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Phytoseiid mites (Acari: Mesostigmata) from Central West Morocco: new records and key to females of all recorded Moroccan species

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Original research

ABSTRACT

Several phytoseiid species are excellent biological control agents for suppressing mite pest populations in many crops and preventing yield losses. This paper aims to improve the knowledge of Phytoseiidae diversity in citrus orchards and argan forest in central western Morocco. The surveys were conducted between April and October during three successive years (2017–2019), in nine conventional citrus orchards covering an area of more than 3,000 hectares and on uncultivated plants in argan forest at an altitude ranging from 150 to 700 meters. Twenty-nine species belonging to 15 genera were found, seven of them being new for the Moroccan fauna: *Amblyseius largoensis*, *A. swirskii*, *Amblyseiella setosa*, *Euseius batus*, *E. dossei*, *Paragigagnathus molestus*, and *Cydnoseius negevi*. Species of nine genera were found on citrus leaves: *Neoseiulus*, *Amblyseius*, *Amblyseiella*, *Transeius*, *Phytoseiulus*, *Euseius*, *Phytoseius*, *Typhlodromus*, and *Paraseiulus*. Stah AlMadina (24.8%), Ouled Abdellah (15.9%), Nour (14.3%) domains contained a high number (more than 60.2%) of individuals in the collected samples. *Malva parviflora*, *Convolvulus althaeoides*, *Solanum nigrum*, *Bryonia dioica*, *Withania somnifera* would be interesting companion plants to be associated in the inter-rows in citrus orchards in this region to ensure sustainability, because they host high densities and diversities of Phytoseiidae. A key of females of all recorded Moroccan species until now is provided.

Keywords argan forest; weed plants; citrus agrosystems; integrated management; key of females

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Introduction

In Morocco, citrus sector development remains confronted to several constraints such as phytosanitary problems associated to damage caused by pests (both indigenous and exotic) (Benziane *et al.* 2003; Mazih 2008; Lamharchi *et al.* 2020a). The main pests in citrus orchards in Morocco and in Mediterranean countries are the Mediterranean fruit fly [*Ceratitis capitata* (Wiedemann), Tephritidae], scale insects including the California red scale [*Aonidiella aurantii* Maskell, Diaspididae] and the citrus leaf miner [*Phyllocnistis citrella* Stainton, Gracillariidae] (Abbassi 1990; Mazih 2008, 2015; Lamharchi *et al.* 2016). To control these pests, producers use large amount of pesticides. As well as phytophagous mites (Tetranychidae, Tenuipalpidae, Tarsonemidae, and Eriophyidae) have started to appear althougth they were considered secondary pests for 20 years (Saba 1978; Kreiter *et al.* 2002; Grissa and Khoufi 2012; Sahraoui

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et al. 2012). To limit pesticide used for controlling these mites, biological control with predators of phytophagous species such as phytoseiid mites, is an innovative alternative.

Phytoseiid mites (Acari: Mesostigmata) have been extensively studied for their potential as biological control agents of phytophagous mites in several countries (McMurtry and Croft 1997; Swirski *et al.* 1998; Tixier *et al.* 2008; Kreiter *et al.* 2010; McMurtry *et al.* 2013). Some species are of great importance for Integrated Pest Management (IPM) programs in Mediterranean orchards (Kasap and Sekeroglu 2004; Tixier *et al.* 2009; McMurtry *et al.* 2013).

The Phytoseiidae family accounts for more 2,557 species (Demite *et al.* 2014, 2023). However, the fauna of some countries such as Morocco has not been completely surveyed (Tixier *et al.* 2008). Until now, about 50 species are reported from Morocco (McMurtry and Bounfour 1989; Kreiter *et al.* 2007; Tixier *et al.* 2016). Knowledge regarding the mite fauna, especially in citrus orchards of central west Morocco, is of considerable importance to establish effective programs for the biological control of pests. The aim of this study is to evaluate the phytoseiid species associated to plants both in citrus orchards, and on uncultivated plants in the argan forest in central western of Morocco, sampled at different seasons.

Material and methods

A survey of phytoseiid diversity was carried out in different citrus orchards in Taroudant region between April and October for two consecutive years 2016–2017 and 2017–2018. Orchard's names and geographic location are shown Table 1. All are conventionally conducted. Some pesticides were applied to control several pests and diseases (sulphur, abamectin, spirodiclofen, fenpropathrin, propargite, benzoxamate, clofentezine, tetradifon, phosmet, malathion, benomyl, deltamethrin, spirotetramat…). Herbicides (glyphosate, oxyfluorfen) were also applied from spring until autumn, and ground was ploughed several times. Additional sampling was undertaken on uncultivated plants in April 2019 between Agadir and Imouzzar Ida or Tanane, area of the argan Forest (Table 1).

Plants (citrus leaves, weeds, and windbreaks) were collected in all orchards in two seasons (spring and autumn). Each sample contains: 150 leaves of citrus varieties/ plot/ date/ year; the aerial part of 50 plants of weeds/ plot/ date/ year and 50 branches of windbreaks/ plot/ date/ year. Mites were collected using the dipping-checking-washing-filtering of leaves method (Boller 1984; Tixier *et al.* 2016). The collected individuals were preserved in 70% ethanol.

Mites were also collected from uncultivated plants in the area of the argan forest between Agadir city and Imouzzar Ida ou Tanane. This additional sampling was carried out as follows: branches of each plant (perennial woody plant: tree or shrub), at a level between 1 m and 1.5 m, were subjected to between 10 to 15 light taps with a stick during five to ten minutes/ plant. Among the individuals fallen on a black background, only the specimens considered to be phytoseiids were isolated, collected with a fine brush imbibed with alcohol. The collected individuals were kept in ethanol for identification. All phytoseiid mites were counted and were mounted on slides using Hoyer's medium (Gutierrez 1985; André 1986). Slides were then dried in an oven at 47 °C for four days for thinning. Once dried, slides were sealed for conservation. Identifications were carried out with a phase and interference contrast microscope (Leica DM LB 2 phase contrast microscope, 10 x 25 HC Plan, Fluotar 100) (400x magnification). The generic classification of Chant and McMurtry (2007) was used for identification. Other more specific literature was used for species determination (Swirski *et al.* 1998; Kreiter *et al.* 2007, 2016a; Papadoulis *et al.* 2009; Ferragut *et al.* 2010; Tixier *et al.* 2013, 2016).

Results

A total of 248 individuals of phytoseiid mites were identified from citrus leaves, weeds, and associated windbreaks (*Cupressus*, other conifers, *Acacia*) in nine orchards in Taroudant region and in the argan forest in central west of Morocco (Table 1). Twenty-two species found were

Table 1 Phytoseiidae species presently observed and their geographical distribution in the sampled citrus orchards and uncultivated plants in the argan forest (the species underlined are new for the Moroccan fauna).

Locality	Latitude N	Longitude W	Genus, Species	Host plant	Family	Stage and number
Ouled Abdellah (Taroudant)	30°33'03.1"	8°39'51.2"	***Amblyseius andersoni***	*Malva parviflora*	Malvaceae	6♀♀ ; 2 ♂♂
			A. largoensis	*Cupressus* spp.	Cupressaceae	3♀♀
			Euseius stipulatus	*Bryonia dioica*	Cucurbitaceae	6♀♀, 2 ♂♂
			E. scutalis	*Solanum nigrum*	Solanaceae	4♀♀
			E. dossei	*Malva parviflora*	Malvaceae	8♀♀
			Paraseiulus talbii	*Citrus* spp.	Rutaceae	3♀♀ and 1♂
				Acacia spp.	Fabaceae	2♀♀
Stah Al Madina (Taroudant)	30°46'76.1"	8°87'69.5"	***Amblyseius andersoni***	*Citrus* spp.	Rutaceae	3♀♀ ; 1♂
			A. swirskii	*Citrus* spp.	Rutaceae	2♀♀
			A. italicus	*Citrus* spp.	Rutaceae	1♀
			Neoseiulus californicus	*Convolvulus althaeoides*	Convolvulaceae	8♀♀ ; 3♂♂
				Citrus spp.	Rutaceae	4♀♀
			N. longilaterus	*Convolvulus arvensis*	Convolvulaceae	2♀♀
			Phytoseiulus persimilis	*Citrus* spp.	Rutaceae	2♀♀
				Malva parviflora	Malvaceae	4♀♀ and 2♂♂
				C . althaeoides	Convolvulaceae	3♀♀
			Paraseiulus triporus	*Citrus* spp.	Rutaceae	5♀♀
			Cydnoseius negevi	*Withania somnifera*	Solanaceae	14♀♀, 2♂♂
Saouda (Ouled Teima)	30°43'92.0"	9°10'21.7"	***A. swirskii***	*Solanum nigrum*	Solanaceae	5♀♀
			Euseius stipulatus	*Citrus* spp.	Rutaceae	1♀, 1 ♂
			P. persimilis	*C. altaheoides*	Convolvulaceae	4♀♀
			Neoseiulella litoralis	*Withania somnifera*	Solanaceae	2♀♀
			Typhloseiulus eleonorae	*Citrus* spp.	Rutaceae	5♀♀
Nour (Ouled Teima)	30°49'60.1"	9°00'87.8"	***A. italicus***	*Cupressus* spp.	Cupressaceae	3♀♀
			Transeius audeae	*Citrus* spp.,	Rutaceae	2♀♀
				Withania somnifera	Solanaceae	5♀♀
			Paragigagnathus tamaricis	*Citrus* spp.	Rutaceae	7♀♀ and 1♂
			Euseius batus	*Malva* spp.	Malvaceae	4♀♀ ; 3♀♀
			Paraseiulus triporus	*Citrus* spp.	Rutaceae	4♀♀
			Typhlodromus (T.) setubali	*Citrus* spp.	Rutaceae	4♀♀
Chabaika	30°36'12.4"	8°27'07.7"	***Graminaseius graminis***	*Malva parviflora*	Malvaceae	3♀♀ ; 2♀♀
			Neoseiulus umbraticus	*C. althaeoides*	Convolvulaceae	2♀♀
				Solanum nigrum	Solanaceae	1♀ and 1♂
			P. persimilis	*C. althaeoides*	Convolvulaceae	4♀♀
Errahim	30°28'23.6"	8°57'23.2"	***Amblyseiella setosa***	*C. althaeoides*	Convolvulaceae	2♀♀
				C. arvensis	Convolvulaceae	1♀♀
			Iphiseius degenerans	*Cupressus* spp.	Cupressaceae	3♀♀
			Cydnoseius negevi	*Withania somnifera*	Solanaceae	7♀♀
Taoufiqui 1	30°40'31.1"	8°27'31.1"	***N. alpinus***	*Solanum nigrum*	Solanaceae	2♀♀
				S. nigrum	Solanaceae	1♀ ; 2♀♀
			N. cucumeris	*Citrus* spp.	Rutaceae	3♀♀
			I. degenerans	*Cupressus* spp.	Cupressaceae	2♀♀
			P. persimilis	*C. althaeoides*	Convolvulaceae	4♀♀ and 1♂
			Phytoseius finitimus	*Citrus* spp.	Rutaceae	6♀♀
			P. triporus	*Malva parviflora*	Malvaceae	3♀♀
			Typhloseiulus eleonorae	*Citrus* spp.	Rutaceae	3♀♀
Taoufiqui 2	30°38'59.2"	8°24'23.6"	***I. degenerans***	*Cupressus* spp.	Cupressaceae	1♀
			Typhlodromus (T.) octogenipilus	*Citrus* spp.	Rutaceae	4♀♀ ; 5♀♀
Taoufiqui 3	30°39'21.0"	8°25'30.8"	-	-	-	-
Bottom of Aourir river (argan forest)	30°30'29,7''	9°34'47,2''	***Paragigagnathus molestus***	*Ricinus communis*	Euphorbiaceae	3 ♀♀ + 1 im
Road to Alma village	30°28'57,7''	9°33'59,7''	***Typhlodromus (T.) setubali***	*Rhamnus* spp.	Rhamnaceae	2 ♀♀
	30°30'24,0''	9°34'06,6''		*Zyziphus lotus*	Rhamnaceae	2 ♀♀
Road to Aksri village	30°33'17,8''	9°33'22,1''	***Euseius scutalis***	*Ceratonia siliqua*	Fabaceae	2 ♀♀
	30°34'55,8''	9°29'19,4''		*C. siliqua*	Fabaceae	6 ♀♀, 2 ♂♂, 1 im.
	30°33'53,6''	9°31'08,3''	***Typhlodromus (A.) rhenanoides***	*Tamarix aphylla*	Tamaricaceae	6 ♀♀, 2 ♂, 4 im.
	30°33'53,6''	9°31'08,3''		*Ficus carica*	Moraceae	1 ♀ + 1 ♂ + 1 im.
Road to Imouzzar Ida ou Tanane	30°36'30,7''	9°29'23,8''	***Euseius scutalis***	*Ceratonia siliqua*	Fabaceae	1♀, 3 ♂♂, 3 im.

already reported and seven species are new for the Moroccan fauna. The list of these species is presented below, with some biological information and uses in biological control when available. Geographical distributions information is issued from Demite *et al.* (2023).

A key of all recorded Moroccan species is given after.

Taxonomy

Subfamily Amblyseiinae

Amblyseiinae Muma 1961: 273.

Tribe Neoseiulini Chant & McMurtry

Neoseiulini Chant & McMurtry 2003a: 6.

Genus *Neoseiulus* Hughes

Neoseiulus Hughes 1948: 141.

Neoseiulus alpinus (Schweizer)

Amblyseius obtusus var. alpinus Schweizer 1922: 41.
Amblyseius alpinus Schweizer 1949: 79.
Typhlodromus (*Amblyseius*) *alpinus*, Chant 1959: 105.
Typhlodromus (*Typhlodromus*) *alpinus*, Westerboer & Bernhard 1963: 651.
Typhlodromips alpinus, Moraes *et al.* 1986: 136.
Amblyseius (*Neoseiulus*) *alpinus*, Karg 1993: 189.
Neoseiulus alpinus, Evans 1987: 1461; Moraes *et al.* 2004a: 100; Chant & McMurtry 2003: 37, 2007: 25.
Neoseiulus polonicus (Willmann 1949): 117 (Synonymy according to Evans 1987).
Neoseiulus aurescens (Athias-Henriot 1961): 441 (Synonymy according to Evans 1987).
Neoseiulus polyporus Wainstein 1962: 143 (Synonymy according to Evans 1987).

World distribution — Algeria, Austria, Australia, Belgium, Chile, Cuba, Czech Republic, England, Finland, France, Georgia, Germany, Greece, Hawaii, Hungary, Italy, Jordan, Latvia, Morocco, Norway, Portugal, Poland, Russia, Slovakia, Spain, Switzerland, Tunisia, Turkey, Ukraine, and USA (Arizona, California, and Washington).

Previous records from Morocco — This species has been reported for the first time by Tixier *et al.* (2016), one specimen was collected on *Echium vulgare* L. (Boraginaceae) in Larache Beach.

Specimens examined — 2 ♀♀ on *Solanum nigrum* L. (Solanaceae) in July 25, 2018 at Taoufiqui 1 domain; 1 ♀ and 2 ♀♀ on the same previous host plant respectively in September 2017 and 2018.

Remarks — Measurements and description of the adult females agree with those provided by Athias-Henriot (1961) and Chant and McMurtry (2003a). This species is considered a synonym of *Neoseiulus aurescens* (Athias-Henriot) in Chant and McMurtry (2003a). It is essentially recorded from Europe and it is observed rarely in crops, sometimes in vineyards and apple orchards (Kreiter *et al.* 2000; Tixier *et al.* 2013).

Neoseiulus californicus (McGregor)

Typhlodromus californicus McGregor, 1954: 89.
Amblyseius californicus, Schuster & Pritchard 1963: 271.
Cydnodromus californicus, Athias-Henriot 1977: 64.

Amblyseius (*Amblyseius*) *californicus*, Ueckermann & Loots 1988: 150; Ehara *et al.* 1994: 126.
Amblyseius (*Neoseiulus*) *californicus*, Ehara & Amano 1998: 33.
Neoseiulus californicus, Moraes *et al.* 1986: 73, 2004a: 109; Chant & McMurtry 2003a: 21, 2007: 25; Guanilo *et al.* 2008a: 27, 2008b: 19; *sensu* Athias-Henriot 1977, Beaulieu & Beard 2018: 469.
Typhlodromus mungeri McGregor, 1954: 92 (Synonymy according to Chant & McMurtry, 2003a).
Typhlodromus chilenensis Dosse, 1958: 55 (Synonymy according to Chant & McMurtry, 2003a).
Amblyseius wearnei Schicha 1987: 103 (Synonymy according to Tixier *et al.* 2014).

World distribution — Algeria, Argentina, Azores, Brazil, Canada, Canary Islands, Chile, Colombia, Cuba, Cyprus, France, Greece, Guadeloupe, Guatemala, Italy, Japan, Mexico, Morocco, Peru, Portugal, Reunion Island, Senegal, Serbia, Slovenia, South Africa, South Korea, Spain, Syria, Taïwan, Tunisia, Turkey, Uruguay, USA, Venezuela, and Vietnam.

Previous records from Morocco — This species has been reported from the Moroccan fauna by Kreiter *et al.* (2007). Several specimens were collected on many plants belonging to the families Malvaceae (*Hibiscus rosa-sinensis* L.), Rhamnaceae (*Ziziphus lotus* L. (Lam)), Anacardiaceae (*Pistacia lentiscus* L.) and Asteraceae (*Calendula arvensis* (M.) Bieb) and Convolvulaceae (*Convolvulus althaeoides* L.) (Tixier *et al.* 2016).

Specimens examined — 8 ♀♀ + 3 ♂♂ on *Convolvulus althaeoides* L. (Convolvulaceae) in May 2017 and in July 2017; 4 ♀♀ on citrus leaves at Stah Al Madina orchard in 2018.

Remarks — Measurements and description of the adult females collected agree with those provided by Tixier *et al.* (2008) for specimens collected worldwide, by Ferragut *et al.* (2010) for specimens from Spain and by Kreiter *et al.* (2020b) for specimens from La Réunion and various regions in the world. This is a very widespread species (Demite *et al.* 2023), reported as generalist predatory mite (Castagnoli and Simoni 2003). It can feed on Tetranychidae (Ferragut *et al.* 2010; Gomez-Moya and Ferragut 2009), tarsonemid mites (Easterbrook *et al.* 2001), or small insects (Rodriguez-Reina *et al.* 1992; Fraulo *et al.* 2008) and even pollen when the primary prey is unavailable (Rhodes and Liburd 2005). Akchour *et al.* (2016, 2021) reported that *N. californicus* is considered as a potential agent to control *Eutetranychus orientalis* (Klein) in citrus orchards in Souss region in central western of Morocco.

Neoseiulus cucumeris (Oudemans)

Typhlodromus cucumeris Oudemans 1930: 69.
Amblyseius cucumeris, Athias-Henriot 1957a 336.
Amblyseius (*Typhlodromopsis*) *cucumeris*, De Leon 1959a.
Typhlodromus (*Amblyseius) cucumeris*, Chant 1959: 78.
Amblyseius (*Amblyseius*) *cucumeris*, Wainstein 1962.
Typhlodromus (*Typhlodromus*) *cucumeris*, Westerboer & Bernhard 1963.
Amblyseius (*Neoseiulus*) *cucumeris*, De Leon 1965: 23.
Neoseiulus cucumeris, Moraes *et al.* 1986: 76, 2004a: 115; Chant & McMurtry 2003: 21, 2007: 25.
Neoseiulus thripsi (McGill 1939): 310 (Synonymy according to Chant 1959).
Neoseiulus bellinus (Womersley 1954): 177 (Synonymy according to Athias-Henriot 1960a).

World distribution — Algeria, Armenia, Australia, Austria, Azerbaijan, Azores, Belarus, Belgium, Canada, Canary Islands, Caucasus Region, Chile, Cyprus, Egypt, England, Finland, France, Georgia, Germany, Greece, Hungary, India, Iran, Israel, Italy, Latvia, Mexico, Moldova, Morocco, Netherlands, New Zealand, Norway, Poland, Portugal, Russia, Saudi Arabia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Tunisia, Turkey, Ukraine, and USA.

Previous records from Morocco — This species has been reported in Morocco by McMurtry and Bounfour (1989). In addition, some females were collected on *Juncus articulatus*

L. (Juncaceae) at Larache, on *Lavandula dentata* L. (Lamiaceae) at Gorges of Zegzel (Tixier *et al.* 2016).

Specimens examined — 3 ♀♀ collected at Taoufiqui 1 domain on citrus leaves in June 2018.

Remarks — Measurements and description of the adult females collected agree with those provided by Beard (1999) and Schicha (1976) for specimens from Australia. This species is commercialised and used in greenhouses to control phytophagous mites and thrips (Messelink *et al.* 2006). It seems able to control *Tetranychus urticae* Kock and *Phytonemus pallidus* (Banks) in field-grown strawberry (Fitzgerald *et al.* 2008). It was also known to feed on tarsonemid mites (Tuovinen and Lindquist 2010), eggs of *Bemisia tabaci* (Gennadius) on vegetables (cucumber, sweet pepper, tomato) in laboratory conditions as reported by Kim *et al.* (2008).

Neoseiulus longilaterus (Athias-Henriot)

Typhlodromus longilaterus Athias-Henriot, 1957b: 218.
Typhlodromus (*Amblyseius*) *longilaterus*, Chant 1959: 79.
Cydnodromus longilaterus, Muma 1961: 290.
Amblyseius (*Amblyseius*) *longilaterus*, Ueckermann & Loots 1988: 128.
Amblyseius longilaterus, Swirski & Amitai 1997a: 14.
Neoseiulus longilaterus, Moraes *et al.* 1986: 85, 2004a: 128; Chant & McMurtry 2003: 23, 2007: 29.

World distribution — Algeria, Israel, Morocco, and Tunisia.

Previous records from Morocco — This species has been reported for the first time in Morocco on *Echium vulgare* (L.) (Boraginaceae) at Larache Beach (Tixier *et al.* 2016).

Specimens examined — 2 ♀♀ collected in June 2018 at Stah Al Madina on *Convolvulus arvensis* M. (Bieb) (Convolvulaceae).

Remarks — Measurements and description of the adult females collected agree with those provided by Evans (1987). Tsolakis *et al.* (2013) showed the ability of this species to feed on *T. urticae*, *Panonychus citri* (McGregor), *P. ulmi* (Koch). This species is only known from the Mediterranean basin and has been observed on *Convolvulus* spp. (Convolvulaceae) and on *Cynodon dactylon* (L.) (Poaceae) (Sahraoui *et al.* 2012). In addition, as reported by Tsolakis *et al.* (2019), *N. longilaterus* have similar traits with some phytoseiid species belonging to type II selective predators, but also with some others included within type III generalist predators. As a matter of fact, it can be considered an interesting biocontrol agent towards *T. urticae*, able also to develop on alternative foods as the pollen of *Oxalis* spp. L. (Oxalidaceae).

Neoseiulus umbraticus (Chant)

Typhlodromus umbraticus Chant, 1956: 26.
Typhlodromus (*Typhlodromus*) *umbraticus*, Beglyarov 1958: 107.
Amblyseius umbraticus, Athias-Henriot 1959: 138.
Typhlodromus (*Amblyseius*) *umbraticus*, Chant 1959: 75.
Amblyseius (*Typhlodromopsis*) *umbraticus*, Muma 1961: 287.
Amblyseius (*Amblyseius*) *umbraticus*, Wainstein & Vartapetov 1973: 103.
Amblyseius (*Neoseiulus*) *umbraticus*, Karg 1991: 23.
Neoseiulus umbraticus, Moraes *et al.* 1986: 99, 2004a: 149; Chant & McMurtry 2003a: 23, 2007: 31.

World distribution — Armenia, Azerbaijan, Azores, Belarus, Caucasus region, Denmark, England, France, Georgia, Germany, Hungary, Iran, Italy, Jamaica, Latvia, Madeira Island, Mexico, Moldova, Montenegro, Morocco, Norway, Poland, Russia, Slovakia, Slovenia, Spain, Switzerland, Turkey, Ukraine, and USA.

Previous records from Morocco — The first report of this species in Morocco has been published by Tixier *et al.* (2016). It was collected on many plants such as *Echium* spp. L. (Boraginaceae), *Mentha pulegium* L. (Lamiaceae), *Dittrichia viscosa* L. Greuter, (Asteraceae), *Juncus articulatus* L. (Juncaceae), and *Lavandula dentata* L. (Lamiaceae).

Specimens examined — 2 ♀♀ on *Convolvulus althaeoides* L. (Convolvulaceae) in July 2017; 1 ♀ and 1 ♂ on *Solanum nigrum* L. (Solanaceae) collected at Chbaika domain in July 2017.

Remarks — Measurements and description of adult females collected in this survey agree with those provided by Ferragut *et al.* (2010) for specimens from Spain and by Tixier *et al.* (2016) for specimens from Morocco. Few studies exist on its biology; it has the ability to develop feeding on *T. urticae* (Kazak *et al.* 2002) and on *Thrips tabaci* Lindeman on leek (*Allium porrum* L.) (Alliaceae) in laboratory conditions (Sengonca and Dresher 2001).

Genus *Paragigagnathus* Amitai & Grinberg

Paragigagnathus Amitai & Grinberg 1971: 327; Karg 1983: 300; Kolodochka 1994: 3; Chant & McMurtry 2003: 39.

Paragigagnathus molestus (Kolodochka)

Pamiroseius molestus Kolodochka 1989: 228;
Paragigagnathus molestus, Moraes *et al.* 1986: 103, 2004a: 159; Chant & McMurtry 2003: 44, 2007: 33.

World distribution — Iran and Turkmenistan.

Specimens examined — 3 ♀♀ + 1 im. associated with tetranychid mites on *Ricinus communis* L. (Euphorbiaceae), specimens collected in April 2019, at the Bottom of Aourir river, between Alma and Aourir villages, Agadir Ida Outanan Province, in the argan forest. This is the first record of this species in Morocco.

Remarks — The description and measurements of the adult females collected agree with those provided by Hajizadeh *et al.* (2010) for specimens from Iran. The type specimens were collected from *Tamarix* spp. L. (Tamaricaceae) in Turkmenistan, Kalinin (Kolodochka 1989), and additional reports from Iran were observed on *Tamarix* spp. (Hajizadeh *et al.* 2010).

Paragigagnathus tamaricis Amitai & Grinberg

Paragigagnathus tamaricis Amitai & Grinberg 1971: 327; Moraes *et al.* 2004a: 159; Chant & McMurtry 2003: 44, 2007: 33.
Paragigagnathus tawfiki (Yousef 1974): 381 (Synonymy according to Chant & McMurtry 2003).

World distribution — Egypt, Iran, Israel, Italy, Jordan, Morocco, Saudi Arabia, and Tunisia.

Previous records from Morocco — This species is reported for the first time by Tixier *et al.* (2016) for Morocco and the Maghreb region. It was collected in the Oasis of Zagora on *Tetraclinis articulata* (Vahl) Mast. (Cupressaceae), at the Damon Oum Er Bia River on *Tamarix africana* Poir. (Tamaricaceae), in the Gorges of Zegzel on *Tamarix communis* L. (Tamaricaceae) (Tixier *et al.* 2016). These authors suggest a narrow relationship between this species and plants of *Tamarix* genus.

Specimens examined — 7 ♀♀ and 1 ♂ on citrus leaves in July 2017, at Nour domain.

Remarks — The description and measurements of the adult females collected agree with those provided by Hajizadeh *et al.* (2010) for specimens from Iran.

Tribe Phytoseiulini Chant & McMurtry

Phytoseiulini Chant &McMurtry 2006: 17.

Genus *Phytoseiulus* Evans

Phytoseiulus Evans 1952: 397.

Phytoseiulus persimilis Athias-Henriot

Phytoseiulus persimilis Athias-Henriot 1957a: 347.
Typhlodromus persimilis, Hirschmann 1962: 75.
Phytoseiulus (*Phytoseiulus*) *persimilis*, Wainstein 1962: 17.
Phytoseiulus persimilis, Chant 1959: 109; Moraes *et al.* 1986: 109, 2004a: 169; Chant & McMurtry 2006: 20, 2007: 53.
Phytoseiulus riegeli Dosse, 1958: 48 (Synonymy according to Kennett & Caltagirone 1968).
Phytoseiulus tardi Lombardini, 1959: 166 (Synonymy according to Kennett & Caltagirone 1968).

World distribution — Algeria, Australia, Canada, Canary Islands, Chile, China, Costa Rica, Cyprus, Egypt, Finland, France, Greece, Guatemala, Hungary, Iran, Israel, Italy, Japan, Jordan, Kenya, Latvia, Lybia, Martinique, Mauritius, Morocco, Netherlands, New Caledonia, New Zealand, Peru, Philippines, Portugal, Reunion Island, Rodrigues Island (Mauritius), Serbia, Slovenia, South Africa, South Korea, Spain, Syria, Tunisia, Turkey, USA, and Venezuela.

Previous records from Morocco — The presence of this species has been reported on wild plants and crops in various regions of Morocco by McMurtry and Bounfour (1989) and Tixier *et al.* (2003). It was observed on *Ricinus communis* L. (Euphorbiaceae), *Stachys ocymastum* (L.) Briq. (Lamiaceae), *Vicia benghalensis* L. (Fabaceae), *Solananum sodomeum* L. (Solanaceae), and *Malva* spp. (Malvaceae).

Specimens examined — 2 ♀♀ on citrus leaves in June 2017; 4 ♀♀ + 2 ♂♂ on *Malva parviflora* L. (Malvaceae); 3 ♀♀ on *Convolvulus althaeoides* L. (Convolvulaceae) at Stah Al Madina. 4 ♀♀ on the same previous substrate at Saouda in June 2017; 4 ♀♀ and 1 ♂ at Taoufiqui 1 domain in the same date. 4 ♀♀ at Chbaika orchards on the same previous substrate in June and September 2018.

Remarks — Description and measurements of the adult females agree with those provided by Ferragut *et al.* (2010) for specimens from Spain and by Kreiter *et al.* (2018, 2020b) for specimens from Mauritius, La Réunion and various regions in the world. This species was mainly known from Mediterranean climates around the world (Takahashi and Chant 1993; Kreiter *et al.* 2010). It is one of the best-known phytoseiid species as specialist predator, since its use to control *T. urticae* in greenhouses (McMurtry and Croft 1997; Escudero and Ferragut 2004; McMurtry *et al.* 2013).

Tribe Amblyseiini Muma

Amblyseiini Muma Wainstein 1962: 26.

Subtribe Amblyseiina Muma

Amblyseiina Muma Chant & McMurtry 2004a: 179.

Genus *Transeius* Chant & McMurtry

Transeius Chant & McMurtry 2004: 181.

Transeius audeae Kreiter, Allam & Tixier

Transeius audeae Kreiter, Allam & Tixier in Tixier *et al.* 2016: 532.

World distribution — Morocco.

Previous records from Morocco — The first report from Morocco of this recently described species was mentioned in Tixier *et al.* (2016). One specimen (1 ♀) has been collected on *Vitis vinifera* L. (Vitaceae) in Meknes region.

Specimens examined — 2 ♀♀ on citrus leaves in July 2018 at Nour domain; 5 ♀♀ on *Withania somnifera* L. (Solanaceae) in July 2018 at Nour domain.

Remarks — The morphological features of the specimens here in collected sample agree with those provided by Tixier *et al.* (2016) for specimens from Morocco.

Genus *Amblyseiella* Muma

Amblyseiella Muma 1955: 266.

Amblyseiella setosa (Muma)

Amblyseiella setosa Muma 1955: 266.
Phytoseiulus setosa, Garman 1958: 71.
Typhlodromus (*Amblyseius*) *setosus*, Chant 1959: 70.
Typhlodromus setosus, Hirschmann 1962: 128.
Amblyseius (*Amblyseiellus*) *setosus*, Wainstein 1962: 15.
Amblyseius setosus, Porath and Swirski 1965: 97.
Amblyseius (*Amblyseiella*) *setosus*, Ehara 1966a: 24.
Amblyseius (*Amblyseiellus*) *setosus*, Arutunjan 1977: 40.
Amblyseius setosa, Rowell *et al.* 1978.
Amblyseiella setosa, Moraes *et al.* 1986: 4, 2004a: 9; Chant & McMurtry 2004: 186, 2007: 71.
Amblyseiella denmarki (El-Borolossy *in* Nasr & Abou-Awad 1985): 245 (Synonymy according to Chant & McMurtry 2004).
Amblyseiella rusticana (Athias-Henriot, 1960a): 292 (Synonymy according to Muma *et al.* 1970).

World distribution — Algeria, Austria, Brazil, Egypt, France, Georgia, Greece, Israel, Peru, Spain, Turkey, and USA.

Specimens examined — 2 ♀♀ and 1 ♀ respectively on *Convolvulus althaeoides* L. and *C. arvensis* M. (Bieb) (Convolvulaceae) in May 2017 at Errahim domain in 2017. This is the first record of this species for the Moroccan fauna.

Remarks — The description and measurements of the adult females collected agree with those provided by Swirski *et al.* (1998) for specimens from Israel and Muma (1955) for specimens from Florida (USA).

Genus *Amblyseius* Berlese

Amblyseius Berlese 1914: 143.

Amblyseius andersoni (Chant)

Typhlodromus andersoni Chant 1957: 296.
Typhlodromus (*Amblyseius*) *andersoni*, Chant 1959: 92.
Amblyseius (*Amblyseius*) *andersoni*, Muma 1961: 287.
Typhlodromus (*Typhlodromus*) *andersoni*, Westerboer & Bernrhard 1963: 682.
Amblyseius (*Multiseius*) *andersoni*, Denmark & Muma 1989: 84.
Amblyseius andersoni, Athias-Henriot 1958: 33; Moraes *et al.* 1986: 7, 2004a: 14; Chant & McMurtry 2004: 199, 2007: 75.
Amblyseiopsis potentillae Garman, 1958: 7 (Synonymy according to Chant & Yoshida-Shaul 1990).
Typhlodromus (*Amblyseius*) *britannicus* Chant, 1959: 87 (Synonymy according to Chant & Yoshida-Shaul 1990).

Amblyseius charui Gupta 1969: 126 (Synonymy according to Gupta 1985).
Amblyseius reflexus Knisley & Denmark 1978: 8 (Synonymy according to Chant and Yoshida-Shaul 1990).

World distribution — Algeria, Austria, Azerbaijan, Canada, Cyprus, Czechoslovakia, Czech Republic, Denmark, England, France, Georgia, Germany, Greece, Hungary, Italy, Japan, Latvia, Moldova, Morocco, Netherlands, Poland, Portugal, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Syria, Turkey, Ukraine, and USA.

Previous records from Morocco — This species was reported from Morocco on citrus (Tixier *et al.* 2003). It has been observed in many regions on many other plants such as *Malva* spp. (L.) (Malvaceae), *Quercus suber* L. (Fagaceae), *Erica arborea* L. (Ericaceae), and *Cistus parviflorus* L. (Cistaceae) (Tixier *et al.* 2016).

Specimens examined — 6 ♀♀ + 2 ♂♂ on *Malva parviflora* L. (Malvaceae) collected in May 2017, at Ouled Abdellah orchard (Taroudant); 3 ♀♀ + 1 ♂ on citrus leaves (Washington sanguine variety) (Rutaceae) collected at Stah Al Madina (Taroudant) in September 2018.

Remarks — The description and measurements of adult females collected agree with those provided by Denmark and Muma (1989). This species is cosmopolitan and considered a polyphagous predatory mite. It has been reported on a wide range of plants, particularly in vineyards (Kreiter *et al.* 2000) and on fruit trees like in apple orchards as reported by Tixier *et al.* (2013). In addition, it feeds on many species of mites, such as *Aculops lycopersici* (Tryon) (Eriophyidae) responsible for tomato russet, key pests of ornamental coniferous plants, i.e., *Oligonychus ununguis* (Jacobi) and *Pentamerismus taxi* (Haller), and pollen of *Pinus sylvestris* L. (Pinaceae) (Lara *et al.* 2012; Puchalska *et al.* 2021).

Amblyseius italicus (Chant)

Typhlodromus (*Amblyseius*) *italicus* Chant 1959: 70.
Amblyseius (*Amblyseialus*) *italicus*, Muma 1961: 287.
Amblyseius (*Amblyseius*) *italicus*, Wainstein 1962: 15.
Amblyseius (*Multiseius*) *italicus*, Denmark & Muma 1989: 82.
Amblyseius italicus, Chant 1959: 70; Athias-Henriot 1966; Moraes *et al.* 1986: 16, 2004a: 31; Chant & McMurtry, 2004: 193, 2007: 78.

World distribution — Italy, Kenya, and Morocco.

Previous records from Morocco — This species was reported by McMurtry and Bounfour (1989) in El Jadida, 2 ♀♀ on cucumber (Cucurbitaceae) leaves in greenhouse.

Specimens examined — 3 ♀♀ on *Cupressus* sp. L. (Cupressaceae) used as windbreaks at Nour orchard (Ouled Teima) in September 2018; 1 ♀ collected on citrus leaves at Stah Al Madina domain in September 2018.

Remarks — The description and measurements of the adult females collected agree with those provided by McMurtry and Bounfour (1989) for specimens from Morocco.

Amblyseius largoensis (Muma)

Amblyseiopsis largoensis Muma 1955: 266.
Typhlodromus (*Amblyseius*) *largoensis*, Chant 1959: 96.
Amblyseius (*Amblyseialus*) *largoensis*, Muma 1961: 287.
Typhlodromus largoensis, Hirschmann 1962.
Amblyseius (*Amblyseius*) *largoensis*, Ehara 1966: 22; Ehara & Bhandhufalck 1977: 67; Denmark & Evans 2011: 69.
Amblyseius largoensis, Ehara 1959: 293; Muma & Denmark 1970: 69; McMurtry & Moraes 1984: 29; Moraes *et al.* 1986: 17, 2000: 239, 2004a: 143, 2004b: 33; Chant & McMurtry 2004: 208, 2007: 78.
Amblyseius sakalava Blommers, 1976: 96 (Synonymy according to Ueckermann & Loots 1988).

Amblyseius amtalaensis Gupta, 1977: 53 (Synonymy according to Gupta 1986).
Amblyseius magnoliae Denmark & Evans, 2011: 69 (Synonym according to Denmark & Evans 2011).

World distribution — Angola, Anjouan Island, Australia, Benin, Brazil, Cambodia, China, Colombia, Cook Islands, Costa Rica, Cuba, Dominican Republic, Figi, French Guiana, Futuna Island, Georgia, Gilbert Islands, Grande Comore Island, Guadeloupe, Guatemala, Guyana, Hawaii, Honduras, India, Indonesia, Iran, Israel, Ivory Coast, Jamaica, Japan, Kenya, La Désirade Island, Madagascar Island, Madeira Island, Malaysia, Marie-Galante Island, Martinique, Mauritius, Mayotte Island, Mexico, Mohéli Island, Mozambique, New Caledonia, New Zealand, Oman, Papua New Guinea, Peru, Philippines, Puerto Rico, Reunion Island, Rodrigues Island, Saint Barthélémy, Saint Kitts, Saint Martin, Saudi Arabia, Sierra Leone, Singapore, Sri Lanka, Tahiti, Taiwan, Tanzania, Thailand, Trinidad, Turkey, USA, US Samoa, Vanuatu, Venezuela, and Vietnam.

Specimens examined — 3 ♀♀ collected on *Cupressus* spp. L. (Cupressaceae) used as windbreaks at Ouled Abdellah in September 2018. This is the first record of this species in Morocco.

Remarks — The description and measurements of the adult females collected agree with those provided by McMurtry and Moraes (1984) for specimens from South Pacific, by Karmakar *et al.* 2017 for specimens from West Bengal (India) and by Fang *et al.* (2020) for specimens from Vietnam. This species is an important natural enemy of mite pests in China (Wu *et al.* 2009). It prefers high humidity environment, and was found the dominant native species in surveyed citrus orchards in Vietnam (Fang *et al.* 2020). *Amblyseius largoensis* is a generalist predator that feeds on a diversity of phytophagous mites, mainly those of the families Eriophyidae, Tenuipalpidae, and Tetranychidae, small insects and other food types, including pollen (Rodriguez and Ramos 2004; Navia *et al.* 2007).

Amblyseius swirskii Athias-Henriot

Amblyseius swirskii Athias-Henriot 1962: 5.
Amblyseius (*Amblyseius*) *swirskii*, Ehara 1966: 23.
Typhlodromips swirskii, Moraes *et al.* 1986: 149, 2004a: 227.
Amblyseius swirskii, Chant & McMurtry 2004: 201, 2007: 81.
Amblyseius rykei, Pritchard & Baker 1962: 249 (Synonymy according to Zannou & Hanna 2011).
Amblyseius enab, El-Badry 1967a: 178 (Synonymy according to Ramadan *et al.* 2009).
Amblyseius capsicum (Basha, Yousef, Ibrahim & Mostafa 2001): 372 (Synonymy according to Abo-Shnaf & Moraes 2014).

World distribution — Argentina, Azerbaijan, Benin, Burundi, Cape Verde, DR Congo, Egypt, Gaza strip, Georgia, Ghana, Israel, Italy, Kenya, Reunion Island, Saudi Arabia, Senegal, Slovenia, Spain, Syria, Tanzania, Turkey, USA, and Yemen.

Specimens examined — 2 ♀♀ collected on citrus leaves at Stah Al Madina orchard in September 2018; 5 ♀♀ on *Solanum nigrum* L. (Solanaceae) at Saouda orchard (Ouled Teima) in September 2018. This is the first record of that species in Morocco, naturally occurring or originating from dispersion in the environment after commercial releases in greenhouses.

Remarks — The description and measurements of the adult females collected agree with those provided by Ferragut *et al.* (2010) for specimens from Spain, by Zannou and Hanna (2011) for specimens from sub-Saharan Africa and by Kreiter *et al.* (2016a, b) for specimens from Reunion Island and from various countries in the world. *Amblyseius swirskii* is one of the most efficient phytoseiid species; it is currently released in more than 50 countries of the world (Calvo *et al.* 2015). It originates from the East Mediterranean coast and has been described in 1962 from almond [*Prunus dulcis* (Mill.) D.A. Webb.] (Rosaceae) in Bet Dagan, Israel by Athias-Henriot. This species is able to develop not only in the Mediterranean basin, but also in subtropical and tropical areas in Africa (Zannou and Hanna 2011). It is commonly used to

control whiteflies and thrips in greenhouse vegetables (especially cucumber and pepper) and some ornamental crops in Europe and North America (Buitenhuis *et al.* 2014; Calvo *et al.* 2015).

Genus *Graminaseius* Chant & McMurtry

Graminaseius Chant & McMurtry 2004: 215.

Graminaseius graminis (Chant)

Amblyseius graminis Chant 1956: 34.
Typhlodromus (Amblyseius) graminis, Chant 1959: 89; Arutunjan 1970.
Amblyseius (*Typhlodromopsis*) *graminis*, Muma 1961: 287.
Typhlodromus (*Typhlodromus*) *graminis*, Westerboer & Bernhard, 1963: 636.
Amblyseius (*Amblyseius*) *graminis*, Wainstein 1973: 178, 1975: 920, 1977: 1415; Ueckermann & Loots 1988: 132.
Neoseiulus graminis, Moraes *et al.* 1986: 81.
Amblyseius (*Typhlodromips*) *graminis*, Karg 1991.
Amblyseius graminis, Moraes *et al.* 2004a: 26.
Graminaseius graminis, Chant & McMurtry 2004: 219, 2007: 85.
Graminaseius collyerae (Chant, 1959): 87 (Synonymy according to Athias-Henriot 1966).
Graminaseius exiguus (Hirschmann, 1962): 26 (Synonymy according to Athias-Henriot 1966).

World distribution — Algeria, Armenia, Australia, Azerbaijan, Azores, Chile, Denmark, England, France, Germany, Greece, Hungary, Iran, Italy, Latvia, Mexico, Moldova, Montenegro, Morocco, Norway, Poland, Portugal, Russia, Spain, Syria, Tunisia, Turkey, Ukraine, and USA.

Previous records from Morocco — This species was already reported by McMurtry and Bounfour (1989) and Tixier *et al.* (2016) from several regions on many plant families such as Apiaceae, Asteraceae, Brassicaceae, and Lamiaceae.

Specimens examined — 3 ♀♀ on *Malva parviflora* L. (Malvaceae) in May 2017 at Chabaika orchard; 2 ♀♀ on the same plant in July 2017 at the same domain.

Remarks — The description and measurements of the adult females collected agree with those provided by Döker *et al.* (2019) for specimens from Turkey. This species is distributed worldwide and has been collected on a great variety of plants including citrus (Kreiter *et al.* 2010; Sahraoui *et al.* 2012) and horticultural crops (Tixier *et al.* 2016).

Tribe Euseiini Chant & McMurtry

Euseiini Chant & McMurtry 2005: 191.

Subtribe Euseiina Chant & McMurtry

Euseiina Chant & McMurtry 2005: 209.

Genus *Euseius* Wainstein

Amblyseius (*Amblyseius*) section *Euseius* Wainstein 1962: 15.

Euseius batus (Ueckermann & Loots)

Amblyseius (*Amblyseius*) *batus* Ueckermann & Loots 1988: 92.
Euseius batus, Moraes *et al.* 2004a: 62.

World distribution — Kenya, Saudi Arabia, South Africa, and Yemen.

Specimens examined — 4 ♀♀ on *Malva parviflora* L. (Malvaceae) in July 2017 and in September 2018 at Nour; 3 ♀♀ on the same plant in association with *Thrips* spp. (Thripidae). This is the first record of this species in Morocco.

Remarks — The description and measurements of the adult females collected agree with those provided by Moraes *et al.* (2001) for specimens from Sub-Saharan Africa by Basahih *et al.* (2015) for specimens from Saudi Arabia.

Euseius dossei (Pritchard & Baker)

Amblyseius (*Amblyseius*) *dossei* Pritchard & Baker, 1962: 286; Ueckermann & Loots 1988: 110.
Euseius dossei, Moraes *et al.* 1986: 40, 1989: 83, 2004a: 65; Chant & McMurtry 2005: 215, 2007: 120.

World distribution — Benin, Burundi, DR Congo, Ghana, Kenya, Mozambique, Nigeria, Rwanda, Sierra Leone, and Uganda.

Specimens examined — 8 ♀♀ on *Malva parviflora* L. (Malvaceae) in September 2018 at Ouled Abdellah. This is the first record of this species in Morocco.

Remarks — The description and measurements of the adult females collected agree with those provided by Moraes *et al.* (2001) for specimens from Sub-Saharan Africa.

Euseius scutalis (Athias-Henriot)

Typhlodromus scutalis Athias-Henriot 1958: 183.
Amblyseius scutalis, Athias-Henriot 1960b.
Amblyseius (*Typhlodromalus*) *scutalis*, Muma 1961.
Amblyseius (*Amblyseius*) *scutalis*, Ueckermann & Loots 1988: 109
Amblyseius scutalis, Ueckermann 1992: 149.
Amblyseius (*Euseius*) *scutalis*, Gupta 2003.
Euseius scutalis, Ferragut & Escudero 1997: 233; Swirski *et al.* 1998: 107; Moraes *et al.* 1986: 52, 2004a: 82; Chant & McMurtry 2005: 216, 2007: 123.
Euseius delhiensis (Narayanan & Kaur, 1960: 5) (Synonymy according to Wysoki & Bolland 1983).
Euseius rubini (Swirski & Amitai 1961): 196 (Synonymy according to Amitai & Swirski 1966).
Euseius gossipi (El-Badry, 1967a): 177; 1970: 503 (Synonymy according to Wysoki & Bolland 1983).
Euseius libanesi (Dosse, 1967): 30 (Synonymy according to Wysoki & Bolland 1983).
Euseius plumerii Romeih *et al.* 2010: 28 (Synonymy according to Abo-Shnaf & Moraes 2014).

World distribution — Algeria, Canary Islands, Cape Verde, Cyprus, Egypt, Ghana, Greece, India, Iran, Israel, Italy, Jordan, Madeira Island (Portugal), Morocco, Oman, Pakistan, Peru, Saudi Arabia, Spain, Syria, Tunisia, Turkey, and Yemen.

Previous records from Morocco — This species was reported by McMurtry and Bounfour (1989) and Tixier *et al.* (2003, 2016).

Specimens examined — 4 ♀♀ on *Solanum nigrum* L. (Solanaceae) collected at Ouled Abdellah in May 2018; 9 ♀♀ + 5 ♂♂ + 4 im. on *Ceratonia siliqua* L. (Fabaceae) collected in April 2019 in Immouzer region at the argan forest.

Remarks — The description and measurements of the adult females collected agree with those provided by Moraes *et al.* (2001) for specimens from Sub-Saharan Africa. This species is mainly reported from the South of the West Palaearctic region and is found in dry climates. It is very common in Maghreb and South of Spain (Kreiter *et al.* 2004) and recorded in Tunisia on many plants including citrus (Kreiter *et al.* 2010; Sahraoui *et al.* 2012). This species is able to feed on *T. urticae* and *P. citri* (Abbassy *et al.* 2012). It can be reared on pollen and is considered as a biological control agent against phytophagous mites, scale insects, and whiteflies on greenhouse cucumber (Nomikou *et al.* 2002).

Euseius stipulatus (Athias-Henriot)

Amblyseius stipulatus Athias-Henriot 1960a: 294.
Typhlodromus stipulatus, Hirshmann 1962.
Amblyseius (*Amblyseius*) *stipulatus*, Ueckermann & Loots 1988: 110.
Euseius stipulatus, Ferragut *et al.* 1985: 225; Moraes *et al.* 1986: 55, 2004a: 84; Chant & McMurtry 2005: 216. 2007: 123.

World distribution — Algeria, Azores, Canary Islands, France, Greece, Hungary, Iran, Italy, Lebanon, Madeira Island, Montenegro, Morocco, Peru, Portugal, Slovenia, Spain, Syria, Tunisia, Turkey, and USA.

Previous records from Morocco — This species was recorded in many regions in Morocco and collected on several plants as reported by Tixier *et al.* (2016).

Specimens examined — 6 ♀♀ + 2 ♂♂ on *Bryonia dioica* Jacq. (Cucurbitaceae) collected in Ouled Abdellah citrus orchard in May 2017; 1 ♀ + 1 ♂ were collected on citrus leaves at Saouda orchard in September 2018.

Remarks — The description and measurements of the adult females collected agree with those provided by Ferragut and Escudero (1997) and by Ferragut *et al.* (2010) for specimens from Spain. *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), *T. urticae* (Moyano *et al.* 2009) and eriophyid mites (Ferragut *et al.* 1987) on many crops such as peach, avocado orchards, and vineyards (Ferragut *et al.* 1983; Papaioannou-Souliotis *et al.* 1994; Ragusa 2006) and citrus (Kreiter *et al.* 2010; Sahraoui *et al.* 2012).

Genus *Iphiseius* (Berlese)

Iphiseius Berlese 1916: nomen nudum; 1921: 95.
Amblyseius (*Iphiseius*) Muma 1961: 288.
Iphiseius (*Iphiseius*) Pritchard & Baker 1962: 298.

Iphiseius degenerans (Berlese)

Seius degenerans Berlese 1889: 9.
Seiulus degenerans, Berlese 1887: 9.
Amblyseius (*Iphiseius*) *degenerans*, Muma 1961: 288.
Iphiseius (*Iphiseius*) *degenerans*, Prichard & Baker 1962: 299.
Typhlodromus degenerans, Hirschmann 1962: 2.
Amblyseius degenerans, Zaher 1986: 99.
Iphiseius degenerans, Berlese 1921: 95; Chant 1959: 110; Moraes *et al.* 1986: 61, 2004a: 92; Chant & McMurtry 2005: 218, 2007: 12.
Iphiseius martigellus El-Badry 1968: 325 (Synonymy according to Chant & McMurtry 2005: 217).

World distribution — Algeria, Azores, Benin, Brazil, Burundi, Cameroon, Canary Islands, Cape Verde, Cyprus, DR Congo, Egypt, Georgia, Ghana, Grande Comore Island, Greece, Israel, Italy, Kenya, Lebanon, Madagascar Island, Madeira Island, Malawi, Morocco, Nigeria, Portugal, Rwanda, Saudi Arabia, Sierra Leone, South-Africa, Syria, Tanzania, Tunisia, Turkey, Uganda, USA, Yemen, Zambia, and Zimbabwe.

Previous records from Morocco — It was reported from Morocco by McMurtry and Bounfour (1989) and by Tixier *et al.* (2003) on *Nerium oleander* L. (Apocynaceae) in Gorges of Zegzel.

Specimens examined — 3 ♀♀ on *Cupressus* spp. (Cupressaceae) collected at Errahim domain in July 2017; 2 ♀♀ and 1 ♀ on the same previous substrate in May 2017 respectively at Taoufiqui 1 and 2 orchards.

Remarks — The description and measurements of the adult females collected agree with those provided by Döker *et al.* (2018) for specimens from Turkey. This species has a wide

distribution in Africa and South Europe and around the Mediterranean Sea (Swirski and Amitai, 1997b; Moraes *et al*, 2004a; Sahraoui *et al*, 2012). It is described by McMurtry and Croft (1997) as a generalist (type III predator), able to feed on a wide range of food such as thrips larvae, spider mites, and pollen (Nwilene and Nachman 1996; Van Rijn and Tanigoshi 1999; Vantornhout *et al.* 2004; Messelink *et al.* 2006). This species is commercialised for biological control of the western flower thrips *Frankliniella occidentalis* (Pergande) in greenhouses (Vantornhout *et al.* 2005).

Subfamily Phytoseiinae Berlese

Phytoseiini Berlese 1913: 3.

Genus *Phytoseius* Ribaga

Phytoseius Ribaga 1904: 177

Phytoseius finitimus Ribaga

Phytoseius finitimus Ribaga 1904: 178; Chant 1959: 108; Moraes *et al.* 2004a: 252; Chant & McMurtry 2007: 129.
Phytoseius (*Dubininellus*) *finitimus*, Wainstein 1959: 1365.
Phytoseius (*Pennaseius*) *finitimus*, Pritchard & Baker 1962: 223; Moraes *et al.* 1986: 214.
Pennaseius finitimus, Schuster & Pritchard 1963: 279.
Phytoseius (*Phytoseius*) *finitimus*, Denmark 1966: 16.
Phytoseius dubinini (Beglyarov 1958): 116 (Synonymy according to Pritchard & Baker 1962).

World distribution — Algeria, Azores, Egypt, France, Greece, Iran, Israel, Italy, Montenegro, Morocco, Portugal, Slovenia, Spain, Syria, Tunisia, Turkey, and USA.

Previous records from Morocco — This species was reported from Morocco for the first time by Tixier *et al.* (2016). It was collected on several regions and plants such as *Mentha* spp. L. (Lamiaceae), *Ficus carica* L. (Moraceae), *Salix pedicellata* Desf. (Salicaceae), and *Coleostephus myconis* (L.) Rchb.f. (Asteraceae).

Specimens examined — 6 ♀♀ on citrus leaves in July 2017at Taoufiqui 1 domain.

Remarks — The measurements of adult females collected agree with those provided by Tixier *et al.* (2016) for specimens from Morocco. *Phytoseius finitimus* is often recorded on plants with highly pubescent leaves (Walter 1992; McMurtry and Croft, 1997). It is found in higher densities on such host plants (Tixier *et al.* 1998; Duso and Vettorazzo 1999), suggesting that it may be promising candidates for biological control of pests. Hairy structures may offer shelters and domatia with favourable microclimatic conditions (increased relative humidity, reduced temperature) for the development and reproduction of this mite (Walter 1996; McMurtry and Croft 1997; Tixier *et al.* 1998; Kreiter *et al.* 2003). *Phytoseius finitimus* is a generalist phytoseiid mite mainly recorded in the Mediterranean region on a variety of both cultivated and non-cultivated plants, such as grapevine, hazelnut, citrus, walnut, mulberry, peach, plum, pomegranate, and cotton (Swirski and Ragusa 1977; Duso and Vettorazzo 1999; Papaioannou Souliotis *et al.* 1999; Tsolakis *et al.* 2000; Nomikou *et al.* 2001). It is a natural enemy of tetranychid and eriophyid mites, but it also feeds on small insect and pollen (Nomikou *et al.* 2001; Momen and El-Borolossy 2010).

Subfamily Typhlodrominae Wainstein

Typhlodromini Wainstein 1962: 26.

Tribe Galendromimini Chant & McMurtry

Chant & McMurtry 1994: 240; 2007: 137.

Genus *Cydnoseius* Muma

Cydnoseius Muma 1967: 274.

Cydnoseius negevi (Swirski & Amitai)

Typhlodromus (*Typhlodromus*) *negevi* Swirski & Amitai, 1961: 194.
Typhlodromus negevi, Amitai & Swirski 1966: 21.
Typhlodromus (*Neoseiulus*) *negevi*, Ehara 1966a: 19.
Cydnodromella negevi, Chant & Yoshida-Shaul 1986: 2815.
Amblydromella negevi, Moraes *et al.* 1986: 168.
Cydnoseius negevi, Moraes *et al.* 2004a: 263; Chant & McMurtry 2007: 137; Abo-Shnaf & Moraes 2014: 39.
Cydnoseius cordiae (Muma 1967): 276 (Synonymy according to Chant & Yoshida-Shaul 1986).
Cydnoseius medanicus (El-Badry 1967b): 108 (Synonymy according to Chant & Yoshida-Shaul 1986).
Cydnoseius zaheri (El-Badry 1967a): 182 (Synonymy according to Chant & Yoshida-Shaul 1986).
Cydnoseius africanus (Yousef 1980): 122 (Synonymy according to Chant & Yoshida-Shaul 1986).
Cydnoseius schusteri (Yousef & El-Borolossy in Zaher 1986): 129 (Synonymy according to Kanouh *et al.* 2012).

World distribution — Egypt, Israel, Oman, Saudi Arabia, and United Arab Emirates.

Specimens examined — 14 ♀♀ + 2 ♂♂ on *Withania somnifera* (L.) Dunal. (Solanaceae); 7 ♀♀ on the same plant in July 2017 respectively at Stah AlMadina and Errahim orchards. This is the first record of this species in Morocco.

Remarks — The measurements of adult females fit well with those provided by Alatawi *et al.* (2017) for specimens from Saudi Arabia.

Tribe Paraseiulini Wainstein

Paraseiulini Wainstein 1976: 697.

Genus *Paraseiulus* Muma

Paraseiulus Muma, 1961: 299.

Paraseiulus talbii (Athias-Henriot)

Typhlodromus talbii Athias-Henriot 1960b: 75.
Typhlodromus (*Neoseiulus*) *talbii*, Ehara 1966a: 17.
Paraseiulus (*Bawus*) *talbii*, Wainstein, 1976: 699.
Bawus talbii, Moraes *et al.* 1986: 180; Swirski & Amitai 1990: 117.
Seiulus talbii, Nicotina & Cioffi 1999: 11.
Paraseiulus talbii, Abbasova 1972: 11; Moraes *et al.* 2004a: 301; Chant & McMurtry 2007: 143.
Paraseiulus subsoleiger, Wainstein 1962: 139 (Synonymy according to Chant & Yoshida-Shaul 1982).
Paraseiulus tetramedius, Zaher & Shehata 1970: 117 (Synonymy according to Chant & Yoshida-Shaul 1982).
Seiulus amaliae, Ragusa & Swirski 1976: 183 (Synonymy according to Chant & Yoshida-Shaul 1982).
Paraseiulus ostiolatus, Athias-Henriot 1978: 699 (Synonymy according to Chant & Yoshida-Shaul 1982).

World distribution — Algeria, Argentina, Austria, Azerbaijan, China, Croatia, Cyprus, Czechoslovakia, Czech Republic, Denmark, Egypt, Finland, France, Georgia, Greece, Hungary, Iran, Israel, Italy, Morocco, Netherlands, Poland, Portugal, Serbia, Slovakia, Slovenia, Spain, Sweden, Syria, Tunisia, and Turkey.

Previous records from Morocco — This species has been reported for the first time by Tixier *et al.* (2016). It has been collected on *Convolvulus althaeoides* L. (Convolvulaceae) and *Vinca major* L. (Apocynaceae).

Specimens examined — 3 ♀♀ + 1 ♂ on citrus leaves in June 2017 at Ouled Abdellah orchard; 2 ♀♀ on *Acacia* spp. (Fabaceae) used as windbreaks at the same domain.

Remarks — The measurements of adult females collected agree with those provided by Chant and McMurtry (1994).

Paraseiulus triporus (Chant & Yoshida-Shaul)

Typhlodromus triporus Chant & Yoshida-Shaul 1982: 3029.
Paraseiulus triporus, Moraes *et al.* 1986: 208, 2004a: 303; Hajizadeh *et al.* 2002: 376; Chant & McMurtry 2007: 143.

World distribution — Czechoslovakia, Czech Republic, Denmark, Finland, France, Georgia, Germany, Greece, Hungary, Iran, Italy, Kazakhstan, Moldova, Morocco, Netherlands, Poland, Portugal, Russia, Serbia, Slovakia, Slovenia, Spain, Sweden, Syria, Turkey, Ukraine, and USA.

Previous records from Morocco — This species has been reported for the first time by Tixier *et al.* (2003). It has been collected on *Ulmus* spp. L. (Ulmaceae) at Ifrane city.

Specimens examined — 5 ♀♀ and 4 ♀♀ on citrus leaves at Stah Al Madina and Nour orchards, respectively; 3 ♀♀ on *Malva parviflora* L. (Malvaceae) at Taoufiqui 1 domain in June 2018.

Remarks — The measurements of adult females collected agree with those provided by Hajizadeh *et al.* (2002) and by Faraji *et al.* (2007).

Tribe Typhlodromini Wainstein

Typhlodromini Wainstein 1962: 26.

Genus *Typhloseiulus* Chant & McMurtry

Typhloseiulus Chant & McMurtry 1994: 246.
Typhloseiulus eleonorae (Ragusa & Swirski)
Seiulus eleonorae Ragusa & Swirski 1981: 269; Moraes *et al.* 1986: 231.
Typhlodromus eleonorae, Chant & Yoshida-Shaul 1983: 1150.
Typhloseiulus eleonorae, Chant & McMurtry 1994: 247, 2007: 145; Moraes *et al.* 2004a: 374.

World distribution — France, Italy, and Morocco.

Previous records from Morocco — The first report of this species was observed by Tixier *et al.* (2016). Specimens were collected near Larache on *Quercus suber* L. (Fagaceae), *Knautia purpurea* Vill. (Caprifoliaceae), Road to Souk El Arba on *Quercus suber* L. (Fagaceae), *Daphne gnidium* L. (Thymelaeaceae).

Specimens examined — 5 ♀♀ and 3 ♀♀ were collected on citrus leaves, at Saouda and Taoufiqui 1 domains, respectively in July 2017.

Remarks — The measurements of adult females collected agree with those provided by Ferragut (2018) from Spain.

Genus *Neoseiulella* Muma

Neoseiulella Muma 1961: 295.
Neoseiulella litoralis (Swirski & Amitai)

Typhloctonus litoralis Swirski & Amitai 1984: 73-76.
Neoseiulella (*Typhloctona*) *litoralis*, Denmark & Rather 1996: 71-72.
Neoseiulella litoralis, Swirski & Amitai 1997b: 37; Moraes *et al.* 2004a: 294; Chant & McMurtry 2007: 147.

World distribution — Cape Verde, Greece, Israel, Morocco, and Spain.

Previous records from Morocco — This species was reported in Morocco and was mainly found near the Atlantic Ocean coast. Tixier *et al.* (2016) reported that this species was observed on several plants such as *Carlina racemosa* L. (Asteraceae), *Emex spinosa* L. (Polygonaceae), *Eryngium maritimum* L. (Apiaceae), *Euphorbia pithyusa* L. (Euphorbiaceae), and *Medicago marina* L. (Fabaceae).

Specimens examined — 2 ♀♀ on *Withania somnifera* (L.) Dunal. (Solanaceae) at Saouda (Ouled Teima) in September 2018.

Remarks — The measurements of adult females collected agree with those provided by Kanouh *et al.* (2010) for specimens from France.

Genus *Typhlodromus* Scheuten

Typhlodromus Scheuten 1857: 111.

Subgenus *Anthoseius* De Leon

Typhlodromus (*Anthoseius*) De Leon 1959: 258.

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

Typhlodromus rhenanoides Athias-Henriot 1960b: 85.
Neoseiulus rhenanoides, Schuster & Pritchard 1963: 205.
Anthoseius rhenanoides, Charlet & McMurtry 1977: 186.
Amblydromella rhenanoides, Moraes *et al.* 1986: 174.
Amblydromella (*Aphanoseia*) *rhenanoides*, Denmark & Welbourn 2002: 308.
Typhlodromus (*Anthoseius*) *rhenanoides*, Moraes *et al.* 2004a: 347, Chant & McMurtry 2007: 155.

World distribution — Algeria, Canary Islands, France, Greece, Hawaii, Italy, Les Saintes, Madeira Island (Portugal), Morocco, Portugal, Spain, Tunisia, and USA.

Previous records from Morocco — This species was reported from Morocco by Kreiter *et al.* (2004), McMurtry and Bounfour (1989) on *Cupressus* spp. L. (Cupressaceae) and Tixier *et al.* (2016) on a great variety of plants and locations, such as on *Lupinus humulus* L. (Fabaceae), *Solananum sodomeum* L. (Solanaceae), *Nicotiana glauca* Grah. (Solanaceae), *Urtica dioica* L. (Urticaceae), and *Solanum nigrum* L. (Solanaceae).

Specimens examined — 6 ♀♀ + 2 ♂ + 4 im. on *Tamarix aphylla* L. (Tamaricaceae) in April 2019; 1 ♀ + 1 ♂ + 1 im. on *Ficus carica* L. (Moraceae) in the argan fores in the Road to Aksri and Imouzzar Ida ou Tenane villages in tha same date.

Remarks — The measurements of adult females agree with redescription provided by Tixier *et al.* (2016) for specimens from Morocco. This species has been reported on many uncultivated plants and sometimes on some orchards such as peach, plum, olive, citrus, and vineyards (Ragusa 2006). Nothing is known of its ability to control pests (Tixier *el al.* 2016).

Subgenus *Typhlodromus* Scheuten

Typhlodromus Scheuten 1857: 111.

Typhlodromus (*Typhlodromus*) *octogenipilus* Kreiter, Tixier & Duso

Typhlodromus (*Typhlodromus*) *octogenipilus* Kreiter *et al.* 2010: 172.

World distribution — Croatia, Greece, Morocco, and Turkey.

Previous records from Morocco — The first report from Morocco of this recently was provided by Tixier *et al.* (2016). Specimens have been collected on *Cistus libanotis* L. (Cistaceae) in Road to Souk El Arba and Mazari Cape.

Specimens examined — 4 ♀♀ on citrus leaves were collected in July 2017 at Taoufiqui 2 domain; 5 ♀♀ on citrus leaves in September 2018 at the same domain.

Typhlodromus (*Typhlodromus*) *setubali* Dosse

Typhlodromus setubali Dosse 1961: 313.*Typhlodromus* (*Typhlodromus*) *setubali*, Moraes *et al.* 1986: 246, 2004a: 369; Chant & McMurtry 2007: 157.*Typhlodromus laurentii*, Ragusa & Swirski 1978: 213 (Synonymy according to Chant & Yoshida-Shaul 1987).

World distribution — Germany, Israel, Italy, Jordan, Madeira Island (Portugal), Morocco, Portugal, Slovakia, Spain, and Tunisia.

Previous records from Morocco — specimens were collected on several plants such as *Quercus suber* L. (Fagaceae), *Nerium oleander* L. (Apocynaceae), *Rosmarinus officinalis* L. (Lamiaceae), *Marrubium incanum* L. (Lamiaceae), *Cistus* spp. L. (Cistaceae), and *Thuya* spp. L. (Cupressaceae) in Damon Oum Er Bia, Beni Slimane, and Ras El Ma regions (Tixier *et al.* 2003, 2016). It was also already reported by McMurtry and Bounfour (1989) on *Olea europea* L. (Oleaceae).

Specimens examined — 4 ♀♀ + 2 ♂♂ on citrus leaves at Nour orchard in July 2018; 2 ♀♀ on *Rhamnus* spp. L. (Rhamnaceae) and 2 ♀♀ on *Zyziphus lotus* L. (Rhamnaceae) in April 2019 at Road to Alma village in the argan forest.

Remarks — The measurements of adult females fit well with those provided by Tixier *et al.* (2016) for specimens from Morocco. The measurements of adult females agree with those provided by Tixier *et al.* (2010) for specimens from Croatia on *Cornus sanguinea* L. (Cornaceae) and by Tixier *et al.* (2016) for specimens from Morocco.

Identification key to females of recorded species of Moroccan Phytoseiidae

This key contains the 59 species presently recorded from Morocco.

1. Podonotal region of the dorsal shield (anterior to setae *R1*) of the female with five or six pairs of "lateral" setae *j3*, *z2*, *z4* and *s4* always present and *z3* and/or *s6* present 2
— Podonotal region of the dorsal shield (anterior to setae *R1*) of the female with four pairs of "lateral" setae *j3*, *z2*, *z4* and *s4* present, *z3* and *s6* absent . . . . . Sub-family Amblyseiinae: 3

2. Posterior "lateral" setae Z1, S2, S4 and S5 absent. Setae r3 usually inserted on the dorsal shield . . . . . Sub-family Phytoseiinae: *Phytoseius finitimus*
— At least one of setae Z1, S2, S4 and S5 present. Setae r3 usually inserted on the interscutal soft cuticule (rarely on the shield) . . . . . Sub-family Typhlodominae: 36

3. Sternal shield with median posterior projection, some forward "migration" of pre-anal setae *ZV2* and/or *JV2* 4
— Sternal shield without posterior projection, without forward "migration" of pre-anal setae *ZV2* and/or *JV2* 8

4. Heavily sclerotised and brown body with separate anal shield and subrectangular ventral shield . . . . . *Iphiseius degenerans*

— Slightly sclerotised and ventri-anal shield entire . . . . . Genus *Euseius*: 5

5. Cervix of the spermatheca tubular 6
— Cervix of the spermatheca of a different shape 7

6. Peritreme long, extending to level of *j3* or between *j3* and *z2*. *stIV* relatively short (54 µm). Cervix of spermatheca tubular with a long cervix of 20 to 25 µm long . . . . . *Euseius stipulatus*
— Peritreme short, extending at maximum to level of *z2*. Dorsal setae long. *stIV* long (77 µm). Cervix of spermatheca tubular, thin, long and sinuous (43 µm) . . . . . *Euseius scutalis*

7. All setae very short, peritreme extending to the level of *j1*. Macrosetae of the leg IV sharp-tipped. Distal half of the cervix thick-walled with the one side curved distally to house the atrium . . . . . *Euseius batus*
— setae *z2*, *z4* and *s4* long, peritreme extending to the level of *j3*, macrosetae of the leg IV knobbed, stIV very long. Spermatheca with broad cervix, about twice as long, as wide and slightly narrowing . . . . . *Euseius dossei*

8. Setae *S4* absent 9
— Setae *S4* present 12

9. Setae *J2*, *S2* absent, female ventri-anal shield reduced, setae j6 very long: 2–3 times longer than distance between their bases, female ventri-anal shield with one pair of pre-anal setae . . . . . *Phytoseiulus persimilis*
— Setae *J2*, *S2* present, female ventri-anal shield elongated with three pre-anal setae, setae *j6* not long 10

10. Striated dorsal shield, *ZV3* absent . . . . . *Eharius chergui*
— Not striated dorsal shield, *ZV3* present 11

11. Presence of six solenostomes on the dorsal shield (*gd1*, *gd2*, *gd4*, *gd6*, *gd8*, *gd9*); ventri-anal shield reduced with two pairs of pre-anal setae . . . . . *Kampimodromus hmiminai*
— Presence of four solenostomes on the dorsal shield (*gd1*, *gd2*, *gd6*, *gd9*); ventri-anal shield not reduced, elongated with threepairs of pre-anal setae . . . . . *Kampimodromus aberrans*

12. *Z2* present, ventri-anal shield reduced with one pair of pre-anal seta *Typhloseiella isotricha*
— *Z2* absent, ventri-anal shield not reduced 13

13. Absence of *J2* 14
— Presence of *J2* 15

14. Differences in the length of the setae *Z5* = 170–196, *Z4* = 155 . . . . *Proprioseiopsis messor*
— Differences in the length of the setae *Z5* = 203–225, *Z4* = 125–127 . . . . . *Proprioseiopsis bordjelaini*

15. 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 16
— Macrosetae usually present on legs II, III and IV, and sometimes also on leg I. Lateral dorsal setae often of quite differentlengths. *J2*, *Z1*, *S2*, *S4* or *S5* may be missing 28

16. Ventri-anal shield reduced and/or markedly wider at anus level, with a marked waist . . . . . Genus *Paragigagnathus*: 17
— Female ventri-anal shield not reduced and/or markedly wider at anus level, without a marked

waist . . . . . Genus *Neoseiulus*: 18

17. Seta st3 inserted on sternal shield of female . . . . . *Paragigagnathus tamaricis*
– Seta st3 inserted off sternal shield of female . . . . . *Paragigagnathus molestus*

18. Absence of *ZV3*, dorsal shield longitudinally striated . . . . . *Neoseiulus thymeleae*
— Presence of *ZV3*, dorsal shield not longitudinally striated 19

19. Spermatheca with atrium forked for at least half its length at juncture with major duct, or atrium appearing thick-walled, vacuolated 20
— Spermatheca with atrium not deeply forked at juncture with major duct, nor appearing thick-walled, vacuolated 21

20. Punctuated pores on the ventri-anal shield . . . . . *N. alpinus*
— Crescenticpores on the ventri-anal shield . . . . . *N. barkeri* & *N. stolidus*

NB: impossible to distinguish between these two latter species already suspected to be synonyms by Ragusa & Athias-Henriot 1983

21. Spermatheca with elongated cervix 22
— Spermatheca with bell shape cervix 23

22. Very elongated cervix (38 µm) . . . . . *N. pseudotauricus*
— Not very elongated cervix 24

23. Non crescentic pores on the ventrianal shield 24
— Crescentic pores on the ventrianal shield 25

24. *Z5* = 47, *Z4* =38, *j3* = 22, *s4* =27 . . . . . *N. cucumeris*
— *Z5* = 60–75, *Z4* = 23–28, *j3* = 18–21, *s4* = 23–26 . . . . . *N. longilaterus*

25. Crescenticpores on the ventri-anal shield . . . . . *N. californicus*
— Minute pores on the ventri-anal shield 26

26. *Z4* = 75, *j3* = 45–50, *s4* = 45–60 . . . . . *N. ornatus*
— *Z4* = 32, *j3* =17, *Z5* = 42–50, *s4* = 27–30 27

27. *Z4* = 32, *j3* =17, *Z5* = 42–50, *s4* = 27–30 . . . . . *N. marinus*
— *Z4* = 53, *j3* =38, *Z5* =64, *s4* = 52 . . . . . *N. umbraticus*

28. Ratio seta *s4*/*S2* < 2.7:1 29
— Ratio seta *s4*/*S2* > 3.0:1.0 30

29. Seta *S5* present . . . . . *Transeius audeae*
— Seta *S5* absent . . . . . *Amblyseiella setosa*

30. Spermatheca with atrium bifurcate/vacuolated at juncture with major duct . . . . . *Graminaseius graminis*
— Spermateca with atrium not bifurcate/vacuolated at the juncture with major duct . . . . . Genus *Amblyseius*: 31

31. Setae *ZV2* off the ventri-anal shield . . . . . *A. italicus*
— Setae *ZV2* on the ventri-anal shield 32

32. Ventri-anal pores punctiform 33
— Ventri-anal pores crescentic 34

33. Setae *Z5* 315; *Z4* 162 . . . . . *A. obtusus*
— Setae *Z5* 180–210; *Z4* 110–130 . . . . . *A. meridionalis*

34. Female ventrianal shield vase-shaped, wider at level of anus than at level of setae ZV2 present . . . . . *Amblyseius largoensis*
— Female ventrianal shied not vase-shaped, not wider at level of anus than at level of setae ZV2 35

35. Spermatheca with short neck; seta *Z5*, around 145 µm long . . . . . *A. andersoni*
— Spermatheca with calyx cup-shaped; setae *Z5*, maximum 100-120 µm long . . . . . *A. swirskii*

36. Setae z3 absent . . . . . *Cydnoseius negevi*
— Seta z3 present 37

37. Setae *z6* present 38
— Setae *z6* absent 41

38. *JV3* Present . . . . . *Kuzinellus saharae*
— *JV3* absent 39

39. Seta *Z3* present . . . . . *Paraseiulus talbii*
— Seta *Z3* absent 40

40. Genu II 1 2/0, 2/0 1; light vertical reticulation on dorsal shield, dorsal shield elongated . . . . . *Paraseiulus minutus*
— Genu II 2 2/1, 2/0 1; distinct to strong squarish reticulation on dorsal shield, rounded shape of the dorsal shield . . . . . *Paraseiulus triporus*

41. Setae *Z1* absent . . . . . Genus *Typhlodromus*: 42
— Setae *Z1* present 58

42. Seta *S5* present . . . . . *Typhlodromus* (*Anthoseius*): 43
— Seta *S5* absent . . . . . *Typhlodromus* (*Typhlodromus*): 49

43. Two pairs of setae on the ventri-anal shield . . . . . *T. (Anthoseius) ilicis*
— Four pairs of setae on the ventri-anal shield 44

44. Presence of three pairs (*gd2*, *gd6*, *gd9*) of solenostomes on a strongly reticulated dorsal shield . . . . . *Typhlodromus* (*A.*) *recki*
— Presence five pairs of solenostomes on a less reticulate dorsal shield 45

45. Ventri-anal shield without pre-anal pores 46
—- Ventri-anal shield with pre-anal pores . . . . . *Typhlodromus* (*A.*) *rhenanoides*

46. Spermatheca with cylindrical calyx with a neck between atrium and cervix, three macrosetae on leg IV 47
— Spermatheca without a neck between atrium and cervix and a long cylindrical major duct, 1 macrosetae on the leg IV (on the basitarsus) 48

47. Seta *j1* 23–34, peritreme reaching *j1* ..... *Typhlodromus* (*A.*) *foenilis*
— Seta *j1* shorter 14–22, peritreme extending between *j1* and *j3* ..... *Typhlodromus* (*A.*) *maspalomensis*

48. Peritreme extending between *j1* and *j3*, elongated and very thin metapodal plate 1 ..... *Typhlodromus* (*A.*) *clairathiasae*
— Peritreme extending between *j1* and *j3*, not so elongated and thin metapodal plate 1 ..... *Typhlodromus* (*A.*) *athenas*

49. Three solenostomes on the dorsal shield 50
— More than three solenostomes on the dorsal shield 53

50. Three pairs of setae on the ventri-anal shield ..... *T.* (*T.*) *thuriferus*
— Four pairs of setae on the ventri-anal shield 51

51. Seven setae on the genu II 52
— Eight setae on the genu II ..... *T.* (*T.*) *ballotae*

52. *Z4* length 27 (21–33), *Z5* length 40 (32–48) ..... *T.* (*T.*) *baccettii*
— *Z4* length 43 (40–48), *Z5* length 61 (53–68) ..... *T.* (*T.*) *leclanti*

53. Six setae on the genu II 54
— More than six setae on the genu II 55

54. Peritreme extending to *z2* ..... *Typhlodromus* (*T.*) *setubali*
— Peritreme extending to *j3* ..... *Typhlodromus* (*T.*) *moroccoensis*

55. Genu II with eight setae 56
— Genu II with seven setae 57

56. *Z4* length 38 (30–46), *Z5* length 59 (49–69), *stIV* length 33 (26–40) ..... *Typhlodromus* (*T.*) *octogenipilus*
— *Z4* length 70 (65–75), *Z5* length 91 (85–95), *stIV* length 45 (40–48) ..... *Typhlodromus* (*T.*) *mazarii*

57. Calyx of the spermatheca squared basally, with a short neck ..... *Typhlodromus* (*T.*) *exhilarates*
— Calyx of the spermatheca rounded basally, without neck ..... *Typhlodromus* (*T.*) *phialatus*

58. No thick setae not araising from tubercules, six small round solenostomes on the dorsal shield (*gd1*, *gd2*, *gd5*, *gd6*, *gd8*, *gd9*) ..... *Neoseiulella litoralis*
— Thick setae raising from tubercules ..... *Typhloseiulus eleonorae*

Discussion and conclusion

Predacious mites of the family Phytoseiidae are small mesostigmatid mites whose habits are very diverse (Chant 1959; McMurtry *et al.* 1970, 2013; Kreiter *et al.* 2001; Tixier *et al.* 2016). Some species of predatory mites rank among the most important biological control agents used in populations control of various pests (whiteflies, thrips, and mites), such as: *Phytoseiulus persimilis*, *Neoseiulus californicus*, *Amblyseius andersoni* and *A. swirskii*. Fifty-two species were known from Morocco until 2016 (McMurtry and Bounfour 1989; Kreiter

et al. 2001; Tixier *et al.* 2003; 2016). In this study, we report 29 species of Phytoseiidae in surveys carried out in nine citrus orchards covering an area of over 3000 hectares and from uncultivated plants in the argan forest between Agadir city and Imouzzar Ida ou Tanane. Among the **29** species herein reported (belonging to 15 genera), seven are new for the Moroccan fauna: *Amblyseius largoensis*, *A. swirskii*, *Amblyseiella setosa*, *Euseius dossei*, *E. batus*, *Paragigagnathus molestus*, and *Cydnoseius negevi*. Some genera were found on citrus leaves such as: *Amblyseius*, *Neoseiulus*, *Transeius*, *Typhlodromus*, *Phytoseiulus*, *Paraseiulus*, and *Phytoseius*. *Phytoseiulus persimilis* is collected from four domains. *Cydnoseius negevi* is observed in two domains, while *Amblyseius largoensis* and *Transeius audeae* were observed in only one domain. The Taoufiqui 3 orchard does not contain phytoseiid mites. These results could probably be explained by the importance of chemical applications and their detrimental effect on natural enemy fauna (Howarth 1991; Naranjo 2001; Cock *et al.* 2010; El Wakeil *et al.* 2013).

Some species have been mainly found on weeds (*Malva parviflora* and *Convolvulus althaeoides*) such as *Phytoseius finitimus*, *Neoseiulella litoralis*, *Typhlodromus* (*Typhlodromus*) *setubali*, *Typhlodromus* (*T.*) *octogenipilus* and *Paraseiulus talbii*. Some weeds such as *Malva parviflora* and *Convolvulus althaeoides* show quite high numbers of Phytoseiidae. This can be explained by leaf characteristics, food occurrence or to biological preferences of mite species as reported by Tixier *el al*. (2016). The new-recorded species were found in Stah Al Madina, Saouda, Ouled Abdellah, Errahim and Nour orchards (Table 1). The global diversity of Phytoseiidae in these four orchards represented more than 70% of species recorded. Results of the present survey will improve phytoseiid fauna knowledge especially in this region of Morocco area with more than 70% of the citrus production intended for export, and will be helpful in biological pest management programs against *T. urticae*, *P. citri* and *E. orientalis.* These species are serious pests, especially species of many fruit trees and grapevines in many countries (Bolland *et al.* 1998; Hare and Phillips 1992; Meck *et al.* 2009; Ledesma *et al.* 2011; González-Domínguez *et al.* 2015). Among phytoseiid species collected in orchards, some Amblyseiinae such as *Neoseiulus californicus*, *Neoseiulus longilaterus*, *Neoseiulus cucumeris*, *Amblyseius andersoni*, *Amblyseius italicus*, *Phytoseiulus persimilis*, *Euseius stipulatus*, *E. sculatis*, *Euseius batus*, *Iphiseius degenerans* and some Typhlodrominae can constitute potential biological control agents since some are considered as general predators which feed on a wide variety of food sources including mites, insects, and pollen. *Malva parviflora*, *Convolvulus arvensis*, *C. althaeoides*, *Solanum nigrum*, *Bryonia dioica*, *Withania somnifera*, *Tecoma* spp. would be among the best plant species to plant in the inter-row in citrus orchards in this region of Morocco to ensure sustainability, high densities and diversity of Phytoseiidae and insect predators species. It would be interesting to complete this survey by studying extent of exchanges of Phytoseiidae between citrus and the ground cover, as well as the influence of the weed management practices currently adopted in orchards on the diversity and density of native fauna, especially to determine how these plants that shelter phytoseiid mites can not also be host plants for mite pests.

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Conflict of interest

The authors declare that they have no conflicts of interest.

Ethical approval

Not applicable, this article does not contain any studies with human participants or animals performed by any of the authors.

Availability of data and materials

The datasets used during the current study are available from the corresponding author on reasonable request.

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