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Mites of superfamily Phytoseioidea (Acari: Mesostigmata) of greenhouses in Rasht County, northern Iran, with new record of a species and an identification key

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Abstract
During 2018 - 2019, fauna of Phytoseioidea (Acari: Mesostigmata) mites associated with greenhouse plants were collected and identified from Rasht County, Guilan Province, north of Iran. In total, twenty-one species belonging to three families; Blattisociidae Garman (*Cheiroseius curtipes*, *Ch. longipes*, *Lasioseius extremus*, *L. scapulatus*, *L. sugawarai*, *L. youcefi*); Podocinidae Berlese (*Podocinum sagax*, *P. pacificum*) and Phytoseiidae Berlese (*Amblyseius herbicolus*, *A. largoensis*, *A. mcmurtryi*, *A. rademacheri*, *A. swirskii*, *Euseius stipulates*, *Neoseiulus barkeri*, *N. umbraticus*, *Phytoseius plumifer*, *Transeius caspiansis*, *Typhlodromus athiasae*, *T. perbibus*, *T. tubifer*) collected from greenhouses of Rasht city. Among them, *Podocinum sagax* Berlese, 1882 (Podocinidae) is considered as new record for mite fauna of Iran. Detailed morphological characteristics of both sexes of *P. sagax* based on specimens collected from Iran are given. Moreover, an identification key for Phytoseioidea mites associated with greenhouse plants of Rasht County is provided.
Key words: Fauna, predatory mites, Phytoseiidae, Blattisociidae, Podocinidae, *Podocinum sagax*

کنه‌های بالاخانوادهٔ Phytoseioidea (Acari: Mesostigmata) در گلخانه‌های شهرستان رشت، شمال ایران، همراه با گزارش جدید یک گونه و کلید شناسایی

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چکیده
طی سال‌های ۱۳۹۸-۱۳۹۷ فون کنه‌های بالا خانوادهٔ Phytoseioidea (Acari: Phytoseioidea) مرتبط با گیاهان گلخانه‌ای در شهرستان رشت، استان گیلان، جمع‌آوری و شناسایی شدند. در مجموع ۲۱ گونه، متعلق به سه خانوادهٔ Blattisociidae Garman (*Cheiroseius curtipes*, *Ch. longipes*, *Lasioseius extremus*, *L. scapulatus*, *L. sugawarai*, *L. youcefi*)؛ Phytoseiidae Berlese (*Amblyseius herbicolus*, *A. largoensis*, *A. mcmurtryi*, *A. rademacheri*, *A. swirskii*, *Euseius stipulates*, *Neoseiulus barkeri*, *N. umbraticus*, *Phytoseius plumifer*, *Transeius caspiansis*, *Typhlodromus athiasae*, *T. perbibus*, *T. tubifer*) و Podocinidae Berlese (*Podocinum sagax*, *P. pacificum*) از گلخانه‌های شهر رشت جمع‌آوری شدند. در بین گونه‌های شناسایی شده، گونهٔ *Podocinum sagax* Berlese, 1882 از خانوادهٔ Podocinidae برای فون ایران به عنوان گزارش جدید تلقی می‌شود. مشخصات شکل‌شناسی جنس نر و ماده گونهٔ *P. sagax* بر اساس نمونه‌های جمع‌آوری شده از ایران، ارائه شده است. همینطور کلیدی برای شناسایی کنه‌های بالا خانوادهٔ Phytoseioidea مرتبط با گیاهان گلخانه‌ای شهرستان رشت ارائه شده است.
واژه‌های کلیدی: فون، کنه‌های شکارگر، Phytoseiidae، Blattisociidae، Podocinidae، *Podocinum sagax*

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Introduction

Total area covered by greenhouses is 3700000 ha worldwide (Chang *et al*., 2013), but it covers 11231 ha in Iran (Ebadzadeh *et al*., 2017). Usually greenhouses have a relatively stable environmental condition, which is necessary for optimal growth of plants. Many varieties of economic plants (including vegetables and ornamental plants) are grown in greenhouses. Not only mites are considered as one of the most important pests in greenhouses, but also they are natural enemies used for biological control of pests in greenhouses, so they are taken among the most important arthropods (Zhang, 2003; Dhooria, 2016). Despite of the importance of mites in greenhouses, as pests causing economic injury on greenhouse crops (e.g. Tetranychidae, Tarsonemidae, Tenuipalpidae, Eriophyidae, Acaridae, etc.) or natural enemies using for biological control of the pest insects and mites in greenhouses (e.g. Phytoseiade, Lealapidae, etc.) (Zhang, 2003), they studied poorly in Iran.

The superfamily Phytoseioidea Berlese (Acari: Mesostigmata) including predatory, parasitic, fungivorous, and pollenophagous species found on ground and plant leaves (Cakmak *et al*., 2011). Four families: Blattisociidae Garman, Otopheidomenidae Treat, Phytoseiidae Berlese and Podocinidae Berlese are belonging to this superfamily (Beaulieu *et al*., 2011). The Phytoseiidae is the most important family including more than 2,700 species (Mendonça *et al*., 2019). The mites of this family are natural enemies of phytophagous mites and other small insect pests of various crops (McMurtry *et al*., 2013; Mandape & Shukla, 2017; Farfan & Schmidt-Jeffris, 2019). About 20 species of phytoseiidae are used for biological control in greenhouses, including genera *Phytoseiulus*, *Neoseiulus*, *Galendromus*, *Typhlodromus*, *Typhlodromalus*, *Amblyseius*, and *Euseius*. Among them, eight species *Phytoseiulus persimilis, Neoseiulus cucumeris, N. barkeri, N. californicus, N. fallacis*, *Iphiseius degenerans*, *Amblyseius swirskii* and *Galendromus occidentalis* have been commonly used in greenhouses (Zhang, 2003; Amano *et al*., 2011; McMurtry *et al*., 2015). Blattisociidae is another family of superfamily includes 329 species belonging to 12 genera (Alatawi *et al*., 2017).

Most of the plant associate Blattisociids belongs to genus *Lasioseius*; about 27 % of the species of this genus were collected on plant parts from the worldwide. Several *Lasioseius* species are known to inhabit flowers (De Moraes *et al*., 2015). Several species in genus *Lasioseius* are reported as predator of important greenhouse mite pests such as *Tetranychus urticae* Koch, *Rhizoglyphus robini* Claparede, *Tyrophagus putrescentiae* (Schrank) and *Polyphagotarsonemus latus* (Banks) (Mowafi, 2005; Wu *et al*., 2009; Momen *et al*., 2011; Britto *et al*., 2012; De Moraes *et al*., 2015; De Moraes *et al*., 2016). Predatory mites of genus *Cheiroseius* have been mentioned as predators of soil nematodes (Halliday *et al.*, 1998; Britto *et al*., 2015). Therefore, mites of these two genera can be considered as controlling agents of this important greenhouse pests in future. The family Podocinidae includes 35 species

worldwide such as Asia, North and South America, Europe, Africa, and Australia (Evans & Hyatt, 1957; De Leon, 1964; Błaszak & Alberti, 1985; Lindquist & Wu, 1987; Halliday, 1990; Yan *et al*., 2012; Santos *et al*., 2017; Santos *et al*., 2019; Trach *et al*., 2019). Podocinid mites have been reported to prey on Collembola and soil mites (Castilho *et al*., 2015). Unfortunately, there is not much information about biological role of Podocinid mites in the greenhouses.

Due to the presence of important predator mite species in superfamily Phytoseioidea, widespread interest in identification of their fauna is evident (De Moraes *et al*., 2004). According to the literature, 87 species belonging to family phytoseiidae (Kamali *et al*., 2001; Faraji *et al.*, 2007; Hajizadeh *et al.*, 2009; Hajizadeh & Mortazavi, 2015; Hajizadeh *et al.*, 2015, Hajizadeh & Faraji, 2016), 44 species belonging to family Blattisociidae (Kazemi & Rajaei, 2013, Nemati *et al*., 2018) and one species belonging to family Podocinidae (Nemati *et al*., 2018) were reported from Iran. However, there is poor information about mites associated with greenhouse plants in Iran and more studies is nessesary to explore the unknown species. Hence, the purpose of this survey is to identify Phytoseioid mites associated with greenhouse plants in Rasht County, Iran. Moreover, an identification key is provided for the known species in this survey.

Materials and methods

This study was carried out in Rasht County, Northern Iran, during 2018–2019. A total twenty greenhouses were sampled in Rasht County and its suburbs (Khomam, Khoshk-e Bijar, Kuchesfahan, Lasht-e Nesha and Sangar Cities). In this study, most of investigated greenhouses were non-modern and cultivation was traditional. Different plants such as ornamentals, vegetables, fruit trees, etc. were observed in visited greenhouses. Different parts of vegetables (such as strawberry, cucumber, tomato, potato, etc.), ornamentals (rose, croton, rubber fig, etc.), weeds and soil samples were collected from greenhouses. Plant species were determined by a botanical specialist. Mites were extracted from samples using Berlese funnel or direct examinations of plant materials under a stereomicroscope. The samples were deposited temporary in 75% ethanol and then dipped in Nesbitt's solution for clarification. Mites were mounted in Hoyer's medium on microscopic slides. The mites were examined under an Olympus BX51 phase-contrast microscope (Olympus Optical Co., LTD., Tokyo, Japan) at 1000× magnification. Mites and insects were identified by use of valid references and keys (Evans & Hyatt, 1957; Triplehorn & Johnson 2005; Yan *et al*., 2012; Hajizadeh & Faraji 2016; Javadpour *et al*., 2018). All the measurements are given in micrometer (μm); the average followed (in parentheses) by the respective ranges. All specimens collected by first author. The voucher specimen of each species was preserved as slide-mounted specimens and was deposited in the Mite Collection of the Acarology Laboratory, Department of Plant Protection, Faculty of Agricultural Sciences at the University of Guilan, Rasht, Iran.

Results

In the current survey, a total of 21 species of superfamily Phytoseioidea, belonging to 9 genera and 3 families associated with greenhouse plants were collected and identified. Among them *Podocinum sagax* Berlese, 1882 is a new record for the mite fauna of Iran. An identification key to the adult females of the 21 recorded species is provided.

Taxonomy

Superfamily Phytoseioidea Berlese

Family Phytoseiidae Berlese

Subfamily Amblyseiinae Muma

***Amblyseius herbicolus* (Chant)**

Typhlodromus (Amblyseius) herbicolus Chant, 1959

Amblyseius impactus Chaudhri, 1968

Amblyseius largoensis Muma, 1961

Amblyseius deleoni Muma & Denmark in Muma *et al.*, 1970

Material examined

Guilan Province, Rasht County, Guilan University (37° 11′ 44″ N 49° 38′ 30″ E, 28 m), 11 November 2018, *centella, Centella asiatica* L. (Apiaceae) leaves infested with spider mites (Tetranychidae), 1 female; orange, *Citrus sinensis* (Rutaceae) 1eaves infested with *mealybugs*, 5 females; Ashrafi Esfahani Educational Institute (37° 11′ 47″ N 49° 39′ 9.4″ E, 27 m), 15 January 2019, wood sorrel, *Oxalis acetosella* L. (Oxalidaceae) 1eaves infested with spider mites (Tetranychidae), 3 females; cucumber, *Cucumis sativus* (Cucurbitaceae) 1eaves infested with spider mites (Tetranychidae), 7 females; grape, *Vitis vinifera* L. (Vitaceae) 1eaves infested with gall mites (Eriophyidae), 6 females; Pir Bazar Village (37° 19′ 57″ N 49° 28′ 59″ E, -18 m), 21 July 2019, bean, *Phaseolus vulgaris* (Fabaceae) 1eaves infested spider mites (Tetranychidae), 4 females.

***Amblyseius largoensis* (Muma)**

Typhlodromus (*Amblyseius*) *largoensis* Chant, 1959

Amblyseius (*Amblyseialus*) *largoensis* Muma, 1961

Material examined

Guilan Province, Rasht County, Ashrafi Esfahani Educational Institute (37° 11′ 47″ N 49° 39′ 9.4″ E, 27 m), 17 April 2019, rose, *Rosa damascena* (Rosaceae) 1eaves infested with spider mites (Tetranychidae), 2 females.

***Amblyseius mcmurtryi* Muma**

Amblyseius (*Amblyseius*) *mcmurtryi* Wu, 1982

Amblyseius (*Multiseius*) *mcmurtryi* Denmark & Muma, 1989

Material examined

Guilan Province, Rasht County, Pir Bazar Village (37° 19′ 57″ N 49° 28′ 59″ E, -18 m), 21 July 2019, grape, *Vitis vinifera* L. (Vitaceae) 1eaves infested with gall mites (Eriophyidae), 1 female; croton, *Codiaeum variegatum* (Euphorbiaceae) 1eaves infested with *mealybugs*, 3 females; cucumber, *Cucumis sativus* (Cucurbitaceae) 1eaves infested with thrips, 1 female; rubber fig, *Ficus elastica* (Moraceae) 1eaves with mealybugs, 4 females; orange, *Citrus sinensis* (Rutaceae) 1eaves infested with *mealybugs*, 1 female.

***Amblyseius rademacheri* Dosse**

Typhlodromips rademacheri Dosse, 1958

Typhlodromus rademacheri Hirschmann, 1962

Amblyseius (*Neoseiulus*) *rademacheri* Ehara & Amano, 1998

Material examined

Guilan Province, Rasht County, Deh Baneh-ye Eslamabad Village (37° 6′ 12″ N 49° 39′ 32″ E, 65 m), 31 July 2019, cucumber, *Cucumis sativus* (Cucurbitaceae) 1eaves infested with whiteflies, 4 females; Lakan Village (37° 13′ 37″ N 49° 34′ 46″ E, 13 m), 18 April 2019, cucumber, *Cucumis sativus* (Cucurbitaceae) 1eaves infested with spider mites (Tetranychidae), 3 females; Bijar Boneh Village (37° 18′ 21″ N 49° 38′ 49″ E, -7 m), 1 May 2019, grape, *Vitis vinifera* L. (Vitaceae) 1eaves infested with gall mites (Eriophyidae), 3 females; Ashrafi Esfahani Educational Institute (37° 11′ 47″ N 49° 39′ 9.4″ E, 27 m), 15 January 2019, eggplant, *Solanum melongena* (Solanaceae) 1eaves infested with trips, 3 females.

***Amblyseius swirskii* Athias-Henriot**

Amblyseius (*Amblyseius*) *swirskii* Ehara, 1966

Material examined

Guilan Province, Rasht County, Deh Baneh-ye Eslamabad Village (37° 6′ 12″ N 49° 39′ 32″ E, 65 m), 31 July 2019, hortensia, *Hydrangea hortensis* (Hydrangeacea) 1eaves infested with whiteflies, 2 females.

***Euseius stipulatus* (Athias-Henriot)**

Typhlodromus stipulates Hirschmann, 1962

Amblyseius (*Amblyseius*) *stipulates* Ueckermann & Loots, 1988

Material examined

Guilan Province, Rasht County, Pir Bazar Village (37° 19′ 57″ N 49° 28′ 59″ E, -18 m), 21 July 2019, cucumber, *Cucumis sativus* (Cucurbitaceae) 1eaves infested with spider mites (Tetranychidae), 4 females; Omesheh Village (37° 12′ 8″ N 49° 38′ 57″ E, 22 m), 27 July 2019, elegant zinnia, *Zinnia elegans* (Asteraceae) 1eaves infested with aphids, 3 females.

***Neoseiulus barkeri* Hughes**

Typhlodromus (*Typhlodromus*) *barkeri* Chant,1959

Amblyseius barkeri Athias-Henriot, 1961

Typhlodromus (*Amblyseius*) *barkeri* Hughes, 1961

Typhlodromus barkeri Hirschmann, 1962

Amblyseius (*Amblyseius*) *barkeri* van der Merwe, 1968

Amblyseius (*Neoseiulus*) *barkeri* Karg, 1983

Neoseiulus bakeri [sic] Ryu *et al*., 2001

Material examined

Guilan Province, Rasht County, Pir Bazar Village (37° 19′ 57″ N 49° 28′ 59″ E, -18 m), 8 December 2018, Strawberry, Fragaria ananassa (Rosaceae) 1eaves infested with spider mites (Tetranychidae), 4 females; Ashrafi Esfahani Educational Institute (37° 11′ 47″ N 49° 39′ 9.4″ E, 27 m), 8 January 2019, wood sorrel, *Oxalis acetosella* L. (Oxalidaceae) 1eaves infested with spider mites (Tetranychidae), 7 females; 15 January 2019, geraniums, *Pelargonum zonale* (Geraniacea) 1eaves infested with whiteflies, 3 females; 17 April 2019, cucumber, *Cucumis sativus* (Cucurbitaceae) 1eaves infested with spider mites (Tetranychidae), 7 females; Deh Baneh-ye Eslamabad Village (37° 6′ 12″ N 49° 39′ 32″ E, 65 m), 26 February 2019, soil, 1 female; Keshel Varzal Village (37° 10′ 59″ N 49° 38′ 42″ E, 34 m), 28 February 2019, bindweed, *Convolvulus arvensis* (Convolvulaceae) 1eaves infested with spider mites (Tetranychidae), 2 females; Bijar Boneh Village (37° 18′ 21″ N 49° 38′ 49″ E, -7 m), 1 May 2019, litter, 4 females.

***Neoseiulus umbraticus* (Chant)**

Typhlodromus (*Typhlodromus*) *umbraticus* Beglyarov 1958

Amblyseius umbraticus Athias-Henriot 1959

Material examined

Guilan Province, Rasht County, Deh Baneh-ye Eslamabad Village (37° 6′ 12″ N 49° 39′ 32″ E, 65 m), 31 July 2019, grape, *Vitis vinifera* L. (Vitaceae) 1eaves infested with gall mites (Eriophyidae), 3 females; bean, *Phaseolus vulgaris* (Fabaceae) 1eaves infested spider mites (Tetranychidae), 4 females; Ashrafi Esfahani Educational Institute (37° 11′ 47″ N 49° 39′ 9.4″ E, 27 m), 24 November 2018, cucumber, *Cucumis sativus* (Cucurbitaceae) 1eaves infested with spider mites (Tetranychidae), 2 females; Lakan Village (37° 13′ 37″ N 49° 34′ 46″ E, 13 m), 18 April 2019, fig, *ficus carica* (Moraceae) 1eaves infested with eriophyid mites, 2 females.

***Transeius wainsteini* Gomelauri, 1968**

Amblyseius wainsteini Gomelauri, 1968

Amblyseius patellae Karg, 1982

Typhlodromips caspiansis Denmark & Daneshvar, 1982

Material examined

Guilan Province, Rasht County, Ashrafi Esfahani Educational Institute (37° 11′ 47″ N 49° 39′ 9.4″ E, 27 m), 24 November 2018, geraniums, *Pelargonum zonale* (Geraniacea) 1eaves infested spider mites (Tetranychidae), 3 females; Vishka Nanak Village (37° 14′ 13″ N 49°

43′ 31″ E, 10 m), 24 November 2018, grape, *Vitis vinifera* L. (Vitaceae) 1eaves infested with gall mites (Eriophyidae), 6 females; Imam Khomeini Institute (37° 13′ 18″ N 49° 38′ 39″ E, 16 m), 1 November 2018, bean, *Phaseolus vulgaris* (Fabaceae) 1eaves infested spider mites (Tetranychidae), 3 females.

Subfamily Phytoseiinae Berlese

***Phytoseius plumifer* (Canestrini & Fanzago)**

Typhlodromus plumifer Hirschmann, 1962

Phytoseius finitimus Chant & McMurtry, 1994

Material examined

Guilan Province, Rasht County, Ashrafi Esfahani Educational Institute (37° 11′ 47″ N 49° 39′ 9.4″ E, 27 m), 24 November 2018, wood sorrel, *Oxalis acetosella* L. (Oxalidaceae) 1eaves infested spider mites (Tetranychidae), 3 females; cucumber, *Cucumis sativus* (Cucurbitaceae) 1eaves infested with spider mites (Tetranychidae), 2 females; grape, *Vitis vinifera* L. (Vitaceae) 1eaves infested with gall mites (Eriophyidae), 2 females; Pir Bazar Village (37° 19′ 57″ N 49° 28′ 59″ E, -18 m), 21 July 2019, bean, *Phaseolus vulgaris* (Fabaceae) 1eaves infested spider mites (Tetranychidae), 2 females; fig, *Ficus elastica* (Moraceae) 1eaves infested with eriophyid mites, 5 females; chrysanths, *Chrysanthemum* sp. (Asteraceae) 1eaves infested with aphids, 6 females.

Subfamily Typhlodrominae Wainstein

***Typhlodromus athiasae* Porath & Swirski**

Typhlodromus (*Typhlodromus*) *siwa* El-Badry, 1967

Typhlodromus (*Typhlodromus*) *pelargonicus* El-Badry, 1968

Typhlodromus (*Typhlodromus*) *hellenicus* Swirski & Ragusa, 1977

Typhlodromus athiasae athiasae Chant & Yoshida-Shaul, 1987

Material examined

Guilan Province, Rasht County, Guilan University (37° 11′ 44″ N 49° 38′ 30″ E, 28 m), 11 November 2018, *centella, Centella asiatica* L. (Apiaceae) leaves infested with spider mites (Tetranychidae), 2 females; 9 April 2019, Orange, *Citrus sinensis* (Rutaceae) 1eaves infested with citrus red mite (*Panonychus citri*), 3 females.

***Typhlodromus perbibus* Wainstein & Arutunjan**

Typhlodromus athiasae perbibus Chant & Yoshida-Shaul, 1987

Material examined

Guilan Province, Rasht County, Guilan University (37° 11′ 44″ N 49° 38′ 30″ E, 28 m), 9 April 2019, orange, *Citrus sinensis* (Rutaceae) 1eaves 1eaves infested with citrus red mite (*Panonychus citri*), 3 females; 15 June 2019, kaghazi**,** *Bougainvillea glabra* (Nyctaginaceae) 1eaves infested with spider mites (Tetranychidae), 2 females.

***Typhlodromus tubifer* Wainstein**

Typhlodromus (*Typhlodromus*) *pyri* Abbasova, 1980

Material examined

Guilan Province, Rasht County, Guilan University (37° 11′ 44″ N 49° 38′ 30″ E, 28 m), 15 June 2019, kaghazi, *Bougainvillea glabra* (Nyctaginaceae) 1eaves infested with spider mites (Tetranychidae), 4 females.

Family Blattisociidae Garman

Genus *Cheiroseius* Berlese

***Cheiroseius curtipes* (Halbert)**

Lasioseius (*Episeius*) *glaber* var. curtipes Halbert, 1923

Sejus curtipes Evans & Hyatt, 1960

Episeius ovaspini Schweizer, 1949

Platyseius ovaspini Schweizer, 1961

Material examined

Guilan Province, Rasht County (37° 15′ 54″ N 49° 35′ 30″ E, 2 m), 27 November 2018, wood sorrel, *Oxalis acetosella* L. (Oxalidaceae) 1eaves infested with spider mites (Tetranychidae), 6 females.

***Cheiroseius longipes* (Willmann)**

Episeius longipes Willmann, 1949

Sejus longipes Karg, 1971

Material examined

Guilan Province, Rasht County, Jirdeh Village (37° 12′ 43″ N 49° 32′ 51″ E, 22 m), 18 April 2019, soil, 5 females.

Genus *Lasioseius* Berlese

***Lasioseius extremus* (Daneshvar)**

Indiraseius extremus Daneshvar, 1987

Material examined

Guilan Province, Rasht County, Keshel Varzal Village (37° 10′ 59″ N 49° 38′ 42″ E, 34 m), 28 February 2019, wood sorrel, *Oxalis acetosella* L. (Oxalidaceae) 1eaves infested with spider mites (Tetranychidae), 3 females; Ashrafi Esfahani Educational Institute (37° 11′ 47″ N 49° 39′ 9.4″ E, 27 m), 17 April 2019, rose, *Rosa damascena* (Rosaceae) 1eaves infested with spider mites (Tetranychidae), 2 females.

***Lasioseius scapulatus* Kennett**

Lasioseius scapulatus Kennett, 1958

Material examined

Guilan Province, Rasht County, Bijar Boneh Village (37° 18′ 21″ N 49° 38′ 49″ E, -7 m), 1 May 2019, wood sorrel, Oxalis *acetosella* L. (Oxalidaceae) 1eaves infested with spider mites (Tetranychidae), 2 females; Pir Bazar Village (37° 19′ 30″ N 49° 29′ 6″ E, -19 m), 4 May 2019, litter, 1 female.

***Lasioseius sugawarai* Ehara**

Lasioseius sugawarai Ehara, 1964

Lasioseius tridentatus Baker, 1976

Material examined

Guilan Province, Rasht County, Pir Bazar Village (37° 19′ 57″ N 49° 28′ 59″ E, -18 m), 8 December 2018, litter, 4 females; 4 May 2019, 1 female; 27 November 2018, Soil, 1 female; Ashrafi Esfahani Educational Institute (37° 11′ 47″ N 49° 39′ 9.4″ E, 27 m), 8 January 2019, litter, 4 females; Omesheh Village (37° 12′ 8″ N 49° 38′ 57″ E, 12 m), 28 February 2019, soil, 2 females; Dalecheh Village (37° 13′ 15″ N 49° 41′ 21″ E, 14 m), 11 April 2019, dwarf umbrella tree, *Schefflera arboricola* (Araliaceae) 1eaves infested with *mealybugs*, 1 female; Pasikhan Village (37° 17′ 49″ N 49° 29′ 28″ E, -9 m), 15 April 2019, wood sorrel, *Oxalis acetosella* L. (Oxalidaceae) 1eaves infested with spider mites (Tetranychidae), 1 female; Jirdeh Village (37° 12′ 43″ N 49° 32′ 51″ E, 22 m), 18 April 2019, soil, 1 female; Bijar Boneh Village (37° 18′ 10″ N 49° 39′ 10″ E, -6 m), 1 May 2019, *Rosa damascena* (Rosaceae) 1eaves infested with spider mites (Tetranychidae), 2 females.

***Lasioseius youcefi* Athias-Henriot**

Lasioseius (Criniacus) youcefi Karg, 1980

Lasioseius mcgregori Chant, 1963

Lasioseius (Lasioseius) paucisetosus Westerboer, 1963

Lasioseius (Lasioseius) proteae Ryke, 1964

Lasioseius lasiodactyli Ishikawa, 1969

Lasioseius (Crinidens) peritremus Christian & Karg, 2006

Material examined

Guilan Province, Rasht County, Bijar Boneh Village (37° 18′ 18″ N 49° 38′ 50″ E, -6 m), 1 May 2019, litter, 5 females; Pir Bazar Village (37° 19′ 43″ N 49° 28′ 49″ E, -19 m), 4 May 2019, wood sorrel, *Oxalis acetosella* L. (Oxalidaceae) 1eaves infested with spider mites (Tetranychidae), 4 females.

Family Podocinidae Berlese

***Podocinum sagax* (Berlese) -** New records for Iranian mites

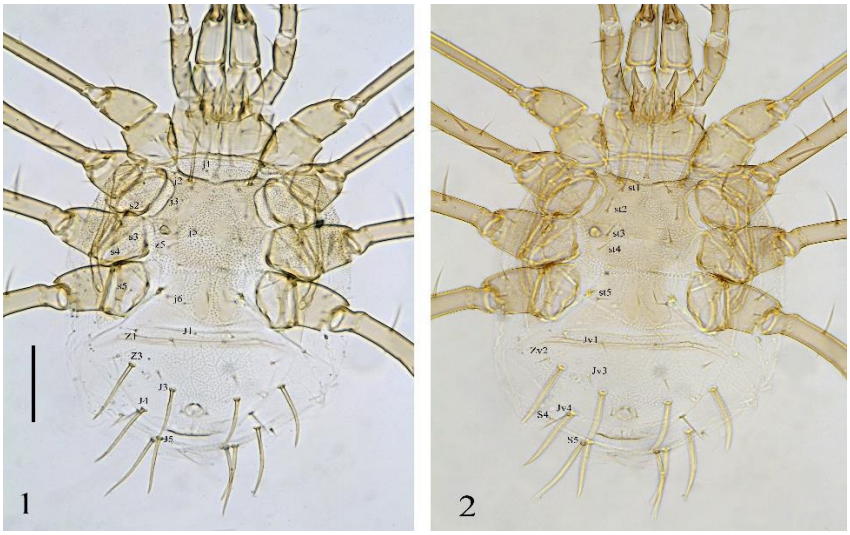
Laelaps sagax Berlese, 1882

Podocinum sagax Berlese, 1882

Adult female – Five specimens measured.

Gnathosoma – Chelicera (Fig. 5); fixed digit 78 (78–79) long, with five teeth in addition to apical tooth and a minute setiform pilus dentilis; movable digit 78 (78–79) long, with two teeth in addition to apical tooth. Apotele 3-tined (Fig. 3). Anterior region of epistome with three distally divided extensions; lateral extensions with outer margin denticulate. Corniculus horn-shaped, about 40 long and 17 (16–20) wide basally. Measurements of setae: *h1* 28 (28–30), *h2* 5 (4–6), *h3* 35 (34–40), *pc* 24 (20–28).

Dorsal idiosoma (Fig. 1) – Dorsal shield covered by small protuberances not aligned to constitute a polygonal network, 514 (456–592) long and 412 (380–472) wide at widest level. Dorsal shield without lateral incisions. Podonotal region with 10 pairs of setae (*j1*, *j2*, *j3*, *j5*, *j6*, *z5*, *s2*, *s3*, *s4*, and *s5*), one pair of distinguishable lyrifissures and four pairs of distinguishable pores. Opisthonotal region with eight pairs of setae (*J1*, *J3*, *J4*, *J5*, *Z1*, *Z3*, *S4*, and *S5*), and one pair of distinguishable pores. Setal lengths: *j1* 7 (6–8), *j2* 84 (74–88), *j3* 14 (12–18), *j5* 13 (12–16), *j6* 17 (14–20), *z5* 14 (12–16), *s2* 14 (14–16), *s3* 13 (12–14), *s4* 17 (14–20), *s5* 25 (24–26), *J1* 18 (14–20), *J3* 88 (82–90), *J4* 109 (104–114), *J5* 90 (82–98), *Z1* 24 (20–30), *Z3* 104 (100–108), *S4* 36 (30–44), *S5* 112 (108–120). Peritremes extending up to setae *j1*



Figs 1–2. *Podocinum sagax* Berlese (Female). **1.** Dorsal view of idiosoma; **2.** Ventral view of idiosoma. Scale bar: 100 μm.

Ventral idiosoma (Fig. 2) – Base of tritosternum indistinguishable; laciniae 44 (40–50) long. Sternal shield 85 (80–88) long at mid-line and 115 (110–124) wide between setae *st1* and *st2*, reticulate; posterior margin slightly concave; with three pairs of setae (*st1*, *st2*, and *st3*); seta *st4* inserted on metasternal plate; ventrianal shield, 160 (150–170) long at mid-line and 294 (272–320) wide at widest level; with four pairs of setae (*Jv1*, *Jv3*, *Jv4*, and *Zv2*). Measurements of setae: *st1* 40 (32–50), *st2* 33 (20–40), *st3* 34 (30–40), *st4* 21 (18–30), *st5* 24 (22–26); *Jv1* 23 (20–26), *Jv3* 25 (20–28), *Jv4* 47 (42–50), *Zv2* 22 (20–24), para-anal 21 (20–22), post-anal 22 (20–24).

Legs – Tarsus I with two Sub-distal setae (Fig. 4). Lengths: I: 1528 (1460–1600); II: 820 (800–860); III: 756 (720–800); IV: 892 (860–900).

Adult male – Five specimens measured.

Gnathosoma – Chelicera; fixed digit 77 (70–88) long; movable digit 73 (68–78) long; Spermadactyl 69 (62–74) long (Fig. 6). Corniculus horn-shaped, about 37 (32–40) long and

15 (14–16) wide basally. Measurements of setae: *h1* 26 (24–30), *h2* 6 (6–8), *h3* 31 (26–34), *pc* 20 (20–22)

Dorsal idiosoma – Dorsal shield ornamentation as in adult female 404 (376–440) long and 343 (320–368) wide at widest level. Podonotal and opisthonotal shields fused, without lateral incisions. Podonotal region with 10 pairs of setae (*j1*, *j2*, *j3*, *j5*, *j6*, *z5*, *s2*, *s3*, *s4*, and *s5*), one pair of distinguishable lyrifissures and four pairs of distinguishable pores. Opisthonotal region with eight pairs of setae (*J1*, *J3*, *J4*, *J5*, *Z1*, *Z3*, *S4*, and *S5*), and one pair of distinguishable pore. Setal lengths: *j1* 10 (8–12), *j2* 73 (64–80), *j3* 13 (12–16), *j5* 14 (12–16), *j6* 16 (12–18), *z5* 13 (12–16), *s2* 15 (12–18), *s3* 12 (10–14), *s4* 14 (14–16), *s5* 17 (14–20), *J1* 16 (14–22), *J3* 61 (60–64), *J4* 86 (80–92), *J5* 70 (66–76), *Z1* 20 (18–20), *Z3* 82 (80–84), *S4* 26 (22–30), *S5* 89 (86–90). Shape of setae as in adult female.

Ventral idiosoma – Tritosternum as in adult female; laciniae 41 (38–46) long. Sternogenital 326 (300–340) long at mid-line and 219 (212–224) wide between setae *Jv1* and *Zv2*; with nine pairs of setae (*st1*, *st2*, *st3*, *st4*, *st5*, *Jv1*, *Jv3*, *Jv4*, and *Zv2*). Measurements of setae: *st1* 30 (22–34), *st2* 28 (24–30), *st3* 29 (28–30), *st4* 19 (16–22), *st5* 21 (20–22); *Jv1* 20 (18–22), *Jv3* 21 (18–22), *Jv4* 34 (30–36), *Zv2* 19 (18–20); para-anal 20 (20–22), post-anal 19 (18–20). Peritreme similar to female.

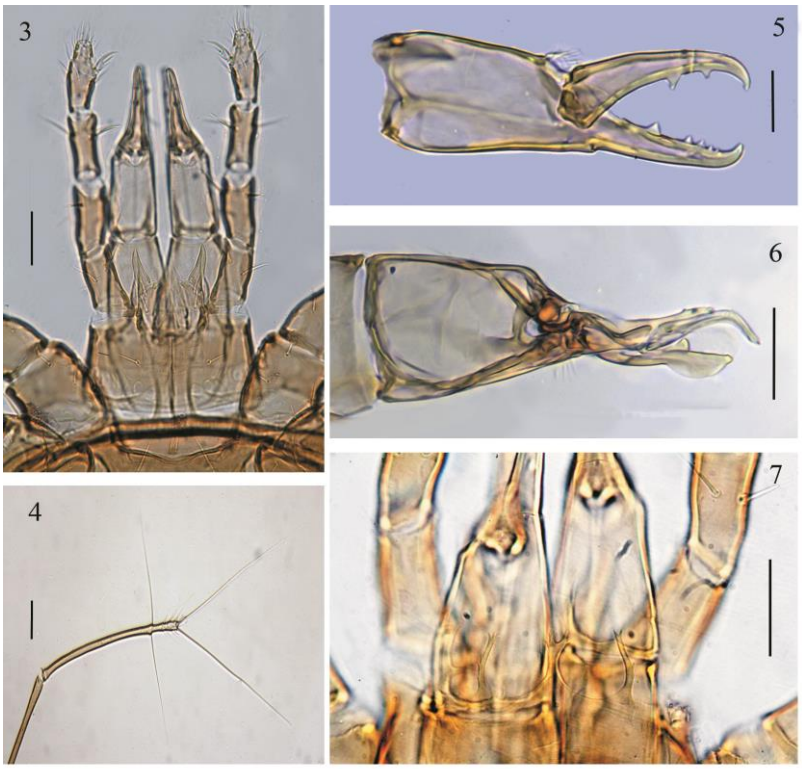
Legs – Lengths: I: 1364 (1300–1420); II: 712 (660–740); III: 664 (640–680); IV: 792 (740–840).

Distribution

Japan, China, Indonesia, India, Italy, Britain, Mexico, Jamaica, Puerto Rico, Guatemala, USA, Argentina (Yan *et al*., 2012).

Material examined

Guilan Province, Rasht County, Ashrafi Esfahani Educational Institute (37° 11′ 47″ N 49° 39′ 9.4″ E, 27 m), 17 April 2019, litter, 3 females and 1 male; 24 April 2019, 4 females and 4 males; Dalecheh Village (37° 13′ 15″ N 49° 41′ 21″ E, 14 m), 11 April 2019, litter, 2 females; Lakan Village (37° 13′ 37″ N 49° 34′ 46″ E, 13 m), 18 April 2019, soil, 2 females; Bijar Boneh Village (37° 18′ 10″ N 49° 39′ 10″ E, -6 m), 25 April 2019, Wood sorrel, *Oxalis acetosella* L. (Oxalidaceae) 1eaves infested with spider mites (Tetranychidae), 4 females.



Figs 3–7. *Podocinum sagax* Berlese. **3.** Hypostome; **4.** Tarsus I; **5.** Female chelicera; **6.** Male chelicera; **7.** Epistome. Scale bar: 50 μm for 3; 200 μm for 4; 25 μm for 5; 25 μm for 6; 40 μm for 7.

***Podocinum pacificum* Berlese**

Podocinum pacificum Berlese, 1895

Material examined

Guilan Province, Rasht County, Ashrafi Esfahani Educational Institute (37° 11′ 47″ N 49° 39′ 9.4″ E, 27 m), 17 April 2019, litter, 5 females.

Key to the females of Phytoseioidea species collected from greenhouses in Rasht County, northern Iran

1. Legs one greatly elongated, antenniform, lacking pretarsus, terminating in either one or two long whip-like setae, palpal claw three tined…**family Podocinidae Berlese**.....3
- Legs one normal, usually with claw and lacking long whip-like setae, papal claw two tined.....2
2. Dorsal shield with less than 20 pairs of setae, setae *J1* absent, and with less than 4 pairs of marginalsetae on soft integument...**Family Phytoseiidae Berlese**.....9
- Dorsal shield with more than 20 pairs of setae, setae *J1* present, and usually with more than 4 pairs of marginal setae on soft integument...**Family Blattisociidae Garman**.....4
3. Sub-distal setae of tarsus I minute, the longest sub-distal seta obviously shorter than or approximately equal to the half of the distance between the setal base and the distal end of tarsus I; dorsal shield with polygonal networks, dorsal shield with 16 pairs of setae ....***Podocinum pacificum* Berlese**
- One or two sub-distal setae of tarsus I very long, obviously longer than or approximately equal to the distance between the setal base and the distal end of tarsus I; dorsal shield without polygonal networks, dorsal shield with 18 pairs of setae .....***Podocinum sagax* (Berlese)**

4. Legs II-IV with median lobe of pulvillus broadly rounded; para-anal setae inserted anterior to hind margin of anus, and usually shorter than post-anal seta...***Lasioseius*** **Berlese** 5
- Legs II-IV with median lobe of pulvillus slender; para-anal setae inserted level with or posterior to hind margin of anus, and longer than post-anal seta...***Cheiroseius*** **Berlese** 8
5. Ventrianal shield with 5 or 6 pairs of preanal setae 6
- Ventrianal shield with 4 pairs of preanal setae 7
6. Seta *Z1* present; *J2* 1/2 distance *J2–J4* ..... ***Lasioseius youcefi*** **Athias-Henriot**
- Seta *Z1* absent; *J2* 1/4 distance *J2–J4* ..... ***Lasioseius extremus*** **(Daneshvar)**
7. Macrosetae of tarsus IV with 88–92 µm length ..... ***Lasioseius scapulatus*** **Kennett**
- Macrosetae of tarsus IV less than 50 µm length ..... ***Lasioseius sugawarai*** **Ehara**
8. Tarsus I shorter than tibia I or equal in length ..... ***Cheiroseius longipes*** **(Willmann)**
- Tarsus I longer than tibia I ..... ***Cheiroseius curtipes*** **(Halbert)**
9. Either or both setae *z3* and *s6* present 10
- Seta *z3* and *s6* absent (subfamily Amblyseiinae Muma)..... 11
10. Setae *Z1*, *S2*, *S4* and *S5* absent (subfamily Phytoseiinae Berlese, ***Phytoseius*** **Ribaga**)..... ..... ***Phytoseius plumifer*** **(Canestrini & Fanzago)**
- At least one of setae *Z1*, *S2*, *S4* and *S5* present (subfamily Typhlodrominae Chant & McMurtry) 19
11. Seta *Jv1* inserted well behind the anterior margin of ventrianal shield and preanal setae arranged in an almost transverse row; cheliceral digits short and stout, fixed digit with a few small teeth near distal end (***Euseius*** **Wainstein**) ..... ***Euseius stipulatus*** **(Athias-Henriot)**
- Seta *Jv1* inserted near margin of ventrianal shield and preanal setae not arranged in a transverse row across the shield, cheliceral digits elongate 12
12. Macrosetae present only on leg IV or absent (***Neoseiulus*** **Hughes**) 13
- Macrosetae at least on genu III, as well as on leg IV 14
13. Spermatheca with atrium forked at junction with major duct, or atrium appearing thick walled, vacuolated, calyx spermatheca elongate, usually tubular ..... ***Neoseiulus barkeri*** **Hughes**
- Spermatheca with atrium not forked at junction with major duct, nor appearing thick walled, vacuolated, calyx of spermatheca bell-shaped ..... ***Neoseiulus umbraticus*** **(Chant)**
14. Ratio of setae *s4*:*S2* < 2.7:1.0 (*Transeius* Chant & McMurtry) ..... *Transeius caspiansis* (Denmark & Daneshvar) ..... ***Transeius wainsteini*** **(Gomelauri)**
- Ratio of setae *s4*:*S2* > 3.0:1.0 (*Amblyseius* Berlese) 15
15. Ventrianal shield vase-shaped 16
- Ventrianal shield not vase-shaped 17
16. Calyx of spermatheca tubular, flaring slightly near vesicle; movable cheliceral digit with four teeth..... ***Amblyseius herbicolus*** **(Chant)**
- Calyx tubular, not flaring; movable digit with 3 teeth ..... ***Amblyseius largoensis*** **(Muma)**
17. Spermatheca with calyx tubular ..... ***Amblyseius mcmurtryi*** **Muma**
- Spermatheca with calyx cup or V-shaped 18
18. Dorsal shield strongly reticulated ..... ***Amblyseius rademacheri*** **Dosse**
- Dorsal shield smooth ..... ***Amblyseius swirskii*** **Athis-Henriot**
19. Dorsal shield with three pairs of prominent pores ..... ***Typhlodromus tubifer*** **Wainstein**
- Dorsal shield with four pairs of prominent pores 20

20. Peritreme extending to level of setae *j1*; setae *Z4* longer than distance between its insertion and that of *Z5*; calyx of spermatheca 23 μm ..... ***Typhlodromus athiasae*** **Porath & Swirski**

- Peritreme not extending to level setae *j3*; setae *Z4* shorter than distance between its insertion and that of *Z5*; calyx of spermatheca 20 μm ..... ***Typhlodromus perbibus*** **Wainstein & Arutunjan**

Discussion

Current study showed presence of valuable fauna of Phytoseioidea (Acari: Mesostigmata) predatory mites (21 species) in greenhouses of Rasht County. More studies are nessesary for conservation and use of these beneficial mites in the greenhouses to control of pest mites and insects in Iran.

Description of the *Podocinum sagax* specimens by different researchers (Evans & Hyatt, 1958; Bhattacharyya, 1994; Santos *et al*., 2017) indicates similarities and some differences between material examined in the current study and their measurements (Table 1). The ventrianal shield is broader than long in *P. sagax* but in Santos *et al*. (2017), unlike to drawn image the length (260 μm) of ventrianal shield mentioned more than its broad (164 μm) that is considered as a writing mistake. Daneshvar (1987) mentioned that *Lasioseius extremus* is very similar to *Lasioseius parberlesi* Bhattacharyya. Nemati *et al*. (2012) considered *L. extremus* as synonym of *L. parberlesi*, but De Morase *et al*. (2016) considered the *L. extremus* as a valid species. Probably *L. parberlesi* record from Iran should be re-considered carefully in the future. For this reason, we considered the *Lasioseius extremus* as a valid name.

Table 1. Comparison among measurements (in µm) of *Podocinum sagax* (Berlese, 1882)

Characters	Evans & Hyatt, 1958 (female)	Bhattacharyya, 1994 (male)	Santos et al., 2017 (female)	Santos et al., 2017 (male)	This study (female)	This study (male)
Length of dorsal shield	384–506	375	526 (513–538)	390 (363–390)	514 (456–592)	404 (376–440)
Width of dorsal shield	330–341	250	370 (355–390)	288	412 (380–472)	343 (320–368)
j1	-	-	8	8	7 (6–8)	10 (8–12)
j2	-	-	74 (73–75)	68	84 (74–88)	73 (64–80)
j3	-	-	11 (10–13)	13	14 (12–18)	13 (12–16)
j5	-	-	14 (13–15)	13	13 (12–16)	14 (12–16)
j6	-	-	15	13	17 (14–20)	16 (12–18)
z5	-	-	15	13	14 (12–16)	13 (12–16)
s2	-	-	12 (10–13)	13	14 (14–16)	15 (12–18)
s3	-	-	13	13	13 (12–14)	12 (10–14)
s4	-	-	15	13	17 (14–20)	14 (14–16)
s5	-	-	18 (15–18)	15	25 (24–26)	17 (14–20)
J1	-	-	16 (15–18)	18 (15–18)	18 (14–20)	16 (14–22)
J3	-	-	74 (73–75)	55 (48–55)	88 (82–90)	61 (60–64)
J4	-	-	99 (95–100)	75 (73–75)	109 (104–114)	86 (80–92)
J5	-	-	85 (85–90)	50	90 (82–98)	70 (66–76)
Z1	-	-	19 (18–20)	18 (15–18)	24 (20–30)	20 (18–20)
Z3	-	-	93 (90–93)	63 (58–63)	104 (100–108)	82 (80–84)
S4	-	-	21 (21–22)	18	36 (30–44)	26 (22–30)
S5	-	-	100 (100–103)	75	112 (108–120)	89 (86–90)
st1	-	-	40 (38–43)	23	40 (32–50)	30 (22–34)
st2	-	-	30 (28–35)	25 (23–25)	33 (20–40)	28 (24–30)
st3	-	-	30 (28–30)	25 (23–25)	34 (30–40)	29 (28–30)
st4	-	-	20	20 (18–20)	21 (18–30)	19 (16–22)
st5	-	-	21 (18–23)	18	24 (22–26)	21 (20–22)
JV1	-	-	22 (20–23)	18	23 (20–26)	20 (18–22)
JV3	-	-	21 (20–23)	18	25 (20–28)	21 (18–22)
JV4	-	-	46 (45–46)	28	47 (42–50)	34 (30–36)
ZV2	-	-	21 (21–22)	18 (15–18)	22 (20–24)	19 (18–20)
Para-anal	-	-	20 (20–21)	19 (19–20)	21 (20–22)	20 (20–22)
Post-anal	-	-	21 (21–22)	19 (19–20)	22 (20–24)	19 (18–20)
Length of leg I	1400	-	1478 (1463–1479)	1375 (1300–1375)	1528 (1460–1600)	1364 (1300–1420)
Length of leg II	-	-	755 (750–765)	638 (563–655)	820 (800–860)	712 (660–740)
Length of leg III	-	-	664 (655–675)	575 (550–575)	756 (720–800)	664 (640–680)
Length of leg IV	-	-	851 (833–863)	725 (675–775)	892 (860–900)	792 (740–840)
Wide of Ventrianal shield	247	-	164 (150–175)	-	294 (272–320)	-
Length of Ventrianal shield	154	-	260 (250–263)	-	160 (150–170)	-

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