PKP
PUBLIC KNOWLEDGE PROJECT

Journal of Biological Studies
ISSN 2209-2560

JBS
An Open Access Peer Reviewed Journal

Predator and parasite mites associated with aphids and scale insects in Guilan Province of Iran

Amir Hossein Navaran . Jalil Hajizadeh*

Department of Plant Protection, Faculty of Agricultural Sciences, University of Guilan, Rasht, Iran

Received: November 01, 2021; **Accepted:** December 08, 2021; **Published online:** December 22, 2021.

Abstract: A faunistic study on the predator and parasite mites (Acari) associated with aphids and scale insects in Guilan province, northern Iran was carried out during 2020- 2021. Totally, 32 species belonging to 23 different genera and 11 families were collected and identified. *Amblyseius herbicolus* (Chant), *Amblyseius meridionalis* Berlese, *Euseius stipulates* (Athias-Henriot), *Euseius finlandicus* (Oudemas), *Neoseiulus barkeri*, *Paraseiulus triporus* (Chant and Yoshida-Shaul), *Paraseiulus soleiger* (Ribaga), *Paraseiulus talbii* (Athias-Henriot), *Transeius wainsteini* (Gomelauri), *Typhlodromus caudiglans* Schuster [Phytoseiidae]; *Cheletogenes ornatus* (Canestrini and Fanzago), *Cheletomimus berlesei* (Oudemans), *Cheletomorpha lepidopterorum* (Shaw), *Cheyletus malaccensis* Oudemans [Cheyletidae]; *Armascirus cerris* Kaluz [Cunaxidae]; *Balastium zhangi* Saboori [Erythraeidae]; *Cyta latirostris* (Hermann) [Bdellidae]; *Lasioseius extremus* (Daneshvar) [Blattisociidae]; *Uropoda orbicularis* (Muller) [Uropodidae] and *Nenteia stylifera* (Edwards) [Trematuridae] are new records for association with aphids and scale insects in Guilan province. Collection information of identified species and the dominances (%) of their families are provided. A tabulated checklist of 67 mite species associated with aphids and scale insects in Guilan Province, Iran, is also provided.

Keywords: Natural enemies; Aphididae; Diaspididae; beneficial mites; Iran.

1 Introduction

Aphids and scale insects (Hemiptera: Aphidoidea and Coccoidea) are the most important agricultural pests in the insect group. They feed on phloem juice, robbing the plant of valuable sugars, literally sucking the life out of their host (Kondo et al., 2008; Blackman and Eastop 2020).

*e-mail: hajizadeh@guilan.ac.ir

Aphids feed on more than 300 different plants families, including herbaceous plants, shrubs, trees and ornamental plants (Blackman and Eastop, 2020). Aphids cause significant economic losses on cultivated plants and also cause severe damage to the park and ornamental plants and weeds. Indirectly, aphids are also vectors of many plant pathogens (Ng and Perry, 2004), and more than 190 aphid species have been reported to transmit plant viruses (Nault, 1997). Scale insects live on a wide variety of plant species and many of them are important agricultural pests. Here are estimated to be more than 7700 species of coccoids assigned variously to 20 or more families (Koteja, 1974; Gullan and Kosztarab, 1997; Kozar et al., 2013).

Commonly pesticides are used in the world for the management of aphids and scale insects. Due to the adverse effects of pesticides on the environment and human health and the rapid resistance rates of aphids and scale insects against them alternative approaches for pesticides are highlighted worldwide (Mota-Sanchez et al., 2002; Cutler and Miller 2005; Bass et al. 2014). Biological control appears to be an essential alternative to pesticides. Applied biological control must be based on fundamental studies that elucidate the taxonomy, biology, mode of reproduction, behavior, prey range and rearing techniques of the potential biological control agent. These studies are considered as the prelude for ecological field research designed to evaluate the relative importance of predatory and parasite mites concerning to their regulation of the target pest. The above-mentioned knowledge must configure a solid basis to develop effective classical, augmentative, or conservation biological control programs (Carrillo et al., 2015). Mites have been used in various ways for biological control, and several species, particularly phytoseiids, are sold commercially throughout the world for biological control strategy (Gerson et al., 2008). Mesostigmata or Gamasida predators are encountered in soil and litter, on aerial parts of plants, or in patchy habitats such as nests or galleries of insects, mammals and birds, where they feed on small insects and nematodes or on phytophagous and mycophagous mites. Prostigmata mites are also found in diverse habitats, including soils and overlaying litter layers, and aerial parts of plants, some of which consist mainly of predatory or parasitic species. Some species of the families Bdellidae, Cunaxidae, Stigmaeidae, Cheyletidae, Raphignathidae, Eupalopsellidae, Hemisarcoptidae showed a wide range of distribution and might play a considerable role in reducing other pest populations (Carrillo et al., 2015; Hernandes et al., 2015; Athanassiou and Palyvos, 2015; Fan and Flechtmann, 2015). Some mite species belonging to families Erythraeidae and Trombidiidae are parasites in their larval stage and predators in their deutonymph and adult stages on aphids (Zhang 1998; Muñoz-Cárdenas et al., 2015). Larvae of species belonging to the genus Allothrombium are common ectoparasites of aphids (Oner et al., 2021). Anyway, our knowledge about taxonomy and biology of the predacious and parasite mites associated with aphids and scale insects in Iran is still very incomplete. The purpose of this paper is to determine the predacious and parasite mite's species associated with aphids and scale insects in Guilan province, northern Iran.

2 Materials and Methods

In this study predator and parasite mites (Acari) associated with aphids and scale insects were collected from infested plants with aphids and scale insects in Guilan province, Northern Iran during 2020-2021. Mites were extracted from samples by using Berlese funnel or direct examinations of plant materials under a stereomicroscope. Parasite specimens were detached by minute insect pin. Specimens of mites were sorted and preserved in Ethanol 70 %. Eventually, specimens were cleared in Nesbitt's fluid and mounted permanently on microscope slides with

using Hoyer's medium. The mites were identified by the relevant taxonomic keys and papers (Ghilyarov and Bregetova, 1977; Karg, 1993; Saboori, 2000; Hajizadeh, 2006, 2007; Saboori et al., 2007; Mašán, 2001; Christian and Karg, 2006; Hajizadeh et al., 2010; De Moraes et al., 2016; Hajizadeh and Faraji, 2016; Xu et al., 2019). For precise inspection of morphological characters of prepared specimens, a compound microscope equipped with differential interference contrast and phase contrast optical system and a drawing tube (Olympus BX51, Olympus Optical Co., Ltd, Tokyo, Japan) was used. The voucher specimens of each species were preserved as slide-mounted specimens and are present in Acarology Laboratory, Department of Plant Protection, Faculty of Agricultural Sciences at University of Guilan, Rasht, Iran.

3 Results and Discussions

During the current faunistic study of predator and parasite mites (Acari) associated with aphids and scale insects in Guilan province, northern Iran, 32 species belonging to 23 genera and 11 families were collected and identified. An alphabetical list of predator and parasite mites (Acari) associated with aphids and scale insects in Guilan province includes collected specimens in the current research is presented in Table 1. Also the relative abundance (%) of mite families base on collected specimens in this study are shown in figures 1 and 2. In addition, detailed collection information of each identified species of predator and parasite mites (Acari) associated with aphids and scale insects in this study is provided.

Table 1. Checklist of the predator and parasite mites associated with aphids and scale insects in Guilan Province of Iran.

No	Species	References
1	*Amblyseius azerbaijanicus* Abbasova	Yazdanpanah et al., 2015; Hajizadeh & Nazari, 2012.
2	*Amblyseius herbicolus* (Chant)	Current study.
3	*Amblyseius meridionalis* Berlese	Current study.
4	*Amblyseius rademacheri* (Dosse)	Yazdanpanah et al., 2015; Tajmiri & Hajizadeh, 2012; current study.
5	*Ameroseius eumorphus* Bregetova	Ghasemi & Hajizadeh, 2021.
6	*Allothrombium pulvinum* Ewing	Jaliliradet et al., 2012; Noei et al., 2013; current study.
7	*Allothrombium triticium* Zhang	Noei et al., 2013; Current study.
8	*Armascirus cerris* Kaluz	Current study.
9	*Balastium zhangi* Saboori	Current study.
10	*Cheiroseius longipes* (Willmann)	Mahjoori et al., 2015.
11	*Cheletogenes ornatus* (Canestrini & Fanzago)	Current study.
12	*Cheletomimus berlesei* (Oudemans)	Current study.
13	*Cheletomimus* (*Hemicheyletia*) *wellsi* (Baker)	Jalilirad et al., 2012; Current study.
14	*Cheletomorpha lepidopterorum* (Shaw)	Current study.
15	*Cheyletus carnifex* (Zachvatkin)	Salarzehi et al., 2018; Current study.
16	*Cheyletus ferox* Trouessart	Ghasemi & Hajizadeh, 2020.
17	*Cheyletus malaccensis* Oudemans	Current study.

Continued Table 1.

No	Species	References
18	*Cheyletus rapax* Oudemans	Ghasemi & Hajizadeh, 2020.
19	*Cyta latirostris* (Hermann)	Current study
20	*Euseius amissibilis* Meshkov	Hajizadeh & Nazari, 2012; Tajmiri & Hajizadeh, 2012.
21	*Euseius stipulates* (Athias–Henriot)	Current study.
22	*Euseius finlandicus* (Oudemas)	Current study.
23	*Erythraeus* (*zaracarus*) *budapestensis* Fain & Ripka	Ghasemi & Hajizadeh, 2020; Current study.
24	*Eustigmaeus anauniensis* (Canestrini)	Jalilirad et al., 2012.
25	*Eustigmaeus segnis* (Koch)	Hajizadeh et al. 2013; Current study.
26	*Evimirus uropodinus* (Berlese)	Ghasemi & Hajizadeh, 2021.
27	*Graminaseius graminis* (Chant)	Hajizadeh & Nazari, 2012.
28	*Hypoaspis* (*Hypoaspisella*) *linteyini* (Samsinak)	Hajizadeh & Joharchi, 2018.
29	*Lasioseius extremus* (Daneshvar)	Current study.
30	*Lasioseius frankbakkeri* FaraJi & Karg	Javadpour el al., 2018.
31	*Lasioseius sugawarai* Ehara	Ghasemi & Hajizadeh, 2020; Javadpour el al., 2018.
32	*Lasioseius tridentatus* Baker	Ghasemi & Hajizadeh, 2020.
33	*Ledermuelleriopsis medicae* Khanjani & Ueckermann	Hajizadeh et al. 2013; Current study.
34	*Neoseiulus barkeri* Hughes	Current study.
35	*Neoseiulus bicaudus* (Wainstein)	Mahjoori et al., 2015.
36	*Neoseiulus brevispinus* (Kennett)	Hajizadeh & Nazari, 2012; Yazdanpanah et al., 2015.
37	*Neoseiulus imbricatus* (Corpuz-Raros & Rimando)	Mahjoori et al., 2015.
38	*Neoseiulus marginatus* (Wainstein)	Yazdanpanah et al., 2015; Mahjoori et al., 2015; Tajmiri & Hajizadeh, 2012.
39	*Neoseiulus multiporus* (Wu & Li)	Tajmiri & Hajizadeh, 2012.
40	*Neoseiulus sugonjaevi* (Wainstein & Abbasova)	Yazdanpanah et al., 2015; Tajmiri & Hajizadeh, 2012.
41	*Neoseiulus tauricus* (Livshitz & Kuzenetsov)	Tajmiri & Hajizadeh, 2012.
42	*Neoseiulella tiliarum* (Oudemans)	Mahjoori et al., 2015.
43	*Neoseiulus umbraticus* (Chant)	Yazdanpanah et al., 2015; Tajmiri & Hajizadeh, 2012; Current study.
44	*Nenteia stylifera* (Edwards)	Current study.
45	*Paraseiulus triporus* (Chant & Yoshida-Shaul)	Current study.
46	*Paraseiulus soleiger* (Ribaga)	Current study.
47	*Paraseiulus talbii* (Athias-Henriot)	Current study.

Continued Table 1.

No	Species	References
48	*Phytoseius finitimus* Ribaga	Yazdanpanah et al., 2015; Hajizadeh & Nazari, 2012; Current study.
49	*Phytoseius juvenis* Wainstein & Arutunjan	Tajmiri & Hajizadeh, 2012.
50	*Phytoseius spoofi* (Oudemans)	Tajmiri & Hajizadeh, 2012.
51	*Proprioseiopsis okanagensis* (Chant)	Tajmiri & Hajizadeh, 2012.
52	*Protogamasellus massula* (Athias-Henriot)	Ghasemi & Hajizadeh, 2021.
53	*Pulaeus martini* Den Heyer	Jalilirad et al., 2012; Current study.
54	*Raphignathus hecmatanaensis* Khanjani & Ueckermann	Ghasemi & Hajizadeh, 2020; Current study.
55	*Spinibdella cronini* (Baker & Balock)	Ghasemi & Hajizadeh, 2020.
56	*Transeius herbarius* (Wainstein)	Tajmiri & Hajizadeh, 2012.
57	*Transeius wainsteini* (Gomelauri)	Current study.
58	*Typhlodromus bakeri* (Garman)	Yazdanpanah et al., 2015.
59	*Typhlodromus caudiglans* Schuster	Current study.
60	*Typhlodromus georgicus* Wainstein	Tajmiri & Hajizadeh, 2012.
61	*Typhlodromus leptodactylus* Wainstein	Yazdanpanah et al., 2015.
62	*Typhlodromus kettanehi* (Dosse)	Mahjoori et al., 2015.
63	*Typhlodromus perbibus* Wainstein & Arutunjan	Yazdanpanah et al., 2015.
64	*Typhlodromus rhenanus* (Oudemans)	Mahjoori et al., 2015; Hajizadeh & Nazari, 2012.
65	*Typhlodromus tubifer* Wainstein	Yazdanpanah et al., 2015.
66	*Uropoda orbicularis* (Muller)	Current study.
67	*Zetzellia mali* (Ewing)	Hajizadeh et al., 2013.

List of identified mite species with detailed information

A. Predatory species

Superfamily Bdelloidea
Family: Cunaxidae

***Armascirus cerris* Kaluz, 2009**

Material examined: 1 ♀, Bandar Anzali (37°2822N, 49°2744E), -26 m, collected on *Ligustrum japonicum* Thunb, infested with diaspidid scale, September 2021.

***Pulaeus martini* Den Heyer, 1980**

Material examined: 4 ♀, Langarud (37°110N, 50°90E), 21 m, collected on *Citrus sinensis* Osbeck, infested with diaspidid scale, September 2020.

Family: Bdellidae

***Cyta latirostris* (Hermann, 1804)**

Material examined: 1 ♀, Sanghar (37.1783°N, 49.6937°E), 40 m, collected on *Buxus* sp., infested with *Unaspis euonymi* (Comstock, 1881), August 2021.

Superfamily Cheyletoidea
Family: Cheyletidae

***Cheletomimus wellsi* (Baker, 1949)**

Material examined: 4 ♀, Bandar Anzali (37°2822N, 49°2744E), -26 m, Khoshkebijar (37°2229N 49°4527E), 8 m, and Kuchesfahan (37°1642N 49°4622E), 4 m, collected on *Citrus* sp., infested with *Chrysomphalus dictyospermi* (Morgan), September 2020, January 2021.

***Cheletogenes ornatus* Canestrini & Fanzago, 1876**

Material examined: 2 ♀, Khomam (37°2321N, 49°3930E), -17 m, collected on *Citrus* sp., infested with scale insects, September 2020.

***Cheletomimus berlesi* Oudemans, 1904**

Material examined: 2 ♀, Sangar (37°10'42"N, 49°41'38"E), 40 m, collected on *Citrus* sp., infested with scale insects, September 2020.

***Cheletomorpha lepidopterorum* (Shaw, 1794)**

Material examined: 2 ♀, Khoshkebijar (37°2229N, 49°4527E), 8 m, collected on *Citrus* sp., infested with *Chrysomphalus dictyospermi* (Morgan), September 2020.

***Cheyletus malaccensis* Oudemans, 1903**

Material examined: 4 ♀, Lashtnesha (37°2158N, 49°5134E), -21 m, and Rasht (37°1651N, 49°3459E), 8 m, collected on *Citrus* sp., infested with diaspidid scales, September 2020.

***Cheyletus carnifex* Zachvatkin, 1935**

Material examined: 2 ♀, Lashtnesha (37°2158N, 49°5134E), -21 m, Rasht (37°1651N, 49°3459E), 8 m, collected on *Citrus* sp., infested with diaspidid scales, September 2020.

Family: Raphignathidae Latreille, 1802

***Raphignathus hecmatanaensis* Khanjani & Ueckermann, 2003**

Material examined: 4 ♀, Langrud (37°110N, 50°90E), 21 m, collected on *Citrus sinensis* Osbeck, infested with diaspidid scale, September 2020.

Family: Stigmaeidae Oudemans, 1931

***Eustigmaeus segnis* Koch, 1836**

Material examined: 3 ♀, Langarud (37°110N, 50°90E), 21 m, collected on *Citrus sinensis* Osbeck, infested with diaspidid scale, September 2020.

***Ledermuelleriopsis medicae* Khanjani & Ueckermann 2002**

Material examined: 3 ♀, Langarud (37°110N, 50°90E), 21 m, collected on *Citrus sinensis* Osbeck, infested with diaspidid scale, September 2020.

Superfamily Ascoidea
Family: Blattisociidae

***Lasioseius extremus* (Daneshvar, 1987)**

Material examined: 1 ♀, Bandar Anzali (37°2822N, 49°2744E), -26 m, collected on *Citrus* sp., infested with *Chrysomphalus dictyospermi* (Morgan), October 2020.

Superfamily Phytoseioidea
Family: Phytoseiidae

***Amblyseius herbicolus* (Chant, 1959)**

Material examined: 7 ♀, Bandar Anzali (37°2822N, 49°2744E), -26 m, collected on *Citrus* sp., infested with *Lepidosaphes beckii* (Newman, 1869), *Chrysomphalus dictyospermi* (Morgan) and *Pulvinaria aurantii* Cockerell, January and August 2021. 3 ♀, Kapourchal (37°3256N, 49°1403E), -21 m, collected on *Buxus* sp., infested with *Unaspis euonymi* (Comstock, 1881), August 2021. 3 ♀, 2 ♂, Siahkal (37°910N, 49°5215E), 200 m, collected on *Urtica membraneacea* Poir., infested with aphids July 2020. 15 ♀, 5 ♂, Amlash (37°459.88N, 50°1059.88E), 13 m, Roudsar (37°80N, 50°170E), -19 m, Shalman (37°919N, 50°1258E), -5 m, Vajargah (37°0227N, 50°2431E), -10 m, and Shaft (37°924N, 49°2426E), collected on *Cucumis sativus* L., infested with *Aphis gossypi* Glover, August 2020. 5 ♀, 3 ♂ Rezvanshahr (37°334N, 49°822E), 15 m, and Rasht (37°170N, 49°350E), collected on *Citrus sinensis* Osbeck, infested with diaspidid scale. 4 female , 3 male , Shalman (37°919N, 50°1258E), -5 m, and Astaneh-e Ashrafiyyeh (37°1554N, 49°5640E), -2 m, collected on *Phaseolus vulgaris* L., infested with *Aphis gossypi* Glover September 2020. 6 ♀, 3 ♂, Lahijan (37°120N, 50°00E), collected on *Euonymus japonicus* L., infested with diaspidid scale.

***Amblyseius meridionalis* Berlese, 1914**

Material examined: 1 ♀, Bandar Anzali (37°2822N, 49°2744E), -26 m, collected on *Citrus* sp., infested with *Chrysomphalus dictyospermi* (Morgan, 1889), January 2021.

***Amblyseius rademacheri* Dosse, 1958**

Material examined: 10 ♀, 3 ♂, Astaneh-e Ashrafiyyeh (37°1554N, 49°5640E), -2 m, Masouleh

(37°918N, 48°5923E), Soumahe Sara (37°180N, 49°180E), 20 m, Kiashahr (37°2510N, 49°5656E), Rasht (37°1651N, 49°3459E), 8 m, and Sangar (37°10'42"N, 49°41'38"E), 40 m, collected on *Urtica membraneacea* Poir., infested with aphids, July 2020. 3 ♀, 1 ♂, Astaneh-e Ashrafiyyeh (37°15 54N, 49°5640E), -2 m, and Kiashahr (37°2510N, 49°5656E), 8 m, collected on *Solanum melongena* L., infested with *Aphis gossypi* Glover Jun 2020. Rasht (37°1651N 49°3459E), 8 m, Sangar (37°10'42"N, 49°41'38"E), 40 m, Amlash (37°459.88N, 50°1059.88E), 13 m, Roudsar (37°80N, 50°170E), -19 m, and Punel (37°3216N, 49°0616E), 15m, collected on *Cucumis sativus* L., infested with *Aphis gossypi* Glover, August 2020. 5 ♀, 2 ♂, Astaneh-e Ashrafiyyeh (37°1554N, 49°5640E), -2 m, and Sangar (37°10'42"N, 49°41'38"E), 40 m, collected on *Phaseolus vulgaris* L., infested with *Aphis gossypi* Glover, July 2020. 6 ♀, Soumahe Sara (37°180N, 49°180E), 20m, Amlash (37°459.88N, 50°1059.88E), 13 m, and Asalem (37°42'14"N, 48°56'27"E), 20 m, collected on *Solanum nigrum* L., infested with aphids.

***Euseius finlandicus* (Oudemans, 1915)**

Material examined: 2 ♀, Kapourchal (37°3256N, 49°1403E), -21 m, collected on *Ligustrum japonicum* Thunb., infested with diaspidid scale, October 2021.

***Euseius stipulates* (Athias–Henriot, 1960)**

Material examined: 26 ♀ and 20 ♂, Bandar Anzali (37°2822N, 49°2744E), -26 m, collected on *Buxus* sp., infested with *Unaspis euonymi* (Comstock); *Citrus* sp., infested with *Chrysomphalus dictyospermi* (Morgan); *Citrus* sp., infested with *Lepidosaphes beckii* (Newman); November 2020, December 2020, January 2021 and February 2021. 5 ♀ and 4 ♂, Khomam (37°2321N, 49°3930E), -17 m, collected on *Citrus* sp., infested with *Lepidosaphes beckii* (Newman); *Citrus* sp., infested with *Planococcus citri* (Risso); *Nerium oleander*,infested with *Aphis nerii* Boyer de Fonscolombe, 1841; *Ligustrum japonicum*, infested with diaspidid scale; February 2021, June 2021; October 2021. 1 ♀, Haji Bekandeh (37°2645N, 49°4723E), -19 m, collected from *Citrus* sp., infested with *Pulvinaria aurantii* Cockerell, April 2021. 7 ♀ and 5 ♂, Kapourchal (37°3256N 49°1403E), -21 m, collected on *Citrus* sp., infested with *Chrysomphalus dictyospermi* (Morgan); *Citrus* sp., infested with *Pulvinaria aurantii* Cockerell; *pomegranate*, infested with *Aphis punicae* Passerini; *Ligustrum japonicum*, infested with diaspidid scale, April 2021, September 2021, October 2021.

***Neoseiulus barkeri* Hughes, 1948**

Material examined: 4 ♀, Rasht (37°1651N, 49°3459E), 8 m, collected on *Cucumis sativus* L., infested with *Aphis gossypi* Glover, August 2020.

***Neoseiulus umbraticus*(Chant)**

Material examined: 7 ♀, Astaneh-e Ashrafiyyeh (37°1554N, 49°5640E),- 2 m, Rasht (37°1651N, 49°3459E), 8 m, and Amlash (37°459.88N, 50°1059.88E), 13 m, collected on *Urtica membraneacea* Poir., infested with aphids, July 2020. 4 ♀, Rasht (37°1651N, 49°3459E), 8 m, and Shalman (37°919N, 50°1258E), -5 m, collected on *Cucumis sativus* L., infested with *Aphis gossypi* Glover August 2020. 3 ♀, Sangar (37°10'42"N, 49°41'38"E), 40 m, and Rostamabad (36°5354N, 49°2926E), 400 m, collected on *Phaseolus vulgaris* L., infested with *Aphis gossypi* Glover, August 2020.

***Paraseiulus soleiger* (Ribaga, 1904)**

Material examined: 3 ♀, Bandar Anzali (37°2822N, 49°2744E), -26 m, collected on *Citrus* sp., infested with *Chrysomphalus dictyospermi* (Morgan), October 2020.

***Paraseiulus talbii* (Athias-Henriot, 1960)**

Material examined: 1 ♀, Bandar Anzali (37°2822N, 49°2744E), -26 m, collected on *Citrus* sp., infested with *Chrysomphalus dictyospermi* (Morgan), November 2020.

***Paraseiulus triporus* (Chant & Yoshida-Shaul, 1982)**

Material examined: 3 ♀, Bandar Anzali (37°2822N, 49°2744E), -26 m, collected on *Citrus* sp., infested with *Chrysomphalus dictyospermi* (Morgan, 1889), November 2020. 1 ♀, Rasht (37°1651N 49°3459E), 8 m, collected on *Citrus* sp., infested with *Pulvinaria aurantii* Cockerell, May 2021. 2 ♀, Asalem (37°42'14"N, 48°56'27"E), 29 m, collected on *Cucumis sativus* L., infested with *Aphis gossypi* Glover, September 2020. 3 ♀, Rasht (37°1651N, 49°3459E), 8 m, collected on *Euonymus japonica* L., infested with diaspididae scale, August 2020.

Phytoseius finitimus Ribaga, 1904

Material examined: 10 ♀, 5 ♂, Punel (37°3216N, 49°0616E), 15m, Rostamabad (36°5354N, 49°2926E), 400 m, and Shaft (37°924N, 49°2426E), collected on *Cucumis sativus* L., infested with *Aphis gossypi* Glover, August 2020. 33 ♀, Rasht (37°1651N, 49°3459E), 8 m, collected on *Chrysanthemum* sp., infested with aphids, June 2020.

Transeius wainsteini (Gomelauri, 1968)

Material examined: 10 ♀ and 5 ♂, Bandar Anzali (37°2822N, 49°2744E), -26 m, collected on *Buxus* sp., infested with *Unaspis euonymi* (Comstock, 1881); *Citrus* sp., infested with *Lepidosaphes beckii* (Newman); rose infested with *Macrosiphum rosae* (Linneaus); *Citrus* sp., infested with *Pulvinaria aurantii* Cockerell; *Citrus* sp., infested with *Toxoptera citricida* (Kirkaldy); *Ligustrum japonicum*, infested with diaspididae scale, September 2020, February 2021, April 2021, July 2021, September 2021. 5 ♀, Haji Bekandeh (37°2645N, 49°4723E), -19 m, collected on *Citrus* sp., infested with *Pulvinaria aurantii* Cockerell, July 2021. 2 ♀, Kapourchal (37°3256N, 49°1403E), -21 m, collected on *Citrus* sp., infested with *Pulvinaria aurantii* Cockerell, June 2021. 2 ♀ and 2 ♂, Rasht (37°1651N, 49°3459E), 8 m, collected on *Ligustrum japonicum*, infested with diaspididae scale; greengage plums infested with aphids, September 2021, April 2021. 5 ♀, Rezvanshahr County (37°334N, 49°822E), 15 m, collected on *Citrus sinensis* Osbeck, infested with diaspidid scale, September 2020. 2 ♀, Siahkal (37°910N, 49°5215E), 200 m, and Masouleh (37°918N, 48°5923E), collected on *Urtica membraneacea* Poir., infested with aphids September 2020. 5 ♀, 4 ♂, Siahkal (37°910N, 49°5215E), 200 m, Masouleh (37°918N, 48°5923E), Rasht (37°170N, 49°350E), and Shalman (37°919N, 50°1258E), -5 m, collected on *Phaseolus vulgaris* L., infested with *Aphis gossypi* Glover, September 2020. 15 ♀, 5 ♂, Amlash (37°459.88N, 50°1059.88E), 13 m, Roudsar (37°80N, 50°170E), -19 m, Shalman (37°919N, 50°1258E), -5 m, Vajargah (37°0227N, 50°2431E), -10 m, Asalem (37°42'14"N, 48°56'27"E), 29 m, Punel (37°3216 N, 49°0616E), 15 m, and Shalman (37°919N, 50°1258E), -5 m, collected on *Cucumis sativus* L., infested with *Aphis gossypi* Glover,

August 2020.

***Typhlodromus caudiglans* Schuster, 1959**

Material examined: 3 ♀, Rostamabad (36°5354N, 49°2926E), 400 m, collected on *Cucumis sativus* L., infested with *Aphis gossypi* Glover, August 2020.

Superfamily Uropodoidea
Family: Uropodidae

***Uropoda orbicularis* (Muller, 1776)**

Material examined: 1 ♀, Bandar Anzali (37°2822N, 49°2744E), -26 m, collected on *Phragmites australis* (Cav.), infested with aphids, August 2021.

Family: Trematuridae

***Nenteia stylifera* (Edwards, 1837))**

Material examined: 1 ♀, Bandar Anzali (37°2822N, 49°2744E), -26 m, collected on *Citrus* sp., infested with *Toxoptera citricida* (Kirkaldy), July 2021.

Superfamily: Trombidioidea
Family: Trombidiidae

***Allothrombium pulvinum* Ewing, 1917 (Adult)**

Material examined: 3 ♀, Rasht (37°1651N, 49°3459E), 8 m, collected on *Citrus* sp., infested with *Pulvinaria aurantii* Cockerell; *Hibiscus syriacus*, infested with aphids, July 2021, May 2021. 5 ♀, Bandar Anzali (37°2822N, 49°2744E), -26 m, collected on *Citrus* sp., infested with *Planococcus citri* (Risso); *Citrus* sp., infested with *Toxoptera citricida* (Kirkaldy); *Cucumis sativus*, infested with *Aphis gossypii* Glover, 1877, June 2021; July 2021, September 2021. 1 ♀, Kuchesfahan (37°1642N, 49°4622E), 4 m, collected on *Citrus* sp., infested with *Planococcus citri* (Risso), June 2021. 1 ♀, Khomam (37.3913°N, 49.6588°E), -17 m, collected on *Citrus* sp., infested with *Pulvinaria aurantii* Cockerell, July 2021.

Remark *Allothrombium pulvinum* Ewing is parasite in larval stage and predators in deutonymph and adult stages on aphids (Zhang 1998).

B. Parasite species

Superfamily Erythraeoidea
Family: Erythraeidae
Subfamily: Balaustiinae

***Balastium zhangi* Saboori, 2000**

Material examined: 1 larva, Bandar Anzali (37°2822N, 49°2744E), -26 m, collected on *Buxus* sp., infested with *Unaspis euonymi* (Comstock), February 2021. 2 larvae, Rasht (37°1651N, 49°3459E), 8 m, collected on rose, infested with *Macrosiphum rosae* (Linneaus); *Buxus* sp., infested with *Aphis fabae* Scopoli, April 2021.

Subfamily: Erythraeinae

***Erythraeus* (*Zaracarus*) *budapestensis* Fain & Ripka, 1998**

Material examined: 11 larvae, Rasht (37°1651N, 49°3459E), 8 m, collected on rose, infested with *Macrosiphum rosae* (Linneaus, 1758); *Buxus* sp., infested with *Aphis fabae* Scopoli; greengage plums infested with aphids; *Platanus* sp., infested with aphids; *Plantago major*, infested with aphids; *Hibiscus syriacus*, infested with *Aphis gossypii* Glover, April 2021. 2 larvae, Bandar Anzali (37°2822N, 49°2744E), -26 m, collected greengage plums, infested with aphids, April 2021. 2 larvae, Haji Bekandeh (37°2645N, 49°4723E), -19 m, collected from *Plantago major* infested with aphids; April 2021. *Nerium oleande*, infested with *Aphis nerii* Boyer de Fonscolombe, 1841; *Chaenomeles japonica*, infested with aphids, April 2021.

Remark: Some mite species belonging to family Erythraeidae are parasites in their larval stage and predators in their deutonymph and adult stages on aphids (Muñoz-Cárdenas et al., 2015; Zhang 1998). Larvae of *Balastium zhangi* Saboori and *Erythraeus* (zaracarus) *budapestensis* Fain & Ripka were collected as ectoparasite on aphid species *Macrosiphum rosae*, *Aphis fabae*, *Aphis gossypii* and *Aphis nerii* in this study.

Superfamily: Trombidioidea
Family: Trombidiidae

***Allothrombium pulvinum* Ewing, 1917 (Larva)**

Material examined: 10 larvae, Kapourchal (37.5528°N, 49.2291°E), -21 m, collected on pomegranate, infested with *Aphis punicae* Passerini; *Chaenomeles japonica* (Thunb.), infested with aphids; *Prunus persica*, infested with aphids, May 2021, June 2021. 25 larvae, Rasht (37°1651N 49°3459E), 8 m, collected from *Chaenomeles japonica* (Thunb.), infested with aphids; pomegranate, infested with *Aphis punicae* Passerini; rose, infested with *Macrosiphum rosae* (Linneaus); *Nerium oleande*, infested with *Aphis nerii* Boyer de Fonscolombe, 1841; *Buxus* sp., infested with *Aphis fabae* Scopoli, 1763; *Citrus* sp., infested with *Icerya purchasi* Mask, May 2021, August 2021, September 2021. 15 larvae, Bandar Anzali (37°2822N, 49°2744E), -26 m, collected from *Chaenomeles japonica* (Thunb.), infested with aphids; Solenostemon, infested with mealybugs; *Prunus persica*, infested with aphids; Watermelon, infested with *Aphis gossypii* Glover; *Phragmites australis*, infested with aphids; *Nerium oleander*, infested with *Aphis nerii* Boyer de Fonscolombe; May 2021, August 2021.

***Allothrombium triticium* Zhang, 1995**

Material examined: 1, Kapourchal (37.5528°N, 49.2291°E), -21 m, collected on pomegranate, infested with *Aphis punicae* Passerini, April 2021.

Remark: *Allothrombium pulvinum* is parasite in larval stage and predators in deutonymph and adult stages on aphids (Zhang 1998). Larvae of *A. pulvinum* and *A. triticium* were collected as ectoparasite on above mentioned aphid species in this study.

Conclusion

The result of this study showed that a total of 32 mites species (from 11 families) associated with aphids and scale insects were identified in Guilan province, Iran. This is a new record for 20 of these species for association with aphids and scale insects in Guilan province. The families Phytoseiidae and Trombidiidae were the most abundant families in association with aphids and scale insects as predator or parasite (figures 1 and 2). In this study, *Euseius stipulates* (32.85 %), *Transeius wainsteini* (15.94 %), *Amblyseius herbicolus* (13.04 %) and *Allothrombium pulvinum* (16.9 %) were the most common mite species in associated with scale insects. *Allothrombium pulvinum* (24.67 %), *Transeius wainsteini* (20.42 %), *Amblyseius herbicolus* (13.61 %), *Amblyseius rademacheri* (12.76 %) and *Euseius stipulates* (8.93 %) were the most common mite species in associated with aphids. Mite species belonging to families Trombidiidae and Erythraeidae observed as ectoparasite on aphids and some scale insects (such as Mealybugs and Giant Coccids) in their larval stage and predators in their adult stage. Larvae of *Allothrombium pulvinum* were common ectoparasites of aphids in this study. Future studies should be conducted to determine the effectiveness of these mite species on aphids and scale insects as predator or parasite and used of them in biological control. The species obtained in this study, especially more abundant species should reared in the laboratory and their effectiveness as natural enemies of aphids and scale insects should be determined in future studies.

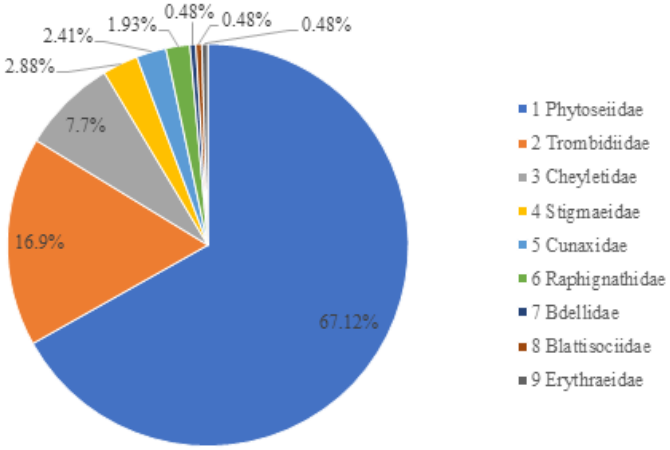

Figure 1: Percentage of families of predator and parasite mites associated with scale insects in Guilan Province of Iran.

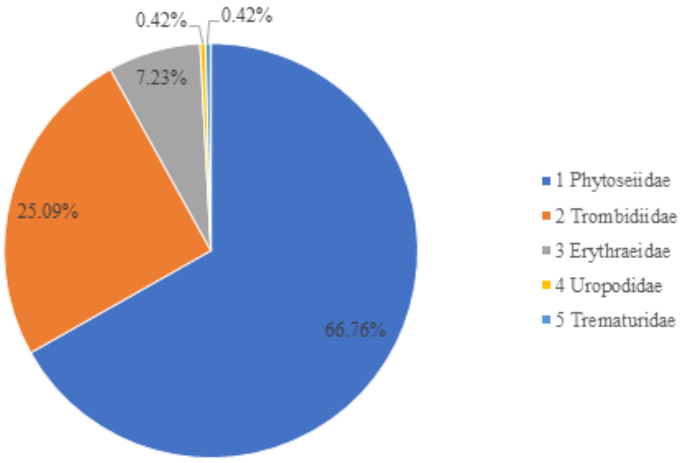

Figure 2: Percentage of families of predator and parasite mites associated with aphids in Guilan Province of Iran.

Acknowledgments

This project was supported by University of Guilan, Rasht, Iran, which are greatly appreciated. We wish to express our gratitude to Dr. Masoud Hakimitabar (Shahrood University of Technology) for identification of parasitengone mite species.

Conflict of interests

The authors declare that there are no competing interests.

References

Athanassiou, C.G., & Palyvos, N.E. (2015). The Cheyletoidea (Prostigmata), with special reference to the potential of *Cheyletus malaccensis* Oudemans as biological control agent of post-harvest pests. In Carrillo, D., De Moraes, G.J. and Peña, J.E. (Eds.) Prospects for biological control of plant feeding mites and other harmful organisms. Springer, Cham, 241–249.

Bass, C., Puinean, A.M., Zimmer, C.T., Denholm, L., Field, L.M., Foster, S.P., Gutbrod, O., Nauen, R., Slater, R., & Williamson M.S. (2014). The evolution of insecticide resistance in the peach potato aphid, Myzus persicae. Insect Biochemistry & Molecular Biology, 51, 41–51.

Blackman, R.L., & Eastop, V.F. (2020). Aphids on the world's plants an online identification and information guide; [cited Nov 2020]. Available from: www.aphidsonworldsplants.info.

Carrillo, D., De Moraes, G.J., & Peña, J.E. (2015). Prospects for biological control of plant feeding mites and other harmful organisms. Springer International Publishing Switzerland, Springer, Cham, 328 pp.

Christian, A., & Karg, W. (2006). The predatory mite genus Lasioseius Berlese, 1916 (Acari, Gamasina). Abhandlungen und Berichte des Naturkundemuseums Görlitz, 77(2), 99–250.

Cutler D.M., & Miller G. (2005). The role of public health improvements in health advances: the 20th century United States. Demography, 42, 1–22.

Fan, Q.H., & Flechtmann, C.H. (2015). Stigmaeidae. In Carrillo, D., De Moraes, G.J. and Peña, J.E. (Eds.). Prospects for biological control of plant feeding mites and other harmful organisms. Springer International Publishing Switzerland, Springer, Cham, 185–206.

Gerson, U., Smiley, R.L., & Ochoa, R. (2008). Mites (Acari) for pest control. John Wiley & Sons. 539 pp.

Ghasemi, A., & Hajizadeh, J. (2020). Mites of superfamily Phytoseioidea (Acari: Mesostigmata) of greenhouses in Rasht County, northern Iran, with new record of a species and an identification key. Journal of Entomological Society of Iran, 39(4), 459–477.

Gullan, P.J., & Kosztarab, M. (1997). Adaptations in scale insects. Annual Review of Entomology, 42, 23–50.

Ghasemi, A., & Hajizadeh, J. (2021). Some new records of mesostigmatid mites (Acari: Mesostigmata) associated with greenhouse plants from Iran. Journal of Biological Studies, 4(1), 24–40.

Ghilyarov, M.S., & Bregetova, N.G. (1977). Key to the soil inhabiting mites. Mesostigmata. Nauka Press, Leningrad, 1–718 pp.

Hajizadeh, J. (2006). Introducing a part of the phytoseiids (Acari: Phytoseiidae) fauna of Guilan province, part I: subfamily Typhlodrominae Scheuten. Agricultural Research, 6(1), 48–64.

Hajizadeh, J. (2007). Phytoseiid mites Fauna of Guilan Province, part II: Subfamilies Amblyseiinae Muma & Phytoseiinae Berlese (Acari: Phytoseiidae). Agricultural Research, 7(1), 7–25.

Hajizadeh, J., & Nazari, M. (2012). A checklist and key for the phytoseiid mites (Acari: Phytoseiidae) of citrus orchards in Iran, with a new record for Iranian phytoseiid mites. Systematic & Applied Acarology, 17(4), 388–396.

Hajizadeh, J., Khanjani, M., Faraji, F., & Ueckermann, E.A. (2013). Stigmaeid mites of Guilan Province of Iran with description of a new species and a checklist for Iranian stigmaeid mites (Prostigmata: Stigmaeidae). International Journal of Acarology, 39(7), 571–579.

Hajizadeh, J., & Faraji, F. (2016). Identification guide and diagnosis key for predatory mites of the family Phytoseiidae of Iran. ACECR of Guilan Province Press, Rasht, Iran, 1–164 pp (In Persian language).

Hajizadeh, J., Faraji, F., & Rafatifard, M. (2010). Ascidae (Acari: Mesostigmata) of Guilan Province, a new genus and four species records for the Iranian mite fauna and a key to the North of Iran Ascid species. Journal of Plant Protection Science, 40(2), 35–50.

Hajizadeh, J., & Joharchi, O. (2018). Review and identification key for mites of family Laelapidae (Acari: Mesostigmata) in Guilan province. Plant Pest Research, 8(3), 15–29.

Hernandes, F.A., de Castro, T.M.M., & Venancio, R. (2015). Prostigmata (Acari: Trombidiformes) as biological control agents. In Carrillo, D., De Moraes, G.J. and Peña, J.E. (Eds.). Prospects for biological control of plant feeding mites and other harmful organisms. Springer International Publishing Switzerland, Springer, Cham, 151–184.

Karg, W. (1993). Raubmilben: Acari (Acarina), Milben Parasitiformes (Allactinochaeta) Cohors Gamasina Leach. Tierwelt Deutsch. 59. Teil. Gustav Fischer Verlag Jena, 1–523 pp.

Kondo, T., Gullan, P.J., & Williams, D.J. (2008). Coccidology. The study of scale insects (Hemiptera: Sternorrhyncha: Coccoidea). Ciencia y Tecnología Agropecuaria, 9(2), 55–61.

Koteja, J. (1974). On the phylogeny and classification of the scale insects (Homoptera, Coccinea) (discussion based on the morphology of the mouthparts). Acta Zoologica Cracoviensia, 19, 267–326.

Kozár, F., Benedicty, Z.K., Fetykó, K., Kiss, B., & Szita, É. (2013). An annotated update of the scale insect checklist of Hungary (Hemiptera, Coccoidea). ZooKeys, (309), 49–66.

Jalilirad, M., Hajizadeh, J., & Noei, J. (2012). Fauna of Prostigmatic mites (Acari: Prostigmata) associated with citrus orchards in Guilan Province. Plant Pests Research, 2(4), 1–13.

Javadpour, M., Hajizadeh, J., & Hosseini, R. (2018). Blattisociid mites of Guilan province of Iran with a checklist for Iranian Blattisociid mites (Mesostigmata: Blattisociidae). Entomofauna, 39(2), 697–710.

Mašán, P. (2001). Mites of the cohort Uropodina (Acarina, Mesostigmata) in Slovakia. Annotationes Zoologicae et Botanical, 223, 1–320.

Mahjoori, M., Hajizadeh, J., & Abbasii Mozhdehi. M. R. (2015). A checklist and a key for the phytoseiid and blattisociid mites (Acari: Phytoseioidea) associated with olive orchards in Guilan Province Iran. Entomofauna, 36(30), 97–108.

Moraes, G.J., Britto, E.P., Mineiro, J.L., & Halliday, B. (2016). Catalogue of the mite families Ascidae Voigts & Oudemans, Blattisociidae Garman and Melicharidae Hirschmann (Acari: Mesostigmata). Zootaxa, 4112(1), 1–299.

Mota-Sanchez, D., Bills, P.S., & Whalon, M.E. (2002). Arthropod resistance to pesticides: status and overview. In Wheeler, W.B. (Ed.) Pesticides in Agriculture and the Environment. CRC Press. 255–286.

Muñoz-Cárdenas, K., Fuentes-Quintero, L.S., Rueda-Ramirez, D., Rodríguez, C.D., & Cantor, R.F. (2015). The Erythraeoidea (Trombidiformes: Prostigmata) as biological control agents, with special reference to the genus Balaustium. In Carrillo, D., De Moraes, G.J. and Peña, J.E. (Eds.). Prospects for biological control of plant feeding mites and other harmful organisms. Springer, Cham. Springer International Publishing Switzerland, Springer, Cham, 207–239.

Nault, L.R. (1997). Arthropod transmission of plant viruses: a new synthesis. Annals of the Entomological Society of America, 90, 521–541.

Ng, J.C.K., & Perry K.L. (2004). Transmission of plant viruses by aphid vectors. Molecular Plant Pathology, 5, 505–511.

Noei, J., Saboori, A., & Hajizadeh, J. (2013). Fauna of terrestrial parasitengone mites in Guilan province (Northern Iran), Iran. Abstract book of Second International Persian Congress of Acarology, 29 pp.

Oner, D., Kök, Ş., Saboori, A., & Cakmak, I. (2021). Mites parasitizing aphids in the parks and gardens of Aydin, with eight newly recorded mite species for Turkey and re-description of *Allothrombium clavatum* (Acari: Trombidiidae). International Journal of Acarology, 47(5), 404–413.

Saboori, A. (2000). Two new larval erythraeine mites (Acari: Erythraeidae) from Iran. Systematic and Applied Acarology, 5(1), 125–130.

Saboori, A., Hosseini, A., & Asadi, M. (2007). Acari of Iran, Vol. 1, Parasitengone Mites. Tehran University Publication, (2815), 280 pp.

Salarzehi, S., Hajizadeh, J., Hakimitabar, M., & Ueckermann, E. A. (2018). A contribution to the knowledge of cheyletid mites of Iran with redescription of *Eucheyletia flabellifera* (Michael, 1878) (Prostigmata: Cheyletidae). Acarologia, 58(2), 457–470.

Salarzehi, S., Hajizadeh, J., Pourbabaei, H., & Hakimitabar, M. (2019). Fauna of Cheyletidae (Acari: Trombidiformes) mites in different habitats of central part of Guilan Province and determination of dominant species. Plant Pests Research, 8(4), 15–27.

Tajmiri, P., & Hajizadeh, J. (2012). Phytoseiid mites (Mesostigmata: Phytoseiidae) fauna of raspberry shrubs in Guilan Province. Plant Pests Research, 2 (1), 1–11.

Xu, S., Yi, T., Guo, J., & Jin, D. (2019). The genus *Erythraeus* (Acari: Erythraeidae) from China with descriptions of two new species and a key to larval species of the genus worldwide. Zootaxa, 4647 (1), 54–82.

Yazdanpanah, M.R., Hajizadeh, J., Mortazavi, S., & Barimani Varandi, H. (2015). Phytoseiid mites (Acari: Phytoseiidae) associated with conifers in northern Iran, with a new species record and an identification key to coniferous phytoseiid mites of Iran. Persian Journal of Acarology, 4(4), 337–353.

Zhang, Z.Q. (1998). Biology & ecology of trombidiid mites (Acari: Trombidioidea). Experimental & Applied Acarology, 22, 139–155.