicolle 1082 -Tunis- Mahrajène, Tunisie.
hajersahraoui@yahoo.fr (* Corresponding author), grissak@yahoo.fr

² Montpellier SupAgro, Unité Mixte de Recherche CBGP (INRA/IRD/CIRAD/SupAgro), Campus International de Baillarguet, CS 30 016, 34988
Montferrier-sur-Lez cedex, France. kreiter@supagro.inra.fr, douin@supagro.inra.fr, tixier@supagro.inra.fr

ABSTRACT — This study presents the results of a survey aimed to determine the species composition of phytoseiid mites on citrus trees, inter-row grasses and conifers planted as break winds within and around citrus orchards. This survey was carried out in forty six citrus orchards in the main citrus growing regions of Tunisia, from September 2009 to August 2011. Twenty six species belonging to ten genera were found, among which eleven are new for the Tunisian fauna. This paper provides a catalogue of all these species, with some information on their biogeography and biology when available. In addition, a key for the identification of all known Tunisian species (38 species belonging to 17 genera) is given.

KEYWORDS — Phytoseiid mites; citrus; Tunisia; biodiversity; survey

INTRODUCTION

Mites of the family Phytoseiidae (Mesostigmata) have been extensively studied for their potential as biological control agents of phytophagous mites (McMurtry and Croft, 1997). Several species are currently used for bio-control of mite and insect pests in several crops all over the world (McMurtry and Croft, 1997). About 2,300 phytoseiid species belonging to 90 genera have been described in this family (Chant and McMurtry, 2007). However, the fauna of all countries has not been equally surveyed (Tixier *et al.*, 2012). Until very recently, only few species were reported from Tunisia (Kreiter *et al.*, 2010). For a long time, *Phytoseiulus persimilis* Athias-Henriot was the unique species reported

from this country (Gafsa, South of Tunisia) (Rambier, 1972), and many works referring to phytoseiids from Tunisia have been recently initiated (Kreiter *et al.*, 2002, 2004, 2006, 2010). A synthesis of the surveys carried out during 15 years (between 1994 and 2008) in the main crops and surrounding vegetation was reported by Kreiter *et al.* (2010): 27 species of phytoseiid mites belonging to 14 genera are now recorded. Among them, twelve species were identified on citrus trees (table 1).

Despite these progresses, additional studies are still necessary in order to evaluate properly the diversity of Phytoseiidae species in Tunisian ecosystems, especially in crops in order to exploit their predatory potential for biological control applica-

TABLE 1: Phytoseiidae species reported on citrus trees in Tunisia in Kreiter *et al.* (2010) and those presently recorded.

Species	Sub-family	
<i>Euseius scutalis</i> (Athias-Henriot)	Amblyseiinae	(Kreiter <i>et al.</i> 2010)
<i>Euseius stipulatus</i> (Athias-Henriot)	Amblyseiinae	(Kreiter <i>et al.</i> 2010)
<i>Graminaseius graminis</i> (Chant)	Amblyseiinae	(Kreiter <i>et al.</i> 2010)
<i>Iphiseius degenerans</i> (Berlese)	Amblyseiinae	(Kreiter <i>et al.</i> 2010)
<i>Neoseiulus californicus</i> (McGregor)	Amblyseiinae	(Kreiter <i>et al.</i> 2010)
<i>Phytoseiulus persimilis</i> (Athias-Henriot)	Amblyseiinae	(Kreiter <i>et al.</i> 2010)
<i>Proprioseiopsis bordjelaini</i> (Athias-Henriot)	Amblyseiinae	New records
<i>Phytoseius finitimus</i> (Ribaga)	Phytoseiinae	(Kreiter <i>et al.</i> 2010)
<i>Paraseiulus talbii</i> (Athias-Henriot)	Typhlodrominae	New records
<i>Typhlodromus (Anthoseius) foenilis</i> (Oudemans)	Typhlodrominae	(Kreiter <i>et al.</i> 2010)
<i>Typhlodromus (Anthoseius) pegazzani</i> (Ragusa and Swirski)	Typhlodrominae	New records
<i>Typhlodromus (Anthoseius) rhenanoides</i> (Athias-Henriot)	Typhlodrominae	(Kreiter <i>et al.</i> 2010)
<i>Typhlodromus (Anthoseius) rhenanus</i> (Oudemans)	Typhlodrominae	(Kreiter <i>et al.</i> 2010)
<i>Typhlodromus (Anthoseius) yasmiae</i> (Faraji)	Typhlodrominae	New records
<i>Typhlodromus (Typhlodromus) ernesti</i> (Ragusa and Swirski)	Typhlodrominae	New records
<i>Typhlodromus (Typhlodromus) exhilaratus</i> (Ragusa)	Typhlodrominae	(Kreiter <i>et al.</i> 2010)
<i>Typhlodromus (Typhlodromus) phialatus</i> (Athias-Henriot)	Typhlodrominae	(Kreiter <i>et al.</i> 2010)
<i>Typhlodromus (Typhlodromus) setubali</i> (Dosse)	Typhlodrominae	New records

tions.

The present paper aims to better accurately characterize the phytoseiid mite diversity in a wide range of citrus plots, located in different growing areas, sampled on several varieties at different seasons.

MATERIALS AND METHODS

A survey of phytoseiid mites was carried out from September 2009 to August 2011, in 46 citrus orchards in the most important productive regions of Tunisia: twenty three orchards are situated in Cap Bon which is the most important citrus productive region (with a surface of about 75 % of the total citrus surface), eight orchards in Tunis (Mornag, Sidi Thabet and Ariana), six orchards in Bizerte, seven in the North West (Béja and Jandouba), one orchard in Sousse and one orchard in Kairouan (Figure 1). One hundred and eight samplings have been carried out in the 46 selected orchards: for each sam-

pling, collections were carried out on citrus trees, uncultivated weeds in inter-rows and break winds trees.

Samples of each plant were individually bagged in plastic bags and transported the same day in freezing boxes to the laboratory for mite extraction. Mites were extracted from leaves using a fine hair brush and were preserved in 70 % ethanol. They were then mounted on slides using Hoyer's medium (Gutierrez, 1985) and identified using a phase contrast microscope.

The generic classification of Chant and McMurtry (2007) was used for identification. Other more specific literature was used for species determination (Ferragut *et al.*, 2009; Papadoulis *et al.*, 2009).

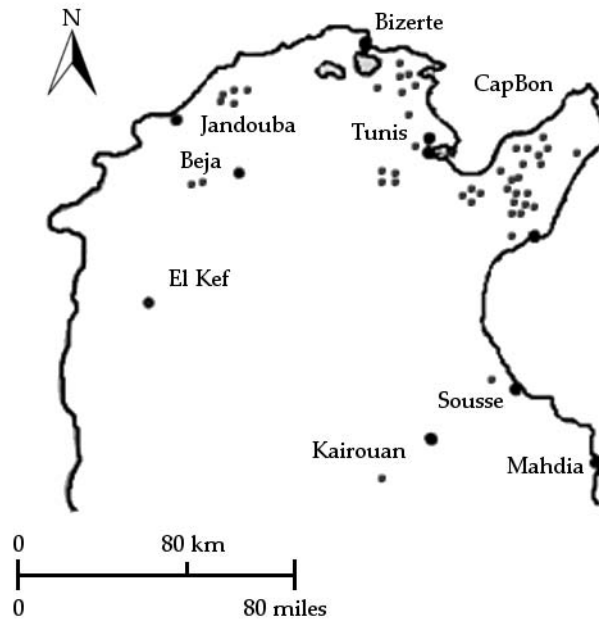


FIGURE 1: Geographical distribution of the sampled orchards in Tunisia.

SPECIES OF PHYTOSEIIDAE MITES PRESENTLY OBSERVED IN CITRUS AGROSYSTEMS

RESULTS

A total of 2,759 individuals (adults) of phytoseiid mites were identified from citrus trees and associated uncultivated plants in the 46 Tunisian orchards considered.

Twenty-six phytoseiid species belonging to 10 genera were found, fifteen of them being already known and eleven are new species for Tunisia (Table 2). Among them six were found on citrus trees (Table 1), the others on weeds and conifers. First, we will present the twenty six species presently found in citrus agrosystems. Some biological data are given when available and helpful for biological control applications, the current geographic distribution of species are from Moraes *et al.* (2004) and Papadoulis *et al.* (2009). Data on the species previously recorded in Tunisia are from Kreiter *et al.* (2010). Then, a key of all the species of Phytoseiidae known from Tunisia is provided.

Sub-family Amblyseiinae

1. *Graminaseius graminis* (Chant)

Amblyseius graminis Chant 1956: 34. *Typhlodromus (Amblyseius) graminis* Chant 1959: 89. *Amblyseius (Typhlodromus) graminis* (Chant) Muma 1961: 287. *Typhlodromus (Typhlodromus) graminis* (Chant) Westerberger and Bernhard 1963: 636. *Amblyseius (Amblyseius) graminis* (Chant) Wainstein 1973: 178; Wainstein 1975: 920; Wainstein 1977: 1415; Ueckermann and Loots 1988: 132. *Neoseiulus graminis* (Chant) Moraes *et al.* 1986: 81. *Graminaseius graminis* (Chant) Chant and McMurtry 2007: 85.

Distribution — Algeria, Armenia, Australia, Azerbaijan, Denmark, England, France, Germany, Greece, Moldova, Morocco, Norway, Poland, Russia, Spain, Turkey, Ukraine, and USA.

Previous records from Tunisia — Cap Bon region – July 2006 on *Citrus* sp. (lemon, navel and orange).

TABLE 2: Phytoseiidae species presently observed and their geographical distribution in the sampled citrus orchards (the species in bold characters are new for the Tunisian fauna).

	Bizerte (Azib, Alia, Ras Jbel)	Grand-Tunis (Morneg, Ariana Sidi Thabèt, Khlidia)	Cap bon (Takelsa, Menzel Bouzelfa, Grombalia, Bouargoub, Slimen, Bni Khalled, Hammamet)	North West (Jandouba- Beja)
<i>E. stipulatus</i>	×	×	×	
<i>E. scutalis</i>		×		
<i>N. californicus</i>	×	×	×	
<i>N. cucumeris</i>		×		
<i>N. longilaterus</i>		×	×	
<i>N. barkeri</i>	×		×	
<i>N. alpinus (aurescens)</i>			×	×
<i>N. paspalivoorus</i>		×		
<i>N. bicaudus</i>			×	
<i>P. persimilis</i>	×	×	×	
<i>I. degenerans</i>	×	×	×	
<i>T. phialatus</i>	×	×	×	×
<i>T. exhilaterus</i>	×	×	×	
<i>T. pegazzani</i>		×		
<i>T. ernesti</i>		×		
<i>T. setubali</i>		×		
<i>P. talbii</i>	×	×	×	
<i>A. foenelis</i>	×	×	×	
<i>A. yasminae</i>	×	×	×	
<i>A. athenas</i>		×	×	×
<i>A. rhenanoides</i>	×	×	×	
<i>A. recki</i>	×			
<i>G. graminis</i>			×	
<i>P. bordjelaini</i>			×	
<i>A. meridionalis</i>		×		
<i>A. obtusus</i>			×	

Additional records from Tunisia — Takelsa (Cap Bon): December – 1♀ on *Citrus* sp.; March – 1♀ on *Malva* sp.; June and July – 7♀ on *Hordeum murinum*.

2. *Amblyseius obtusus* (Koch)

Zercon obtusus Koch 1839: 13; Canestrini and Fanzagò 1876: 130-141; Oudemans 1930: 71. *Seius obtusus* (Koch) Berlese 1889: 7. *Amblyseius obtusus* (Koch) Berlese 1914: 144; Athias-Henriot 1957: 340;

Livshitz and Kuznetsov 1972: 23, Wainstein and Shcherbak 1972: 35; Moraes *et al.* 1986: 24; Papadoulis and Emmanuel 1997: 22; Chant and McMurtry 2007: 80. *Typhlodromus obtusus* (Koch) Chant 1957a: 306; Karg 1960: 443. *Typhlodromus (Amblyseius) obtusus* (Koch) Chant 1959: 90. *Amblyseius (Amblyseius) obtusus* (Koch) Muma 1961: 287; Ehara 1966: 22; Wainstein 1973: 178; Wainstein 1975: 916; Ueckermann and Loots 1988: 68; Denmark and

Muma 1989: 7.

Distribution — Algeria, Armenia, Canada, Czech Republic, England, France, Greece, Germany, Hawaii, Hungary, Italy, Moldova, Morocco, Norway, New Zealand, Pakistan, Poland, Russia, Spain, Sweden, Turkey, USA, Ukraine and Venezuela.

Specimens examined — Takelsa (Cap Bon): March – 1♀ on *Malva* sp.; April – 2♀ and 1♂ on *H. murinum*. This is the first record of this species in Tunisia.

3. *Amblyseius meridionalis* (Berlese)

Amblyseius obtustus var. *meridionalis* Berlese 1914: 144. *Amblyseius meridionalis* Berlese; Athias-Henriot 1958b: 32; Athias-Henriot 1966: 203; Wainstein and Shcherbak 1972: 35; Livshitz and Kuznetsov 1972: 22; Chant and Yoshida-Shaul 1978: 1062; Kolodochka and Sklyar 1981: 103; Moraes *et al.* 1986: 21; Papadoulis and Emmanouel 1993: 321; Moraes *et al.* 2004: 37; Chant and McMurtry 2007: 80. *Typhlodromus (Amblyseius) meridionalis* (Berlese) Chant 1959: 85. *Amblyseius (Amblyseius) meridionalis* (Berlese) Muma 1962: 23. *Typhlodromus (Typhlodromus) meridionalis* (Berlese) Westerboer and Bernhard 1963: 690. *Amblyseius (Pauciseius) meridionalis* (Berlese) Denmark and Muma 1989: 131.

Distribution — Algeria, Azerbaijan, Canada, Germany, Greece, Hungary, Italy, Morocco, Poland, Spain, Switzerland and Ukraine.

Specimens examined — Boumhal (Tunis): June 2011 – 1♀ on *Convolvulus* sp. This is the first record of this species in Tunisia.

4. *Proprioseiopsis bordjelaini* (Athias-Henriot)

Amblyseius bordjelaini Athias-Henriot 1966:193.

Distribution — Spain, Canary Islands, Algeria and Morocco.

Specimens examined — Takelsa (Cap Bon), December – 1♀ on *Citrus* sp. This is the first record of this species in Tunisia.

5. *Euseius scutalis* (Athias-Henriot)

Typhlodromus scutalis Athias-Henriot 1958a: 183. *Amblyseius scutalis* Athias-Henriot 1960a: 297. *Amblyseius (Amblyseius) scutalis* Muma 1961: 288. *Am-*

blyseius (Typhlodromus) scutalis Ueckermann and Loots 1988: 109.

Distribution — Algeria, Canary Islands, Cape Verde, Ghana, Egypt, Greece, India, Iran, Israel, Italy, Jordan, Lebanon, Morocco, Pakistan, South Africa, Spain and Turkey.

Previous records from Tunisia — this is a wide spread species in Tunisia, recorded in several orchards (citrus, vineyards, ornamental plants, fruit trees, wild cover).

Additional records from Tunisia — INAT (Tunis) (Institut National Agronomique de Tunisie), June – 1♀ on *Citrus* sp.

Biology — *Euseius scutalis* was described from Algeria by Athias-Henriot (1958). This species can be reared on pollen (Alshammeri, 2011) and was recorded as a predator of *Panonychus citri* (Mc Gregor) in citrus orchards (McMurtry, 1969, 1977; Kasap and Ekerog, 2004). *Euseius scutalis* has also been reported as a biological control agent of *Bemisia tabaci* (Gennadius) (Nomikou *et al.*, 2003; Dale and Donald, 1986).

6. *Euseius stipulatus* (Athias-Henriot)

Amblyseius stipulatus Athias-Henriot 1960a: 294. *Amblyseius (Amblyseius) stipulatus* Ueckermann and Loots 1988: 110. *Euseius stipulatus* (Athias-Henriot) Ferragut *et al.* 1985: 225; Chant and McMurtry 2005: 216; 2007: 123

Distribution — Algeria, Canary Islands (Spain), France, Greece, Italy, Montenegro, Morocco, Portugal, Tunisia, Turkey, and former Yugoslavia

Previous records from Tunisia — recorded in many regions in the Cap Bon, Mateur (North region), Sousse (Sahel region), on *Citrus* sp. and *M. domestica* and in Degache (South), July 2005 on *Olea europea*.

Additional records from Tunisia — Tekelsa (Cap Bon): all the year – 343♀ and 39♂ on *Citrus* sp.; February, April and June – 129♀ and 60♂ on *Acalypha rhomboidea*; March – 2♀ and 3♂ on *Mercurialis annua*; April – 2♀ and 5♂ on *U. dioica*; April, May and June – 9♀ on *Solanum nigrum*; April – 5♀ on *Conyza canadensis*; May and July – 3♀ on *Cupressus* sp.; March – 1♀ on *Chrysanthemum* sp., June – 3♀

on *H. murinum*, April – 13♀ and 1♂ on *Convolvulus* sp.; March – 3♀ and 4♂ on *Amaranthus retroflexus*; Alia and Ras eǧbal (Bizerte): March, April and May – 80♀ and 28♂ on *Citrus* sp.; April – 7♀ and 1♂ on *A. retroflexus*; March – 1♀ on *M. annua*; May – 1♀ on *S. nigrum*; May – 2♀ and 2♂ on *Cupressus* sp.; March – 1♀ on *Nerium oleander*; April – 2♀ and 2♂ on *Malva* sp.; Grombalia (Cap Bon): February, March, April, and June – 96♀ and 13♂ on *Citrus* sp., April and May – 2♀ and 1♂ on *A. rhomboidea*; April – 2♀ on *Malva* sp.; May – 1♀ on *S. nigrum*; April – 7♀ on *Convolvulus* sp.; Mornag (Tunis): December, March and April – 29♀ and 9♂ on *Citrus* sp.; March – 2♀ on *M. annua*; April – 1♀ on *U. dioica*; April – 2♀ and 1♂ on *Hedera helix*.

Biology — *Euseius stipulatus* was classified by McMurtry and Croft (1997) as a specialized pollen feeder. This species feeds also on pest mites such as *P. citri* (Ferragut *et al.* 1988, 1992), *Tetranychus urticae* Koch (Moyano *et al.*, 2009) and eriophyid mites (Ferragut *et al.*, 1987).

7. *Iphiseius degenerans* (Berlese)

Seiulus degenerans Berlese 1887: 9. *Iphiseius degenerans* (Berlese) Berlese 1921: 95. *Amblyseius (Iphiseius) degenerans* (Berlese) Muma 1961: 288. *Iphiseius (Iphiseius) degenerans* (Berlese) Pritchard and Baker 1962: 299.

Distribution — Algeria, Benin, Brazil, Burundi, Cape Verde, China (Hong-Kong), Congo, Egypt, Georgia, Greece, Israel, Italy, Kenya, Lebanon, Madeira Islands, Madagascar, Malawi, Morocco, Nigeria, Portugal, Rwanda, South-Africa, Canary Islands, Tanzania, Turkey, Yemen, Zaire and Zimbabwe.

Previous records from Tunisia — Sousse (Sahel region): April 2000 on *Citrus* sp. and *Hibiscus syriacus* near citrus orchard; Cap Bon Region: May 2006 on *Citrus* sp. (Thomson, Navel and oranges).

Additional records from Tunisia — Sidi Thabet (Tunis): March – 1♀ on *Citrus* sp.; Alia (Bizerte): March and April – 2♀ and 1♂ on *Citrus* sp.

Biology — Described in Italy during the 19th century (Berlese, 1887), this species has a wide distribution in Africa and around the Mediterranean

Sea (Moraes *et al.*, 2004). *Iphiseius degenerans* is described by McMurtry and Croft (1997) as a generalist (type III predator), able to feed on a wide range of foods such as thrips larvae (Messelink *et al.*, 2005), spider mites (Nwilene and Nachman, 1996; Vantornhout *et al.*, 2004) and pollen (van Rijn *et al.*, 1999). This species is commercialised for the biological control of the western flower thrips *Frankliniella occidentalis* (Pergande) in greenhouses (Vantornhout *et al.*, 2005).

8. *Neoseiulus barkeri* Hughes

Neoseiulus barkeri Hughes 1948: 142; 1976: 343. *Typhlodromus barkeri* Nesbitt 1951: 35; Chant 1959: 61. *Amblyseius barkeri* Athias-Henriot 1961: 440. *Amblyseius mckenziei* Schuster and Pritchard 1963: 268.

Distribution — Algeria, Australia, Brazil, Canary Islands, Cape Verde, China, Finland, France, Georgia, Germany, Ghana, Greece, Guinea, Hawaiï, Israel, Italy, Japan, Jordan, Madagascar, Netherlands, Nigeria, Norway, Reunion Island, Russia, South Africa, South Korea, Spain, Sweden, Turkey, Ukraine, United Kingdom, West Bank and Yemen.

Previous records from Tunisia — Beni Khair (Cap Bon region): October 1995 on *Oxalis* sp. in citrus orchard; Palmeraie Ibn Chabbat (South): July 2000 on *C. dactylon*; Segdoud: January 2006 on *Ph. dactylifera* cv. Alig.

Additional records from Tunisia — Takelsa (Cap Bon): May – 1♀ on *S. nigrum*; April – 1♀ on *Conyza canadensis*; Alia (Bizerte): July – 1♀ on *C. canadensis*.

Biology — Various studies have shown its ability to control *F. occidentalis* (Rodriguez-Reina *et al.*, 1992), *Thrips tabaci* (Lindeman) (Hansen, 1988; Bonde, 1989; Dsgaard *et al.*, 1992) and *T. urticae* in cucumber (Yuqing and Pettitt, 1994). Fan and Pettitt (1994) showed that augmentative releases of *N. barkeri* provided control of broad mite [*Polyphagotarsonemus latus* (Banks)] on peppers.

9. *Neoseiulus californicus* (McGregor)

Typhlodromus californicus McGregor 1954: 89. *Amblyseius californicus* Schuster and Pritchard 1963: 271. *Cydnodromus californicus* Athias-Henriot 1977: 62. *Amblyseius (Amblyseius) californicus* Ueckermann

and Loots 1988: 150; Ehara *et al.* 1994: 126. *Amblyseius (Neoseiulus) californicus* Ehara and Amano 1998: 33. *Neoseiulus californicus* Moraes *et al.* 1986: 73; Moraes *et al.* 2004: 109.

Distribution — Algeria, Argentina, Brazil, Chile, Colombia, Cuba, France, Greece, Guatemala, Italy, Japan, Mexico, Peru, South Korea, Spain, Taiwan, Uruguay, USA (California) and Venezuela.

Previous records from Tunisia — Sousse (Sahel Region): April 2000 on *Lycopersicon esculentum* in greenhouses; Mateur (North Region): July 2000 on *M. domestica*; Chekmo oasis (South): June 2005 on *Malva* sp.; Hammamet, Mraïssa, Grombalia, Menzel Bou Zelfa (Cap Bon Region): July 2006 on *Citrus* sp. (lemon, clementine and maltaise).

Additional records from Tunisia — Grombalia (Cap Bon): July – 1♀ on *Citrus* sp., April – 6♀ on *Malva* sp.; Takelsa (Cap bon): December, January, February, March and April – 47♀ and 16♂ on *Citrus* sp.; May, April – 3♀ on *S. nigrum*; July – 1♀ on *Fubus* sp.; April, May – 73♀ and 5♂ on *M. annua*, August – 1♀ on *P. persica*; March, April – 76♀ and 1♂ on *Malva* sp., May – 1♀ on *Cupressus* sp.; July – 2♀ and 1♂ on *Tamarix* sp.; July – 1♀ on *F. carica*; Alia (Bizerte): August – 1♀ on *Citrus* sp.; March – 1♀ on *N. oleander*, July – 8♀ and 1♂ on *Phaseolus vulgaris*; August – 9♀ and 2♂ on *S. nigrum*; July – 3♀ and 3♂ on *A. rhomboidea*; July – 5♀ and 1♀ on *C. canadensis*; August – 1♀ and 1♀ *Salvia officinalis*; August – 6♀ and 1♂ on *Malva* sp.; August – 5♀ and 1♂ on *A. retroflexus*; July – 6♀ and 1♂ on *Cupressus* sp.; March – 13♀ on *M. annua*; Morneg (Tunis): April – 1♀ on *Citrus* sp.; August – 1♀ on *Convolvulus* sp.; August – 1♀ on *Malus* sp.; April – 1♀ on *U. dioica*.

Biology — This is a very widespread species (Moraes *et al.*, 2004). *Neoseiulus californicus* has characteristics of both specialist and generalist predatory mites (Castagnoli and Simoni, 2003). It prefers to feed on Tetranychidae mites (Escudero *et al.*, 2004, 2005; Greco *et al.*, 2005; Katayama *et al.*, 2006; Fraulo *et al.*, 2008; Gomez *et al.*, 2009), but can also consume other mite species like tarsonemid mites [*Phytonemus pallidus* (Banks)] (Easterbrook *et al.*, 2001), small insects, such as thrips (Rodriguez *et al.*, 1992) and even pollen when the primary prey is unavailable (Rhodes and Liburd, 2005).

10. *Neoseiulus cucumeris* (Oudemans)

Typhlodromus cucumeris Oudemans 1930: 69. *Amblyseius cucumeris* Athias-Henriot 1957: 336. *Typhlodromus (Amblyseius) cucumeris* Chant 1959: 78. *Amblyseius (Neoseiulus) cucumeris* (Oudemans) De Leon 1965: 23. *Neoseiulus cucumeris* (Oudemans) Moraes *et al.* 1986: 76; Chant and McMurtry 2007: 25.

Distribution — Algeria, Armenia, Australia, Austria, Azerbaijan, Belgium, Byelorussia, Canada, Canary Islands, Caucasus Region, Egypt, England, Finland, France, Georgia, Germany, Greece, Hungary, India, Iran, Israel, Italy, Mexico, Moldova, Morocco, Netherlands, New Zealand, Norway, Poland, Russia, Spain, Sweden, Switzerland, Tunisia, Ukraine, USA and West Bank.

Previous records from Tunisia — recorded in several palmeraies in the south of Tunisia on *C. dactylon*, *Sorghum vulgare*, *Setaria* sp., *Digitaria communata* and *Ph. dactylifera*.

Additional records from Tunisia — Sidi Thabet (Tunis): June – 6♀ on *Elytrigia repens*.

Biology — The biological characteristics of this species have been well documented because of its ability to control thrips on various cultivated plants in greenhouses (McMurtry and Croft, 1997; Meselink *et al.*, 2005).

11. *Neoseiulus bicaudus* (Wainstein)

Amblyseius bicaudus Wainstein 1962a: 146. *Typhlodromus bicaudus* (Wainstein) Hirshmann 1962a: 250. *Neoseiulus bicaudus* (Wainstein) Moraes *et al.* 1986: 72; Chant and McMurtry 2007: 25.

Distribution — Armenia, Azerbaijan, Caucasus region, France, Georgia, Greece, Hungary, Israel, Italy, Kazakhstan, Moldova, Norway, Russia, Spain, Switzerland, Turkey and USA (Washington).

Specimens examined — Takelsa (Cap Bon): July – 1♀ on *Cupressus* sp. This is the first record of this species in Tunisia.

12. *Neoseiulus longilaterus* Athias-Henriot

Neoseiulus longilaterus Athias-Henriot 1957: 218. *Cydnodromus longilaterus* Muma 1961: 290.

Distribution — Algeria, Israel.

Specimens examined — Manzel Bouzelfa (Cap Bon): August – 1♀ on *Convolvulus* sp., Sidi Thabèt (Tunis): 1♀ on *C. dactylon*. This is the first record of this species in Tunisia.

13. *Neoseiulus alpinus* Athias-Henriot

Amblyseius obtustus var. *alpinus* Schweizer 1922: 41. *Amblyseius alpinus* Schweizer 1949: 79. *Typhlodromus (Amblyseius) alpinus* (Schweizer) Chant 1959: 105. *Typhlodromus (Typhlodromus) alpinus* (Schweizer) Westerboer and Bernhard 1963: 651. *Amblyseius (Neoseiulus) alpinus* (Schweizer) Karg 1993: 189. *Neoseiulus alpinus* (Schweizer) Evans 1987: 1461; Chant and McMurtry 2007: 25. *Neoseiulus aurescens* (Athias-Henriot) Tuttle and Muma 1973: 20.

Distribution — Algeria, Australia, Belgium, Cuba, Czech Republic, England, France, Georgia, Russia, Ukraine, Germany, Greece, Hawaii, Hungary, Italy, Jordan, Norway, Poland, Switzerland, Spain, Turkey and USA (Arizona, California, Washington).

Specimens examined — Mjaz el Bab (Béja): May – 1♀ on *M. annua*; Takelsa (Cap Bon): 1♀ on *S. nigrum*, 1♀ on *H. murinum*. This is the first record of this species in Tunisia.

14. *Neoseiulus paspalivorus* (De Leon)

Typhlodromus paspalivorus De Leon, 1957: 143 *Neoseiulus paspalivorus* Muma and Denmark, 1971: 110 *Amblyseius paspalivorus* Schicha, 1981: 210.

Distribution — Guadeloupe, India, Jamaica, Philippines, USA (Florida).

Previous Records in Tunisia — Palmeraie M'Rah Lahouara, on *C. dactylon*, July 2000.

Additional records from Tunisia — Sidi Thabèt: June 2011 – 1♀ on *Chenopodium murale*.

Biology — *Neoseiulus paspalivorus* was found only on coconut and on fruits, in association with *A. guerreronis* (Moraes *et al.*, 2004). This species is a promising candidate for the biological control of the coconut eriophyid (Lawson-Balagbo *et al.*, 2008).

15. *Phytoseiulus persimilis* Athias-Henriot

Phytoseiulus persimilis Athias-Henriot 1957: 347. *Phytoseiulus riegeli* Dosse 1958: 48. *Typhlodromus persimilis* Hirschmann 1962: 75. *Phytoseiulus (Phytoseiulus) persimilis* (Athias-Henriot) Wainstein 1962b: 17. *Phytoseiulus tardi* (Lombardini) Kennett and Caltagione 1968: 571.

Distribution — Algeria, Australia, Canary Islands, Chile, China, Costa Rica, Finland, France, Greece, Guatemala, Hungary, Israel, Italy, Jordan, Lebanon, Lybia, Morocco, New Caledonia, Peru, Reunion Island, South Africa, South Korea, Spain, Tunisia, Turkey, Venezuela and USA (California).

Previous records from Tunisia — Sousse (Sahel region): April 2000 on *L. esculentum* and *Cucumis sativus* in greenhouses; Hammamet, Menzel Bouzelfa and Mraïssa (Cap-Bon region): November 1994, October 1995 and July 2001 on *Citrus* sp. (Thomson, Navel and lemon); Metline (Bizerte region): June 2000 on *M. domestica*.

Additional records from Tunisia — Grombalia (Cap Bon): February, July, April – 31♀ and 2♂ on *Citrus* sp.; July – 4♀ on *Convolvulus* sp.; Takelsa (Cap bon): March, April and July – 13♀ on *Citrus* sp.; March, July – 7♀ on *S. nigrum*; March – 2♀ and 1♂ on *M. annua*; March, August – 30♀ on *Malva* sp.; July – 1♀ and 1♂ on *Cupressus* sp.; July – 1♀ on *Tamarix* sp.; July – 1♀ on *Ficus carica*; Alia (Bizerte): July – 2♀ on *Citrus* sp.; July, August – 163♀ on *Ph. vulgaris*; April, July, August – 101♀ and 3♂ on *S. nigrum*; July – 1♀ on *C. canadensis*; July, August – 3♀ on *S. officinalis*; July, August – 46♀ and 1♂ on *Malva* sp.; March – 147♀ on *M. annua*.

Biology — *Phytoseiulus persimilis* was first collected in Algeria (Athias-Henriot, 1957). It is known mainly from Mediterranean climates around the world (Takahashi and Chant, 1993). Many studies deal with this specialist predator because of its economic importance, especially in the bio-control of *T. urticae* Koch in greenhouses all over the world (McMurtry and Croft, 1997).

Sub-Family Typhlodrominae16. *Paraseiulus talbii* Athias-Henriot

Typhlodromus talbii Athias-Henriot 1960b: 75. *Paraseiulus subsoleiger* Wainstein 1962a: 139. *Typhlodromus subsoleiger* (Wainstein) Hirshmann 1962: 12. *Paraseiulus talbii* (Athias-Henriot) Chant and McMurtry 2007: 143.

Distribution — Algeria, Armenia, Azerbaijan, China, Cyprus, Caucasus region, Denmark, Egypt, Finland, France, Georgia, Germany, Greece, Hungary, Israel, Italy, Iran, Kazakhstan, Moldova, Netherlands, Slovakia, Spain, Sweden, Switzerland, Turkey and Ukraine.

Specimens examined — INAT (Tunis): June – 3♀ on *Citrus* sp.; Takelsa (Cap Bon): July – 1♀ on *F. carica*, August – 1♀ on *P. persica*; Alia (Bizerte): June – 2♀ and 1♂ on *Citrus* sp., May – 2♀ on *Cupressus* sp. This is the first record of this species in Tunisia.

17. *Typhlodromus (Anthoseius) athenas*
Swirski and Ragusa

Typhlodromus (Anthoseius) athenas Swirski and Ragusa 1976: 111.

Distribution — Greece, Israel, Italy, Morocco.

Previous records from Tunisia — Gafsa: March 2004 and March 2007 on *O. europea*; Segdoud: November 2005, October 2006 and October 2007 on *Ph. dactylifera*; April 2006 on *S. melongena* (Kreiter et al. 2010).

Additional records from Tunisia — Takelsa (Cap Bon): July – 17♀ on *Cupressus* sp.; INAT (Tunis): June – 11♀ and 2♀ on *Citrus* sp.; Testour (Béja): May – 2♀ on *P. granatum*; Hammamet (Cap Bon): July – 1♀ on *Cupressus* sp.

18. *Typhlodromus (Anthoseius) foenilis*
Oudemans

Typhlodromus foenilis Oudemans 1930: 70; senior synonym of *Typhlodromus cryptus* Athias-Henriot 1960b: 89. *Anthoseius (Amblydromellus) foenilis* (Oudemans) Andre 1986: 111. *Amblydromella foenilis* (Oudemans) Moraes et al. 1986: 173. *Anthoseius foenilis* (Oudemans) Evans and Edland 1998: 41–62. *Amblydromella (Aphanoseia) foenilis* (Oudemans)

Denmark and Welbourn 2002: 308. *Typhlodromus (Anthoseius) foenilis* (Oudemans) Moraes et al. 2004: 323; Chant and McMurtry 2007: 152.

Distribution — Azerbaijan, Belgium, Canada, England, France, Greece, Ireland, Israel, Italy and Norway.

Previous records from Tunisia — Degache: May 2005 on *P. granatum*; Cap Bon: June 2005 on *Citrus* sp.

Additional records from Tunisia — Takelsa (Cap Bon): July and August – 27♀ on *Cupressus* sp.; August – 3♀ on *Tamarix* sp.; June – 1♀ on *H. murinum*; INAT (Tunis): June – 2♀ and 2♀ on *Citrus* sp.; Bouargoub (Cap Bon): April – 1♀ on *A. rhomboidea*; July – 3♀ and 2♀ on *Cupressus* sp. Alia (Bizerte): June and July – 39♀ and 9♀ on *Cupressus* sp.; March – 2♀ on *N. oleander*.

19. *Typhlodromus (Anthoseius) rhenanoides*
Athias-Henriot

Typhlodromus rhenanoides Athias-Henriot 1960b: 85. *Neoseiulus rhenanoides* (Athias-Henriot) Schuster and Pritchard 1963: 205. *Anthoseius rhenanoides* (Athias-Henriot) Charlet and McMurtry 1977: 186. *Amblydromella rhenanoides* (Athias-Henriot) Moraes et al. 1986: 174. *Typhlodromus (Anthoseius) rhenanoides* (Athias-Henriot) Chant and McMurtry 2007: 155.

Distribution — Algeria, Canary Islands, France, Hawaii, Italy, Les Saintes, Morocco, Spain and USA (California).

Previous records from Tunisia — Cap Bon region: November 1994 and October 1995 on *Citrus* sp.; Chekmo oasis (South): June 2005 on *Tamarix* sp.

Additional records from Tunisia — Takelsa (Cap Bon): October, December, February and July – 9♀ and 3♂ on *Citrus* sp.; July, August – 71♀ and 15♂ on *Cupressus* sp.; August – 8♀ on *Tamarix* sp.; August – 3♀ on *Malva* sp.; June – 4♀ on *S. nigrum*., August – 7♀ on *Rubus* sp.; March – 3♀ and 2♂ on *M. annua*; March – 1♀ on *A. rhomboidea*; Morneg (Tunis): April – 1♀ on *H. helix*; April – 1♀ on *U. dioica*; April – 10♀ and 1♂ on *Chenopodium murale*; August – 4♀ on *Cupressus* sp.; Hammamet (Cap Bon): July – 7♀ on *Cupressus* sp.; Alia (Bizerte): March, April, August

– 26♀ and 6♂ on *Citrus* sp.; April, June – 1♀ and 3♂ on *A. rhomboidea*; July, August – 43♀ on *Cupressus* sp.; June – 9♀ on *Malva* sp.; March – 3♀ on *M. annua*; August – 1♀ on *C. canadensis*; August – 4♀ on *A. retroflexus*.

20. *Typhlodromus (Anthoseius) recki*
Wainstein

Typhlodromus recki Wainstein 1958: 203. *Typhlodromus (Typhlodromus) recki* Wainstein; Chant 1959: 62. *Typhlodromella recki* (Wainstein) Muma 1961: 299. *Typhlodromus (Neoseiulus) recki* (Wainstein) Ehara 1966: 18. *Anthoseius (Amblydromellus) recki* (Wainstein) Kolodochka 1980: 39. *Typhlodromus (Anthoseius) recki* (Wainstein) Moraes *et al.* 2004: 344; Chant and McMurtry 2007: 155.

Distribution — Algeria, Armenia, Azerbaijan, Cyprus, Caucasus region, France, Georgia, Greece, Hungary, Israel, Italy, Kazakhstan, Lebanon, Moldova, Russia, Turkey and Ukraine.

Previous records from Tunisia — several vineyards in Cap Bon region, *V. vinifera*, July 1995.

Additional records from Tunisia — Alia (Bizerte): March – 6♀ on *C. canadensis*.

21. *Typhlodromus (Anthoseius) pegazzani*
Ragusa and Swirski

Typhlodromus pegazzani Ragusa and Swirski 1978: 218. *Anthoseius pegazzani* (Ragusa and Swirski) Rivany and Swirski 1980: 177. *Amblydromella pegazzani* (Ragusa and Swirski) Moraes *et al.* 1986: 169. *Typhlodromus (Anthoseius) pegazzani* (Ragusa and Swirski) Chant and McMurtry 2007: 155.

Distribution — Greece and Italy.

Specimens examined — Sidi Thabet (Tunis): June – 5♀ and 4♂ on *Citrus* sp. (traps); Mornag (Tunis): June – 1♀ *Citrus* sp. (traps). This is the first record of this species in Tunisia.

22. *Typhlodromus (Anthoseius) yasminae*
Faraji

Typhlodromus (Anthoseius) yasminae Faraji 2008: 106

Distribution — This species was recently described in Spain (Baldomar) in *V. vinifera*. Nothing is known on its biology.

Specimens examined — Takelsa (Cap Bon): April, May, June – 32♀ and 2♂ on *Cupressus* sp., August – 1♀ on *Tamarix* sp., May – 2♀ on *Citrus* sp.; Nianou (Cap Bon): May – 1♀ and 2♂ on *Cupressus* sp.; Alia (Bizerte): June, July and August – 11♀ and 1♂ on *Cupressus* sp.; Morneg (Tunis): August – 1♀ on *Cupressus* sp. This is the first record of this species in Tunisia.

23. *Typhlodromus (Typhlodromus) exhilaratus*
Ragusa

Typhlodromus exhilaratus Ragusa 1977: 380. *Typhlodromus exhilaratus exhilaratus* (Ragusa) Chant and Yoshida-Shaul 1987: 1795. *Typhlodromus exhilaratus americanus* (Ragusa) Chant and Yoshida-Shaul 1987: 1795. *Typhlodromus (Typhlodromus) exhilaratus* (Ragusa) Mores *et al.* 2004: 371; Chant and McMurtry 2007: 157.

Typhlodromus exhilaratus has been considered as a synonym of *T. tiliae* Oudemans by Denmark (1992).

Distribution — Cyprus, France, Greece, Israel, Italy, Morocco and USA.

Previous records from Tunisia — Sousse (Sahel region): July 2000 on *M. domestica*; (Cap Bon region): May 2006 on *Citrus* sp. (maltaise, Thomson and lemon); Gafsa (South): March 2007 on *O. Europea*.

Additional records from Tunisia — Takelsa (Cap Bon): July – 5♀ on *Malva* sp.

Biology — *Typhlodromus exhilaratus* was reported as type III predators (generalist predators, able to develop without prey) (McMurtry and Croft, 1997), its food range includes Tetranychidae, Eriophyidae and pollen (Ragusa, 1979, 1981). Its intrinsic population growth rate (*rm*) is higher on *Eotetranychus carpini* (Oudemans) and pollen than on *P. ulmi* (Castagnoli and Liguori, 1986; Castagnoli *et al.*, 1989).

24. *Typhlodromus (Typhlodromus) phialatus*
Athias-Henriot

Typhlodromus phialatus Athias-Henriot 1960b: 100. *Typhlodromus (Typhlodromus) phialatus* Athias-Henriot; Moraes *et al.* 2004: 366; Chant and McMurtry 2007: 157.

Distribution — Algeria, Cyprus France, Germany, Hungary, Israel, Italy, Jordan, Moldova, Morocco, Norway, Russia, Spain and Ukraine.

Previous Records from Tunisia — Cap Bon region: June 1994 on *Citrus* sp., July 1995 in several vineyards, on *V. vinifera*; September 2006 on *Citrus* sp.; Monastir (Sahel region): November 1994 on *Citrus* sp.; Slimane (Cap Bon region) and Sousse (Sahel region): July 2000 on *M. domestica*.

Additional records from Tunisia — Takelsa (Cap Bon): December, May, June, July – 7♀ on *Citrus* sp.; July, August – 5♀ and 1♂ on *Cupressus* sp.; July, August – 4♀ on *Tamarix* sp.; March, April – 22♀ on *A. rhomboidea*; March, April – 4♀ on *Malva* sp.; April – 2♀ and 1♂ on *E. repens*; April – 2♀ on *M. annua*; June, July – 15♀ on *H. murinum*; June, August – 7♀ on *S. nigrum*. Bouargoub (Cap Bon): February, July – 2♀ on *Citrus* sp.; April – 4♀ and 1♂ on *A. rhomboidea*. Alia (Bizerte): July – 1♀ on *Cupressus* sp.; March – 2♀ on *A. rhomboidea*; May – 1♀ on *S. nigrum*. Bousalem (Jandouba): March, June – 19♀ and 1♂ on *Cupressus* sp.; March – 1♀ on *M. annua*; June – 1♀ on *A. retroflexus*; Testour (Béja): May – 6♀ on *Malus* sp.; May – 2♀ on *Citrus* sp. Sidi Thabèt (Tunis): March – 2♀ on *Citrus* sp. Morneg (Tunis): August – 2♀ on *Malus* sp. INAT (Tunis): June – 3♀ on *Citrus* sp.

Biology — This species is known to feed on red spider mites and to consume pollen (Ferragut *et al.*, 1987, 1992).

25. *Typhlodromus (Typhlodromus) setubali*
Dosse

Typhlodromus (Typhlodromus) setubali Dosse 1961: 313.

Distribution — Germany, Israel, Jordan, Morocco and Spain.

Specimens examined — INAT (Tunis): June – 2♀ on *Citrus* sp. This is the first record of this species in Tunisia.

26. *Typhlodromus (Typhlodromus) ernesti*
Raguza and Swirski

Typhlodromus (Typhlodromus) ernesti Raguza and Swirski 1978: 211 *Typhlodromus ernesti postici* Karg 1989: 275

Distribution — Israel, Norway, Russia and Sweden.

Specimens examined — Sidi Thabèt: June 2011 – 1♀ on *Citrus* sp. (traps). This is the first record of this species in Tunisia.

Key to the species of Phytoseiid mites of Tunisia

Thirty eight species belonging to 17 genera are known from Tunisia. Among them, 18 species were identified on citrus trees. In order to facilitate the identification of the Phytoseiidae species reported from Tunisia until now, a dichotomous key comprising these 38 species of Phytoseiidae is provided below.

1. Podonotal region of the dorsal shield (anterior to setae R1) of the female with 5 or 6 pairs of "lateral" setae j3, z2, z4 and s4 always present and z3 and/or s6 present 2
- 1'. Podonotal region of the dorsal shield (anterior to setae R1) of the female with 4 pairs of "lateral" setae j3, z2, z4 and s4 present, z3 and s6 absent Amblyseinae: 3
- 2 (1). Posterior "lateral" setae Z1, S2, S4 and S5 absent. Setae r3 usually inserted on the dorsal shield Phytoseiinae: *Phytoseius finitimus*
- 2' (1). At least one of setae Z1, S2, S4 and S5 present. Setae r3 usually inserted on the interscutal soft cuticle (rarely on the shield) Typhlodrominae: 22
- 3 (1'). Sternal shield with median posterior projection, some forward "migration" of preanal setae ZV2 and/or JV2 4
- 3' (1'). Sternal shield without posterior projection, without forward "migration" of preanal setae ZV2 and/or JV2 7
- 4 (3). Heavily sclerotized and brown body with separate anal shield and subrectangular ventral shield *Iphiseius degenerans*
- 4' (3). Lightly sclerotised and ventrianal shield entire *Euseius*: 5
- 5 (4'). Cervix of spermatheca thin, long and sinuous (43 µm). Macrosetae of the basitarsus of the leg IV

long (77 µm) Peritreme short, extending to level of z4 or between z2 and z4 *Euseius scutalis* 5'(4'). Cervix of the spermatheca tubular and not sinuous (20-25 µm). Macrosetae of the basitarsus of the leg IV shorter (50-60 µm). Peritreme long, extending to level of j3 or between j3 and z2 6

6 (5'). Cervix of the spermatheca not vase-shape (side walls of the calyx parallel), atrium globular. Dorsum slightly reticulated *Euseius stipulatus* 6' (5'). Cervix of spermatheca vase-shaped (side walls of the calyx not parallel) Dorsum more strongly reticulated *Euseius gallicus*

7 (3'). Setae S4 absent 8
7' (3'). Setae S4 present 9

8 (7). Setae J2, S2 absent, female ventrianal shield reduced, setae j6 very long: 2-3 times longer than distance between their bases, female ventrianal shield with 1 pair of preanal setae. . . *Phytoseiulus persimilis* 8' (7). Setae J2, S2 present, female ventrianal shield elongated with three preanal setae, setae j6 not long *Kampidromus aberrans*

9 (7'). Z2 present, ventrianal shield reduced
. *Typhloseiella isotricha*
9' (7'). Z2 absent 10

10 (9'). Macrosetae usually present only on leg IV (rarely missing on this leg) but sometimes also on leg III. Lateral dorsal setae except Z5 usually subequal. J2, Z1, S2, S4 and S5 always present. 11
10' (9'). Macrosetae usually present on legs II, III and IV, and sometimes also on leg I. Lateral dorsal setae often of quite different lengths. J2, Z1, S2, S4 or S5 may be missing. Dorsal shield smooth and sclerotized 19

11 (10). Female ventrianal shield reduced and/or markedly wider at anus level, with a marked waist. Movable and fixed cheliceral digits with 1 and 1-3 distal teeth, respectively . *Paragigagnathus tamaricis* 11' (10). Female ventrianal shield not reduced and/or markedly wider at anus level, without a

marked waist. Movable and fixed cheliceral digits with a larger number of teeth not confined to apical region *Neoseiulus*: 12

12 (11'). Spermatheca with atrium forked for at least half its length at juncture with major duct, or atrium appearing thick-walled, vacuolated 13
12' (11'). Spermatheca with atrium not deeply forked at juncture with major duct, nor appearing thick-walled, vacuolated 14

13 (12). 4 pairs of solenostomes on the dorsal shield *Neoseiulus barkeri*
13' (12). 7 pairs of solenostomes on the dorsal shield *Neoseiulus alpinus*

14 (12'). Female ventrianal shield large, square or rectangular, rounded posteriorly. Dorsal shield with marked "shoulder" at level of seta r3, Z5 serrated. 15
14' (12'). Female ventrianal shield pentagonal or with lateral margins slightly rounded. Dorsal shield without marked "shoulder" at level of seta r3 16

15 (14). Leg IV without macrosetae
. *Neoseiulus mumai*
15' (14). Setaceous macroseta on basitarsus IV *Neoseiulus paspalivorus*

16 (14'). Spermatheca bell-shaped 17
16' (14'). Cervix of the spermatheca cup-shaped and short. 18

17 (16). Ventrianal shield with preanal pores, Five pairs of prominent crateriform solenostomes on the dorsal shield *Neoseiulus cucumeris*
17' (16). Ventrianal shield without preanal pores, six pairs of solenostomes *Neoseiulus longilaterus*

18 (16'). Ventrianal shield with large prominent crescentic preanal pores close to the central part. Setae Z4 longer than S4, J2 longer than S5
. *Neoseiulus californicus*
18' (16'). Ventrianal shield with small slightly crescent preanal pores, setae Z4 shorter than

S5.....*Neoseiulus bicaudus*

19 (10'). J2 present; leg IV usually with 3 strong macrosetae, setae z2 and z4 usually short; setae j5, S2 and S4 present; setae J2, S5 and Z1 present/absent 20
 19' (10'). J2 absent; legs II-IV with/without macrosetae, setae z2 and/or z4 often longer, setae j5 present.....*Proprioseiopsis bordjelaini*

20 (19). Spermatheca with atrium bifurcate/vacuolated at juncture with major duct. Male spermatophoral process T-shaped, with both heel and toe elongate, approximately subequal*Graminaseiulus graminis*
 20' (19). Spermatheca with atrium not bifurcate/vacuolated at the juncture with major duct*Amblyseiulus meridionalis*

21 (20'). Fixed digit of chelicerae with more than 7 teeth, spermatheca short cup-shaped with long tubular calyx having annulated stalk.....*Amblyseiulus obtusus*
 21' (20'). Fixed digit of chelicerae with less than 5 teeth, movable digit without tooth, spermatheca with saccular cervix and c-shaped atrium.....*Amblyseiulus meridionalis*

22 (2'). Setae z6 present, ventrianal shield sole-shaped, with 2 pairs of preanal setae, Setae Z1 and JV2 absent and setae R1 present*Paraseiulus talbii*
 22' (2'). Setae z6 absent..... 24

23 (22). Seta Z3 present.....*Paraseiulus talbii*
 23' (22). Seta Z3 absent, one pair of solenostomes on dorsal shield*Paraseiulus soleiger*

24 (22'). Both S4 and JV4 present 25
 24' (22'). Both setae S4 and JV4 absent.....*Africoseiulella flechtmanni*

25 (24). Setae Z1 absent*Typhlodromus*: 26
 25' (24). Setae Z1 present, Seta on dorsal shield slender, setiform, peritreme punctuate, 3 or 4 pairs of

preanal setae *Neoseiulella*: 37

26 (25). Setae S5 present.....*Typhlodromus (Anthoseiulus)*: 27
 26' (25). Setae S5 absent.....*Typhlodromus (Typhlodromus)*: 34

27 (26). Presence of 3 pairs (gd2, gd6, gd9) of solenostomes on a strongly reticulated dorsal shield.....*Typhlodromus (Anthoseiulus) recki*
 27' (26). Presence of more than 3 pairs of solenostomes on a less reticulate dorsal shield 28

28 (27'). Ventrianal shield without preanal solenostome..... 29
 28' (27'). Ventrianal shield with preanal solenostomes..... 31

29 (28). Dorsal shield with 5 pairs of solenostomes..... 30
 29' (28). Dorsal shield with 4 pairs of solenostomes, Spermatheca with a globulous atrium, sometimes with a thick neck between it and cervix. Ventrianal shield elongate and not pentagonal.....*Typhlodromus (Anthoseiulus) kazachstanicus*

30 (29). Movable digit of chelicerae with 2 teeth, spermatheca with cylindrical calyx, ventrianal shield pentagonal in outline and with inconspicuous ornamentation.....*Typhlodromus (Anthoseiulus) foenilis*
 30' (29). Movable digit of chelicerae with 1 tooth, spermatheca without a neck between atrium and cervix and a long cylindrical major duct. Ventrianal shield subpentagonal and large.....*Typhlodromus (Anthoseiulus) athenas*

31 (28'). Leg IV with a long knobbed macroseta on tarsus 32
 31' (28'). Leg IV with macroseta, not knobbed on tarsus..... 33

32 (30). Spermatheca with calyx elongate and tubular*Typhlodromus (Anthoseiulus) rhenanoides*
 32' (30). Spermatheca with calyx cup-shaped and

with c-shaped atrium on a short stalk.
 *Typhlodromus (Anthoseius) yasminae*

33 (30'). Macroseta of leg IV short, less than 30 μm
 *Typhlodromus (Anthoseius) rhenanus*

33' (30'). Macroseta of leg IV long, 56 (54-60) μm
 *Typhlodromus (Anthoseius) pegazzani*

34 (26'). Peritreme extending to about the level of z2. Six setae on the the genu II.
 *Typhlodromus (Typhlodromus) setubali*

34' (26'). Peritreme extending to about the level between j1 and j3. Seven setae on the the genu II. ... 35

35 (34'). Basitarsus IV with macroseta having blunt tip
 *Typhlodromus (Typhlodromus) ernesti*

35' (34'). Basitarsus IV with macroseta having bulbous tip. 36

36 (35'). Calix of the spermatheca squared basally, with a short neck.
 *Typhlodromus (Typhlodromus) exhilaratus*

36' (35'). Calix of the spermatheca rounded basally, without neck.
 *Typhlodromus (Typhlodromus) phialatus*

37 (25'). Four large and one small solenostomes on the dorsal shield (gd1, gd2, gd6, gd8, gd9). Ventrianal shield not reduced, with 4 pairs of preanal setae and without pores. Dorsal setae mostly slender and almost of the same medium size. Peritreme short, extending anteriorly between z3 and z4. Cervix of spermatheca saccular. Leg IV without macroseta.
 *Neoseiulella tiliarum*

37' (25'). Six small round solenostomes on the dorsal shield (gd1, gd2, gd5, gd6, gd8, gd9). Ventrianal shield reduced, with 4 pairs of preanal setae and without solenostome. Dorsal setae also slender, but short and not of the same size. Peritreme long, extending anteriorly to z2. Cervix of spermatheca saccular. Leg IV with a macroseta on basitarsus.
 *Neoseiulella perforata*

DISCUSSION AND CONCLUSION

Twenty-seven species were known from Tunisia until now (Kreiter *et al.*, 2010), including one new genus and one new species to science found in the South of Tunisia. In this study, twenty six species belonging to 10 genera were found, eleven of them being new for the Tunisian fauna. Among these species, six were found on citrus trees: *Typhlodromus*

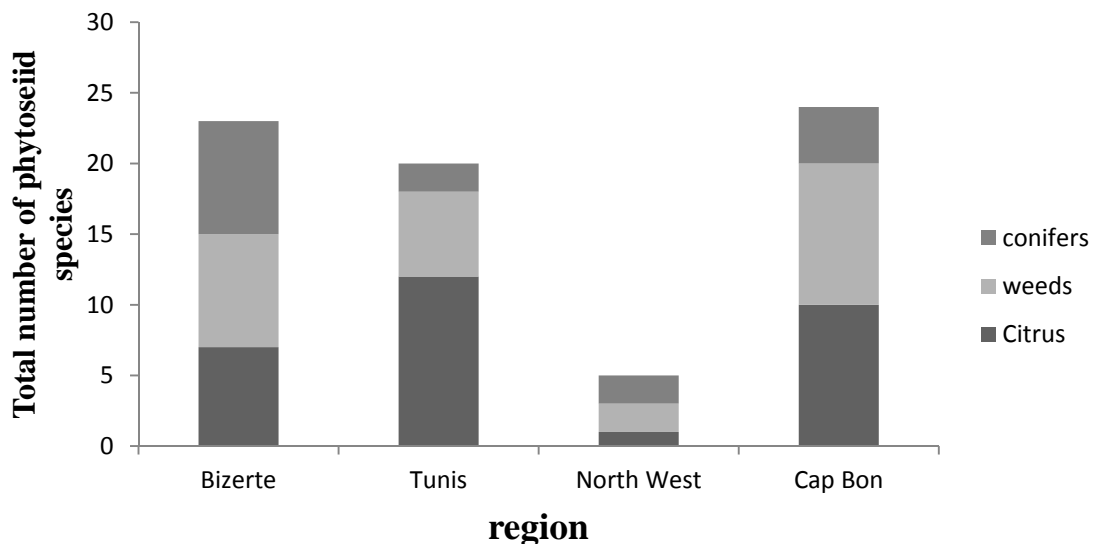


FIGURE 2: Number of species collected by region on citrus trees, weeds and conifers.

(*Typhlodromus setubali*, *Typhlodromus (Typhlodromus) ernesti*, *Typhlodromus (Anthoseius) pegazzani*, *Typhlodromus (Anthoseius) yasminae*, *Proprioseiopsis bordjellaini* and *Paraseiulus talbii*). Only one of these six species (*Paraseiulus talbii*) was found in two samples and two different regions (Bizerte and Cap Bon), the other species were found only once (one or two individuals per species) (Table 2). These latter species seem thus to be rare on citrus trees. Two of the 10 newly reported species were also found on *Cupressus* sp. (conifer planted usually around orchards to break winds) and *Tamarix* sp.: *Neoseiulus bicaudus* and *Typhlodromus (Anthoseius) yasminae*. Three others were also found on weeds: *Neoseiulus longilaterus*, *Neoseiulus alpinus*, *Amblyseius obtusus* and *Amblyseius meridionalis*; all of them being rare. Only one of the new reported species was present in many samples and several regions (Bizerte, Tunis and Cap Bon), *Typhlodromus (Anthoseius) yasminae*, but almost on the same plants: *Cupressus* sp. and *Tamarix* sp. (on *Citrus* sp. in only one sample). These new recorded species were found in Cap Bon region, North region (Bizerte), North West (Beja) and in Tunis (Ariana, Sidi Thabet, Morneg and Boumhal) (Table 2). Even the number of citrus plots sampled in the Cap Bon region (23 plots) was higher than of Tunis (8 plots) and Bizerte (6 plots), the global diversity of Phytoseiidae in these three regions is similar (Figure 2).

Euseius stipulatus was the most abundant species on citrus trees (82 %) followed by *P. persimilis*, *N. californicus*, *A. rhenanoides* and *T. phialatus* which only represented respectively 4 %, 5 %, 3 % and 1 % of the phytoseiids collected from citrus trees. These most abundant phytoseiid species could be helpful in biological pest management programs. Since these most important species are also present in weeds, it is important to know which weed plants are favorable to these phytoseiid species. Additional studies are required to determine the factors that affect the diversity but also the abundance of preys and predators.

ACKNOWLEDGEMENTS

We thank the direction and all the staff of CTA (Centre Technique des Agrumes) in Tunisia for their im-

portant help given during the surveys.

REFERENCES

- Al-Shemmary K. 2011 — Plant pollen as an alternative food source for rearing *Euseius scutalis* (Acari: Phytoseiidae) in Hail, Saudi Arabia — *J. Entomol.*, 8: 365-374. doi:10.3923/je.2011.365.374
- André HM. 1986 — Notes on the ecology of corticolous epiphyte dwellers. 4. Actinedida (especially Tydeidae) and Gamasida (especially Phytoseiidae) — *Acarologia*, 27: 107-115.
- Athias-Henriot C. 1957 — Phytoseiidae et Aceosejidae (Acarina, Gamasida) d'Algérie. I. Genres *Blattisocius* Keegan, *Iphiseius* Berlese, *Amblyseius* Berlese, *Phytoseius* Ribaga, *Phytoseiulus* Evans — *Bull. Soc. Hist. Nat. Afr. Nord*, 48: 319-352.
- Athias-Henriot C. 1958a — Contribution à la connaissance du genre *Typhlodromus* Scheuten. Description de deux espèces nouvelles d'Algérie et clé des espèces du groupe *finlandicus* — *Rev. Pathol. Vég. Entomol. Agric. Fr.*, 37: 179-186.
- Athias-Henriot C. 1958b — Phytoseiidae et Aceosejidae (Acarina, Gamasida) d'Algérie. II. Phytoseiidae: clé des genres, genres *Amblyseius* Berlese (suite) et *Seiulus* Berlese — *Bull. Soc. Hist. Nat. Afr. Nord*, 49: 23-43.
- Athias-Henriot C. 1960a. — Nouveaux *Amblyseius* d'Algérie — *Acarologia*, 2: 288-299.
- Athias-Henriot C. 1960b — Phytoseiidae et Aceosejidae d'Algérie. 4. Genre *Typhlodromus* Scheuten — *Bull. Soc. Hist. Nat. Afr. Nord*, 51: 62-107.
- Athias-Henriot C. 1961 — Mésostigmatés édaphiques méditerranéens — *Acarologia*, 3: 381-509.
- Athias-Henriot C. 1966 — Contribution à l'étude des *Amblyseius* paléarctiques (Acariens anactinotriches, Phytoseiidae) — *Bulletin Scientifique de Bourgogne*, 24: 181-230.
- Athias-Henriot C. 1977 — Nouvelles notes sur les *Amblyseius*. III. Sur le genre *Cydnodromus*: Redéfinition, composition (Parasitifomes, Phytoseiidae) — *Entomophaga*, 22: 61-73. doi:10.1007/BF02372991
- Berlese A. 1887 — Acari, Myriopoda and Scorpiones hucusque in Italia reperta. *Tipografia del Seminario — Padova*, Vol. VI, Fasc. 54: 7-9.
- Berlese A. 1889 — Acari, Myriopoda et Scorpiones hucusque in Italia reperta. *Tipografia del Seminario — Padova*, Vol. VI, Fasc. 54, No. 7, 8, 9.
- Berlese A. 1914 — Acari nuovi. Manipulus IX — *Redia*, 10: 113-150.
- Berlese A. 1921 — Acari, Myriopoda et Pseudoscorpiones hucusque in Italia reperta. I. Indice sinonimico dei generi e delle specie illustrate nei fascicoli 1 a 101 — *Redia*, 14: 77-105.

- Bonde J. 1989 — Biological studies including population growth parameters of the predatory mite *Amblyseius barkeri* (Acarina: Phytoseiidae) in the laboratory — Entomophaga, 34: 275-287.
- Canestrini G., Fanzago F. 1876 — Nuovi acari italiani (seconda serie) — Atti Accad. Sci. Veneto-Trentino-Istriana, 5: 130-154.
- Castagnoli M., Liguori M. 1986 — Tempi di sviluppo e ovideposizione di *Typhlodromus exhilaratus* Ragusa (Acarina: Phytoseiidae) allevato con vari tipi di cibo — Redia, 69: 361-368.
- Castagnoli M., Simoni S. 2003 — *Neoseiulus californicus* (McGregor) (Acarina: Phytoseiidae): survey of biological and behavioral traits of a versatile predator — Redia, 86: 153-164.
- Castagnoli M., Amato F., Monagheddu M. 1989 — Osservazioni biologiche e parametri demografici di *Eotetranychus carpini* (Oud.) (Acarina: Tetranychidae) e del suo predatore *Typhlodromus exhilaratus* Ragusa (Acarina: Phytoseiidae) in condizioni di laboratorio — Redia, 72: 545-557.
- Chant D.A. 1956 — Some mites of the sub-family Phytoseiinae (Acarina: Laelaptidae) from southeastern England, with descriptions of new species — Can. Entomol., 88: 26-37. doi:10.4039/Ent8826-1
- Chant D.A. 1957a — Descriptions of some phytoseiid mites (Acarina: Phytoseiidae). Part. I. Nine new species from British Columbia. Part. II. Redescriptions of eight species described by Berlese — Can. Entomol., 89: 289-308. doi:10.4039/Ent89289-7
- Chant D.A. 1957b — Note on the status of some genera in the family Phytoseiidae (Acarina) — Can. Entomol., 89: 528-532. doi:10.4039/Ent89528-11
- Chant D.A. 1959 — Phytoseiid mites (Acarina: Phytoseiidae). Part I. Bionomics of seven species in southeastern England. Part II. A taxonomic review of the family Phytoseiidae, with descriptions of 38 new species — Can. Entomol., 91 suppl. 12: 1-166. doi:10.4039/entm9112fv
- Chant D.A., McMurtry J.A. 2005 — A review of the Subfamily Amblyseiinae Muma (Acarina: Phytoseiidae): Part VI The tribe Euseiini n. tribe, subtribes Typhlodromalina n. subtribe, Euseiina n. subtribe, and Ricoseiina n. subtribe — Int. J. Acarol., 31: 187-224. doi:10.1080/01647950508684424
- Chant D.A., McMurtry J.A. 2007 — Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world (Acarina: Mesostigmata) — Indira Publishing House, Pub Michigan: pp. 220.
- Chant D.A., Yoshida-Shaul E. 1978 — Descriptions of three new species in the genera *Amblyseius* Berlese and *Typhlodromus* Scheuten (Acarina: Phytoseiidae) in Canada, with descriptions of males of nine other species and some new collection records — Can. Entomol., 110: 1059-1076. doi:10.4039/Ent1101059-10
- Chant D.A., Yoshida Shaul E. 1987 — A review of the *pyri* species group in the genus *Typhlodromus* Scheuten (Acarina: Phytoseiidae) — Can. J. Zool., 65: 1770-1804. doi:10.1139/z87-272
- Charlet L.D., McMurtry J.A. 1977 — Systematics and bionomics of predaceous and phytophagous mites associated with pine foliage in California — Hilgardia, 45: 173-236.
- Dale E.M., Donald L.C. 1986 — Evaluation of Two Biotypes of *Euseius scutalis* (Acarina: Phytoseiidae) as Predators of *Bemisia tabaci* (Homoptera: Aleyrodidae) — J. Econ. Entomol., 79: 659-663.
- De Leon D. 1957 — Three new *Typhlodromus* from southern Florida — Flo. Entomol. 40: 141-144.
- De Leon D. 1965 — A note on *Neoseiulus* Hughes 1948 and new synonymy (Acarina: Phytoseiidae) — Proc. Entomol. Soc. Wash., 67: 23.
- Denmark H.A. 1992 — A revision of the genus *Typhlodromus* Scheuten — Occasional Papers of the Florida State Collection of Arthropods, 7: 1-43
- Denmark H.A., Muma M.H. 1989 — A revision of the genus *Amblyseius* Berlese, 1914 (Acarina: Phytoseiidae) — Occasional Papers of the Florida State Collection of Arthropods, 4: 1-149.
- Denmark H. A., Welbourn W.C. 2002 — Revision of the genera *Amblydromella* Muma and *Anthoseius* De Leon (Acarina: Phytoseiidae) — Int. J. Acarol., 28: 291-316. doi:10.1080/01647950208684308
- Desgaard B., Hansen L.S. 1992 — Effect of *Amblyseius cucumeris* and *Amblyseius barkeri* as biological control agents of *Thrips tabaci* on glasshouse cucumbers — BioCont. Sci. Techn., 2: 215-223.
- Dosse G. 1958 — Über einige neue Raubmilbenarten — Pflanzenschutz Berichte, 21: 44-61.
- Dosse G. 1961 — Zur Klärung der Artenfrage von *Typhlodromus* (*Typhlodromus*) *pyri* Scheuten 1857 (= *T. tiliae* Oud. 1929) und *Typhlodromus* (*Typhlodromus*) *setubali* n. sp. (Acar., Phytoseiidae) — Z. Angew. Zool., 48: 313-323.
- Easterbrook M.A., Fitzgerald J.D., Solomon M.G. 2001 — Biological control of strawberry tarsonemid mite *Phytonemus pallidus* and two-spotted spider mite *Tetranychus urticae* on strawberry in the UK using species of *Neoseiulus* (*Amblyseius*) (Acarina: Phytoseiidae) — Exp. Appl. Acarol., 25: 25-36. doi:10.1023/A:1010685903130
- Ehara S. 1966 — A tentative catalogue of predatory mites of Phytoseiidae known from Asia, with descriptions of five new species from Japan — Mushi, 39: 9-30.


- Ehara S., Amano H. 1998 — A revision of the mites family Phytoseiidae in Japan (Acari: Gamasina), with remarks on its biology — *Species diversity*, 3: 25-73.
- Ehara S., Okada Y., Kato H. 1994 — Contribution to the knowledge of the mite family Phytoseiidae in Japan (Acari: Gamasina) — *J. Fac. Educ., Nat. Sci., Tottori Univ.*, 42: 119-160.
- Escudero L.A., Baldo-Gosalvez M., Ferragut F. 2005 — Predation by phytoseiid mites (Acari: Phytoseiidae) on spider mites from vegetable crops *Tetranychus urticae*, *T. turkestanii*, *T. ludeni* and *T. evansi* (Acari: Tetranychidae) — *Bol. San. Veg., Plagas*, 31: 377-383.
- Escudero L.A., Ferragut F. 2004 — Life-history of predatory mites *Neoseiulus californicus* and *Phytoseiulus persimilis* (Acari: Phytoseiidae) on four spider mite species as prey, with special reference to *Tetranychus evansi* (Acari: Tetranychidae) — *BioControl*, 32: 378-384.
- Evans G.O. 1952 — On a new predatory mite of economic importance — *Bull. Entomol. Res.*, 43: 397-401. doi:10.1017/S0007485300040566
- Evans G.O. 1987 — The status of three species of the Phytoseiidae (Acari) described by Carl Willmann — *J. Nat. Hist.*, 21: 1461-1467. doi:10.1080/00222938700770921
- Evans G.O., Edland T. 1998 — The genus *Anthoseius* De Leon (Acari: Mesostigmata) in Norway — *Fauna Norvegica, Ser. B.*, 45: 41-62.
- Fan Y., Pettitt F.L., 1994 — Biological control of broad mite, *Polyphagotarsonemus latus* (Banks), by *Neoseiulus barkeri* Hughes on pepper — *BioControl*, 4: 390-395.
- Faraji, F., Bakker F., Roig J. 2008 — A new species and two new records of Phytoseiidae (Acari: Mesostigmata) from Spain — *Rev. Iber. Aracnol.*, 16: 105-111.
- Ferragut F., Costa-Comelles J., Gomez Bernardo J., Garcia Mari F. 1985 — Contribucion al conocimiento de los acaros fitoseidos (Gamasida: Phytoseiidae) de los cultivos espanoles — *Actas II Congreso Iberico Entomol. Lisboa*, 223-231.
- Ferragut F., Costa-Comelles J., Garcia-Mari F. 1988 — Population dynamics of the phytoseiid *Euseius stipulatus* (Athias-Henriot) and its prey *Panonychus citri* (McGregor) (Acari: Phytoseiidae, Tetranychidae), in Spanish citrus — *Bol. San. Veg., Plagas*, 4: 45-54.
- Ferragut F., Garcia Mari F., Costa-Comelles J., Laborda R. 1987 — Influence of food and temperature on development and oviposition of *Euseius stipulatus* and *Typhlodromus phialatus* — *Exp. Appl. Acarol.*, 3: 317-330. doi:10.1007/BF01193168
- Ferragut F., Laborda R., Costa-Comelles J. 1992 — Feeding behaviour of *Euseius stipulatus* and *Typhlodromus phialatus* on the citrus red mite *Panonychus citri* (Acari: Phytoseiidae, Tetranychidae) — *Entomophaga*, 37: 537-543. doi:10.1007/BF02372323
- Ferragut F., Pérez Moreno I., Iraola V., Escudero A. 2009 — Acaros Depredadores de la familia Phytoseiidae en las plantas cultivadas — *Ediciones Agrotecnicas, S. L.*, pp. 202.
- Fraulo A.B., McSorley R., Liburd O.E. 2008 — Effect of the Biological Control Agent *Neoseiulus californicus* (Acari: Phytoseiidae) on Arthropod Community Structure in North Florida Strawberry Fields — *Fla. Entomol.*, 91: 436-445. doi:10.1653/0015-4040(2008)91[436:EOTBCA]2.0.CO;2
- Gomez-Moya C.A., Ferragut F. 2009 — Spatial distribution pattern and efficacy of *Neoseiulus californicus* and *Phytoseiulus persimilis* (Acari: Phytoseiidae) in the control of red spider mites on vegetables under semi-field conditions — *Bol. San. Veg., Plagas*, 35: 377-390.
- Greco N.M., Sanchez N.E., Liljestro M.G.G. 2005 — *Neoseiulus californicus* (Acari: Phytoseiidae) as a potential control agent of *Tetranychus urticae* (Acari: Tetranychidae): effect of pest/predator ratio on pest abundance on strawberry — *Exp. Appl. Acarol.* 37: 57-66. doi:10.1007/s10493-005-0067-7
- Gutierrez J. 1985 — Mounting techniques — *In: Helle W, Sabelis MW (eds) Spider mites, their biology, natural enemies and control* — Elsevier, vol 1A. Amsterdam, 351-353.
- Hansen L.S. 1988 — Control of *Thrips tabaci* (Thysanoptera: Thripidae) on glasshouse cucumber using large introductions of predatory mites *Amblyseius barkeri* (Acarina: Phytoseiidae) — *Entomophaga*, 33: 33-42. doi:10.1007/BF02372311
- Hirschmann W. 1962 — Gangsystematik der Parasitiformes. *Acarologie Schriftenreihe für Vergleichende Milbenkunde* — Hirschmann-Verlag, Furth/bay, 5(5-6): pp. 80.
- Hugues A.M. 1948 — The mites associated with stored food products — *Ministry of Agriculture and Fisheries, London, H. M. Stationary Office*, pp. 168.
- Hugues A.M. 1976 — The mites of stored food and houses (2nd edition) — *Tech. Bull. - Minist. Agric., Fish. Food*, 9: 1-400.
- Karg W. 1960 — Zur Kenntnis der Typhlodromiden (Acarina: Parasitiformes) aus Acker und Grünlandboden — *Z. Angew. Entomol.*, 47: 440-452. doi:10.1111/j.1439-0418.1960.tb02848.x
- Karg W. 1989 — Zur Kenntnis der Raubmilben der Typhlodromus pyri Gruppe (Acarina, Phytoseiidae) — *Dtsch. Entomol. Z.*, 36: 273-282. doi:10.1002/mmnd.19890360409
- Karg W. 1993 — Acari (Acarina), Milben, Parasitiformes (Anactinochaeta), Cohors Gamasina Leach, Raubmilben, *In: Teil G. Fisher (ed.), Die Tierwelt Deutschlands*, 59 (2nd ed.) — Jena, Stuttgart, New York, pp. 523.

- Kasap I., Ekerog E.S. 2004 — Life history of *Euseius scutalis* feeding on citrus red mite *Panonychus citri* at various temperatures — *BioControl*, 49: 645-654.
- Katayama H., Masui S., Tsuchiya M., Tatara A., Makoto D., Kaneko S., Saito T. 2006 — Density suppression of the citrus red mite *Panonychus citri* (Acari: Tetranychidae) due to the occurrence of *Neoseiulus californicus* (McGregor) (Acari: Phytoseiidae) on Satsuma mandarin — *Appl. Entomol. Zool.*, 41: 679-684. doi:10.1303/aez.2006.679
- Kennet C.E., Caltagirone L.E. 1968 — Biosystematics of *Phytoseiulus persimilis* Athias-Henriot (Acarina: Phytoseiidae) — *Acarologia*, 10: 563-577.
- Koch C.L. 1839 — Deutschlands Crustaceen, Myriapoden und Arachniden — Herrich-Schaeffer: Regensburg, v.5 and 6, fasc.25, t.22; fasc.27, t.6, 13.
- Kolodochka, L.A. 1980. New phytoseiid mites (Parasitiformes, Phytoseiidae) from Molodova — *Vestn. Zool.*, 4: 39-45.
- Kolodochka L.A., Sklyar V.E. 1981 — Phytoseiid mites (Phytoseiidae: Parasitiformes) from soil, litter and nests of rodents in the steppe and forest-steppe zones of Ukraine. *Problemy Pochvennoy Zoologii, Tezisy Dokladov VII Vsesoyuznogo Soveshchaniya* — *Dokl. Akad. Nauk Ukr. SSR*, 102-103.
- Kreiter S., Auger P., Lebdi Grissa K., Tixier M.-S., Chermiti B., Dali M. 2002 — Plant inhabiting mites (Acari: Prostigmata & Mesostigmata) of some Northern Tunisian crops — *Acarologia*, 42: 389-402.
- Kreiter S., Tixier M.-S., Auger P., Lebdi Grissa K. 2006 — Phytoseiid mites (Acari: Mesostigmata) of southern Tunisia — *Acarologia*, 46: 5-13.
- Kreiter S., Tixier M.-S., Ferragut F., Allam L., Lebdi Grissa K. 2004 — Preliminary observations on the diversity of phytoseiid mites in the Maghreb and comparisons to the fauna of Canaria — *Phytophaga*, 14: 477-484.
- Kreiter S., Tixier M.-S., Sahraoui H., Lebdi Grissa K., Ben Chaabane S., Chatti A., Chermiti B., Khoualdia O., Ksantini M. 2010 — Phytoseiid mites (Acari: Mesostigmata) from Tunisia: Catalogue, biogeography and key for identification — *Tun. J. Plant Prot.*, 5: 151-178.
- Lawson-Balagbo L. M., Gondim M. G. C., de Moraes G. J., Hanna R., Schausberger P. 2008 — Compatibility of *Neoseiulus paspalivorus* and *Proctolaelaps bickleyi*, candidate biocontrol agents of the coconut mite *Aceria guerrerensis*: spatial niche use and intraguild predation — *Exp. Appl. Acarol.*, 45: 1-13. doi:10.1007/s10493-008-9156-8
- Livshitz I.Z., Kuznetsov N.N. 1972 — Phytoseiid mites from Crimea (Parasitiformes: Phytoseiidae). *In: Pests and diseases of fruit and ornamental plants* — Proceedings of The All-Union V. I. Lenin Academy of Agricultural Science, TheState Nikita Botanical Gardens, Yalta, Ukraine, 61: 13-64.
- McGregor E.A. 1954 — Two new mites in the genus *Typhlodromus* (Acarina: Phytoseiidae) — *Bull. South. Calif. Acad. Sci.*, 3: 89-92.
- McMurtry J.A. 1969 — Biological Control of citrus Red Mite in California — *Proc. Int. Citrus Symp.*, 1st, 2: 855-862.
- McMurtry J.A. 1977 — Some predaceous mites (Phytoseiidae) on citrus in the Mediterranean region — *Entomophaga*, 22: 19-30.
- McMurtry J.A., Croft B.A. 1997 — Life-styles of phytoseiid mites and their roles in biological control — *Annu. Rev. Entomol.*, 42: 291-321. doi:10.1146/annurev.ento.42.1.291
- Messelink G. J., Van Steenpaal S. E. F., Ramakers P.M.J. 2005 — Evaluation of phytoseiid predators for control of western flower thrips on greenhouse cucumber — *BioControl*, 51: 753-768.
- Moraes G.J. de, McMurtry J.A., Denmark H.A. 1986 — A catalog of the mite family Phytoseiidae. References to Taxonomy, Synonymy, Distribution and Habitat — *Embrapa, Brasilia*, pp. 353.
- Moraes G.J. de, McMurtry J.A., Denmark H.A., Campos C.B. 2004 — A revised catalog of the mite family Phytoseiidae — *Zootaxa*, 434: 1-494.
- Moyano R. A., Pina T., Ferragut F., Urbaneja A. 2009 — Comparative life-history traits of three phytoseiid mites associated with *Tetranychus urticae* (Acari: Tetranychidae) colonies in clementine orchards in Eastern Spain: implications for biological control — *Exp. Appl. Acarol.*, 47: 121-132. doi:10.1007/s10493-008-9197-z
- Muma M.H. 1961 — Subfamilies, genera, and species of Phytoseiidae (Acarina: Mesostigmata) — *Fla. St. Mus. Bull.*, 5: 267-302.
- Muma M.H. 1962 — New Phytoseiidae (Acarina: Mesostigmata) from Florida — *Fla. Entomol.*, 45: 1-10. doi:10.2307/3492897
- Muma M.H. 1967 — New Phytoseiidae (Acarina: Mesostigmata) from southern Asia — *Fla. Entomol.*, 50: 267-280. doi:10.2307/3493156
- Muma M.H., Denmark H.A. 1971 — Phytoseiidae of Florida. *Arthropods of Florida and Neighbouring land Areas*, 6: 1-50.
- Nesbitt H.H.J. 1951 — A taxonomic study of the Phytoseiinae predaceous upon Tetranychidae of economic importance — *Zool. Verh.*, 12: 1-96.
- Nomikou M., Janssen A., Sabelis M. W. 2003 — Phytoseiid predator of whitefly feeds on plant tissue — *Exp. Appl. Acarol.*, 31: 27-36. doi:10.1023/B:APPA.0000005150.33813.04

- Nwilene F.E., Nachman G. 1996 — Functional responses of *Iphiseius degenerans* and *Neoseiulus teke* (Acari: Phytoseiidae) to changes in the density of the cassava green mite, *Mononychellus tanajoa* (Acari: Tetranychidae) — Exp. Appl. Acarol., 20: 259-271. doi:10.1007/BF00052876
- Oudemans A.C. 1930 — Acarologische Aanteekeningen — CII. Entomol. Ber. 8: 69-74.
- Papadoulis G., Emmanouel N.G. 1993 — New records of Phytoseiid mites from Greece, with a description of two new species of *Typhlodromus* Scheuten (Acarina: Phytoseiidae) — Int. J. Acarol., 19: 321-328. doi:10.1080/01647959308683986
- Papadoulis G., Emmanouel N.G. 1997 — New records of Phytoseiid mites from Greece, with a description of *Typhlodromus kimbasi* sp. nov. (Acarina: Phytoseiidae) — Acarologia, 37: 21-28.
- Papadoulis G., Emmanouel N.G., Kapaxidi E.V. 2009 — Phytoseiidae of Greece and Cyprus — Indira Publishing House, West Bloomfield, Michigan, USA: 24-171.
- Rambier A. 1972 — Les acariens dans le vignoble — Progr. Agric. Vitic., 16: 385-396.
- Pritchard A.E., Baker E.W. 1962 — Mites of the family Phytoseiidae from Central Africa, with remarks on genera of the world — Hilgardia, 33: 205-309.
- Ragusa S. 1977 — Notes on phytoseiid mites in Sicily with a description of a new species of *Typhlodromus* (Acarina: Mesostigmata) — Acarologia, 18: 379-392.
- Ragusa S. 1981 — Influence of different kinds of food substances on the development time in young stages of the predacious mite *Typhlodromus exhilaratus* Ragusa (Acarina: Phytoseiidae) — Redia, 64: 237-243.
- Ragusa S. 1979 — Laboratory studies on the food habits of the predacious mite *Typhlodromus exhilaratus*. In: Rodriguez JG (ed.) Recent advances in Acarology — Academic Press, pp. 485-490.
- Ragusa S., Swirski E. 1978 — Description of three new species of *Typhlodromus* Scheuten from Italy with redescription of *Typhlodromus baccetii* Lombardini (Acari: Phytoseiidae) — Int. J. Acarol., 4: 211-220. doi:10.1080/01647957808683118
- Rhodes E.M., Liburd O.E. 2005 — Predatory Mite, *Neoseiulus californicus* (McGregor) (Arachnida: Acari: Phytoseiidae) — University of Florida, publication EENY, 359: 01-04.
- Rivany T., Swirski E. 1980 — Four new species of Phytoseiid mites (Acarina: Mesostigmata) from Israel — Phytoparasitica, 8: 173-187.
- Rodriguez-Reina J.M., Garcia-Mari F., Ferragut F. 1992 — Predatory activity of phytoseiid mites on different developmental stages of the Western flower thrips *Frankliniella occidentalis* — Bol. San. Veg. Plagas, 18: 253-263.
- Schicha E. 1981 — A new species of *Amblyseius* from Australia compared with ten closely related species from Asia, America and Africa — Int. J. Acarol., 7: 203-216. doi:10.1080/01647958108683262
- Schuster R.O., Pritchard A.E. 1963 — Phytoseiid mites of California — Hilgardia, 34: 191-285.
- Schweizer J. 1922 — Beitrag zur kenntnis der terrestrischen Milbenfauna der Schweiz — Veröff. Natf. Ges. Basel, 33: 23-112.
- Schweizer J. 1949 — Die Landmilben des Schwizerischen Nationalparkes. I. Teil: Parasitiformes Reuter, 1909. Ergebnisse Wissenschaftlichen Untersuchungen in Schweizerischen Nationalpark — Liestal, Switzerland 2, pp. 99.
- Swirski E., Ragusa S. 1976 — Notes on predacious mites of Greece, with a description of five new species — Phytoparasitica, 4: 101-122.
- Takahashi F., Chant D.A. 1993 — Phylogenetic relationships in the genus *Phytoseiulus* Evans. I. Geographic distribution — Int. J. Acarol., 19: 15-22. doi:10.1080/01647959308683534
- Tixier M.-S., Kreiter S., Douin M., Moraes G.J. de. 2012 — Rates of description of Phytoseiidae mite species (Acari: Mesostigmata): space, time and body size variations — Biodivers. Conserv: On line first, doi:10.1007/s10531-012-0235-0
- Tuttle D.M., Muma M.H. 1973 — Phytoseiidae (Acarina: Mesostigmata) inhabiting agricultural and other plants in Arizona — Agric. Exp. Sta., Univ. Arizona Techn. Bull., 208: 1-55.
- Ueckermann E.A., Loots G.C. 1988 — The African species of the subgenera *Anthoseius* De Leon and *Amblyseius* Berlese (Acari: Phytoseiidae) — Entomol. Mem. Dep. Agric. Water Supply, Rep. South Afr., 73: 1-168.
- van Rijn P.C.J., Tanigoshi L.K. 1999 — Pollen as food for the predatory mites *Iphiseius degenerans* and *Neoseiulus cucumeris* (Acari: Phytoseiidae): dietary range and life history — Exp. Appl. Acarol., 23: 785-802. doi:10.1023/A:1006227704122
- Vantornhout I., Minnaert H., Tirry L., De Clercq P. 2004 — Effect of pollen, natural prey and factitious prey on the development of *Iphiseius degenerans* — BioControl, 49: 627-644.
- Vantornhout I., Minnaert H.L., Tirry L., De Clercq P. 2005 — Influence of diet on life table parameters of *Iphiseius degenerans* (Acari: Phytoseiidae) — Exp. Appl. Acarol., 35: 183-195. doi:10.1007/s10493-004-3940-x
- Wainstein B.A. 1958 — New species of mites of the genus *Typhlodromus* from Georgia — Soobshcheniya Akademii Nauk Gruzinskoy SSR, 21: 201-207.

- Wainstein B.A. 1962a — Some new predatory mites of the family Phytoseiidae (Parasitiformes) of the USSR fauna — *Entomol. Obozr.*, 41: 230-240.
- Wainstein B.A. 1962b — Révision du genre *Typhlodromus* Scheuten, 1857 et systématique de la famille des Phytoseiidae (Berlese 1916) (Acarina: Parasitiformes) — *Acarologia*, 4: 5-30.
- Wainstein B.A. 1973 — Predatory mites of the family Phytoseiidae (Parasitiformes) of the fauna of the Moldovan SSR, *In: Yaroshenko M.F. et al.* (eds.) *Fauna and Biology of Moldavian Insects* — Kishinev, Shtüntza. pp. 176-180.
- Wainstein B.A. 1975 — Predatory mites of the family Phytoseiidae (Parasitiformes) of Yaroslav province — *Entomol. Obozr.*, 54: 914-922.
- Wainstein B.A. 1977 — A contribution to the fauna of the family Phytoseiidae (Parasitiformes) in Australia — *Zool. Zh.*, 56: 1413-1416.
- Wainstein B.A., Shcherbak G.I. 1972 — Gamasid species of the genus *Amblyseius* Berlese, 1904 (Parasitiformes: Phytoseiidae) new for the Ukrainian fauna — *Vestn. Zool.*, 6: 35-44.
- Westerboer I., Bernhard F. 1963 — Die Familie Phytoseiidae Berlese 1916. *In: Stammer H.* (ed. from Kreiter et al., 2010). *Beitrage Zur Systematik und Okologie Mitteleuropaischer Acarina* — Band II, Mesostigmata I, Germany, 451-791.
- Yuqing J.P., Pettitt F.L. 1994 — Functional response of *Neoseiulus barkeri* Hughes on two-spotted spider mite (Acari: Tetranychidae) — *Exp. Appl. Acarol.*, 18: 521-613.

COPYRIGHT

 Sahraoui H. *et al.* *Acarologia* is under free license. This open-access article is distributed under the terms of the Creative Commons-BY-NC-ND which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original author and source are credited.