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Prostigmatid mites (Acari: Prostigmata) associated with tea orchards in Iran

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Abstract

During 2018 - 2019 a project was carried out to determine the prostigmatid mites (Acari: Prostigmata) associated with tea orchards in Guilan province, Northern Iran. The soil, litter and plant samples were collected from tea orchards in eastern and western parts of Guilan province. Mites were extracted by placing soil, plant foliage and litter in a Berlese/Tullgren funnel or by direct examination of plant materials under a stereomicroscope. Collected mites were cleared in Lactic acid or Nesbitt's fluid and mounted in Hoyer's medium on microscopic slides. Totally, 23 species belonging to 20 different genera and 15 families were collected and identified. Except *Allothrombium pulvinum*, *Brevipalpus obovatus*, *Calacarus carinatus*, *Panonychus citri*, *Peterobia harti*, and *Tetranychus urticae* which had been previously reported from tea orchards, all the others 17 species are new records for tea mite's fauna in Iran. Collection information and dominances (%) of identified species are provided. A tabulated checklist of 42 prostigmatid mite species recorded from tea orchards in Iran is also provided.
Keywords: Arthropoda, natural enemies, predatory mites, pest, *Camellia sinensis*, Guilan

1 Introduction

Tea, *Camellia sinensis* (L.) O. Kuntze, is an intensively managed perennial monoculture crop cultivated on large and small scale plantations in more than 34 countries across Asia, Africa, Latin America, and Oceania (Deka et al., 2006). Tea had been known as a medicinal plant. The tea leaves contain more than 700 chemicals, including flavanoides, amino acids, vitamins, caffeine and polysaccharides that are closely related to human health (Bhagat, et al., 2010). Tea is one of the

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plantation commodities that have an economic important role in Iran. First tea farm in Iran was established in Lahijan county in 1900. Iran with 18493 hectares' tea plantation (90 percent are located in Guilan province and the 10 percent in Mazandaran province) and dry tea production of 109357 tons is the ninth largest tea producer in the world (Ghaderi et al., 2019). Globally, 1031 arthropod species are associated with tea; a small number of pests (about 3%) are common throughout the world. Mites are persistent and the most serious pests of tea in almost all tea producing countries in Asia and Africa (Hazarika et al., 2009; Mitra et al., 2018).

The Prostigmata is a suborder of mites belonging to the order Trombidiformes. Prostigmata, with 25,981 described species range in size from 0.1 to 2 mm and vary widely in body form, color, habitat, and feeding adaptations (Walter et al., 2009; Walter et al., 2011). They include predatory and omnivorous species living in organic strata of soils and on algae, lichens, mosses, trees, and shrubs. Suborder Prostigmata include obligatory plant-feeding groups, including the spider mites (Tetranychoidea), false spider mites (Tenuipalpidae), and eriophyoid mites, many of which are serious economic pests of field crops, orchards, and greenhouse plants, in some cases acting at vectors of damaging plant viruses (Walter et al., 2009; Walter and Proctor, 2013). Some prostigmatid mites are persistent and the most serious pests of tea in almost all tea producing countries. *Tetranychus kanzawai* Kishida (Acarina: Tetranychidae) is important in Japan, China, Taiwan, and the Philippines. Likewise, *Brevipalpus phoenicis* (Geijskes) (Acarina: Tenuipalpidae), *Acaphylla theae* (Watt) (Acarina: Eriophyidae), and *Calcarus carinatus* (Green) (Acarina: Eriophyidae) occur in most of the tea-growing Asian and African countries. Perhaps the most important mite is the red spider mite, *Oligonychus coffeae* Nietner (Acarina: Tetranychidae), which was discovered in 1868 in Assam, India. This pest is widely distributed in India, Bangladesh, Sri Lanka, Taiwan, Burundi, Kenya, Malawai, Uganda, and Zimbabwe (Hazarika et al., 2009). The Prostigmata also contains a large array of soil species. Many of these species are predators, but some families contain fungal or algae-feeding mites (Kethley, 1990; Coleman et al., 2004; Carrillo et al., 2015). Other Prostigmata live as parasites on vertebrates or invertebrates (Walter and Proctor, 2013; Walter et al., 2009).

Several studies have been done for identification of the prostigmatid mites fauna of Iran, but only a few are related with prostigmatid mites of tea orchards (Taghavi et al., 1998; Nejadghanbar et al., 2010). The recent study was conducted to identify the prostigmatid mites (Acari: Prostigmata) associated with tea in Guilan province, Northern Iran. The checklist of prostigmatid mite species recorded from tea orchards in Iran is also provided.

2 Materials and Methods

Prostigmatid 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 kilograms that was taken from a depth of 15 centimeters. Mites were extracted from samples using Berlese funnel or direct examinations of plant materials under a stereomicroscope. Mites specimens were preserved in Ethanol 70%. Specimens were cleared in Lactic acid or Nesbitt's fluid and mounted permanently in Hoyer's medium on microscope slides. The prostigmatid mites were identified by the relevant taxonomic keys and papers (Volgin, 1987; Smiley, 1992; Ostovan and Kamali 1995; Meyer and Ueckermann 1997; Lin and Zhang 2002; Khanjani and Ueckermann, 2003; Khanjani and Ueckermann, 2003; Zhang 2003; Bochkov et al., 2005; Saboori et al., 2007; Krantz and walter, 2009; Hajizadeh et al., 2013; Khanjani et al. 2013; Akbari et al. 2015; Salarzehi et al., 2018). 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

Twenty-three species belonging to 20 genera and 15 families were collected and identified during faunistic study of prostigmatid mites associated with tea orchards in Guilan province, Northern Iran. The checklist of prostigmatid mites associated with tea plantations of Iran includes collected specimens in the current research is showed in Table 1. The first reported species from Iran is indicated with an asterisk in Table 1. According to the preserved slides collection, dominance (%) of collected mite's families in this study is shown in Fig. 1. As well as, detailed collection information of identified species in this study is provided.

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

No.	Species	References
1	*Acaphylla theae* (Watt, 1898)	Taghavi et al., 1998; Kamali et al. 2001
2	*Allothrombium pulvinum* Ewing, 1917	Taghavi et al., 1998; Kamali et al. 2001; current study
3	*Armascirus cerris* Kalúz, 2009 *	Current study
4	*Bdella* sp.	Nejadghanbar et al., 2010
5	*Bdellodes* sp.	Taghavi et al., 1998
6	*Brevipalpus obovatus* Donnadieu, 1875	Nejadghanbar et al., 2010; & Taghavi et al., 1998; current study
7	*Calacarus carinatus* (Green, 1890)	Taghavi et al., 1998; Kamali et al. 2001
8	*Caligonella humilis* Koch, 1838*	Current study
9	*Chaussieria warrengense* (Hirst, 1931)	Nejadghanbar et al., 2010
10	*Chaussieria* sp.	Nejadghanbar et al., 2010
11	*Cocceupodes* sp.	Nejadghanbar et al., 2010
12	*Coleoscirus buartsus*	Den Heyer, 1980* Current study
13	*Cunaxa papuliphora*	Sergeyenko, 2009* Current study
14	*Cunaxa* sp.	Taghavi et al., 1998; current study
15	*Cyta latirostris* (Hermann, 1804)	Taghavi et al., 1998
16	*Cyta* sp.	Nejadghanbar et al., 2010
17	*Dinothrombium* sp.	Nejadghanbar et al., 2010
18	*Erythraeus* sp.*	Current study
19	*Eupalopsellus* sp.*	Current study
20	*Eupodes voxencollinus* Thor, 1934	Taghavi et al., 1998; Kamali et al. 2001
21	*Eustigmaeus anauniensis* Canestrini, 1889*	Current study
22	*Eustigmaeus segnis* Koch, 1836*	Current study
23	*Hemicheyletia wellsi* Summer & Price, 1970*	Current study
24	*Leptus* sp.	Nejadghanbar et al., 2010
25	*Lorryia oregonensis* (Baker, 1970)	Taghavi et al., 1998; Kamali et al. 2001

No.	Species	References
26	*Neocunaxoides* sp.	Taghavi et al., 1998; Kamali et al. 2001
27	*Panonychus citri* (McGregor, 1916)	Taghavi et al., 1998, current study
28	*Peterobia harti* (Ewing, 1909)	Taghavi et al., 1998; Kamali et al. 2001; current study
29	*Polyphagotarsonemus latus* (Banks, 1904)	Current study
30	*Pulaeus martini* Den Heyer, 1981*	Current study
31	*Raphignathus gracilis* (Rack, 1962)*	Current study
32	*Spinibdella cronini* (Baker & Balock, 1944)*	Current study
33	*Storchia rubusta* (Berlese, 1885)*	Current study
34	*Tarsonemus* sp.	Taghavi et al., 1998; Kamali et al. 2001
35	*Tetranychus urticae* Koch, 1836	Nejadghanbar et al., 2010; Taghavi et al., 1998; current study
36	*Triophtydeus immanis* Kuznetzov, 1973	Taghavi et al., 1998; Kamali et al. 2001
37	*Tuckerella flabellifera* Miller, 1964	Taghavi et al., 1998; Kamali et al. 2001
38	*Tuckerella hypoterra* McDaniel & Morihara, 1975	Nejadghanbar et al., 2010
39	*Tuckerella japonica* Ehara, 1975*	Current study
40	*Tycherobius* sp.	Nejadghanbar et al., 2010
41	*Tydeus inclutus* Livshitz, 1973	Taghavi et al., 1998; Kamali et al. 2001
42	*Tydeus meshkinensis* André, Ueckermann & Rahmani, 2010*	Current study

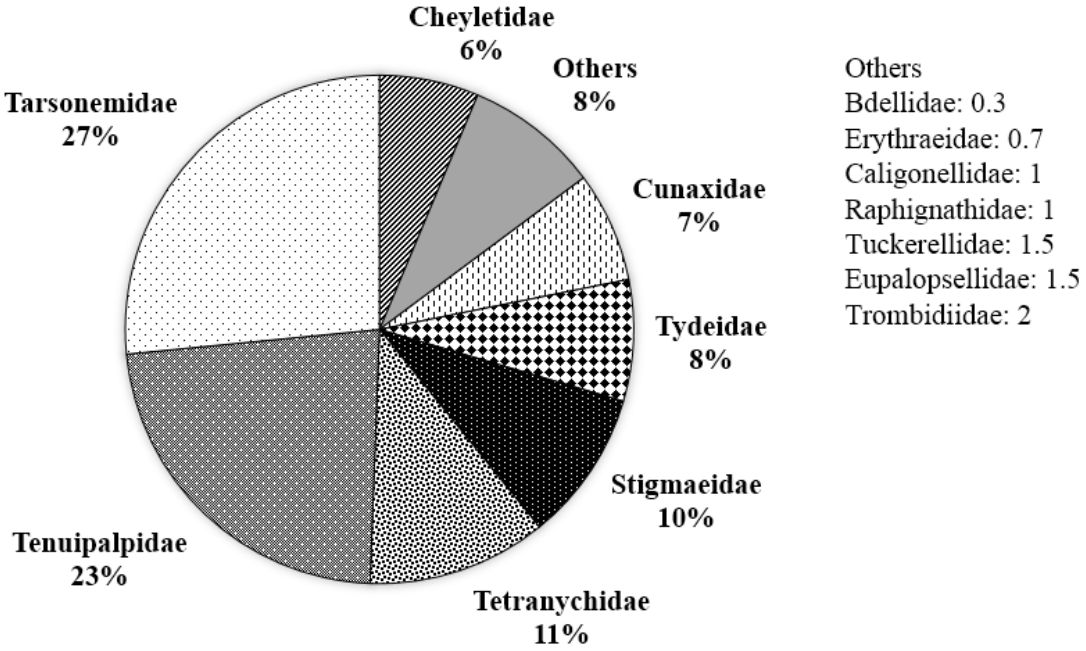

Figure 1. Percentage of families of prostigmatid mites associated with tea plant in Iran according to a threshold dominance of more than 5

List of prostigmatid mites associated with tea plantation in Iran with detailed information

Family Bdellidae

Spinibdella cronini (Baker & Balock, 1944) (Fig. 2)

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

Remarks: Mites of family Bdellidae are common on plants and in the soil. They are active predators of small arthropods, as springtails, dipteran larvae and other mites (Gerson et al., 2003; Chen et al. 2007, 2008).

Family Caligonellidae

Caligonella humilis Koch, 1838 (Fig. 3)

Material examined: 3 ♀, 37°12'23.00"N, 50°00'00.00"E , 5 m, collected from soil, July 2019.

Remarks: Some species of family Caligonellidae were assumed to feed on the eggs of pestiferous spider mites (Tetranychidae) (Gerson et al., 2003).

Family Cheyletidae

Hemicheyletia wellsi Summer & Price, 1970 (Fig. 4)

Material examined: 2 ♀, Parashkuh, 37°11'00.00"N, 50°09'00.00"E, 150 m July 2019; 3 ♀, Chaboksar, 36°58'00.00"N, 50°35'00.00"E , 200 m, May 2019; 1 ♀, Dizbon, 37°11'00.00"N, 50°09'00.00"E, 20 m, May 2019; 2 ♀, Qasemabad, 36°58'00.00"N, 50°35'00.00"E , 300 m, July 2019; 3 ♀, Kelachay, 37°04'44.00"N, 50°23'43.00"E , -20 m, May 2019; 2 ♀, Kumeleh, 37°09'10.00"N, 50°10'0037.00"E, 120 m, February 2019; 1 ♀, Langarud, 37°11'00.00"N, 50°09'00.00"E, 21 m, July 2019; 3 ♀, Leyla Kuh 37°11'00.00"N, 50°09'00.00"E, 50 m, May 2019; all collected from soil.

Remarks: The predatory mites of the family Cheyletidae occur on plants and in the soil as well as in vertebrate nests and stored products, feeding on mites or small insects. Some species [e.g. *H. bakeri* (Ehara)] have ability to control spider mites (Gerson et al. 2003).

Family Cunaxidae

Armascirus cerris Kalúz, 2009 (Fig. 5)

Material examined: 1 ♀, Qasemabad, 36°58'00.00"N, 50°35'00.00"E, 300 m, July 2019; 2 ♀, Kelachay, 37°04'44.00"N, 50°23'43.00"E, -20 m, May 2019; 2 ♀, Langarud, 37°11'00.00"N, 50°09'00.00"E, 21 m, July 2019, all collected from soil.

Coleoscirus buartsus Den Heyer, 1980 (Fig. 6)

Material examined: 2 ♀, Qasemabad, 36°58'00.00"N, 50°35'00.00"E, 300 m, July 2019, collected from soil.

Cunaxa papuliphora Sergeyenko, 2009 (Fig. 7)

Material examined: 4 ♀, Langarud, 37°11'00.00"N, 50°09'00.00"E, 21 m, July 2019; 4 ♀, Leyla Kuh 37°11'00.00"N, 50°09'00.00"E, 50 m, May 2018, all collected from soil.

Cunaxa sp. Material examined: 1 ♀, Lahijan, 37°12'00.00"N, 50°00'00.00"E, 2 m, collected from soil, October 2019.

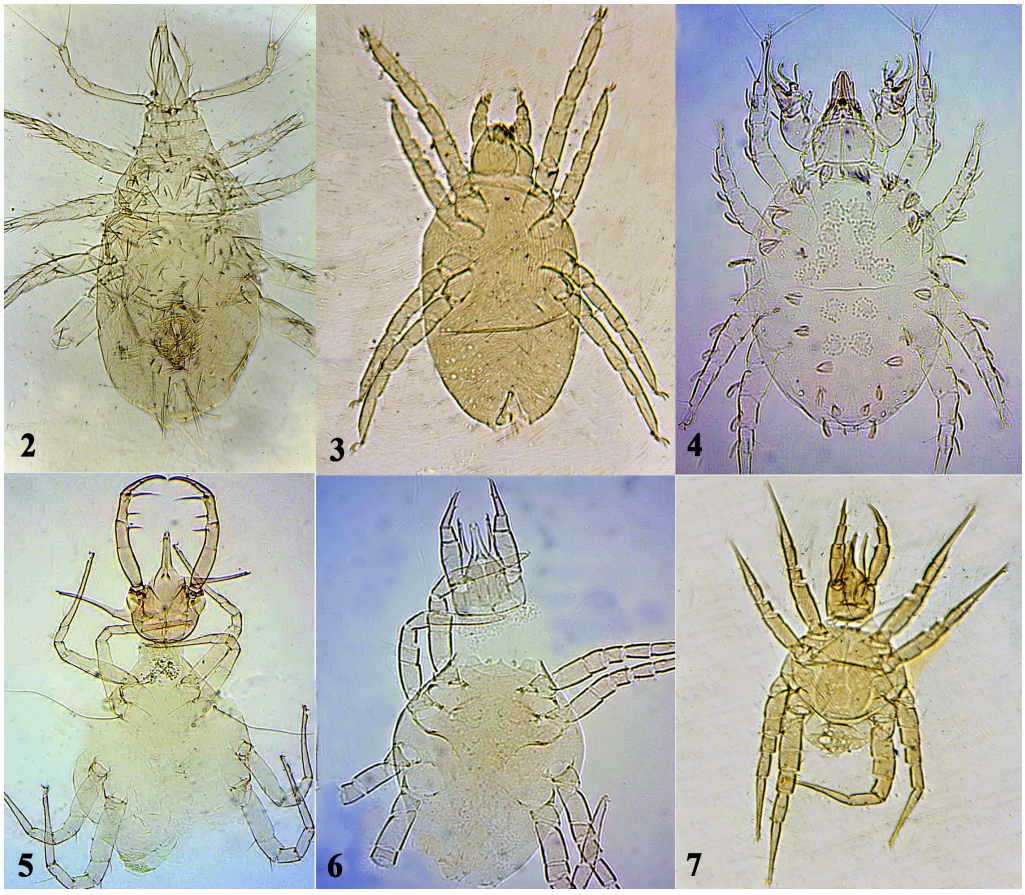

Figure 2-7. 2- *Spinibdella cronini* (Baker & Balock, 1944); 3- *Caligonella humilis* Koch, 1838; 4- *Hemicheyletia wellsi* Summer & Price, 1970; 5- *Armascirus cerris* Kalúz, 2009; 6- *Coleoscirus buartsus* Den Heyer, 1980; 7- *Cunaxa papuliphora* Sergeyenko, 2009..

Pulaeus martini Den Heyer, 1981(Fig. 8)

Material examined: 3 ♀, Sarash-Lahijan, 37°05'18.83"N, 50°05'27.43"E, 68 m, collected from soil, September 2018.

Remarks: Mites of Family Cunaxidae are fast-running, red, brown or yellow generalist predators that attack small arthropods on diverse crops, in stored products and in litter. In the soil they feed on root-knot nematodes (*Meloidogyne* spp.), major pests of many crops (Gerson et al. 2003). Studies have shown the ability of cunaxids to prey upon Eriophyoidea and Tetranychoidea, as well as upon other small arthropods and nematodes (Walter and Kaplan, 1991; Walter et al., 1993; Sathiamma, 1995 and Castro and Moraes, 2010).

Family Erythraeidae

Erythraeus sp.

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

Remarks: The larvae of the Erythraeidae are parasites of various arthropods, including insects and spiders. Postlarval erythraeids (deutonymphs and adults) are predators (Gerson et al. 2003; Wohltmann et al. 2007).

Family Eriophyidae

Calacarus carinatus, (Green, 1890)

Material examined: A large number of different stages, Ramsar, Telarsar village, 36°50'47.00"N, 50°43'07.00"E, 500 m, September 8, 2020, collected from infested leaves.

Family Eupalopsellidae

Eupalopsellus sp.

Material examined: 4 ♀, Rahimabad-Rudsar, 37°0'27.61"N, 50°16'56.13"E, 52 m, collected from leaves, September 2019.

Remarks: Mites of family Eupalopsellidae are often associated with armoured scale insects (Hemiptera: Diaspididae), they feed on eggs or first stage nymphs ('crawlers') of them (Gerson et al. 2003).

Family Raphignathidae

Raphignathus gracilis (Rack, 1962) (Fig. 9)

Material examined: 1 ♀, Sarash-Lahijan, 37°05'18.83"N, 50°05'27.43"E, 68 m, collected from soil, September 2018; 1 ♀, Rahimabad-Rudsar, 37°0'27.61"N, 50°16'56.13"E, 52 m, collected from soil, November 2019; 1 ♀, Tea Research Institute-Lahijan, 37°12'17.11"N, 50°01'23.19"E, 2 m, collected from soil, October 2018.

Remarks: Members of the family Raphignathidae are predator. They can be found under tree bark, in lichens, in moss, in leaf litter, in bird nests, in soil, on plants and in house dusts (Fan and Yin, 2000; Khanjani and Ueckermann, 2003).

Family Stigmaeidae

Eustigmaeus anauniensis Canestrini, 1889 (Fig. 10)

Material examined: 2 ♀, Otaqvar, 37°11'00.00"N, 50°09'00.00"E , 131 m, July 2019; 2 ♀, Amlash, 37°04'59.88"N, 50°10'59.88"E, 13 m, April 2019; 2 ♀, Chaboksar, 36°58'00.00"N, 50°35'00.00"E, 200 m, May 2019; 2 ♀, Chaykhansar, 36°58'00.00"N, 50°35'00.00"E , 25 m, July 2019; 4 ♀, Rudsar, 37°08'00.00"N, 50°17'00.00"E, 10 m, July 2019; 2 ♀, Kelachay, 367°04'0044.00"N, 50°23'43.00"E, -20 m, May 2019; 4 ♀, Langarud,37°11'00.00"N, 50°09'00.00"E, 21 m, May 2019, all collected from soil.

Eustigmaeus segnis Koch, 1836 (Fig. 11)

Material examined: 2 ♀, Parashkuh, 37°11'00.00"N, 50°09'00.00"E, 80 m July 2019; 2 ♀, Rudsar, 37°08'00.00"N, 50°17'00.00"E, 10 m, July 2019; all collected from soil.

Storchia rubusta (Berlese, 1885) (Fig. 12)

Material examined: 4 ♀, Parashkuh, 37°11'00.00"N, 50°09'00.00"E, 80 m July 2019, collected from soil.

Remarks: Stigmaeids live on plants and in the soil, often feeding on the eggs and sessile forms of tetranychid, tenuipalpid and other mites that infest commercial crops in many parts of the world. A few species prey on scale insects or parasitise flies (Gerson et al. 2003; Fan and Flechtmann, 2015).

Family Tarsonemidae

Polyphagotarsonemus latus (Banks, 1904) (Fig. 14-15)

Material examined: 5 ♀, Sarash-Lahijan, 37°05'18.83"N, 50°05'27.43"E, 68 m, collected from leaf, September 2018; 4 ♀, Sarcheshmeh-Lahijan, 37°08'59.34"N, 50°05'07.92"E; 70 m, 5 ♀, Lahijan, 37°12'17.11"N, 50°01'23.19"E, 9 m, collected from leaf, October 2018; 8 ♀, Rahimabad-Rudsar, 37°00'27.61"N, 50°16'56.13"E, 392 m, collected from soil, November 2019; 25 ♀, 25 ♂, Fuman,

37°13'48.00"N, 49°17'24.00"E, 70, collected from leaf, October 2019.
Remarks: The broad mite, *P. latus* (Banks) is one of the most injurious tarsonemid mites with different names, i.e. broad mite, chilli mite, citrus silver mite, white mite and yellow tea mite. It is distributed worldwide in the tropical and subtropical regions, attacking more than 60 plant families, feeding on plant juice and possibly injects toxic compounds in plant tissues (Gerson 1992; Abou-Awad et al., 2014). *Polyphagotarsonemus latus* was recorded on tea plant in Guilan province, Iran in 2019. The symptoms of damage on tea plant are diagnosed by deformity, curling, darkening and thickness of leaves and deformation of tip branches and buds. The damage of broad mite is so severe on tip branches and buds of tea plant (Ramzi et al., 2019).

Family Tenuipalpidae
Brevipalpus obovatus Donnadieu, 1875 (Fig. 13)
Material examined: 5 ♀, 4 ♂, Sarash-Lahijan, 37°05'18.83"N, 50°05'27.43"E, 68 m, collected from leaf, September 2018; 3 ♀, Rahimabad-Rudsar, 37°01'40.58"N, 50°21'01.05"E, 52 m, collected from leaf, October 2018; 30 ♀, 20 ♂, Fuman, 37°12'51.30"N, 49°15'37.57"E, 70m, collected from leaf, October 2019.
Remarks: The Tenuipalpidae are commonly referred to as false spider mites or flat mites. Among the genera of this family, emergent importance is assigned to species belonging to genus *Brevipalpus*. *Brevipalpus obovatus* has been collected on 451 plants belonging to 119 genera and five botanical families (Childers et al., 2003a, b). The main damages associated with Brevipalpus mites are indirect; they are listed as vectors of plant viruses (Childers et al. 2003b). Scarlet mite or privet mite, *B. obovatus* is one of the important and cosmopolitan species of pests, active on many crops, fruit and ornamental plants. This mite was recorded for the first time on tea in 1961 from northern regions of Iran and then reported from other parts of the country. The mite is able to make damage to all varieties of tea (Abbasipour et al., 1997).
Family Tetranychidae
Panonychus citri (McGregor, 1916) (Fig. 16)
Material examined: 1 ♀, Oshiyan, 37°58'00.00"N, 50°35'00.00"E, 200 m, July 2019; 2 ♀, Parashkuh, 37°11'00.00"N, 50°09'00.00"E, 80 m, collected from leaf, July 2019; 2 ♀, Chaboksar, 37°58'00.00"N, 50°35'00.00"E, 200 m, collected from leaf, May 2019; 1 ♀, Chayjan, 36°58'00.00"N, 50°35'00.00"E, 200 m, collected from leaf, July 2019; 2 ♀, Chaykhansar, 36°58'00.00"N, 50°35'00.00"E , 25 m, collected from leaf, April 2019; 3 ♀, Rudsar, 37°08'00.00"N, 50°17'00.00"E, 10 m, collected from leaf, May 2019; 1 ♀, Siahkalrud, 36°58'00.00"N, 50°35'00.00"E, 216 m, collected from leaf, July 2019; 2 ♀Shalman, 37°11'00.00"N, 50°09'00.00"E, -5 m, July 2019; 1, ♀, Qasemabad, 36°58'00.00"N, 50°35'00.00"E, 300 m, July 2019; 1 ♀, Kelachay, 37°04'44.00"N, 50°23'43.00"E , -20 m, collected from leaf, May 2019; 1 ♀, Langarud,37°11'00.00"N, 50°09'00.00"E, 21 m, collected from leaf, May 2019; 2 ♀, Vajargah, 37°02'27.00"N, 50°24'31.00"E, -10 m, collected from leaf, July 2019.
Remarks: *Panonychus citri* is commonly known as the citrus red mite. It is of worldwide distribution and recorded on 111 host plants (Migeon and Dorkeld, 2006). It is a major pest of citrus and occasionally attacks grapes, ornamental flowers, tea and evergreen shrubs grown in greenhouses and nurseries (Zhang, 2003). Citrus red mite is one of the minor pests of tea that has been reported in citrus and tea mixed orchards in Guilan and Mazandaran provinces of Iran (Taghavi et al., 1998; Nejadghanbar et al., 2010).

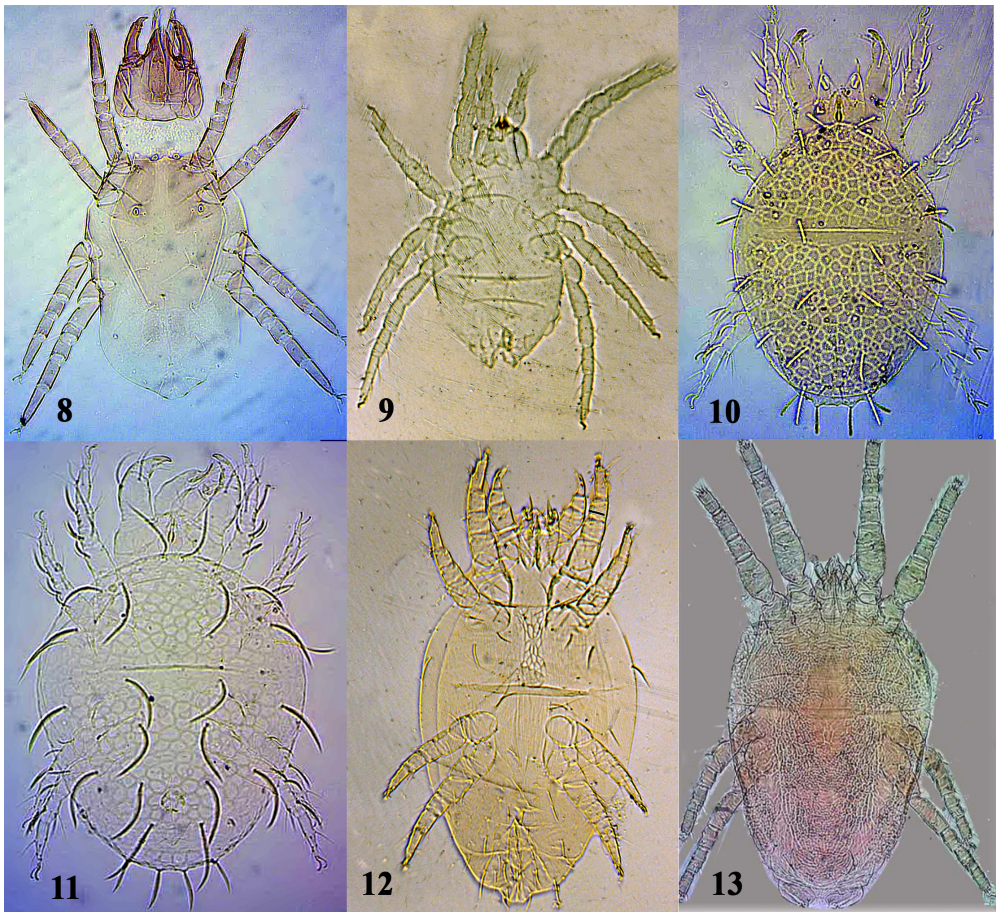

Figure 8-13. 8- *Pulaeus martini* Den Heyer, 1981; 9- *Raphignathus gracilis* (Rack, 1962); 10- *Eustigmaeus anauniensis* Canestrini, 1889; 11- *Eustigmaeus segnis* Koch, 1836; 12- *Storchia rubusta* (Berlese, 1885); 13- *Brevipalpus obovatus* Donnadieu, 1875.

Peterobia harti (Ewing, 1909) (Fig. 17)

Material examined: 2 ♀, Astaneh-e Ashrafiyyeh, 37°15'54.00"N, 49°56'40.00"E , 2 m, collected from leaf, January 2019.

Remarks: A small number of *P. harti* have been reported from tea orchards of Guilan and Mazandaran provinces in Iran (Taghavi et al., 1998; Nejadghanbar et al., 2010).

Tetranychus urticae Koch, 1836 (Fig. 18)

Material examined: 2 ♀, Chaboksar, 36°58'00.00"N, 50°35'00.00"E, 200 m, collected from leaf, May 2019; 2 ♀, 1 ♂, Chaykhansar, 36°58'00.00"N, 50°35'00.00"E, 25 m, collected from leaf, April 2019; 2 ♀, Rudsar, 37°08'00.00"N, 50°17'00.00"E, 10 m, collected from leaf, May 2019; 2 ♀, 1 ♂, Langarud, 37°11'00.00"N, 50°09'00.00"E, 21 m, collected from leaf, July 2019.

Remarks: A small number of *Tetranychus urticae* have been reported from tea orchards of Guilan province in Iran (Nejadghanbar et al., 2010).

Family Trombidiidae

Allothrombium pulvinum Ewing, 1917 (Fig. 20-21)

Material examined: 6 ♀, Tea Research Institute-Lahijan, 37°12'17.11"N, 50°01'23.19"E, 9 m, collected from soil, October 2018; 3 larvae, Fuman Moein Hotel-, 37°12'51.30"N, 49°15'37.57"E, 70 m, collected from leaf, October 2018.

Remarks: Larvae of *A. pulvinum* are ectoparasites of aphids whereas deutonymphs and adults are free-living predators of aphids and spider mites. Wide occurrence and abundance of *A. pulvinum*

in Iran especially northern provinces are the traits that make this species a good candidate as a biocontrol agent (Saboori and Zhang, 1996).

Family Tuckerellidae

Tuckerella japonica Ehara, 1975 (Fig. 19)

Material examined: 4 ♀, Rahimabad-Rudsar, 37°0'27.61"N, 50°16'56.13"E, 392 m, collected from leaf, November 2019.

Remarks: The Tuckerellidae number few species and are commonly plant-feeding mites, but their damage potential is doubtful and unclear. According to Gerson (2003), they do not cause a consistent economic level of injury nor require control measures. A small number of tuckerellid mites have been reported from tea orchards of Guilan and Mazandaran provinces in Iran (Taghavi et al., 1998; Nejadghanbar et al., 2010).

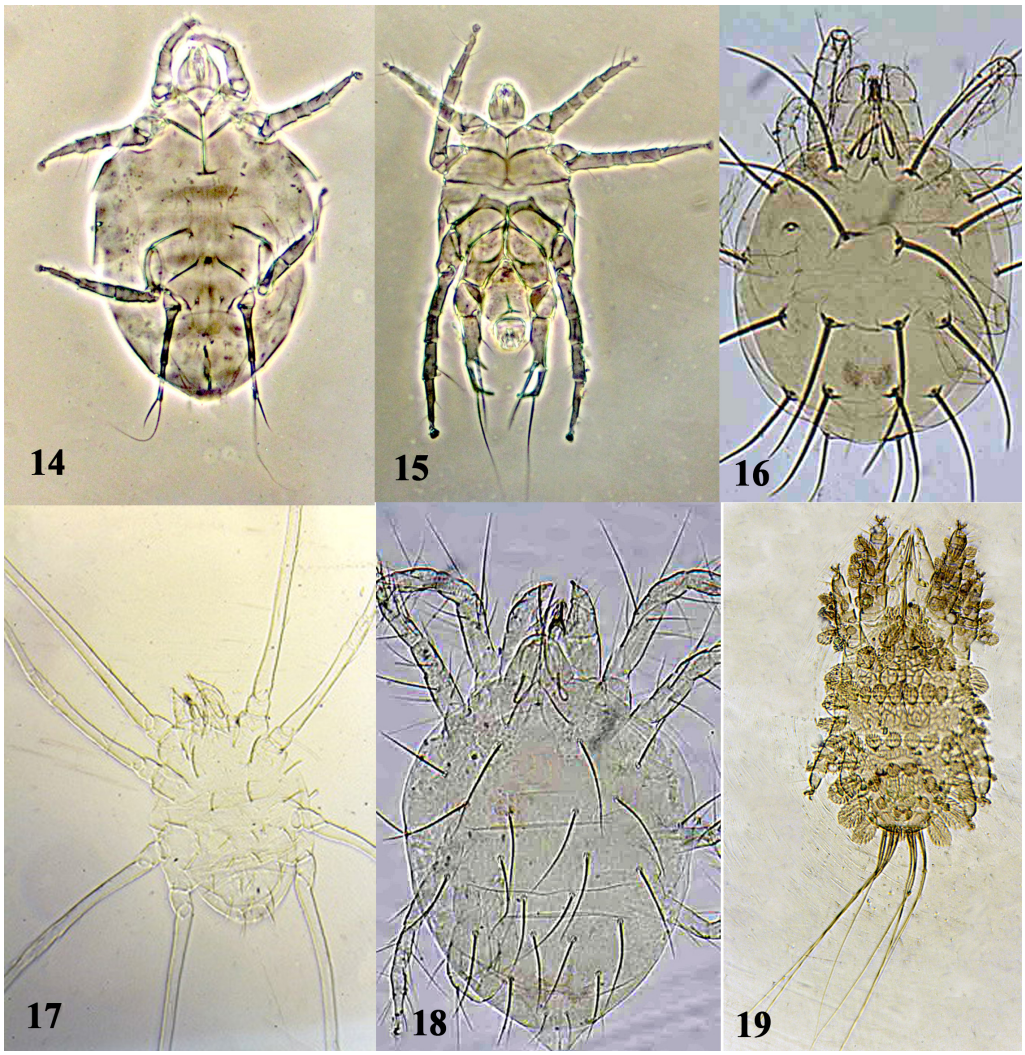

Figure 14-19. 14- *Polyphagotarsonemus latus* (Banks, 1904) female; 15 *Polyphagotarsonemus latus* (Banks, 1904) male; 16- *Panonychus citri* (McGregor, 1916); 17- *Peterobia harti* (Ewing, 1909); 18- *Tetranychus urticae* Koch, 1836; 19- *Tuckerella japonica* Ehara, 1975.

Family Tydeidae

Tydeus meshkinensis André, Ueckermann & Rahmani, 2010 (Fig. 22)

Material examined: 2 ♀, Amlash, 37°04'59.88"N, 50°10'59.88"E, 13 m, collected from leaf, July 2019; 2 ♀, Parashkuh, 37°11'00.00"N, 50°09'00.00"E , 80 m, collected from leaf, July 2019; 2 ♀, Chaboksar, 36°58'00.00"N, 50°35'00.00"E, 200 m, collected from leaf, May 2019; 2 ♀, Chayjan, 36°58'00.00"N, 50°35'00.00"E, 200 m, collected from leaf, July 2019; 3 ♀, Chaykhansar, 36°58'00.00"N, 50°35'00.00"E, 25 m, collected from leaf, April 2019; 2 ♀, Dizbon, 37°11'00.00"N, 50°09'00.00"E , 20 m, collected from leaf, May 2019; 2 ♀, Rudsar, 37°08'00.00"N, 50°17'00.00"E, 10 m, collected from leaf, May 2019; 3 ♀, Kelachay, 37°04'59.88"N, 50°10'59.88"E , 1-20 m, collected from leaf, May 2019; 2 ♀, Langarud, 37°11'00.00"N, 50°09'00.00"E, 21 m, collected from leaf, July 2019; 1 ♀, Vajargah, 37°02'27.00"N, 50°24'31.00"E, -10 m, collected from leaf, July 2019.
Remarks: Family Tydeidae (Prostigmata) is containing more than 300 species in more than 40 genera. Most species are fungivorous, some are predatory and some are facultatively phytophagus (Zhang, 2003). A small number of tydeid mites have been reported from tea orchards of Guilan and Mazandaran provinces in Iran (Taghavi et al., 1998; Nejadghanbar et al., 2010).

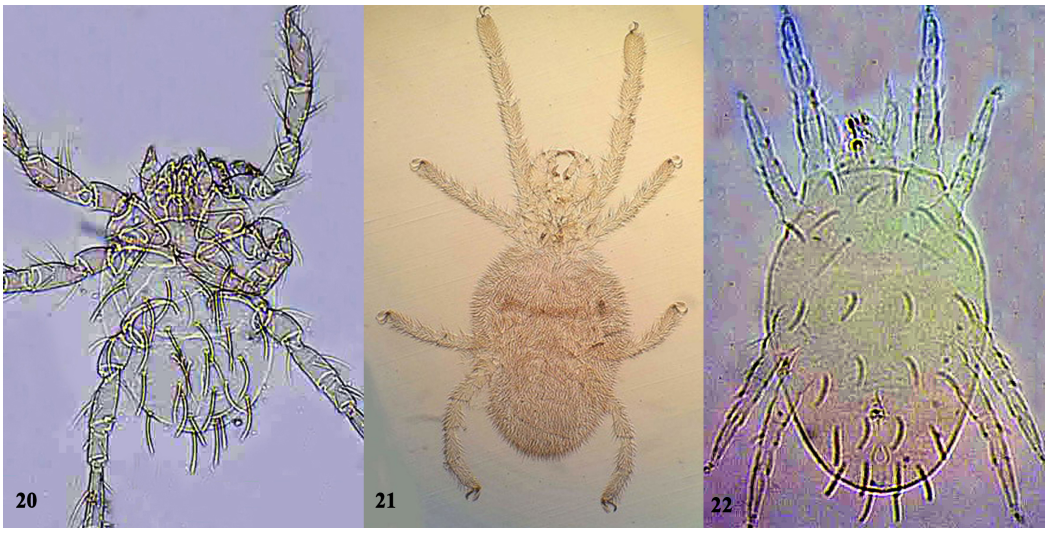

Figure 20- 22. 20- *Allothrombium pulvinum* Ewing, 1917 larva; 21- *Allothrombium pulvinum* Ewing, 1917 adult; 22- *Tydeus meshkinensis* André, Ueckermann & Rahmani, 2010..

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 prostigmatid mites in tea orchards of Iran (Table 1). Collected prostigmatid mites species can be divided into two harmful and beneficial groups. *Brevipalpus obovatus*, *Calacarus carinatus*, *Panonychus citri*, *Peterobia harti*, *Polyphagotarsonemus latus*, *Tetranychus urticae* and *Tuckerella japonica* are in the injurious group and most of other species are in beneficial (predator or parasite of tea pests) group. The most abundant and injurious species were from Tarsonemidae (27%), Tenuipalpidae (23%) and Tetranychidae (11%) families (Fig. 1). Among injurious species *P. latus* and *B. obovatus* were most abundant species. The most abundant and beneficial species were from Stigmaeidae (10%), Cunaxidae (7%) and Cheyletidae (6%) families (Fig. 1). Among beneficial species *Hemicheyletia wellsi*, *Eustigmaeus anauniensis*, *Cunaxa papuliphora* and *Allothrombium pulvinum* were most abundant species. The most important injurious mites in tea orchards of Iran are ornamental flat mite *B. obovatus* and yellow broad mite *P. latus* (Banks) (Taghavi et al., 1998; Ramzi et al., 2019). After predatory

mesostigmatid mites such as family Phytoseiidae, predatory prostigmatid mites may play a role in controlling these two important mite pests of tea plant in Iran (Hajizadeh et al., 2020). 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 some families of edaphic prostigmatid predatory mites (such as Cunaxidae 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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