

Article

Incidence of predatory phytoseiid mites in Saudi Arabia: new records and a key to the Saudi Arabian species (Acari: Mesostigmata: Gamasina)

MOHAMED W. NEGM¹, FAHAD J. ALATAWI & YOUSIF N. ALDRYHIM*Department of Plant Protection, College of Food & Agriculture Sciences, King Saud University, Riyadh 11451, P.O. Box 2460, Saudi Arabia.*¹Corresponding author: E-mail: waleednegm@yahoo.com

Abstract

Cydnoseius negevi (Swirski & Amitai, 1961), *Neoseiulus paspalivorus* (De Leon, 1957) and *Proprioseiopsis beatus* (Chaudhri, 1968) are reported for the first time from Saudi Arabia. The mite genus *Cydnoseius* Muma, 1967 is also new to the Saudi Arabian fauna. *Cydnoseius negevi* was collected from various host plants in three different regions (Riyadh, Hail, Eastern region) while *N. paspalivorus* and *P. beatus* were collected from *Cynodon dactylon* L. (Poaceae) in date palm orchards in Riyadh and Eastern region respectively. A key is provided to the adult females of the known species of Phytoseiidae of Saudi Arabia.

Key words: Acari, Mesostigmata, Phytoseiidae, key, new records, Saudi Arabia

Introduction

Predatory mites of the family Phytoseiidae are the most important natural enemies of mite pests (Kostiainen & Hoy 1996, McMurtry & Croft 1997). This family comprises over 90 genera and more than 2,300 nominal species (Chant & McMurtry 2007; Beaulieu *et al.* 2011). Faunistic studies about phytoseiid mites in Saudi Arabia are still limited (Table 1). Dabbour and Abdel-Aziz (1982) reported two genera, *Amblyseius* Berlese, 1914 and *Phytoseius* Ribaga, 1904, with unnamed species associated with unidentified plants, soil and animal manure. These specimens were re-examined and identified by the senior author as *Neoseiulus barkeri* Hughes, 1948 and *Phytoseius plumifer* (Canestrini & Fanzago, 1876). Fouly and Al-Rehiyani (2011) listed five species collected from different habitats, including *Amblyseius cydnodactylon* Shehata & Zaher, 1969. *Neoseiulus cydnodactylon* (Shehata & Zaher) is listed in Chant and McMurtry (2007) as a species of *Neoseiulus*, but they have not indicated that it is a suspected synonym of *N. barkeri* as they did in Chant and McMurtry (2003) and so this species is included in the key below. Negm *et al.* (2012) carried out the most extensive work on Saudi Arabian Phytoseiidae so far, including a description of a new species, *Neoseiulus saudiensis* Negm, Alatawi & Aldryhim.

The objectives of this paper are to report on three phytoseiid mite species new to the Saudi Arabian mite fauna and provide a key to the 19 known species of Phytoseiidae of Saudi Arabia.

TABLE 1. Phytoseiid mites previously reported from Saudi Arabia.

Mite species	Plant host/habitat	Reference
<i>Amblyseius</i> sp.*	Unspecified plants	Dabbour & Abdel-Aziz (1982)
<i>Phytoseius</i> sp.**	Soil and animal manure	Dabbour & Abdel-Aziz (1982)
<i>Euseius scutalis</i> (Athias-Henriot)	Eggplant leaves Grape vine, <i>Vitis vinifera</i> L. leaves Castor bean, strawberry and eggplant leaves	Al-Shammery (2010) Al-Atawi (2011b) Fouly & Al-Rehiayani (2011)
<i>Amblyseius mumae</i> (Shehata & Zaher)	<i>Citrus</i> sp. soil	Al-Atawi (2011b)
<i>Neoseiulus barkeri</i> Hughes	Leaves of apple, <i>Malus domestica</i> Borkh.	Al-Atawi (2011b)
<i>Neoseiulus cucumeris</i> (Oudemans)	<i>Allium sativum</i> L., <i>Capsicum</i> sp.	Al-Atawi (2011a)
<i>Amblyseius cydnodactylon</i> Shehata & Zaher***	Debris of date palm trees	Fouly & Al-Rehiayani (2011)
<i>Metaseiulus (Typhlodromus) pyri</i> (Scheuten)	Fig leaves	Fouly & Al-Rehiayani (2011)
<i>Phytoseius plumifer</i> (Canestrini & Fanzago)	Leaves and buds of fig and strawberry	Fouly & Al-Rehiayani (2011)
<i>Typhlodromips (Amblyseius) swirskii</i> Athias-Henriot	Citrus leaves	Fouly & Al-Rehiayani (2011)
<i>Neoseiulus bicaudus</i> (Wainstein)	<i>Tropaeolum majus</i> L., in a date palm orchard	Negm <i>et al.</i> (2012)
<i>Neoseiulus conterminus</i> (Kolodochka)	<i>Convolvulus arvensis</i> L., in a date palm orchard	Negm <i>et al.</i> (2012)
<i>Neoseiulus makuwa</i> (Ehara)	<i>Sesuvium</i> sp., in a date palm orchard	Negm <i>et al.</i> (2012)
<i>Neoseiulus rambami</i> (Swirski & Amitai)	<i>Cynodon dactylon</i> L., <i>Phoenix dactylifera</i> L., in date palm orchards	Negm <i>et al.</i> (2012)
<i>Neoseiulus saudiensis</i> Negm, Alatawi & Aldryhim	<i>C. dactylon</i>	Negm <i>et al.</i> (2012)
<i>Proprioseiopsis asetis</i> (Chant)	<i>Chenopodium murale</i> L., <i>C. dactylon</i> , in date palm orchards	Negm <i>et al.</i> (2012)
<i>Proprioseiopsis messor</i> (Wainstein)	<i>Bauhinia variegata</i> L., in a date palm orchard	Negm <i>et al.</i> (2012)
<i>Proprioseiopsis ovatus</i> (Garman)	<i>C. dactylon</i> , <i>Ficus carica</i> L., <i>P. dactylifera</i> , <i>Sesuvium</i> sp., in date palm orchards	Negm <i>et al.</i> (2012)

* Re-examined and identified as *Neoseiulus barkeri* by the senior author; also appears in the literature as *Amblyseius barkeri*.

** Re-examined and identified as *Phytoseius plumifer* by the senior author.

*** *Amblyseius cydnodactylon* also appears in the literature as *Neoseiulus cydnodactylon*.

Materials and methods

Tullgren funnels were used to extract the mites from the plant material. Mites were also sampled by using specialized hand-held aspirators (BioQuip[®], CA, USA) after modifying the collecting chamber by adding a small piece of light cloth. Mite specimens were cleared in Nesbitt's solution, mounted in Hoyer's medium and studied under a phase-contrast microscope (BX51, Olympus[®], Japan). The classification system adopted is that of Chant and McMurtry (1994, 2003, 2005, 2007).

The voucher material of the three species recorded as new to Saudi Arabia is deposited at King Saud Museum of Arthropods, Riyadh (KSMA). Also, another collection of *Cydnoseius negevi* and *Neoseiulus paspalivorus* was deposited as slide mounted specimens in the Acarology Laboratory, Museum of Biological Diversity, The Ohio State University, 1315 Kinnear Road, Columbus, Ohio 43212, USA; voucher numbers are (OSAL0102691) for *C. negevi* and (OSAL0102690) for *N. paspalivorus*.

Species records

Cydnoseius negevi (Swirski & Amitai, 1961)

Typhlodromus (*Typhlodromus*) *negevi* Swirski & Amitai, 1961: 194.

Typhlodromus negevi: Amitai & Swirski, 1966: 21.

Typhlodromus (*Neoseiulus*) *negevi*: Ehara, 1966: 19.

Cydnodromella negevi: Chant & Yoshida-Shaul, 1986: 2815.

Cydnoseius negevi: Chant & McMurtry, 1994: 241; Moraes *et al.*, 2004: 263; Chant & McMurtry, 2007: 137; Palevsky *et al.*, 2009: 1732.

Specimens examined

10 females, 5 males, Alwaseel (Riyadh region), Saudi Arabia, 24°48'896N, 46°31'214E, elevation 630 m, *Cynodon dactylon* L. (Poaceae) in date palm orchards, 15 February 2010; 1 female, Alhassa (Eastern region), Saudi Arabia, 25°22'942N, 49°34'883E, elevation 161 m, *C. dactylon* in a date palm orchard, 25 June 2010; 4 females, 2 males, Al-Kharj (Riyadh region), Saudi Arabia, 24°22'054N, 47°47'018E, elevation 520 m, fruits of *Phoenix dactylifera* L. (Arecaceae), 02 November 2010; 2 females, Dierab (Riyadh region), Saudi Arabia, 24°24'482N, 46°39'520E, elevation 570 m, on the pinnate leaves of *P. dactylifera*, 07 March 2011; 1 female, Ouyaina (Riyadh region), Saudi Arabia, 24°53'751N, 46°21'106E, elevation 740 m, *Tropaeolum majus* L. (Tropaeolaceae) in a date palm orchard, 17 March 2011; 4 females, 2 males, Alkhutta (Hail region), Saudi Arabia, 28°01'718 N, 41°55'438E, elevation 789 m, *Citrus* spp. (Rutaceae), 05 April 2011; 2 females, Alhassa (Eastern region), Saudi Arabia, 25°23'451N, 49°38'149E, elevation 149 m, *C. dactylon* in a date palm orchard, 25 October 2011; 4 females, Wadi Al-Dawaser (Riyadh region), Saudi Arabia, 20°29'461N, 44°45'851E, elevation 674 m, *Sesuvium* sp. (Aizoaceae) in a date palm orchard, 01 December 2011, all collected by Mohamed W. Negm.

Remarks

This species is a new record for the Saudi Arabian mite fauna. *Cydnoseius negevi* originally was described from specimens collected from Wadi Arava, Southern District, Israel, on date palm (*P. dactylifera*) (Swirski & Amitai 1961) and was redescribed by Amitai and Swirski (1966), Chant and Yoshida-Shaul (1986) and Palevsky *et al.* (2009). The morphological characters of the Saudi specimens of *C. negevi* agree with the redescription given by Palevsky *et al.* (2009) for specimens collected from Israel. According to Chant and McMurtry (2007), there are six nominal species in the

genus *Cydnoseius*, four of which, *cordiae* Muma, 1967, *zaheri* El Badry, 1967a, *medanicus* El Badry, 1967b and *africanus* Yousef, 1980, are junior synonyms of *C. negevi*. Therefore, this genus has only two species, *C. negevi* and *C. muntius* (Schicha & Corpuz-Raros, 1992), the latter described from Makiling Botanic Gardens, Luzon, Philippines, on *Shorea guiso* (Blanco) Blume (Diptrocarpaceae). Moraes *et al.* (2004) indicated the validity of *C. muntius* was questionable, but the reason for their decision is not known.

Distribution

Israel (Swirski & Amitai 1961, Palevsky *et al.* 2009), Egypt (El Badry 1967a, 1970, Muma 1967, Zaher & Shehata 1969, Yousef 1980, Zaher 1986), Pakistan (Muma 1967), Sudan (El Badry 1967b), Oman (Hountondji *et al.* 2010), Emirates (Pers. Comm. of M.S. Gassouma with Mohamed W. Negm), Saudi Arabia (this study).

***Neoseiulus paspalivorus* (De Leon, 1957)**

Typhlodromus paspalivorus De Leon, 1957: 143.

Typhlodromus (*Amblyseius*) *paspalivorus*: Chant, 1959: 79.

Cydnodromus paspalivorus: Muma, 1961: 290.

Neoseiulus paspalivorus: Muma *et al.*, 1970: 110; Moraes *et al.*, 2004: 137; Kreiter *et al.*, 2010: 158; Ostovan *et al.*, 2012: 53.

Amblyseius paspalivorus: Schicha, 1981: 210.

Amblyseius (*Neoseiulus*) *paspalivorus*: Ghai & Gupta, 1984: 173.

Specimens examined

6 females, Al-Imam Mohamed Bin Saud Islamic University (Riyadh region), Saudi Arabia, 24°48'770N, 46°42'734E, elevation 645 m, *C. dactylon* in a date palm orchard, 08 October 2011, collected by Mohamed W. Negm.

Remarks

This species is a new record for the Saudi Arabian mite fauna. The species group *paspalivorus* is characterized by having a reticulated dorsal shield which is much longer than wide and with a distinct shoulder at the level of setae *r*₃ (Chant & McMurtry 2003). The Saudi specimens match the redescription of Ostovan *et al.* (2012) based on the specimen collected from Iran. In Tunisia, *N. paspalivorus* was collected from palm trees in association with eriophyid mites (Kreiter *et al.* 2010).

Distribution

Guadeloupe (Moraes *et al.* 2000), India (Gupta 1986), Jamaica (Denmark & Muma 1978), Philippines (Schicha & Corpuz-Raros 1992), USA (Muma *et al.* 1970), Cuba (Cabrera *et al.* 2008), Tunisia (Kreiter *et al.* 2010), Benin, Brazil, Ghana (Sourassou *et al.* 2011), Iran (Ostovan *et al.* 2012), Saudi Arabia (this study).

***Proprioseiopsis beatus* (Chaudhri, 1968)**

Amblyseius beatus Chaudhri, 1968: 551.

Proprioseiopsis beatus: Chaudhri *et al.*, 1979: 52; Chant & McMurtry, 2005: 15; 2007: 87; Palevsky *et al.*, 2009: 1717.

Specimens examined

1 female, Dammam (Eastern region), Saudi Arabia, 26°26'633N, 50°07'043E, elevation 528 m, *C. dactylon* in a date palm orchard, 09 May 2012, collected by Asmaa A. El-Naggar. 1 female, Jeddah (Makkah region), Saudi Arabia, 21°32'150N, 39°13'293E, elevation 1026 m, *C. dactylon* in a date palm orchard, 27 July 2012, collected by Asmaa A. El-Naggar.

Remarks

This is the first record of this species in Saudi Arabia. The original description of *Proprioiseiopsis beatus* was based on specimens collected from Lyallpur, Punjab, Pakistan, on *Triticum aestivum* L. (Poaceae) (Chaudhri 1968). *Proprioiseiopsis beatus* belongs to the species subgroup *belizensis* which comprises 74 nominal species (Chant & McMurtry 2005). The Saudi specimens are very similar to the Israeli specimen redescribed by Palevsky *et al.* (2009). However, Palevsky *et al.* (2009) reported that setae *S2* are longer than reported in the type material (51 vs 36 µm) while in the Saudi specimens the setae *S2* length match the type material.

Distribution

Pakistan (Chaudhri 1968), Israel (Palevsky *et al.* 2009), Saudi Arabia (this study).

Key to the Phytoseiidae of Saudi Arabia (female)

1. Seta *z3* and *s6* absent (subfamily Amblyseiinae Muma) 4
- Either or both setae *z3* and *s6* present 2
2. Setae *Z1*, *S2*, *S4* and *S5* absent (subfamily Phytoseiinae Berlese)
. *Phytoseius plumifer* (Canestrini & Fanzago)
- At least one of setae *Z1*, *S2*, *S4* and *S5* present (subfamily Typhlodrominae Chant & McMurtry)
. 3
3. Seta *z3* absent, *Z1* present *Cydnoseius negevi* (Swirski & Amitai)
- Seta *z3* present, *Z1* absent *Typhlodromus pyri* Scheuten
4. Preanal setae aligned in approximately two transverse rows, *JVI* not inserted on anterior margin
of ventrianal shield; peritremes not reaching the level of *j3* *Euseius scutalis* (Athias-Henriot)
- Preanal setae arranged in three rows, *JVI* inserted on anterior margin of ventrianal shield;
peritremes reach and pass the level of *j3* 5
5. If macrosetae present, only occur on leg IV *Neoseiulus* Hughes 10
- Macrosetae at least on genua III as well as on leg IV 6
6. Setae *J2* present *Typhlodromips swirskii* (Athias-Henriot)
- Setae *J2* absent *Proprioiseiopsis* Muma 7
7. Calyx of spermatheca cup-shaped *P. asetus* (Chant)
- Calyx of spermatheca elongate and tubular 8
8. Setae *Z5* longer than distance between their bases *P. messor* (Wainstein)
- Setae *Z5* shorter than distance between their bases 9
9. Sternal shield and lateral parts of genital shield reticulated *P. ovatus* (Garman)
- Sternal and genital shields smooth *P. beatus* (Chaudhri)
10. Macrosetae absent on leg IV *N. mumae* (Shehata & Zaher)
- Macroseta/e present on leg IV 11
11. Spermatheca with atrium not forked at junction with major duct 12
- Spermatheca with atrium forked at junction with major duct 16
12. Calyx of spermatheca bell-shaped; atrium simple or elongate 13

- Calyx of spermatheca bowl-shaped; atrium nodular. 14
- 13. Atrium appearing thick-walled and moderately elongate *N. conterminus* (Kolodochka)
- Atrium not appearing thick-walled nor elongate. *N. cucumeris* (Oudemans)
- 14. Stalk clearly present between calyx and atrium; seta *Z5* longer than 75µm
. *N. bicaudus* (Wainstein)
- Stalk hardly visible between calyx and atrium; seta *Z5* shorter than 75 µm 15
- 15. Sternal and genital shields moderately reticulated; *StIV* short (less than 20µm)
. *N. paspalivorus* (De Leon)
- Sternal and genital shields smooth; *StIV* long (more than 50µm).
. *N. rambami* (Swirski & Amitai)
- 16. Calyx of spermatheca trumpet-shaped; genu IV with macroseta *N. makuwa* (Ehara)
- Calyx of spermatheca cone-shaped; genu IV without macroseta 17
- 17. Spermatheca with a stalk between calyx and atrium. *N. saudiensis* Negm, Alatawi & Aldryhim
- Spermatheca without a stalk between calyx and atrium 18
- 18. Setae *Z4* subequal in length to *Z5* *N. cydnodactylon* (Shehata & Zaher)
- Setae *Z4* shorter than *Z5* *N. barkeri* Hughes

Acknowledgements

The authors would like to thank Dr. Mohamed S. Gassouma (Ajman Municipality, Public Health Pest Control, Emirates) for providing information about the reporting of *C. negevi* in Emirates. Many thanks to Eddie Ueckermann (ARC-PPRI, Pretoria, South Africa) for his kind review of the manuscript.

References

- Al-Atawi, F.J. (2011a) Phytophagous and predaceous mites associated with vegetable crops from Riyadh, Saudi Arabia. *Saudi Journal of Biological Sciences*, 18, 239–246.
- Al-Atawi, F.J. (2011b) Six new records of predaceous mites associated with trees from Riyadh, Saudi Arabia. *Acarines*, 5, 37–39.
- Al-Shammery, K.A. (2010) Different biological aspects of the predaceous mite *Euseius scutalis* (Acari: Gamasida: Phytoseiidae) and the effects due to feeding on three tetranychid mite species in Hail, Saudi Arabia. *Asian Journal of Biological Sciences*, 3, 77–84.
- Amitai, S. & Swirski, E. (1966) Illustrations of spermathecae in several previously described phytoseiid mites (Acarina) from Hong Kong and Israel. *The Israel Journal of Agricultural Research*, 16, 19–24.
- Beaulieu, F., Dowling, A.P.G, Klompen, H., Moraes, G.J. de & Walter, D.E. (2011) Superorder Parasitiformes Reuter, 1909. In: Zhang, Z.-Q. (Ed.), *Animal biodiversity: an outline of higher-level classification and survey of taxonomic richness*. *Zootaxa*, 3148, 123–128.
- Cabrera, R.I., Cueto Rodríguez, J.R. & Otero Colina, G. (2008) Natural enemies of mite *Aceria guerreronis* Keifer (Acari: Eriophyidae) in Cuba and their perspectives for pest management. *Fitosanidad*, 12, 99–107.
- Canestrini, G. & Fanzago, F. (1876) Nuovi acari italiani (Seconda Serie). *Atti Societa Veneto-Trentina di Scienze Naturali*, Italy, 5, 130–142.
- Chant, D.A. (1959) Phytoseiid mites (Acarina: Phytoseiidae). Part I. Bionomics of seven species in southeastern England. Part II. A taxonomic review of the family Phytoseiidae, with descriptions of 38 new species. *Canadian Entomologist*, 91(suppl. 12), 1–166.
- Chant, D.A. & McMurtry, J.A. (1994) A review of the subfamilies Phytoseiinae and Typhlodrominae (Acari: Phytoseiidae). *International Journal of Acarology*, 20, 223–310.
- Chant, D.A. & McMurtry, J.A. (2003) A review of the subfamily Amblyseiinae Muma (Acari: Phytoseiidae).

- Part I. Neoseiulini new tribe. *International Journal of Acarology*, 29, 3–46.
- Chant, D.A. & McMurtry, J.A. (2005) A review of the subfamily Amblyseinae Muma (Acari: Phytoseiidae): Part V. Tribe Amblyseiini, Subtribe Proprioseiopsina Chant and McMurtry. *International Journal of Acarology*, 31, 3–22.
- Chant, D.A. & McMurtry, J.A. (2007) *Illustrated Keys and Diagnoses for the Genera and Subgenera of the Phytoseiidae of the World (Acari: Mesostigmata)*. West Bloomfield, Michigan, Indira Publishing House. 220pp.
- Chant, D.A. & Yoshida-Shaul, E. (1986) A new subfamily, Cydnodromellinae, in the family Phytoseiidae (Acari: Gamasina). *Canadian Journal of Zoology*, 64(12), 2811–2823.
- Chaudhri, W.M. (1968) Six new species of mites of the genus *Amblyseius* (Phytoseiidae) from Pakistan. *Acarologia*, 10, 550–562.
- Chaudhri, W.M., Akbar, S. & Rasool, A. (1979) *Studies on the Predatory Leaf Inhabiting Mites of Pakistan*. Faisalabad, Pakistan, University of Agriculture. 243pp.
- Dabbour, A.I. & Abdel-Aziz, M.I. (1982) Scientific note on Acarina in Saudi Arabia. *Journal of the College of Agriculture, King Saud University*, 4, 113–116.
- De Leon, D. (1957) Three new *Typhlodromus* from southern Florida (Acarina: Phytoseiidae). *Florida Entomologist*, 40, 141–144.
- Denmark, H.A. & Muma, M.H. (1978) Phytoseiidae of Jamaica, an annotated list (Acari: Mesostigmata). *International Journal of Acarology*, 4(1), 1–22.
- Ehara, S. (1966) A tentative catalogue of predatory mites of Phytoseiidae known from Asia, with descriptions of five new species from Japan. *Mushi*, 39, 9–30.
- El Badry, E.A. (1967a) Five new phytoseiid mites from U.A.R., with collection notes on three other species (Acarina: Phytoseiidae). *Indian Journal of Entomology*, 29, 177–184.
- El Badry, E.A. (1967b) Three new species of phytoseiid mites preying on the cotton white fly, *Bemisia tabaci* in the Sudan (Acarina: Phytoseiidae). *The Entomologist*, 100, 106–111.
- El-Badry, E.A. (1970) Taxonomic review of the phytoseiid mites of Egypt. *Bulletin de la Société Entomologique d’Egypte*, 54, 495–510.
- Fouly, H. & Al-Rehiayani, S.M. (2011) Predaceous mites in Al-Qassim Region, Saudi Arabia, with description of two new laelapid species (Acari: Gamasida: Laelapidae). *Journal of Entomology*, 8, 139–151.
- Ghai, S. & Gupta, S.K. (1984) A new species of *Treatia* Krantz and Khot (Acari: Otopheidomenidae) with a new record of *Amblyseius* Berlese (Acari: Phytoseiidae) from India. *Bulletin of the Zoological Survey of India*, 6(1–3), 171–175.
- Gupta, S.K. (1986) *Acari: Mesostigmata, Family Phytoseiidae. Fauna of India*. Calcutta, Zoological Survey of India. 350pp.
- Hountondji, F.C.C., Moraes, G.J.de & Al-Zawamri, H. (2010) Mites (Acari) on coconut, date palm and associated plants in Oman. *Systematic & Applied Acarology*, 15, 228–234.
- Hughes, A.M. (1948) *The Mites of Stored Food and Houses*. London, Ministry of Agriculture, Fisheries and Food, H.M. Stationery Office. 400pp.
- Kostiainen, T.S. & Hoy, M.A. (1996) *The Phytoseiidae as Biological Control Agents of Mite Pests and Insects. A Bibliography (1960-1994)*. Gainesville, University of Florida, IFAS Monograph 17. 355pp.
- Kreiter, S., Tixier, M.-S., Sahraoui, H., Lebdi-Grissa, K., Ben Chabaan, S., Chatti, A., Chermiti, B., Khouldia, O., & Ksantini, M. (2010) Phytoseiid mites (Acari: Mesostigmata) from Tunisia: catalogue, biogeography, and key for identification. *Tunisian Journal of Plant Protection*, 5, 151–178.
- McMurtry, J.A. & Croft, B.A. (1997) Life-styles of phytoseiid mites and their roles in biological control. *Annual Review of Entomology*, 42, 291–321.
- Moraes, G.J. de, Kreiter, S. & Lofego, A.C. (2000) Plant mites (Acari) of the French Antilles. 3. Phytoseiidae (Gamasida). *Acarologia*, 40(3), 237–264.
- Moraes, G.J. de, McMurtry, J.A., Denmark, H.A. & Campos, C.B. (2004) A revised catalog of the mite family Phytoseiidae. *Zootaxa*, 434, 1–494.
- Muma, H.M. (1961) Subfamilies, genera and species of Phytoseiidae (Acarina: Mesostigmata). *Bulletin of the Florida State Museum. Biological Sciences*, 5, 267–302.
- Muma, H.M. (1967) New Phytoseiidae (Acarina: Mesostigmata) from southern Asia. *Florida Entomologist*, 50, 267–280.
- Muma, M.H., Denmark, H.A. & De Leon, D. (1970) Phytoseiidae of Florida. *Arthropods of Florida and Neighboring Land Areas*, 6, 1–150.
- Negm, M.W., Alatawi, F.J. & Aldryhim, Y.N. (2012) A new species of *Neoseiulus* Hughes, with records of

- seven species of predatory mites associated with date palm in Saudi Arabia (Acari: Phytoseiidae). *Zoo-taxa*, 3356, 57–64.
- Ostovan, H., Faraji, F., Kamyab, F. & Khadempour, F. (2012) Notes on *Neoseiulus paspalivorus* (De Leon) and *Proprioseiopsis messor* (Wainstein) (Acari: Phytoseiidae) collected in Iran. *Acarologia*, 52, 51–58.
- Palevsky, E., Gal, S. & Ueckermann, E.A. (2009) Phytoseiidae from date palms in Israel with descriptions of two new taxa and a key to the species found on date palms worldwide (Acari: Mesostigmata). *Journal of Natural History*, 43, 1715–1747.
- Schicha, E. (1981) A new species of *Amblyseius* from Australia compared with ten closely related species from Asia, America and Africa. *International Journal of Acarology*, 7, 203–216.
- Schicha, E. & Corpuz-Raros, L.A. (1992) *Phytoseiidae of the Philippines*. West Bloomfield, Michigan, USA, Indira Publishing House. 190pp.
- Shehata, K.K. & Zaher, M.A. (1969) Two new species of the genus *Amblyseius* in the U.A.R. (Acarina - Phytoseiidae). *Acarologia*, 11, 175–179.
- Sourassou, N.F., Hanna, R., Zannou, I., Moraes, G.J. de, Negloh, K. & Sabelis, M.W. (2011) Morphological variation and reproductive incompatibility of three coconut-mite-associated populations of predatory mites identified as *Neoseiulus paspalivorus* (Acari: Phytoseiidae). *Experimental & Applied Acarology*, 53, 323–338.
- Swirski, E. & Amitai, S. (1961) Some phytoseiid mites (Acarina: Phytoseiidae) of Israel, with a description of two new species. *The Israel Journal of Agricultural Research*, 11, 193–202.
- Yousef, A.T.A. (1980) Morphology and biology of *Typhlodormus africanus* n. sp. (Acarina: Mesostigmata: Phytoseiidae). *Acarologia*, 22(2), 121–125.
- Zaher, M.A. (1986) *Predaceous and Nonphytophagous Mites (Nile Valley and Delta)*. Text. Survey and Ecological Studies on Phytophagous, Predaceous and Soil Mites in Egypt. Egypt, PL 480 Programme USA, Project EG_ARS_30, Grant No. FG_EG_139. 567pp.
- Zaher, M.A. & Shehata, K.K. (1969) Two new species of the genus *Typhlodromus* (Acarina: Phytoseiidae). *Bulletin of Entomology. Entomological Society of India*, 10, 54–59.

Accepted by Anne Baker: 8 Aug. 2012; published 31 Aug. 2012