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A new species of *Neoseiulus* Hughes, with records of seven species of predatory mites associated with date palm in Saudi Arabia (Acari: Phytoseiidae)

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Abstract

Eight species of phytoseiid mites are reported from date palm orchards in Saudi Arabia. Seven of them were first records for this country: *Neoseiulus bicaudus* (Wainstein), *N. conterminus* (Kolodochka), *N. makuwa* (Ehara), *N. rambami* (Swirski & Amitai), *Proprioseiopsis asetus* (Chant), *P. messor* (Wainstein), *P. ovatus* (Garman). *Neoseiulus makuwa* and *P. asetus* are recorded from the Middle East and North Africa for the first time. One new species is described from Bermuda grass, *Neoseiulus saudiensis* **n. sp**. The new species is most similar to *Neoseiulus alpinus* (Schweizer) and *N. marginatus* (Wainstein). A key for identification of the included species is provided.

Key words: Acari, Mesostigmata, Phytoseiidae, biological control, predatory mites, *Neoseiulus saudiensis*, Saudi Arabia.

Introduction

The predatory mite family Phytoseiidae contains most of the species presently used as biological control agents of mite pests (Kostiainen & Hoy, 1996; McMurtry & Croft, 1997). The fauna of Phytoseiidae in Saudi Arabia is very poorly known, with only ten species previously recorded (Dabbour & Abdel-Aziz, 1982; Al-Shammery, 2010; Al-Atawi, 2011a,b; Fouly & Al-Rehiayani, 2011). Projects are underway to identify the fauna of phytoseiid mites in Saudi Arabia and select the species that may have potential as biological control agents.

In Saudi Arabia, date palm is an economic plant that is attacked by several pests. Among these is the old world date mite *Oligonychus afrasiaticus* (McGregor, 1939) (Acari: Tetranychidae), which affects the quality of the product and downgrades its value on the market. The present study was intended to identify the predatory mites in date palm orchards, mainly in Riyadh region, and recommend promising species for further studies.

Material and methods

Orchards were sampled for predatory mites over two years (2010–2011). Tullgren funnels or/and direct observation under a stereoscopic microscope (SZX10, Olympus®, Japan) were used to extract the mites from the plant material. Sampling included herbs and weeds growing in the orchards. Mites on weeds were sampled by using specialised hand-held aspirators (BioQuip®, CA, USA) after modifying the collecting chamber by adding a small piece of light cloth. The collected specimens were cleared in Nesbitt's solution, mounted in Hoyer's medium on glass slides, dried on a hot plate, ringed with nail polish and examined under a phase-contrast microscope (BX51, Olympus®). Measurements were taken with a graded eyepiece and illustrations were made using a drawing tube attached to the microscope. Identification was carried out according to Chant & McMurtry (2003, 2005, 2007). Setal nomenclature follows that of Rowell *et al*. (1978) and Chant & Yoshida-Shaul (1991) for dorsal and ventral surfaces of the idiosoma, respectively. Notation of idiosomal poroidotaxy follows Athias-Henriot (1975). All measurements are in micrometres (µm) and presented as means followed by the range (in parentheses). The type material and voucher

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specimens were deposited at King Saud Museum of Arthropods, Riyadh (KSMA). One paratype female was deposited at the National Insect and Mite Collection of the National Museum of Natural History (USNM), Smithsonian Institution located in Beltsville, Maryland, USA and one paratype female at the Agriculture Research Council, Plant Protection Research Institute, Biosystematics Division, Pretoria, South Africa (ARC-PPRI). All paratypes have the same data as the holotype.

Family Phytoseiidae Berlese, 1913
Subfamily Amblyseiinae Muma, 1961
Tribe Neoseiulini Chant & McMurtry, 2003
***Neoseiulus* Hughes, 1948**
Species group *barkeri* Chant & McMurtry, 2003
Species subgroup *womersleyi* Chant & McMurtry, 2003

***Neoseiulus saudiensis* n. sp.**
(Figures 1–5)

Female (Figures 1–5) (n=5)

Dorsal idiosoma (Figure 1). Dorsal shield 330 (324–337) long and 172 (165–180) wide at *j6* level, completely reticulated, with 17 pairs of smooth dorsal setae except for *Z4* and *Z5*, which are slightly serrate, and two pairs of lateral setae. Seven pairs of solenostomes present, gd1, gd2, gd4, gd5, gd6, gd8, gd9. Lengths of dorsal setae: *j1* 20 (18–21), *j3* 30 (29–31), *j4* 23 (22–25), *j5* 23 (23–24), *j6* 25 (24–27), *J2* 30 (29–30), *J5* 12 (12–13), *z2* 30 (30–31), *z4* 29 (28–29), *z5* 23 (23–24), *Z1* 28 (26–29), *Z4* 49 (48–50), *Z5* 69 (68–70), *s4* 40 (39–41), *S2* 37 (36–39), *S4* 34 (32–36), *S5* 31 (30–33) and lateral setae *r3* 26 (25–28), *R1* 27 (26–29). Peritreme extending to *j1* level (Figure 1).

Ventral idiosoma (Figure 2). Sternal shield slightly reticulated, 63 (61–65) long (*ST1–ST3*) and 55 (54–58) wide at *ST2* level, straight posterior and convex anterior margins, with three pairs of setae and two pairs of poroides (*iv1–2*). Setae *ST1* 26 (26–27), *ST2* 27 (27–28), *ST3* 26 (25–27) and *ST4* 28 (28–29) and a pair of poroides on metasternal shields. Genital shield 57 (56–58) wide at *ST5* level, setae *ST5* 27 (26–27), paragenital poroides located on soft integument between setae *ST5* and *ZV1*, posterior margin straight. Two pairs of metapodal shields present, primary 30 (29–32) and accessory 9 (9–10). Ventrianal shield 120 (118–121) along midline and 90 (88–92) wide at *ZV2* level, reticulate, with three pairs of preanal setae *JV1* 24 (24–25), *ZV2* 25 (25–26), *JV2* 23 (22–24) and a pair of well separated glandular pores posteromesad to *JV*2, distance between these pores 26 (26–27). Four pairs of smooth opisthogastric setae around the ventrianal shield *ZV1* 21 (20–22), *ZV3* 19 (18–20), *JV4* 22 (21–23), *JV5* 53 (51–54)-slightly serrate.

Spermatheca. Calyx of spermatheca saccular 21 (20–22) long, narrow neck connecting calyx with forked atrium (Figure 3).

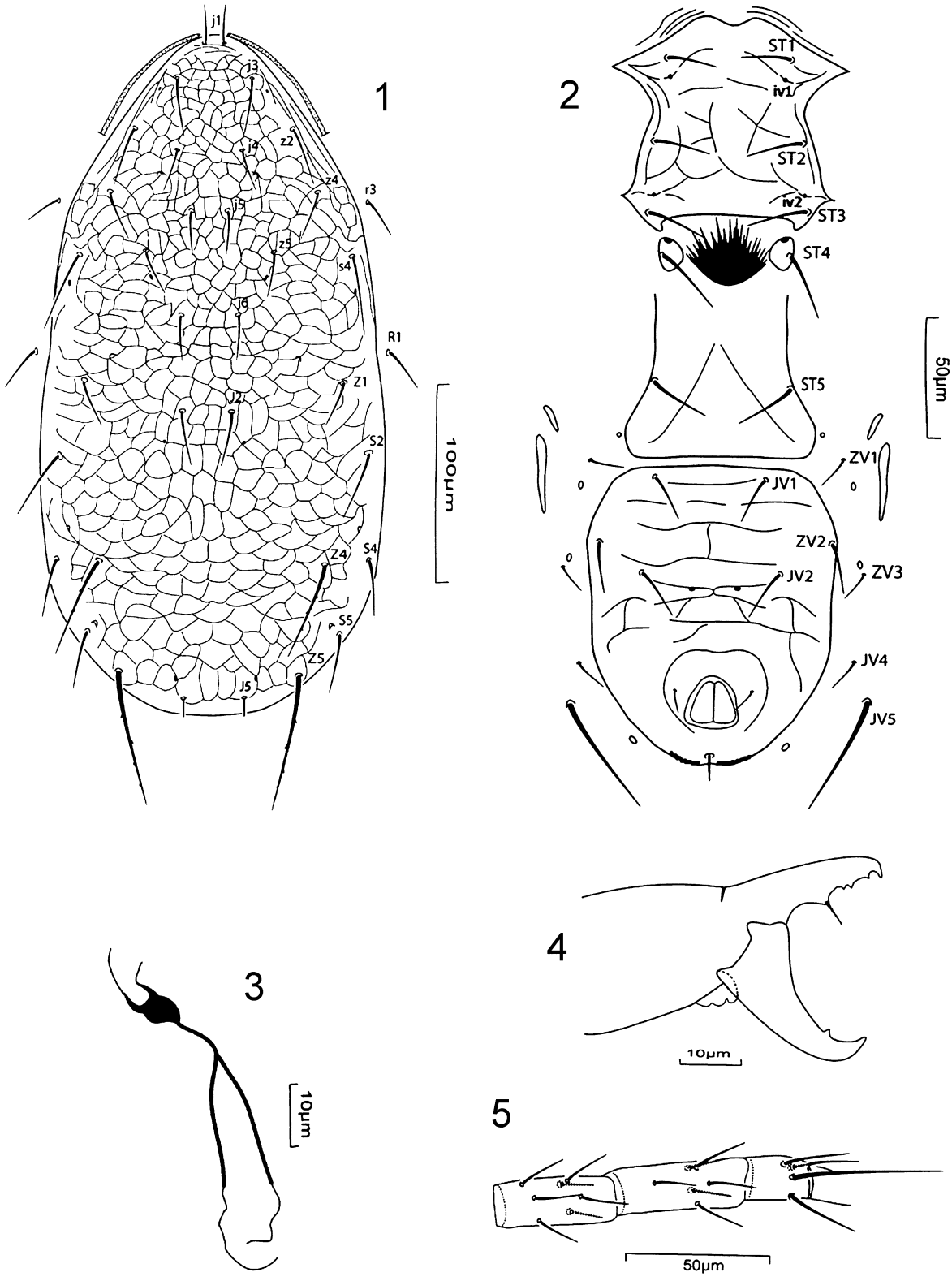
Chelicera (Figure 4). Movable digit 25 (25–26) long with one tooth; fixed digit 27 (26–28) long with three teeth and a pilus dentilis 4 (4–5) long.

Legs. One pointed macroseta on basitarsus IV 53 (50–56) (Figure 5); genua and tibiae I–IV with 10–7–7–7 and 10–7–7–6 setae, respectively.

Etymology. The name *saudiensis* refers to the country where the type specimens were collected.

Specimens examined. Holotype female and 24 paratype females, on aerial part of Bermuda grass, *Cynodon dactylon* (L.) Pers. (Poaceae) in a date palm orchard, Dereiya, Riyadh region, Saudi Arabia, 24º 42' N, 46º 37' E, alt. 645 m, 19 November 2010, coll. Mohamed W. Negm. Holotype and 22 paratypes deposited at King Saud Museum of Arthropods (KSMA); 1 paratype female at the National Insect and Mite Collection of the National Museum of Natural History (USNM), Smithsonian Institution, Beltsville, Maryland, USA; 1 paratype female at the Agriculture Research Council, Plant Protection Research Institute, Biosystematics Division, Pretoria, South Africa (ARC-PPRI).

Remarks. This species is characterised by the following combination of characters: dorsal shield completely reticulated, sternal shield slightly reticulated, peritreme extending to *j1* level, calyx of spermatheca saccular and connected to a forked atrium with long narrow neck.



FIGURES 1–5. *Neoseiulus saudiensis* Negm, Alatawi & Aldryhim **n. sp.** Female, 1. idiosoma dorsum, 2. idiosoma venter, 3. spermatheca, 4. chelicera, 5. genu, tibia and basitarsus IV.

The new species belongs to the *barkeri* species group and the *womersleyi* species subgroup as defined by Chant & McMurtry (2003). *Neoseiulus alpinus* (Schweizer, 1922) and *Neoseiulus marginatus* (Wainstein, 1961) are similar to this new species. However, *Neoseiulus saudiensis* **n. sp.** differs from the former by having all dorsal setae much longer, sternal shield straight posteriorly, a longer neck between the calyx and atrium, and it differs

from the latter in having longer anterodorsal setae (*j3*, *j4*, *j5*, *j6*, *J2*, *z2*, *z4*, *z5*, *Z1*, *s4*), completely reticulated dorsal shield, narrower and longer neck between calyx and atrium, and shorter macroseta St IV. The new species was compared with redescriptions of *N. marginatus* by Palevsky *et al*. (2009) and Faraji *et al*. (2011) on the specimens collected from Israel and Turkey, respectively.

Species group *cucumeris* Chant & McMurtry, 2003
Species subgroup *paraki* Chant & McMurtry, 2003

***Neoseiulus bicaudus* (Wainstein)**

Amblyseius bicaudus Wainstein, 1962: 146.
Neoseiulus bicaudus.— Chant & McMurtry, 2003: 23; 2007: 25; Moraes *et al*., 2004: 108; Palevsky *et al*., 2009: 1729; Asali Fayaz *et al*., 2011: 375.

Specimens examined. One female, Ouyaina, Riyadh, 17 March 2010, 24°53' N, 46°21' E, alt. 740 m, on Garden nasturtium, *Tropaeolum majus* L. (Tropaeolaceae) in a date palm orchard.

Remarks. The type specimens of this species were collected from grass at Kargalink, Alma-Ata, Kazakhstan. The Saudi specimen is very similar to the redescription done by Palevsky *et al*. (2009) who illustrated genu IV (Fig. 6E) with six setae. However, genu IV has seven setae in the Saudi specimen. This is the first record of this species in Saudi Arabia. This species occurs in Armenia, Azerbaijan, Caucasus, France, Georgia, Greece, Hungary, Israel, Italy, Moldova, Norway, Russia, Serbia, Spain, Switzerland, Tajikistan, Turkey, Ukraine, USA (Moraes *et al*., 2004) and Iran (Asali Fayaz *et al*., 2011).

Species group *cucumeris* Chant & McMurtry, 2003
Species subgroup *paraki* Chant & McMurtry, 2003

***Neoseiulus conterminus* (Kolodochka)**

Amblyseius conterminus Kolodochka, 1990: 161.
Neoseiulus conterminus.— Chant & McMurtry, 2003: 23; Moraes *et al*., 2004: 114; Chant & McMurtry, 2007: 25; Palevsky *et al*., 2009: 1727.

Specimens examined. One female, Dereiya, Riyadh, 9 June 2010, 24˚44' N, 46˚34' E, alt. 670 m, on Bindweed, *Convolvulus arvensis* L. (Convolvulaceae) in a date palm orchard.

Remarks. The type specimens were collected from soil at Karakalpak, Uzbekistan while the Saudi specimen was found on *Convolvulus arvensis* leaves. Our specimen of *N. conterminus* agrees with the redescription given by Palevsky *et al*. (2009) for two female specimens collected from *Cynodon dactylon* in date palm orchards, Israel. This species is a new record for the Saudi mite fauna. This species has been recorded from Israel and Uzbekistan.

Species group *barkeri* Chant & McMurtry, 2003
Species subgroup *womersleyi* Chant & McMurtry, 2003

***Neoseiulus makuwa* (Ehara)**

Amblyseius (*Amblyseius*) *makuwa* Ehara, 1972: 154.
Amblyseius makuwa.— Wu *et al*., 1991: 89.
Amblyseius (*Neoseiulus*) *makuwa*.— Ehara and Amano, 1998: 37.
Neoseiulus makuwa.- Chant & McMurtry, 2003: 37; Moraes *et al*., 2004: 131; Zannou *et al*., 2006: 261; Chant & McMurtry, 2007: 29.

Specimens examined. Three females, Dereiya, Riyadh, 19 May 2011, 24°44' N, 46°34' E, alt. 678 m, on Sea-purslanes, *Sesuvium* sp. (Aizoaceae) in a date palm orchard.

Remarks. The type specimens were found on *Cucumis melo* var. *makuwa* at Kita-usa, Usa, Oita, Kyushu, Japan. The Saudi specimens completely agree with the redescription of *N. makuwa* given by Zannou *et al*. (2006), who reported one female specimen for the first time in Africa (Cameroon), on *Ageratus conyzoides*. This is the first record of this species in Saudi Arabia, as well as in the Middle East and North Africa. This species has also been recorded in China, Indonesia (Sumatra), Japan, South Korea, Taiwan (Ehara and Amano, 2004; Moraes *et al*., 2004); Cameroon (Zannou *et al*., 2006).

Species group *paspalivorus* Chant & McMurtry, 2003

Neoseiulus rambami (Swirski & Amitai)

Amblyseius rambami Swirski & Amitai, 1990: 117.
Neoseiulus rambami, Chant & McMurtry, 2003: 27; 2007: 29; Palevsky *et al*., 2009: 1724.

Specimens examined. Five females, Alhasa region, 26 October 2011, 25°22' N, 49°34' E, alt. 160 m, three specimens on the pinnate leaves of *Phoenix dactylifera* L. (Arecaceae) and two on *Cynodon dactylon*.

Remarks. The type specimens of *Neoseiulus rambami* were found on *Ficus religiosa*, Tiberias, Israel (Swirski & Amitai, 1990). Morphological characteristics of the Saudi specimens are very close to those as redescribed by Palevsky *et al*. (2009). The only remarkable difference is that Palevsky *et al*. (2009, Fig. 4E) illustrated genu IV with six setae. However, genu IV has seven setae in the Saudi specimen. Males are described for the first time by Palevsky *et al*. (2009). This is the first record of this species in Saudi Arabia, and it is otherwise known only from Israel.

Tribe Amblyseiini Wainstein, 1962
Subtribe Proprioseiopsina Chant & McMurtry, 2005
Proprioseiopsis Muma, 1961
Species group *belizensis* Chant & McMurtry, 2005
Species subgroup *asetus* Chant & McMurtry, 2005

Proprioseiopsis asetus (Chant)

Typhlodromus (*Amblyseius*) *asetus* Chant, 1959: 80.
Amblyseiulus asetus.— Muma, 1961: 278.
Proprioseiopsis asetus.— Fouly *et al*., 1994: 205; Moraes *et al*., 2004: 171; Chant & McMurtry, 2005: 13; 2007: 89.

Specimens examined. One female, three males, Dereiya, Riyadh, 17 March 2011, 24˚44' N, 46˚34' E, alt. 675 m, on *Cynodon dactylon* in a date palm orchard; one female, Ouyaina, Riyadh, 08 May 2011, 24°54' N, 46°23' E, alt. 736 m, on Nettle-leaved goosefoot, *Chenopodium murale* L. (Amaranthaceae) in a date palm orchard.

Remarks. The original description of *P. asetus* is based on material collected from apple, at Kearneysville, West Virginia, USA. Muma *et al*. (1970) recorded and described the males and females of 16 species in Florida including *P. asetus*. Our specimens of *P. asetus* agree with the data provided by Fouly *et al*. (1994) on the specimens collected in debris samples under "Hamlin" orange trees at Fellsmere, Indian River County, Florida. According to the redescription provided by Fouly *et al*. (1994, Figs. 29, 31), the genua and tibiae II–IV have 10–6 and 7–7 setae, respectively. However, the examined Saudi specimens have genua and tibiae II–IV with 8–7 and 7–6 setae, respectively. A description of larvae, protonymphs and deutonymphs of *P. asetus* including ontogenetic development of the idiosomal setae was given by Fouly *et al*. (1994). This is the first record of this species in Saudi Arabia, as well as in the Middle East and North Africa. It is otherwise known from Brazil, Galapagos, Hawaii, Jamaica, Mexico, Taiwan, USA (Moraes *et al*., 2004).

Species group *belizensis* Chant & McMurtry, 2005
Species subgroup *belizensis* Chant & McMurtry, 2005

***Proprioseiopsis messor* (Wainstein)**

Typhlodromus messor Wainstein, 1960: 688.
Amblyseius messor.— Athias-Henriot, 1961: 425.
Amblyseius (*Amblyseius*) *messor*.— Ueckermann & Loots, 1988: 66.
Proprioseiopsis messor.— Moraes *et al*., 2004: 180; Chant & McMurtry, 2005: 15; 2007: 89; Moraes *et al*., 2007: 16.

Specimens examined. Four females, Dereiya, Riyadh, 29 March 2011, 24°43' N, 46°37' E, alt. 674 m, on Orchid tree, *Bauhinia variegata* L. (Fabaceae) in a date palm orchard.

Remarks. Specimens of *Proprioseiopsis messor* were found on *Bauhinia variegata* close to the soil surface. Mites were found associated with thrips (Insecta). The Saudi specimens of *P. messor* agree with the data provided by Moraes *et al*. (2007) for two specimens collected in sub-Saharan Africa (South Africa). This species is a new record for the Saudi mite fauna. It has previously been recorded from Algeria, Armenia, Australia, Azerbaijan, France, Gaza Strip, Georgia, Germany, Greece, Israel, Italy, Morocco, New Zealand, South Africa, Spain, Turkmenistan, Ukraine (Moraes *et al*., 2004); Argentina (Ruiz *et al*., 2005).

Species group *belizensis* Chant & McMurtry, 2005
Species subgroup *belizensis* Chant & McMurtry, 2005

***Proprioseiopsis ovatus* (Garman)**

Amblyseiopsis ovatus Garman, 1958: 78.
Typhlodromus (*Amblyseius*) *ovatus*.— Chant, 1959: 90.
Amblyseiulus ovatus.— Muma, 1961: 278.
Proprioseiopsis ovatus.— Moraes *et al*., 2004: 184; Chant & McMurtry, 2005: 15; 2007: 89; Moraes *et al*., 2007: 19; Faraji *et al*., 2008: 109.

Specimens examined. One female, one male, Ouyaina, Riyadh, 01 November 2010, 24°54' N, 46°23' E, alt. 736 m, on Fig, *Ficus carica* L. (Moraceae) in a date palm orchard; 11 females, Al-Imam Mohamed Bin Saud Islamic University, Riyadh, 20 April 2011, 24°49' N, 46°42' E, alt. 657 m, on *Sesuvium* sp., in a date palm orchard; 12 females, 27 males, Unaiza, Qassim region, 25 May 2011, 26˚04' N, 43˚59' E, alt. 683 m, on *Cynodon dactylon*, in a date palm orchard; 3 females, Nadec company, Wadi Al-Dawaser, 06 July 2011, 20˚20' N, 45˚08' E, alt. 308 m, on *Phoenix dactylifera*.

Remarks. The holotype of *Proprioseiopsis ovatus* was collected on *Cattleya* sp. from Ecuador, intercepted at Brownsville, Texas, USA and deposited in United States National Museum. The specimens of *P. ovatus* in this study resemble those redescribed by Moraes *et al*. (2007) and Faraji *et al*. (2008), which were collected from sub-Saharan Africa and Spain, respectively. This is the first record of this species in Saudi Arabia. The species is also known from Brazil, Costa Rica, Cuba, Ecuador, Egypt, Ghana, Hawaii, Honduras, Kenya, Philippines, Puerto Rico, Sierra Leone, South Africa, Taiwan, USA, Zimbabwe (Moraes *et al*., 2004; Moraes *et al*., 2007); Spain (Faraji *et al*., 2008).

Key to species of the Phytoseiidae treated in this paper

1. Setae *J2* present . . . . . *Neoseiulus* Hughes...2
- Setae *J2* absent . . . . . *Proprioseiopsis* Muma...6
2. Spermatheca with atrium forked at juncture with major duct 3
- Spermatheca with atrium not forked at juncture with major duct 4
3. Calyx trumpet-shaped, genu IV with macroseta . . . . . *N. makuwa* (Ehara)
- Calyx saccular, genu IV without macroseta . . . . . *N. saudiensis* **n. sp.**
4. Calyx of spermatheca bell-shaped; atrium moderately elongate . . . . . *N. conterminus* (Kolodochka)

- Calyx of spermatheca bowl-shaped; atrium nodular 5
5. Stalk clearly present between the calyx and atrium; seta *Z5* longer than 75µm, movable digit of chelicera with one tooth . . . . . *N. bicaudus* (Wainstein)
- Stalk hardly seen between calyx and atrium; seta *Z5* shorter than 75µm, movable digit with two teeth . . . . . *N. rambami* (Swirski & Amitai)
6. Calyx of spermatheca pocular . . . . . *P. asetus* (Chant)
- Calyx of spermatheca saccular 7
7. Sternal shield smooth at the central region; all surface of genital shield smooth; atrium of spermatheca compact to base of the calyx; internal surface of calyx base appears convex . . . . . *P. messor* (Wainstein)
- Sternal shield reticulate at the central region; genital shield with lateral striae; atrium nodular; internal surface of calyx base is normally rounded . . . . . *P. ovatus* (Garman)

Discussion

The current study is the most comprehensive study that has been conducted on the phytoseiid fauna in Saudi Arabia. The new species and the seven new records may indicate that this area is rich in phytoseiid species. Moreover, recording *Neoseiulus makuwa* and *Proprioseiopsis asetus* for the first time in the Middle East as an alien species may show that phytoseiid mites could work well as biological control agents in this semi-arid area. Therefore, further and extensive studies are recommended for phytoseiid mites on other plant species.

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