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

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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 fourty 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	
Euseius scutalis (Athias-Henriot)	Amblyseiinae	(Kreiter *et al.* 2010)
Euseius stipulatus (Athias-Henriot)	Amblyseiinae	(Kreiter *et al.* 2010)
Graminaseius graminis (Chant)	Amblyseiinae	(Kreiter *et al.* 2010)
Iphiseius degenerans (Berlese)	Amblyseiinae	(Kreiter *et al.* 2010)
Neoseiulus californicus (McGregor)	Amblyseiinae	(Kreiter *et al.* 2010)
Phytoseiulus persimilis (Athias-Henriot)	Amblyseiinae	(Kreiter *et al.* 2010)
Proprioseiopsis bordjelaini (Athias-Henriot)	Amblyseiinae	New records
Phytoseius finitimus (Ribaga)	Phytoseiinae	(Kreiter *et al.* 2010)
Paraseiulus talbii (Athias-Henriot)	Typhlodrominae	New records
Typhlodromus (*Anthoseius*) *foenilis* (Oudemans)	Typhlodrominae	(Kreiter *et al.* 2010)
Typhlodromus (*Anthoseius*) *pegazzani* (Ragusa and Swirski)	Typhlodrominae	New records
Typhlodromus (*Anthoseius*) *rhenanoides* (Athias-Henriot)	Typhlodrominae	(Kreiter *et al.* 2010)
Typhlodromus (*Anthoseius*) *rhenanus* (Oudemans)	Typhlodrominae	(Kreiter *et al.* 2010)
Typhlodromus (*Anthoseius*) *yasminae* (Faraji)	Typhlodrominae	New records
Typhlodromus (*Typhlodromus*) *ernesti* (Ragusa and Swirski)	Typhlodrominae	New records
Typhlodromus (*Typhlodromus*) *exhilaratus* (Ragusa)	Typhlodrominae	(Kreiter *et al.* 2010)
Typhlodromus (*Typhlodromus*) *phialatus* (Athias-Henriot)	Typhlodrominae	(Kreiter *et al.* 2010)
Typhlodromus (*Typhlodromus*) *setubali* (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 sampling, 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).

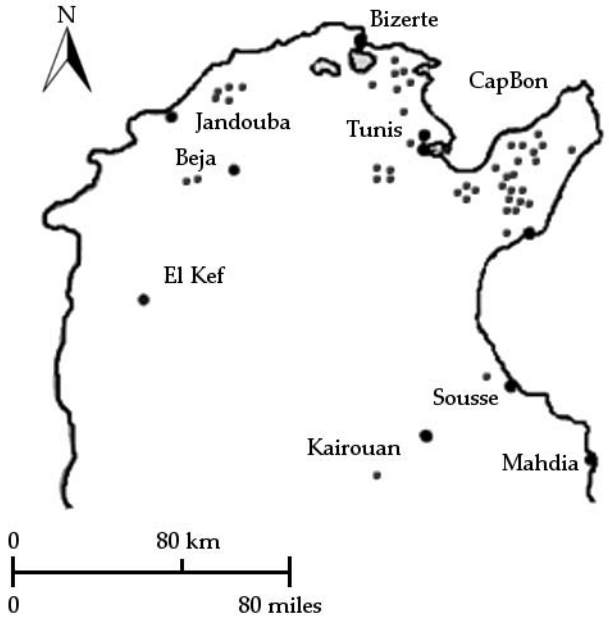

FIGURE 1: Geographical distribution of the sampled orchards in Tunisia.

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.

SPECIES OF PHYTOSEIIDAE MITES PRESENTLY OBSERVED IN CITRUS AGROSYSTEMS

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) Westerboer 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)
E. stipulatus	×	×	×	
E. scutalis		×		
N. californicus	×	×	×	
N. cucumeris		×		
N. longilaterus		×	×	
N. barkeri	×		×	
N. alpinus (*aurescens*)			×	×
N. paspalivorus		×		
N. bicaudus			×	
P. persimilis	×	×	×	
I. degenerans	×	×	×	
T. phialatus	×	×	×	×
T. exhilaterus	×	×	×	
T. pegazzani		×		
T. ernesti		×		
T. setubali		×		
P. talbii	×	×	×	
A. foenelis	×	×	×	
A. yasminae	×	×	×	
A. athenas		×	×	×
A. rhenanoides	×	×	×	
A. recki	×			
G. graminis			×	
P. bordjelaini			×	
A. meridionalis		×		
A. obtusus			×	

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 Fanzago 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*) *obtustus* (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. *Amblyseius* (*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 ejbal (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) Prichard 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, Hawaï, 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 Khiar (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 Petitt, 1994). Fan and Petitt (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, Taïwan, 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, Junuary, 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. dactilifera.*

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; Messelink *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, Kasakhstan, 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 Caltagiorne 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 Typhlodrominae

16. 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, Fubruary 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*. Boussalem (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 . . . . . Amblyseiinae: 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 cuticule (rarely on the shield) . . . . . Typhlodominae: 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 whith 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 suequal ..... *Graminaseius graminis*
20′ (19). Spermateca with atrium not bifurcate/vacuolated at the juncture with major duct ..... .*Amblyseius*: 21

21 (20′). Fixed digit of chelicerae with more than 7 teeth, spermatheca short cup-shaped with long tubular calyx having annulated stalk. .... *Amblyseius obtusus*
21′ (20′). Fixed digit of chelicerae with less than 5 teeth, movable digit without tooth, spermatheca with saccular cervix and c-shaped atrium. .... *Amblyseius 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*: 23
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* (*Anthoseius*): 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* (*Anthoseius*) *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* (*Anthoseius*) *kazachstanicus*

30 (29). Movable digit of chelicerae with 2 teeth, spermatheca with cylindrical calyx, ventrianal shield pentagonal in outline and with inconspicuous ornamentation. .... *Typhlodromus* (*Anthoseius*) *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* (*Anthoseius*) *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* (*Anthoseius*) *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 blint 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*

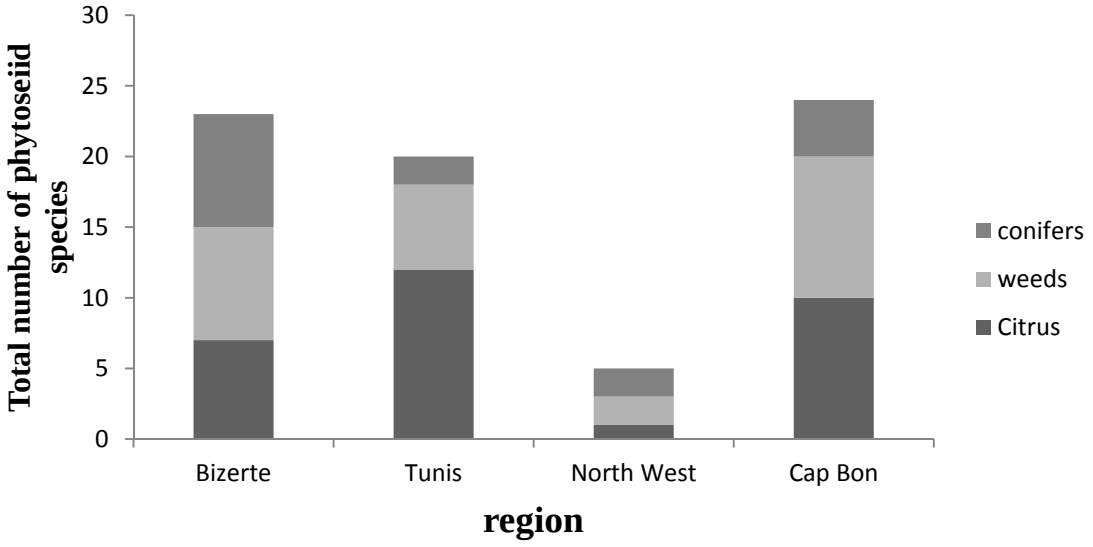

FIGURE 2: Number of species collected by region on citrus trees, weeds and conifers.

(*Typhlodromus*) *setubali*, *Typhlodromus* (*Typhlodromus*) *ernesti*, *Typhlodromus* (*Anthoseius*) *pegazzani*, *Typhlodromus* (*Anthoseius*) *yasminae*, *Proprioseiopsis bordjelaini* 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 abondant 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 helplful 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.

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