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Mesostigmatid mites (Acari: Mesostigmata) associated with tea orchards in Iran

Jalil Hajizadeh[1*], Samar Ramzi[2], Elaheh Daghighi[1]

[1]*Department of Plant Protection, Faculty of Agricultural sciences, University of Guilan, Rasht, Iran.*
[2]*Tea Research center, Horticultural Science Research Institute, Agricultural Research, Education and Extension organization (AREEO), Lahijan, Iran.*
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Abstract

A faunistic study of mesostigmatid mites (Acari: Mesostigmata) associated with tea orchards in Guilan province, Northern Iran was carried out during 2018 and 2019. Plant, soil and litter samples were collected from tea orchards in eastern and western parts of Guilan province. Mesostigmatid mites were extracted by using Berlese funnel or direct examinations of plant materials under a stereomicroscope. Collected mites were cleared in Nesbitt's fluid and mounted in Hoyer's medium on microscopic slides. Totally, 33 species belonging to 25 different genera and 16 families were collected and identified. Except *Amblyseius herbicolus*, *Lasioseius extremus*, *L. sugawarai* and *Transeius wainsteini* which had been previously reported from tea orchards, others 29 species are new records for tea mite's fauna in Iran. Collection information and dominances (%) of identified species are provided. A tabulated checklist of 44 mesostigmatid mite species recorded from tea orchards in Iran is also provided.
Keywords: natural enemies, predatory mites, *Camellia sinensis*, Guilan

1 Introduction

Tea, Camellia sinensis (L.) O. Kuntze, is a popular beverage and one of the most important agricultural crops all over the world. It is an intensively managed perennial monoculture crop cultivated on large- and small-scale plantations. In Iran because of the economic significance of this strategic production and its considerable share in imports, interests to tea grow derived by establishing the first tea farm in Lahijan county in 1900 (Ministry of Agriculture Jihad, 2017). According to the World Food Organization (2018), Iran with the acreage of 18493 ha tea plantation (90 percent are located in Guilan province and the rest in Mazandaran province) and dry tea

*e-mail: jntrivedi26@yahoo.co.in

production of 109357 tons is the ninth largest tea producer in the world (Ghaderi et al., 2019). Totally, 1031 species of arthropods have been reported associated with tea worldwide. In the phylum Arthropoda, mites (Acari) are considered as persistent and serious pests of tea and they occur in most tea-growing Asian and African countries (Hazarika et al., 2009; Mitra et al., 2018). In the subclass Acari, the order mesostigmata is a large, diverse and cosmopolitan parasitiformes and comprises of three suborders: Monogynaspida, Trigynaspida and Sejida, 109 families and about 11,500 species (Beaulieu et al., 2011; Zhang, 2013). Despite their great potential in order to be applied in biological control of pests, they are considered as bioindicators of soil quality and sustainability in agriculture. The majority of them are free-living dynamic predators, although many species are reported as symbionts of mammals, birds, reptiles and arthropods (Lindquist et al., 2009; Kazemi and Rajaei, 2013; Walter and Proctor, 2013; Bagheri Kordeshami et al., 2015). There are several studies have been done to investigate the mesostigmatid mites fauna of Iran, but only few referring to the mesostigmatid mites collected from tea orchards (Taghavi et al., 1998; Nejadghanbar et al., 2010; Abbasipour et al., 2012; Javadpour et al., 2018). Because of the insufficient study about the arthropods fauna specifically different groups of mites associated with tea, the current study provides the possibility to improve the knowledge about the Iranian mesostigmatid mites (Acari: Mesostigmata) associated with tea plantations as a strategic crop in Northern Iran.

This contribution is a necessary step to fulfil the perspective for filling the gaps in providing a precise complemented overview of overall arthropods collected from tea orchards in Guilan province, Northern Iran.

2 Materials and Methods

In this study mesostigmatid mites were collected from plant foliage, soil and litter samples of tea orchards in Guilan province, Northern Iran between September 2018 and March 2019. Each soil or litter sample contained about 2 kg that was taken from a depth of 15 cm. Thereafter, mites were extracted from samples using Berlese funnel or direct examinations of plant materials under a stereomicroscope. Specimens of mesostigmatid mites were sorted and preserved in Ethanol 70%. Eventually, specimens were cleared in Nesbitt's fluid and mounted permanently on microscope slides using Hoyer's medium. The mesostigmatid mites were identified by the relevant taxonomic keys and papers (Ghilyarov and Bregetova, 1977; Karg, 1993; Mašán, 2001; Christian and Karg, 2006; Mašán, 2007; Hajizadeh et al., 2010; De Moraes et al., 2016; Hajizadeh and Faraji, 2016; Karaca et al., 2017; Hajizadeh and Joharchi, 2018; Mojahed 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 discussion

During the current faunistic study of mesostigmatid mites associated with tea orchards in Guilan province, Northern Iran, 33 species belonging to 25 genera and 16 families were collected and identified. An alphabetical list of mesostigmatid mites associated with tea plantations of Iran includes collected specimens in the current research is presented in Table 1. The first reported species from

Iran is indicated with an asterisk in Table 1.

Table 1. Checklist of the collected mesostigmatid mites associated with tea plant in Iran.

No.	Species	References
1	*Amblyseius herbicolus* (Chant, 1959)	Taghavi et al., 1998; Kamali et al. 2001; Abbasipour et al. 2012; current study
2	*Amblyseius largoensis* (Muma, 1955)	Nejadghanbar et al., 2010
3	*Amblyseius rademacheri* Dosse ,1958	Abbasipour et al. 2012
4	*Ameroseius sp.*	Nejadghanbar et al., 2010
5	*Cosmolaelaps dorfakiensis* Ramroodi, Hajizadeh & Joharchi, 2014*	Current study
6	*Cosmolaelaps lutegiensis* (Shcherbak, 1971)*	Current study
7	*Dendrolaelaps zwoelferi* Hirschmann, 1960*	Current study
8	*Dendrolaelaps* sp.	Nejadghanbar et al., 2010
9	*Euandrolaelaps karawaiewi* (Berlese, 1903)*	Current study
10	*Eugamasus cavernicola* Trägårdh, 1912	Current study
11	*Evimirus uropodinus* (Berlese, 1903)*	Current study
12	*Gaeolaelaps aculeifer* (Canestrini, 1883)*	Current study
13	*Gaeolaelaps angustus* (Karg, 1965)*	Current study
14	*Gaeolaelaps queenslandicus* (Womersley, 1956)*	Current study
15	*Gamasholaspis incisus* Petrova, 1968*	Current study
16	*Gamasiphis lanceolatus* Karg, 1987*	Current study
17	*Gamasiphis* sp.	Nejadghanbar et al., 2010
18	*Gymnolaelaps myrmophilus* (Michel, 1891)*	Current study
19	*Holaspina alstoni* (Evans, 1956)*	Current study
20	*Iphiseius* sp.	Nejadghanbar et al., 2010
21	*Lasioseius extremus* (Daneshvar, 1987)	Daneshvar, 1987; Kamali et al. 2001; current study
22	*Lasioseius sugawarai* Ehara, 1964	Javadpour et al. 2018; current study
23	*Macrocheles penicilliger* (Berlese, 1904)*	Current study
24	*Multidentorhodacarus denticulatus* (Berlese, 1920)	Current study
25	*Multidentorhodacarus sogdianus* (Shcherbak, 1980)	Current study
26	*Neodiscopoma splendida* (Kramer, 1882)	Current study
27	*Neodiscopoma* sp.	Current study
28	*Neogamasus insignis* (Holzmann, 1969)*	Current study
29	*Neparholaspis arcuatus* Petrova, 1977*	Current study
30	*Neoseiulus barkeri* Hughes, 1948	Taghavi et al., 1998; Kamali et al. 2001; Abbasipour et al. 2012
31	*Neoseiulus imbricatus* (Corpuz-Raros & Rimando, 1966)	Abbasipour et al. 2012

No.	Species	References
32	*Olopachys caucasicus Koroleva*, 1976*	Current study
33	*Olopachys* sp.	Current study
34	*Onchodellus alpinus* (Willmann, 1953)*	Current study
35	*Pachylaelaps grandis* Koroleva, 1977*	Current study
36	*Pachyseius* sp.	Nejadghanbar et al., 2010
37	*Prozercon dominiaki* Błaszak, 1979*	Current study
38	*Sejus* sp.*	Current study
39	*Transeius patellae* (Karg,1982)	Abbasipour et al. 2012
40	*Transeius wainsteini* (Gomelauri, 1968)	Nejadghanbar et al., 2010; Current study
41	*Urojanetia excavata* (Wasmann, 1899)*	Current study
42	*Veigaia exigua* (Berlese, 1916)*	Current study
43	*Veigaia planicola* Berlese, 1892*	Current study
44	*Vulgrogamasus* sp.	Nejadghanbar et al., 2010

Dominance (%) of families of collected mites in this study according to the preserved slides collection in the current study is shown in Fig. 1. In addition, detailed collection information of each identified species of mesositgmatid mites related to tea orchards in Iran is provided.

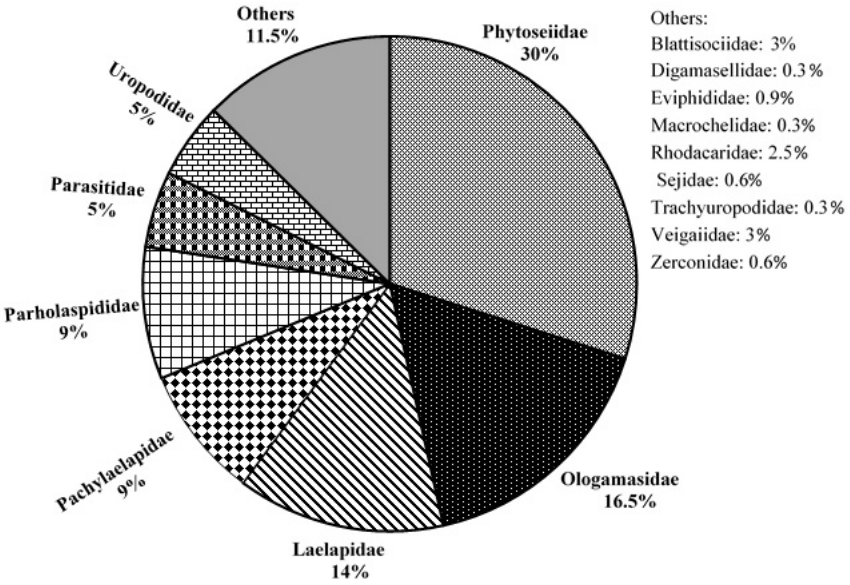


Figure 1. Percentage of families of mesostigmatid mites associated with tea plant in Iran according to a threshold dominance of more than 5

List of mesostigmatid mites associated with tea plantation in Iran with detailed information.

Family Blattisociidae

***Lasioseius extremus* (Daneshvar, 1987) (Fig. 2)**

Material examined: 1 ♀, Vajargah-Kelachay, 37°.02379N, 50°.40444E, 30 m, collected from soil, November 2019.

Remarks: This species had been reported from tea orchards of Lahijan in Iran (Daneshvar, 1987).

***Lasioseius sugawarai* Ehara, 1964** (Fig. 3)
Material examined: 3 ♀, Rahimabad-Rudsar, 37°01'40.58"N, 50°21'01.05"E, 52 m, collected from soil and leaf litter, October 2018; 1 ♀, Parashkuh-Langarud, 37°08'38.01"N, 50°09'59.30"E, 6 m, collected from soil, October 2018; 3 ♀, 1 ♂, Langarud, 37° 7'52.36"N, 50°11'5.77"E, 15 m, collected from soil, December 2019; 1 ♂, Langarud, 37° 8'3.64"N, 50°10'55.48"E, 5 m, collected from soil, December 2019.

Remarks: This species had been reported from tea orchards in Iran (Javadpour et al., 2018). Generally, *Lasioseius* spp. are predators feeding on Collembola, soil-inhabiting mites, small insects, nematodes and fungi. It has been observed on leaves that they feed on spider and rust mites (Christian & Karg 2006; De Moraes et al., 2015; De Moraes et al., 2016). Though, they have the potential to be applied under specified conditions for controlling of certain pests (Gerson et al., 2008; De Moraes et al., 2016). This species has also been reported to be associated with the Millipede host *Oxidus gracilis* (Diplopoda) from Japan (Farfan & Klompen 2012).

Family Digamasellidae
***Dendrolaelaps zwoelferi* Hirschmann, 1960** (Fig. 4)
Material examined: 1 ♀, Sarash-Lahijan, 37°05'18.83"N, 50°05'27.43"E, 68 m, collected from soil, September 2018.

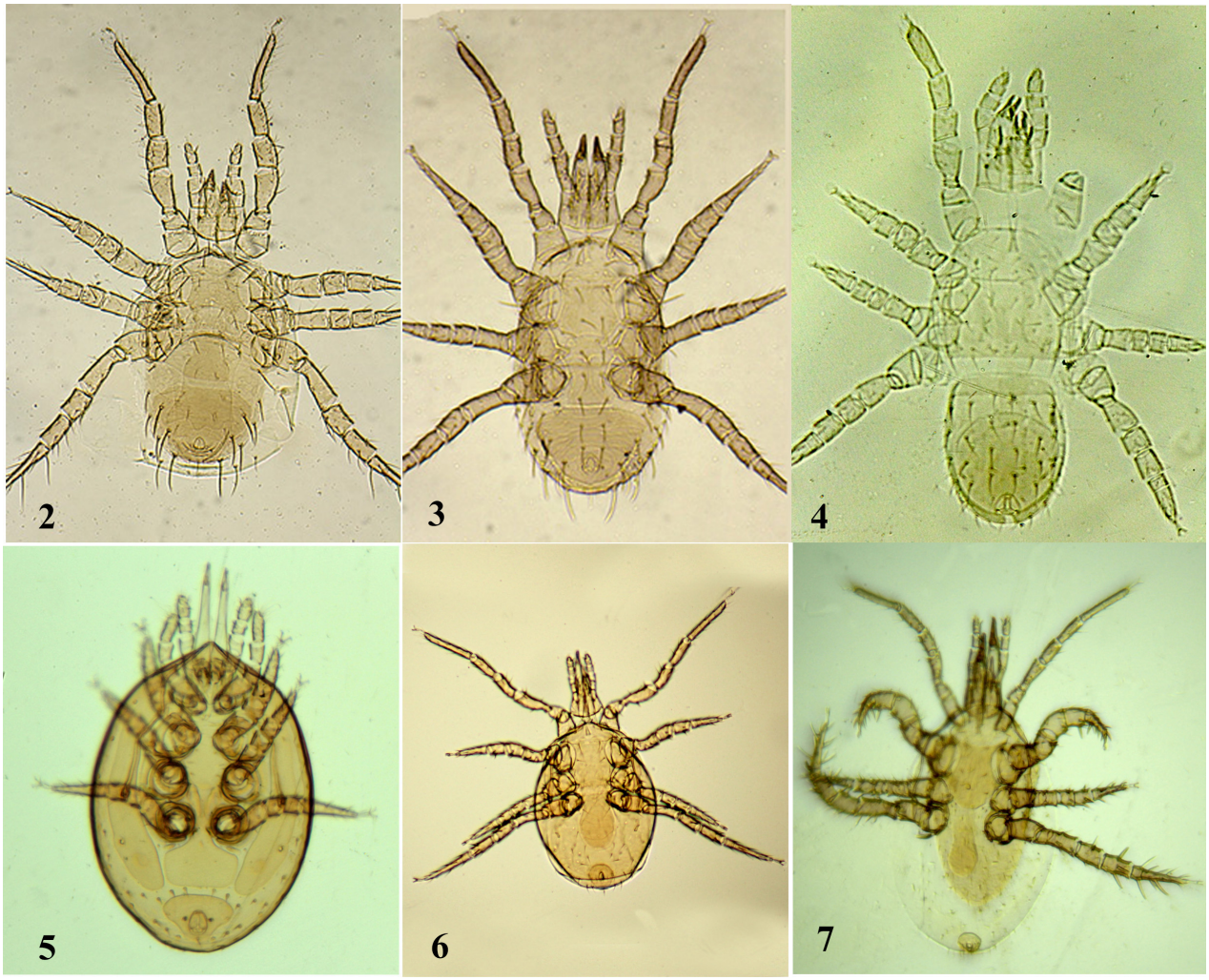
Remarks: Some species of the genus *Dendrolaelaps* have been observed to be nematophagous and sometimes functioned as mutualism factor between mite and beetle in the aspect of natural biological control (Gerson et al., 2008; Castilho et al., 2015).

Family Eviphididae
***Evimirus uropodinus* (Berlese, 1903)** (Fig. 5)
Material examined: 1 ♀, Moein Hotel-Fuman, 37°12'51.30"N, 49°15'37.57"E, 70m, collected from soil, October 2018; 2 ♀, Otaghvar-Langarud, 37°5'46.82"N, 50°6'45.46"E, 175 m, collected from soil, December 2019. Remarks: The overall species diversity of the family Eviphididae are considered as nematophagous specimens (Gerson et al., 2008).

Family Laelapidae
***Cosmolaelaps lutegiensis* (Shcherbak, 1971)** (Fig. 6)
Material examined: 1 ♀, Tea Research Institute-Lahijan, 37°12'17.11"N, 50°01'23.19"E, 9 m, collected from soil, October 2018.

Remarks: Some species of the genus *Cosmolaelaps* have been reported to be associated with insects such as cockroaches and termites. It is also observed that some species have been encountered in the nests of mammals or arthropods (Ramroodi et al., 2014; Moreira and De Moraes, 2015; Mahjoori et al., 2015).

***Cosmolaelaps dorfakiensis* Ramroodi, Hajizadeh & Joharchi, 2014** (Fig. 7)
Material examined: 1 ♀, Amlash, 37°5'32.64"N, 50°8'57.80"E, 123 m, collected from soil, December 2019.



Figures 2-7. 2- *Lasioseius extremus* (Daneshvar, 1987); 3- *Lasioseius sugawarai* Ehara, 1964; 4- *Dendrolaelaps zwoelferi* Hirschmann, 1960; 5- *Evimirus uropodinus* (Berlese, 1903); 6- *Cosmolaelaps lutegiensis* (Shcherbak, 1971); 7- *Cosmolaelaps dorfakiensis* Ramroodi Hajizadeh & Joharchi, 2014.

***Euandrolaelaps karawaiewi* (Berlese, 1903)** (Fig. 8)

Material examined: 3 ♀, 1 ♂, Sarash-Lahijan, 37°05'18.83"N, 50°05'27.43"E, 68 m, collected from soil and leaf litter, September 2018; 1 ♀, Mahvizan-Someh Sara, 37°18'23.01"N, 49°11'28.01"E, 26 m, collected from soil, October 2018.

***Gaeolaelaps aculeifer* (Canestrini, 1883)** (Fig. 9)

Material examined: 2 ♀, 2 ♂, Sarash-Lahijan, 37°05'18.83"N, 50°05'27.43"E, 68 m, collected from soil, September 2018; 3 ♀, Divshal-Langarud, 37°10'34.27"N, 50°06'21.94"E, 199 m, collected from soil, January 2019; 1 ♀Divshal-Langarud, 37°10'34.27"N, 50°06'21.94"E, 199 m, collected from soil, January 2019; 1 ♀, Amlash, 37°5'20.21"N, 50°8'53.77"E, 76 m, collected from soil, December 2019; 1 ♀, Otaghvar-Langarud, 37°6'1.31"N, 50°6'22.32"E, 70 m, collected from soil, December 2019; 1 ♀, Langarud, 37°8'21.48"N, 50°10'30.24"E, 4 m, collected from soil, December 2019; 2 ♀, Langarud, 37°8'3.64"N, 50°10'55.48"E, 5 m, collected from soil, December 2019; 4 ♀, 1 ♂, Amlash, 37°3'28.16"N, 50°7'28.78"E, 156 m, collected from soil, December 2019; 10 ♀, Rahimabad-Rudsar, 37°0'27.61"N, 50°16'56.13"E, 393 m, collected from soil, November 2019.

Remarks: Specimens of *G. aculeifer* feed on different small arthropods, nematodes and fungi. It can be considered as an efficient predator in both natural environments and greenhouse condition and its potential in effective controlling of *Rhizoglyphus echinopus* as biocontrol agents has been examined under the condition of determining the optimal temperature range (Amin et al., 2014; Moreira & De Moraes, 2015). It was shown that this species has the potential to be used against sciarid fly and this case has been done once in Iranian mushroom production (Ajvad et al., 2016).

***Gaeolaelaps angustus* (Karg, 1965)** (Fig. 10)

Material examined: 2 ♀, Tataf-Someh Sara, 37°18'00.98"N, 49°13'11.30"E, 26 m, collected from soil, October 2018; 1 ♀, Amlash, 37°5'32.64"N, 50°8'57.80"E, 123 m, collected from soil, December 2019; 1 ♀, Vajargah-Kelachay, 37°2'27.79"N, 50°23'39.20"E, 12 m, collected from soil, November 2019.

***Gaeolaelaps queenslandicus* (Womersley, 1956)** (Fig. 11)

Material examined: 1 ♀, Moein Hotel-Fuman, 37°12'51.30"N, 49°15'37.57"E, 70 m, collected from soil, October 2018.

***Gymnolaelaps myrmophilus* (Michael, 1891)** (Fig. 12)

Material examined: 1 ♀, Tea Research Institute-Lahijan, 37°12'17.11"N, 50°01'23.19"E, 9 m, collected from soil, October 2018.

Family Macrochelidae

***Macrocheles penicilliger* (Berlese, 1904)** (Fig. 13)

Material examined: 1 ♀, Moein Hotel-Fuman, 37°12'51.30"N, 49°15'37.57"E, 70 m, collected from soil, October 2018.

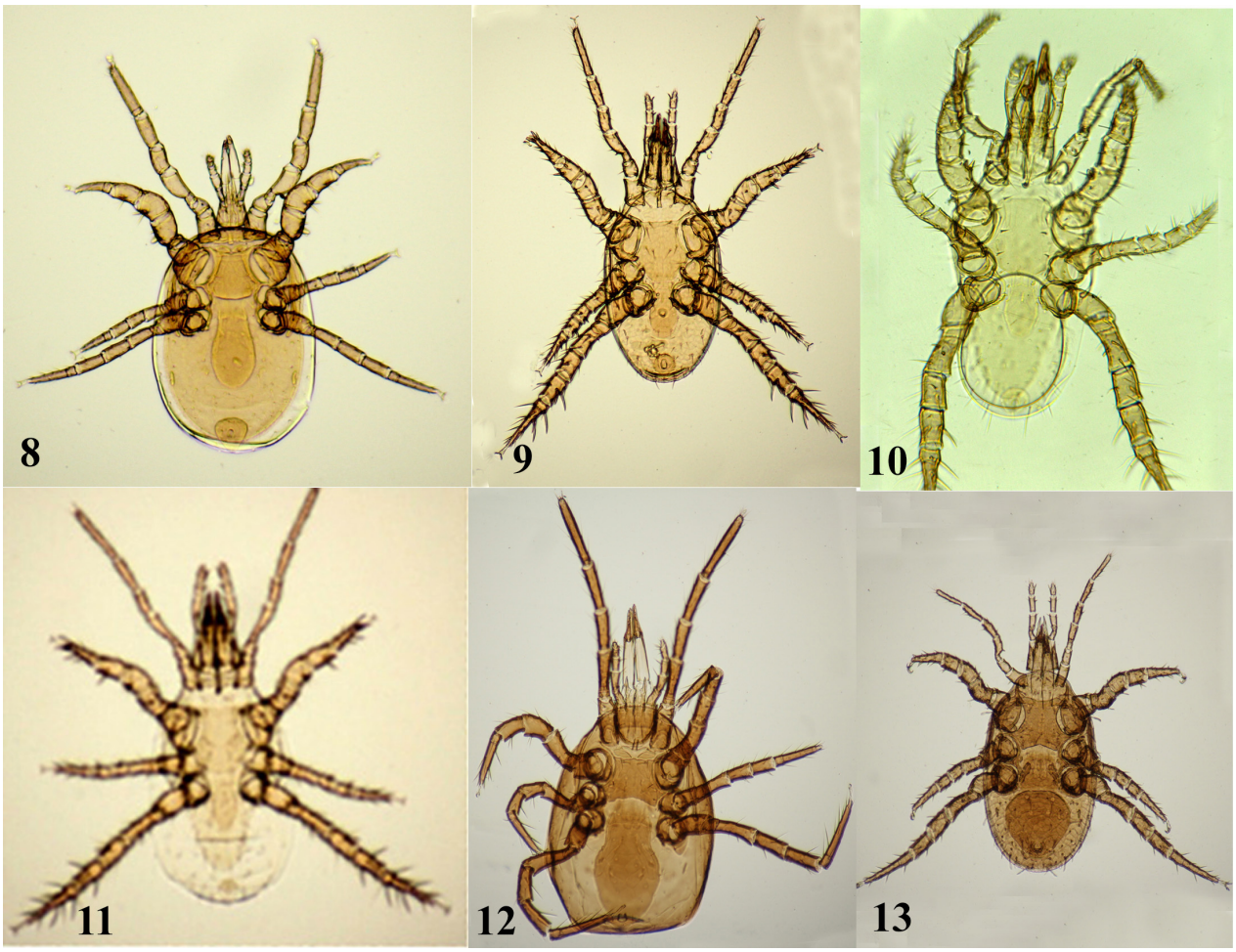
Remarks: *Macrocheles* spp. have been found in association with dung beetles and this situation makes Macrochelid mites able to have the potential in conveying the entomopathogenic fungi to that beetle pests. They have also been considered as biocontrol agent against houseflies. So generally these mites have the attributes to promote their application in biological pest control (Gerson et al., 2003; De Azevedo et al., 2015).

Family Ologamasidae

***Gamasiphis lanceolatus* Karg, 1987** (Fig. 14)

Material examined: 1 ♂, Sarash-Lahijan, 37°05'18.83"N, 50°05'27.43"E, 68 m, collected from soil, September 2018; 1 ♂, Siahkal, 37°08'53.63"N, 49°52'49.18"E, 53 m, collected from soil, October 2018; 1 ♀, 1 ♂, Lahijan, 37°12'25.46"N, 50°00'12.12"E, 2 m, collected from soil, October 2018; 2 ♀, 2 ♂, Tea Research Institute-Lahijan, 37°12'17.11"N, 50°01'23.19"E, 9 m, collected from soil, October 2018; 2 ♀, Parashkuh-Langarud, 37°08'38.01"N, 50°09'59.30"E, 6 m, collected from soil, October 2018; 1 ♀, Otaghvar-Langarud, 37°06'31.85"N, 50°06'52.01"E, 50 m, collected from soil, October 2018; 1 ♀, Kumeleh-Langarud, 37°09'26.02"N, 50°10'21.47"E, -14 m, collected from soil, October 2018; 8 ♀, 4 ♂, Mahvizan-Someh Sara, 37°18'23.01"N, 49°11'28.01"E, 26 m, collected from soil, October 2018; 2 ♀, 3 ♂, Tataf-Someh Sara, 37°18'00.98"N, 49°13'11.30"E, 26 m, collected from soil, October 2018; 2 ♀, 3 ♂, Moein Hotel-Fuman, 37°12'51.30"N, 49°15'37.57"E, 70 m, collected from soil and leaf, October 2018; 1 ♀, Otaghvar-Langarud, 37°5'46.82"N, 50°6'45.46"E, 175 m, collected from soil, December 2019; 1 ♀, 1 ♂, Amlash, 37°5'20.21"N, 50°8'53.77"E, 76 m, collected from soil, December 2019; 1 ♂, Langarud, 37°7'52.36"N, 50°11'5.77"E, 15 m, collected from soil, December 2019; 1 ♀, Amlash, 37°3'40.69"N, 50°6'54.18"E, 134 m, collected from soil, December 2019; 1 ♀, 1 ♂, Vajargah-Kelachay, 37°2'27.79"N, 50°23'39.20"E, 12 m, collected from soil,

November 2019; 1 ♀, Vajargah-Kelachay, 37°2'25.88"N, 50°24'12.17"E, 7 m, collected from soil, November 2019; 3 ♀, Langarud, 37°7'52.17"N, 50°10'10.94"E, 43 m, collected from soil, December 2019; 2 ♀, Vajargah-Kelachay, 37.02379N, 50.40444E, 30 m, collected from soil, November 2019.



Figures 8-13. 8- *Euandrolaelaps karawaiewi* (Berlese, 1903); 9- *Gaeolaelaps aculeifer* (Canestrini, 1883); 10- *Gaeolaelaps angustus* (Karg, 1965); 11- *Gaeolaelaps queenslandicus* (Womersley, 1956); 12- *Gymnolaelaps myrmophilus* (Michael, 1891); 13- *Macrocheles penicilliger* (Berlese, 1904).

Family Pachylaelapidae

***Olopachys caucasicus* Koroleva, 1976** (Fig. 15)

Material examined: 2 ♀, Moein Hotel-Fuman, 37°12'51.30"N, 49°15'37.57"E, 70 m, collected from soil, October 2018; 1 ♀, Otaghvar-Langarud, 37°5'4.19"N, 50°5'12.60"E, 90 m, collected from soil, December 2019; 2 ♀, Rahimabad-Rudsar, 37°0'27.61"N, 50°16'56.13"E, 392 m, collected from soil, November 2019.

***Olopachys* sp.**

Material examined: 1 ♀, Otaghvar-Langarud, 37°5'46.82"N, 50°6'45.46"E, 175 m, collected from soil, December 2019.

***Onchodellus alpinus* (Willmann, 1953)** (Fig. 16)

Material examined: 1 ♀, Moein Hotel-Fuman, 37°12'51.30"N, 49°15'37.57"E, 70 m, collected from

soil, October 2018; 1 ♀, Vajargah-Kelachay, 37.02379N, 50.40444E, 30 m, collected from soil, November 2019.

***Pachylaelaps grandis* Koroleva, 1977** (Fig. 17)
Material examined: 3 ♂, Lahijan, 37°12'25.46"N, 50°00'12.12"E, 2 m, collected from soil, October 2018; 1 ♀, Kumeleh-Langarud, 37°09'26.02"N, 50°10'21.47"E, -14 m, collected from soil, October 2018; 2 ♀, 1 ♂, Mahvizan-Someh Sara, 37°18'23.01"N, 49°11'28.01"E, 26 m, collected from soil, October 2018; 3 ♀, Moein Hotel-Fuman, 37°12'51.30"N, 49°15'37.57"E, 70 m, collected from soil, October 2018; 1 ♀, 1 ♂, Otaghvar-Langarud, 37°5'4.19"N, 50°5'12.60"E, 90 m, collected from soil, December 2019; 1 ♀, Rahimabad-Rudsar, 37°0'27.61"N, 50°16'56.13"E, 392 m, collected from soil, November 2019; 1 ♀, 1 ♂, Amlash, 37°5'32.64"N, 50°8'57.80"E, 123 m, collected from soil, December 2019; 3 ♀, Otaghvar-Langarud, 37°5'23.80"N, 50°6'9.35"E, 95 m, collected from soil, December 2019.

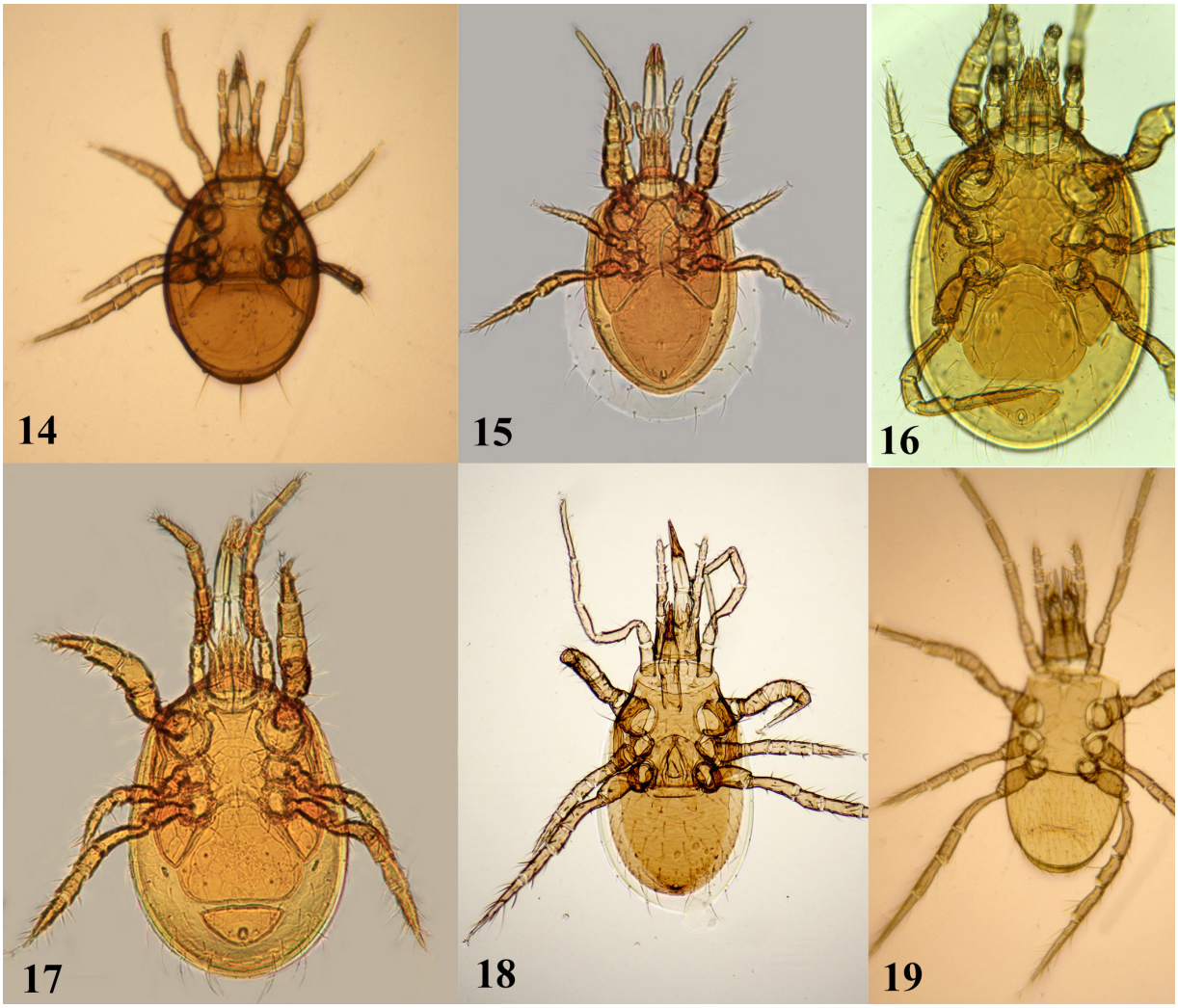
Family Parasitidae
***Neogamasus insignis* (Holzmann, 1969)** (Fig. 18)
Material examined: 6 ♀, 4 ♂, Moein Hotel-Fuman, 37°12'51.30"N, 49°15'37.57"E, 70 m, collected from soil, October 2018; 1♀, 1 ♂Someh Sara, 37°18'23.01"N, 49°11'28.01"E, 26 m, collected from soil, February 2019; 1 ♀, 1 ♂, Vajargah-Kelachay, 37°2'25.88"N, 50°24'12.17"E, 7 m, collected from soil, November 2019.

***Eugamasus cavernicola* Trägårdh, 1912** (Fig. 19)
Material examined: 1 ♂, Divshal-Langarud, 37°10'34.27"N, 50°06'21.94"E, 199 m, collected from soil, January 2019.

Family Parholaspididae
***Gamasholaspis incisus* Petrova, 1968** (Fig. 20)
Material examined: 1 ♀, Tea Research Institute-Lahijan, 37°12'17.11"N, 50°01'23.19"E, 9 m, collected from soil, October 2018.

***Holaspina alstoni* (Evans, 1956)** (Fig. 21)
Material examined: 2 ♀, 2 ♂, Tea Research Institute-Lahijan, 37°12'17.11"N, 50°01'23.19"E, 9 m, collected from soil, October 2018; 3 ♀, 2 ♂, Rahimabad-Rudsar, 37°01'40.58"N, 50°21'01.05"E, 52 m, collected from soil and leaf litter, October 2018; 5 ♀, 2 ♂, Vajargah-Kelachay, 37°2'25.88"N, 50°24'12.17"E, 7 m, collected from soil, November 2019.

***Neparholaspis arcuatus* Petrova, 1977** (Fig. 22)
Material examined: 1 ♀, Moein Hotel-Fuman, 37°12'51.30"N, 49°15'37.57"E, 70 m, collected from soil, October 2018; 1♀, 3 ♂, Otaghvar-Langarud, 37°5'46.82"N, 50°6'45.46"E, 175 m, collected from soil, December 2019; 1♀, Vajargah-Kelachay, 37°2'37.92"N, 50°23'59.60"E, 4 m, collected from soil, November 2019; 1♀, Otaghvar-Langarud, 37°6'1.31"N, 50°6'22.32"E, 70 m, collected from soil, December 2019; 1 ♀, Rahimabad-Rudsar, 37°0'27.61"N, 50°16'56.13"E, 392 m, collected from soil, November 2019; 1 ♀, Amlash, 37°5'32.64"N, 50°8'57.80"E, 123 m, collected from soil, December 2019.



Figures Figures 14- 19. 14- *Gamasiphis lanceolatus* Karg, 1987; 15- *Olopachys caucasicus* Koroleva, 1976; 16- *Onchodellus alpinus* (Willmann, 1953); 17- *Pachylaelaps grandis* Koroleva, 1977; 18- *Neogamasus insignis* (Holzmann, 1969); 19- *Eugamasus cavernicola* Trägårdh, 1912.

Family Phytoseiidae

***Amblyseius herbicolus* (Chant, 1959)** (Fig. 23).

Material examined: 3 ♀, Rahimabad-Rudsar, 37°01'40.58"N, 50°21'01.05"E, 52 m, collected from leaf, September 2018; 1 ♀, Tea Research Institute-Lahijan,37°12'17.11"N, 50° 01'23.19"E, 9 m, collected from soil, October 2018; 4 ♀, Langarud, 37°11'00.00"N, 50° 9'00.00"E, 21m, collected from leaf, June 2018; 10♀, Amlash, 37°06'00.00"N, 50° 11'00.00"E, 13m, collected from leaf, July 2018; 5 ♀, Chaboksar, 36°58'00.00"N, 50° 35'00.00"E, -20m, collected from leaf, July 2018.

Remark: *Amblyseius herbicolus* has wide distribution range in Guilan Province of Iran. While there are some tea and citrus mixed orchards in Guilan province. *Amblyseius herbicolus* was the most abundant phytoseiid species in citrus orchards of Guilan Province (Hajizadeh & Nazari, 2012). According to some laboratory studies in Iran, *A. herbicolus* is potential predators for controlling spider mites such as *Tetranychus urticae* (Notghi Moghadam et al., 2010).

***Transeius wainsteini* (Gomelauri, 1968)** (Fig. 24)

Material examined: 5 ♀, 3 ♂, Chaboksar, 37°58'00.00"N, 50° 35'00.00"E, -20m, collected from leaf, July 2018; 4 ♀, 2 ♂, Langarud, 37°11'00.00"N, 50° 9'00.00"E, 21m, collected from leaf, June

2018; 8 ♀, 2 ♂, Shalman, 37°15'00.95"N, 50° 21'00.67"E, 5m, collected from leaf, June 2018; 6 ♀, 2 ♂, Kelachay, Vajargah, 37°02'00.27"N, 50°24'00.31"E, -10m, collected from leaf, July 2018; 6 ♀, 3 ♂, Roudsar, 12m, 37°13'00.00"N, 50° 3'00.00"E, collected from leaf, July 2007; 12 ♀, 5 ♂, Amlash, 37°06'00.00"N, 50° 11'00.00"E, 13m, collected from leaf, July 2018; 7 ♀, 2 ♂, Lahijan, 37°12'00.00"N, 50° 0'00.00"E , 2m, collected from leaf, July 2018.

Remark: *Transeius wainsteini* has wide distribution range in Northern Provinces (Guilan, Mazandaran and Golestan) of Iran (Daneshvar, 1990). Laboratory studies showed good potential of this predatory mite for control of injurious mites such as citrus red mite, *Panonychus citri* and two spotted spider mite, *Tetranychus urticae* (Daneshvar, 1990; Rafatifard et al., 2004).

Family Rhodacaridae

***Multidentorhodacarus denticulatus* (Berlese, 1920)** (Fig. 25)

Material examined: 1 ♀, Siahkal, 37°08'53.63"N, 49°52'49.18"E, 53 m, collected from soil, October 2018; 3 ♀, Tea Research Institute-Lahijan, 37°12'17.11"N, 50°01'23.19"E, 9 m, collected from soil, October 2018.

Remarks: *Multidentorhodacarus denticulatus* has been observed to be one nematophagous species (Walter et al., 1988). Also the ability of these specimens has been examined in reducing the number of nematodes in the greenhouse condition (Gerson et al., 2008).

***Multidentorhodacarus sogdianus* (Shcherbak, 1980)** (Fig. 26)

Material examined: 2 ♀, Otaghvar-Langarud, 37°5'46.82"N, 50°6'45.46"E, 175 m, collected from soil, December 2019; 1 ♀, Otaghvar-Langarud, 37°5'4.19"N, 50°5'12.60"E, 90 m, collected from soil, December 2019; 1 ♀, Amlash, 37°3'28.16"N, 50°7'28.78"E, 149 m, collected from soil, December 2019.

Family Sejidae

***Sejus* sp.**

Material examined: 2 ♀, Sarash-Lahijan, 37°05'18.83"N, 50°05'27.43"E, 68 m, collected from soil, September 2018.

Family Trachyuropodidae

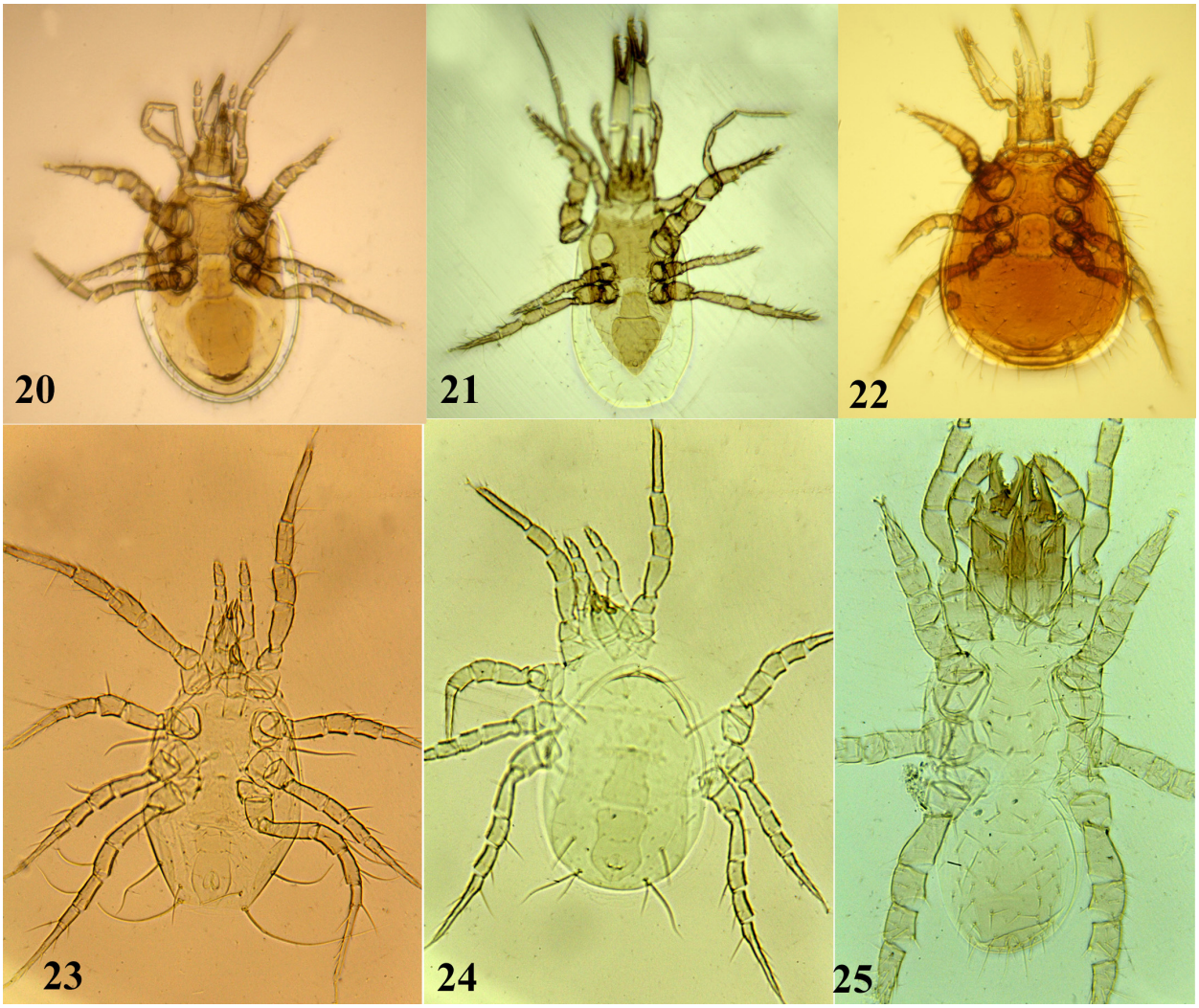
***Urojanetia excavata* (Wasmann, 1899)** (Fig. 27)

Material examined: 1 ♀, Mahvizan-Someh Sara, 37°18'23.01"N, 49°11'28.01"E, 26 m, collected from soil, October 2018.

Family Uropodidae Kramer, 1881

***Neodiscopoma* sp.**

Material examined: 1 ♀, Lahijan, 37°12'25.46"N, 50°00'12.12"E, 2 m, collected from soil, October 2018; 2 ♀, Mahvizan-Someh Sara, 37°18'23.01"N, 49°11'28.01"E, 26 m, collected from soil, October 2018; 1 ♀, Tataf-Someh Sara, 37°18'00.98"N, 49°13'11.30"E, 26 m, collected from soil, October 2018; 4 ♀, Moein Hotel-Fuman, 37°12'51.30"N, 49°15'37.57"E, 70 m, collected from leaf and soil, October 2018.



Figures Figures 20-25. 20- *Gamasholaspis incisus* Petrova, 1968; 21- *Holaspina alstoni* (Evans, 1956); 22- *Neparholaspis arcuatus* Petrova, 1977; 23- *Amblyseius herbicolus* Chant, 1959; 24- *Transeius wainsteini* (Gomelauri, 1968); 25- *Multidentorhodacarus* denticulatus (Berlese, 1920).

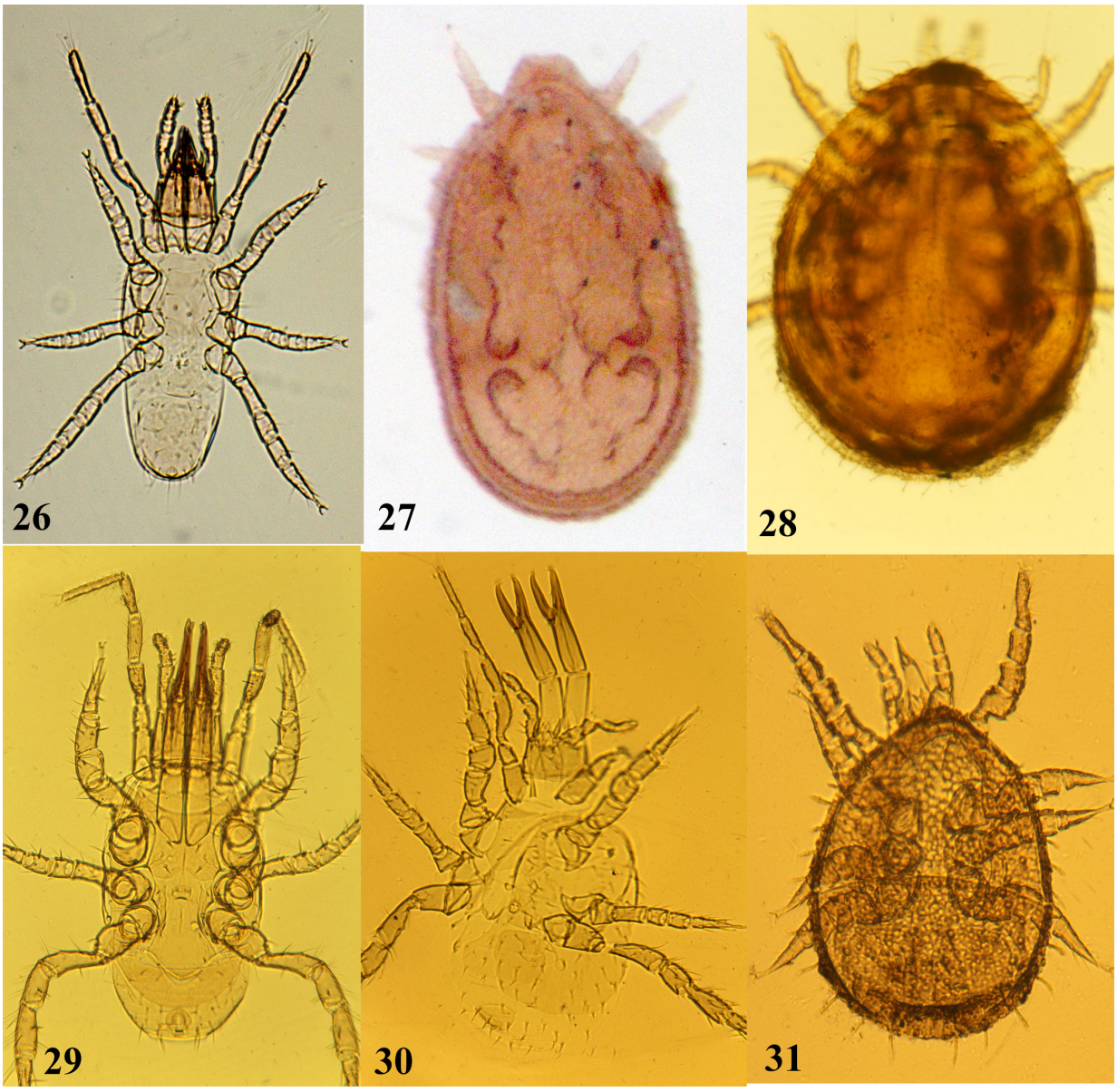
***Neodiscopoma splendida* (Kramer, 1882)** (Fig. 28)
Material examined: 1 ♀, Sarash-Lahijan, 37°05'18.83"N, 50°05'27.43"E, 68 m, collected from soil, September 2018; 1 ♀, Moein Hotel-Fuman, 37°12'51.30"N, 49°15'37.57"E, 70m, collected from soil, October 2018; 2 ♂, Mahvizan-Someh Sara, 37°18'23.01"N, 49°11'28.01"E, 26 m, collected from soil, October 2018; 1 ♂, Sarash-Lahijan, 37°05'18.83"N, 50°05'27.43"E, 68 m, collected from soil, September 2018; 1 ♂, Divshal-Langarud, 37°10'34.27"N, 50°06'21.94"E, 199 m, collected from soil, January 2019; 1 ♀, Otaghvar-Langarud, 37°5'4.19"N, 50°5'12.60"E, 90 m, collected from soil, December 2019.

Family Veigaiidae

***Veigaia planicola* Berlese, 1892** (Fig. 29)
Material examined: 1 ♀, Siahkal, 37°08'53.63"N, 49°52'49.18"E, 53 m, collected from soil, October 2018; 1 ♀, Amlash, 37°5'20.21"N, 50°8'53.77"E, 76 m, collected from soil, December 2019; 1 ♀, Otaghvar-Langarud, 37°5'4.19"N, 50°5'12.60"E, 90 m, collected from soil, December 2019; 1 ♀, Rahimabad-Rudsar, 37°0'27.61"N, 50°16'56.13"E, 392 m, collected from soil, November 2019; 4 ♀, Amlash, 37°3'40.69"N, 50°6'54.18"E, 134 m, collected from soil, December 2019.

Remarks: It has been observed that *Veigaia* spp. feeding preferences composed of bacterial and root feeding nematodes, collembolans, proturans, pauropods and soft-bodied mites (Manu et al., 2017).

***Veigaia exigua* (Berlese, 1916)** (Fig. 30)
Material examined: 1♀Mahvizan-Someh Sara, 37°18'23.01"N, 49°11'28.01"E, 26 m, collected from soil, October 2018; 1 ♀, Divshal-Langarud, 37°10'34.27"N, 50°06'21.94"E, 199 m, collected from soil, January 2019.



Figures Figures 26-31. 26- *Multidentorhodacarus sogdianus* (Shcherbak, 1980); 27- *Urojanetia excavata* (Wasmann, 1899); 28- *Neodiscopoma splendida* (Kramer, 1882); 29- *Veigaia planicola* Berlese, 1892; 30- *Veigaia exigua* (Berlese, 1916); 31- *Prozercon dominiaki* Błaszak, 1979.

Family Zerconidae
***Prozercon dominiaki* Błaszak, 1979** (Fig. 31)

Material examined: 1 ♀, Divshal-Langarud, 37°10'34.27"N, 50°06'21.94"E, 199 m, collected from soil, January 2019; 1 ♀, Langarud, 37°8'3.64"N, 50°10'55.48"E, 5 m, collected from soil, December 2019.

4 Conclusion

Based on the samples collected from tea plantations in Guilan province, during 2018 and 2019 and result of previous studies we found a rich fauna of mesostigmatid mites in tea orchards of Iran (Table 1). The most abundant and potential predators were from family phytoseiidae (30%) (Fig. 1). *Transeius wainsteini* (Gomelauri) with 22.3% dominance was the most abundant species among collected species. According to some laboratory studies in Iran, both phytoseiid species (*A. herbicolus* and *T. wainsteini*) are potential predators for controlling spider mites such as *T. urticae*, and *P. citri* (Banks) (Daneshvar, 1990; Rafatifard et al., 2004; Notghi Moghadam et al., 2010).

In Iran, the predatory mite *Transeius wainsteini* is distributed along the coast of the Caspian Sea, from the eastern parts of Mazandaran province to Astara in Guilan province (Daneshvar, 1990). Laboratory studies showed good potential of this predatory mite for control of injurious mites such as citrus red mite, *Panonychus citri* (Daneshvar, 1990; Rafatifard et al., 2004). Because *T. wainsteini* is also abundant in tea orchards of Iran, conservation measures for protection of this useful species would be advantageous. The most important injurious mites in tea orchards of Iran are ornamental flat mite *Brevipalpus obovatus* Donnadieu and yellow broad mite *Polyphagotarsonemus latus* (Banks) (Taghavi et al., 1998; Ramzi et al., 2019). Predatory mesostigmatid mites of families Phytoseiidae and Blattisociidae can be useful for control of these two important mite pests of tea plant in Iran. Further research is needed to evaluate predatory mites for control of *B. obovatus* and *P. latus* in tea orchards of Iran. Another important pest of tea plantations in Iran is root lesion nematode *Pratylenchus loosi* Loof (Seraji et al. 2007). There are many families of edaphic mesostigmatid predatory mites (such as Laelapidae, Rhodacaridae, etc.) in Iranian tea orchards (Fig. 1) that can be effective in controlling this nematode. Further research is needed to evaluate these predatory mites for control of tea root lesion nematode in Iran. Nematocides can be harmful and dangerous for beneficial soil organisms. Therefore, protective measures are needed to protect beneficial soil organisms such as predatory mites in tea orchards of Iran.

Conflict of interests

There are no conflicts of interest.

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