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Distribution and predators of the invasive spider mite *Tetranychus evansi* (Acari: Tetranychidae) in the Syrian coastal region, with first record of predation by the native *Scolothrips longicornis* (Thysanoptera: Thripidae)

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Original research

ABSTRACT

The tomato red spider mite, *Tetranychus evansi* Baker & Pritchard, has emerged as a destructive invasive pest of solanaceous crops worldwide. It was first recorded in Syria in 2011, in Latakia governorate, in the coastal region. Successful management of *T. evansi* in a given region benefits from information about its distribution, host plants, and associated natural enemies. Therefore, we investigated, in 2019 and 2020, the status of *T. evansi* on solanaceous plants in the Syrian coastal region, an important producer of solanaceous crops. A total of 237 samples were collected at 187 sites in Latakia and Tartus governorates. *Tetranychus evansi* was found in 34 cultivated and wild solanaceous plant samples collected at 29 sites distributed across all districts in those governorates, and in a variety of landscapes and elevations, ranging from the coastal plains to high altitudes in the Syrian Coastal Mountain Range. It was collected from three solanaceous crops, namely tomato (*Solanum lycopersicum* L.), eggplant (*Solanum melongena* L.) and potato (*Solanum tuberosum* L.), as well as from two wild solanaceous plants: black nightshade (*Solanum nigrum* L.) and red nightshade (*Solanum villosum* Mill.). A total of 14 species of predatory insects and mites, and five species of phytophagous mites, were identified in association with *T. evansi*. Predatory insects were more frequent and abundant than predatory mites. The insect predator *Feltiella acarisuga* (Vallot) was the most common and abundant species among the predators, followed by *Stethorus gilvifrons* (Mulsant) and *Scolothrips longicornis* Priesner. The predatory mite *Phytoseiulus persimilis* Athias-Henriot was the most frequent and abundant species of associated predatory mites.

Keywords tomato red spider mite ; natural enemies ; biological control ; predatory insects ; Solanaceae

Introduction

The tomato red spider mite, *Tetranychus evansi* Baker & Pritchard, considered to have originated in South America, has emerged as a destructive invasive pest of solanaceous crops worldwide (Boubou *et al.* 2011; Navajas *et al.* 2013).

The Syrian coastal region, which includes Latakia and Tartus governorates, is one of the main solanaceous crop producers in Syria and provides more than 50% of the total national

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tomato (*Solanum lycopersicum* L.; Solanaceae) production in both protected and open-field conditions (AASA 2018). *Tetranychus evansi* was first detected in Latakia governorate in 2011, on tomato and black nightshade (*Solanum nigrum* L.) (Zriki *et al.* 2015). According to Migeon *et al.* (2009), the Mediterranean climate of the Syrian coastal region is highly favorable for development and establishment of *T. evansi*, and resulting outbreaks could be dramatic.

Due to the threat that this mite represents to agriculture in this region, information about its distribution, host plants and associated natural enemies is crucial for designing successful pest management programs. In a recent study, we reported new records of this mite species and of two associated predaceous insects, namely *Feltiella acarisuga* (Vallot) (Diptera: Cecidomyiidae) and *Stethorus gilvifrons* (Mulsant) (Coleoptera: Coccinellidae) on tomato and black nightshade plants in Latakia governorate (Dayoub *et al.* 2020). In the present study, we complete the previous reports and report additional localities, host plants, and predators identified in association with *T. evansi* in the Syrian coastal region.

Material and methods

Surveys were conducted in 187 sites distributed across all districts of Latakia and Tartus governorates (Figure 1), from March to November of 2019 and 2020. Because of the economic importance and widespread cultivation of solanaceous crops in this area, sampling efforts were restricted to plants of this family. At each site, samples were taken from crops in open fields and/or greenhouses and from weeds from the surroundings of cultivated plots or spontaneously growing along roads and watercourses. Crops sampled were eggplant (*Solanum melongena* L.) in 55 open field and 21 greenhouse crops, tomato in 11 open field and 24 greenhouse crops, tobacco (*Nicotiana tabacum* L.) in 22 open field crops, and potato (*Solanum tuberosum* L.) in 17 open field crops. Weeds included 70 samples of black nightshade (*S. nigrum*), 10 samples of red nightshade (*Solanum villosum* Mill.), and 7 samples of jimson weed (*Datura* sp.).

A total of 237 plant samples were collected, each consisting of 30 leaves of each solanaceous species. Each sample was placed in a plastic bag and transported to the laboratory, where leaves were examined under a stereomicroscope (Micros, Ladybird MZ1240, Austria). Mites were counted and collected with a fine brush in 70% ethanol, and later mounted in Hoyer's medium for identification. However, when spider mites were too numerous, their numbers were visually estimated. When mixed populations of *T. evansi* and *Tetranychus urticae* Koch were present, the respective numbers of nymphs and adults were estimated according to the presence of spots and body coloration. Then, 20 males and 20 females of each of them were collected and mounted to confirm the identification. Predatory insects belonging to the families Cecidomyiidae, Coccinellidae, Staphylinidae and Thripidae, well known as natural enemies of spider mites (Chazeau 1985), were also counted and collected. Cecidomyiid and coccinellid insects were prepared for identification as in Dayoub *et al.* (2020). For coccinellid insects, male genitalia were extracted and then mounted in a drop of glycerin on a slide to examine important diagnostic features. To identify cecidomyiid predators, some of the ethanol preserved adults were cleared in KOH and subsequently slide-mounted in Hoyer's medium. Adult thrips were macerated in KOH, dehydrated using absolute ethanol, and mounted in Hoyer's medium, following the method of Mirab-Balou and Chen (2010).

Mites were identified at family level using the keys by Krantz and Walter (2009). Identification was carried out to species level whenever possible and to genus level otherwise, using the identification keys provided in the following publications: Tetranychidae (Baker and Pritchard 1960; Jeppson *et al.* 1975; Seeman and Beard 2011), Tenuipalpidae (Beard *et al.* 2015; Mesa *et al.* 2009; Welbourn *et al.* 2003), Tarsonemidae (Nucifora and Vacante 2004; Zhang 2003), Phytoseiidae (Barbar 2013; Döker *et al.* 2016, 2020; Ferragut 2018; Kreiter *et al.* 2016, 2020), Anystidae (Smith Mayer and Ueckermann 1987), Stigmaeidae (Fan *et al.* 2016; Gonzalez 1963; Koç *et al.* 2005) and Iolinidae (Panou *et al.* 2001). Predatory insects were identified using the identification keys provided by: Cecidomyiidae (Gagné 1995, 2018), Coccinellidae (Kapur 1948), and Thripidae (Mirab-Balou *et al.* 2013; Mound 2011).

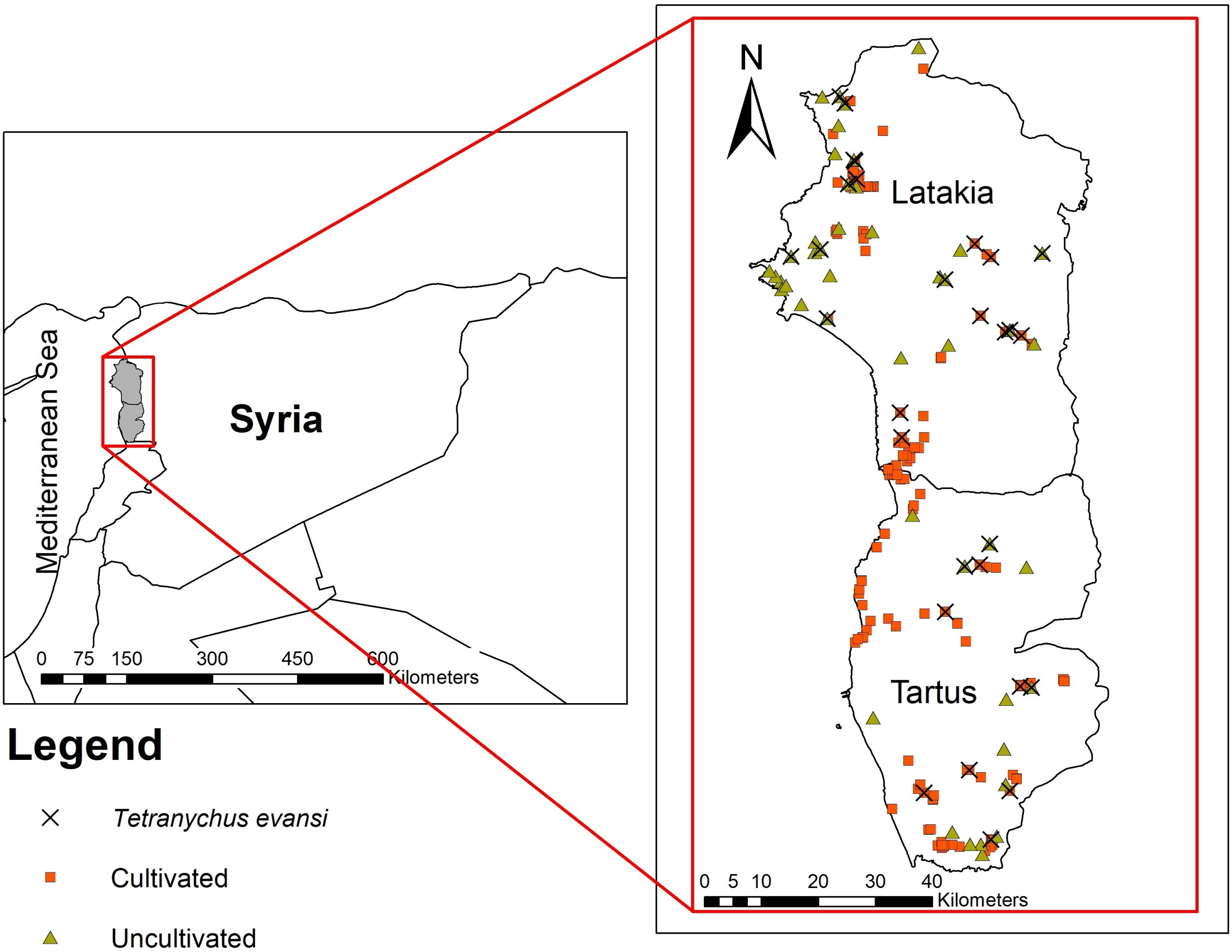

Figure 1 Sampling sites and distribution records of *Tetranychus evansi* in the Syrian coastal region (Latakia and Tartus governorates).

Slide-mounted specimens were deposited as voucher specimens at the laboratory of Plant Protection Research, Faculty of Agriculture, Tishreen University, Latakia, Syria****. For the purpose of this paper, only plant samples infested with *T. evansi* were presented in the results.

Results

Tetranychus evansi was found in 29 sites (15.5% of the sampling sites), from all districts in the governorates of Latakia (19 sites) and Tartus (10 sites), at elevations ranging from 17 to 1110 meters above sea level (Table 1, Figure 1). Sixteen of the sites were cultivations in open fields; in nine of these, *T. evansi* was collected from crop plants only, in three from adjacent solanaceous weeds only, and in four from both crop plants and weeds. Thirteen of the sites were uncultivated, where black nightshade grew naturally along roads and watercourses (Table 1). Despite comparable sampling efforts, *T. evansi* was not reported from greenhouse crops nor in tobacco fields.

Out of 237 plant samples, *T. evansi* was found in 34 samples (14.3%) from five plant species: tomato (3 samples), eggplant (7), potato (4), black nightshade (18) and red nightshade

Table 1 Records of *Tetranychus evansi* and associated natural enemies on solanaceous plants in the Syrian coastal region during 2019 and 2020.

Site	Collection date	Geographic coordinates	aasl* (m)	Host plant	Type	Phytophagous mites (Number of specimens)	Predators (Number of specimens)
Latakia							
Al-Eadiyah	08-IX-2019	35°18'43.1"N 35°57'33.0"E	28	*Solanum nigrum*	Weed	*Tetranychus evansi* (500)	*Phytoseiulus persimilis* (1) *Typhlodromus* (*Typhlodromus*) *athiasae* (2) *Amblyseius swirskii* (1) *Feltiella acarisuga* (8) *Stethorus gilvifrons* (6)
Ugarit	13-IX-2019	35°35'51.5"N 35°47'04.0"E	17	*S. nigrum*	Weed	*T. evansi* (15) *T. urticae* (20)	*Pronematus* sp. (6) *F. acarisuga* (7) *Scolothrips longicornis* (3) **
Slanfah	18-IX-2019	35°36'07.4"N 36°10'51.3"E	1110	*S. nigrum*	Weed	*T. evansi* (200)	*F. acarisuga* (8)
Bereen	18-IX-2019	35°35'47.1"N 36°05'59.9"E	644	*S. lycopersicum*	Open Field	*T. evansi* (61) *T. urticae* (38) Eriophyidae	*Typhlodromus* (*Anthoseius*) *recki* (12) *F. acarisuga* (3)
Al-Dakleyiah	18-IX-2019	35°37'04.0"N 36°04'28.7"E	530	*S. nigrum*	Weed	*T. evansi* (250)	*F. acarisuga* (12) *S. gilvifrons* (8) *P. persimilis* (2)
				S. lycopersicum	Open Field	*T. evansi* (1856) *T. urticae* (691)	*P. persimilis* (11) *T.* (*T.*) *athiasae* (2) *T.* (*A.*) *recki* (3) *S. gilvifrons* (1) *S. longicornis* (1)
Al-Bassa	27-IX-2019	35°29'58.4"N 35°50'29.8"E	19	*S. nigrum*	Weed	*T. evansi* (500)	*F. acarisuga* (31)
Miseet (1)	01-X-2019	35°28'52.3"N 36°07'47.3"E	549	*S. nigrum*	Weed	*T. evansi* (600)	*F. acarisuga* (25) *S. gilvifrons* (14) *S. longicornis* (1)
Zenio	01-X-2019	35°28'21.1"N 36°08'53.7"E	794	*S. lycopersicum*	Open Field	*T. evansi* (63) *T. urticae* (206)	*T.* (*A.*) *recki* (3) *F. acarisuga* (2)
AL-Maghrit	15-XI-2019	35°36'30.1"N 35°49'50.5"E	68	*S. nigrum*	Weed	*T. evansi* (1200) *T. urticae* (20)	*F. acarisuga* (27) *S. gilvifrons* (13) *Agistemus exsertus* (2)
Al-Defleh	19-XI-2019	35°50'20.9"N 35°52'11.6"E	20	*S. nigrum*	Weed	*T. evansi* (400)	*F. acarisuga* (9) *S. gilvifrons* (4)
Ras Al-Basit	19-XI-2019	35°50'57.6"N 35°51'43.0"E	20	*S. nigrum*	Weed	*T. evansi* (200) *Brevipalpus obovatus* (1)	*F. acarisuga* (1)
Al-Herajiah (1)	19-XI-2019	35°44'59.3"N 35°53'02.5"E	56	*S. nigrum*	Weed	*T. evansi* (450)	*F. acarisuga* (6) *S. longicornis* (6)
Al-Herajiah (2)	19-XI-2019	35°44'49.9"N 35°53'08.6"E	58	*S. melongena*	Open Field	*T. evansi* (9) *T. urticae* (268) *Polyphagotarsonemus latus* (12)	*Phytoseius finitimus* (1) *A. swirskii* (1) *T.* (*T.*) *athiasae* (1) *Agistemus* sp. (2)
Miseet (2)	01-X-2019	35°28'41.9"N 36°07'20.6"E	530	*S. melongena*	Open Field	*T. evansi* (2) *T. urticae* (21) *B. obovatus* (42) *P. latus* (55) Eriophyidae	*P. finitimus* (12) *Agistemus duzgunesae* (2) *Pronematus* sp. (9)
				S. villosum	Weed	*T. evansi* (450)	*F. acarisuga* (1) *Pronematus* sp. (8)
Wadi Qandil	26-XI-2019	35°42'43.4"N 35°52'31.5"E	22	*S. nigrum*	Weed	*T. evansi* (300)	*F. acarisuga* (6) *S. longicornis* (6) *P. persimilis* (1)
Hebeet	26-XI-2019	35°33'40.1"N 36°01'38.8"E	267	*S. nigrum*	Weed	*T. evansi* (300)	*F. acarisuga* (26)
Besaysin	2-VIII-2020	35°21'02.4"N 35°57'23.8"E	21	*S. melongena*	Open Field	*T. evansi* (1162)	*F. acarisuga* (33) *S. gilvifrons* (36) *P. persimilis* (8)
				S. nigrum	Weed	*T. evansi* (150) Eriophyidae	*F. acarisuga* (3) *S. gilvifrons* (2) *T.* (*T.*) *athiasae* (1)
Qalaat Mahalibeh	21-X-2020	35°30'13.7"N 36°05'00.3"E	652	*S. melongena*	Open Field	*T. evansi* (284)	*S. gilvifrons* (4) *P. persimilis* (7)
				S. tuberosum	Open Field	*T. evansi* (825)	----
Zaghreen	31-X-2020	35°43'08.3"N 35°53'16.7"E	34	*S. tuberosum*	Open Field	*T. evansi* (5)	----
Tartus							
Al-Hittaneh	20-X-2019	35°08'37.9"N 36°05'54.1"E	676	*S. nigrum*	Weed	*T. evansi* (200)	----
Beit Al-Marj	20-X-2019	35°06'40.0"N 36°04'55.3"E	518	*S. villosum*	Weed	*T. evansi* (200)	*P. finitimus* (2)
Tanita	20-X-2019	35°06'30.4"N 36°03'30.1"E	336	*S. nigrum*	Weed	*T. evansi* (150) *B. phoenicis* (1) *Cenopalpus* sp. (1)	*F. acarisuga* (2) *S. gilvifrons* (3) *Anystis baccarum* (L.) **
Nab'e El-Dulbah	24-IX-2020	34°55'09.0"N 36°08'47.0"E	376	*S. melongena*	Open Field	*T. evansi* (1) *T. urticae* (84)	----
				S. nigrum	Weed	*T. evansi* (300)	*S. gilvifrons* (24) *S. longicornis* (3)
Al-Braikhieah	24-IX-2020	34°55'02.1"N 36°09'50.9"E	442	*S. nigrum*	Weed	*T. evansi* (350)	*S. gilvifrons* (7)
Talsnon	31-X-2020	34°40'37.4"N 36°06'00.4"E	44	*S. nigrum*	Weed	*T. evansi* (700)	*F. acarisuga* (2) *S. gilvifrons* (5) *S. longicornis* (2)
Samariyan	9-XI-2020	34°45'04.2"N 35°59'39.6"E	47	*S. tuberosum*	Open Field	*T. evansi* (17)	----
Buwydit Al-Suwyqat	1-XI-2020	34°47'12.9"N 36°03'58.1"E	148	*S. melongena*	Open Field	*T. evansi* (750)	*F. acarisuga* (43) *S. gilvifrons* (4)
Um Hawsh	1-XI-2020	34°45'14.2"N 36°07'47.3"E	135	*S. melongena*	Open Field	*T. evansi* (140) *T. urticae* (225)	*F. acarisuga* (1) *Oligota* sp. (4)
Al-Qamsiyah	9-XI-2020	35°02'12.4"N 36°01'42.2"E	579	*S. tuberosum*	Open Field	*T. evansi* (6) *T. urticae* (9)	*F. acarisuga* (2)

* Altitude above sea level; ** recorded for the first time from Syria.

(2). In 64.7% of these samples (22), no other phytophagous mites were observed in association with *T. evansi*, and 68.2% of the samples with *T. evansi* as the sole phytophagous mite (15 out of 22) referred to heavily infested black and red nightshade plants (Table 1).

Five phytophagous mite species were identified in association with *T. evansi* on 12 samples, and *T. urticae* was the most frequent (83.3%), particularly on cultivated plants (Table 1).

A total of 515 specimens of predators belonging to four species of insects and ten species of mites were found (Table 1). Predatory insects were more frequent (76.5%) and abundant (415 specimens) than predatory mites (respectively 47.1% and 102 specimens).

Feltiella acarisuga was the most frequent and abundant predator; 288 specimens of this acarophagous gall midge were collected in 22 (out of 34) samples of all plant species infested by *T. evansi* (Table 2). The second most frequent (14 samples) and abundant (131 specimens) predatory insect was *S. gilvifrons*, collected mainly on *S. nigrum* and *S. melongena*.*Scolothrips longicornis* Priesner (Thysanoptera: Thripidae) was the third most frequent and abundant predator. It was found in seven samples, mostly of *S. nigrum.* Preliminary observations conducted in the laboratory showed that larvae and adults of *S. longicornis* preyed on all developmental stages of *T. evansi* (Figure 2).

This is the first record of *S. longicornis* in Syria. Diagnostic morphological characters of this species include: (1) the presence of three dark bands or spots on forewings (including clavus); (2) a pronotum lacking a pair of posteromesad discal setae; (3) the absence of any dark/shaded patterns on the thorax and abdomen; (4) the white color of the antennal segment II; and (5) the males are hemimacropterous (Figure 3).

The most common predatory mites collected in this study belonged to Phytoseiidae, and *Phytoseiulus persimilis* Athias-Henriot was the most frequent and abundant species among them (Tables 1, 2). In addition, among other predatory mites found in this study, *Anystis baccarum* (L.) is reported for the first time in Syria.

Discussion

Tetranychus evansi was shown to be widely distributed in the Syrian coastal region, though at low frequencies. It was found in a variety of landscapes and elevations, ranging from the coastal

Table 2 Samples of *Tetranychus evansi* infested solanaceous plant species bearing each predator species, and respective abundances in the Syrian coastal region, in surveys conducted in 2019 and 2020.

Predator	Number of samples of each plant species							
	Tomato	Eggplant	Potato	Black nightshade	Red nightshade	Total number of samples	Frenquency (%)*	Total number of specimens
Feltiella acarisuga	2	3	1	15	1	22	64.7	258
Stethorus gilvifrons	1	3		10		14	41.2	131
Scolothrips longicornis	1			6		7	20.6	22
Phytoseiulus persimilis	1	2		3		6	17.6	30
Typhlodromus (*Typhlodromus*) *athiasae*	1	1		2		4	11.8	6
Pronematus sp.		1		1	1	3	8.8	23
Phytoseius finitimus		2			1	3	8.8	15
Typhlodromus (*Anthoseius*) *recki*	3					3	8.8	18
Amblyseius swirskii		1		1		2	5.9	2
Agistemus exsertus				1		1	2.9	2
Agistemus duzgunesae		1				1	2.9	2
Agistemus sp.		1				1	2.9	2
Anystis baccarum				1		1	2.9	2
Oligota sp.		1				1	2.9	4

* For overall number of 34 samples with *T. evansi.*

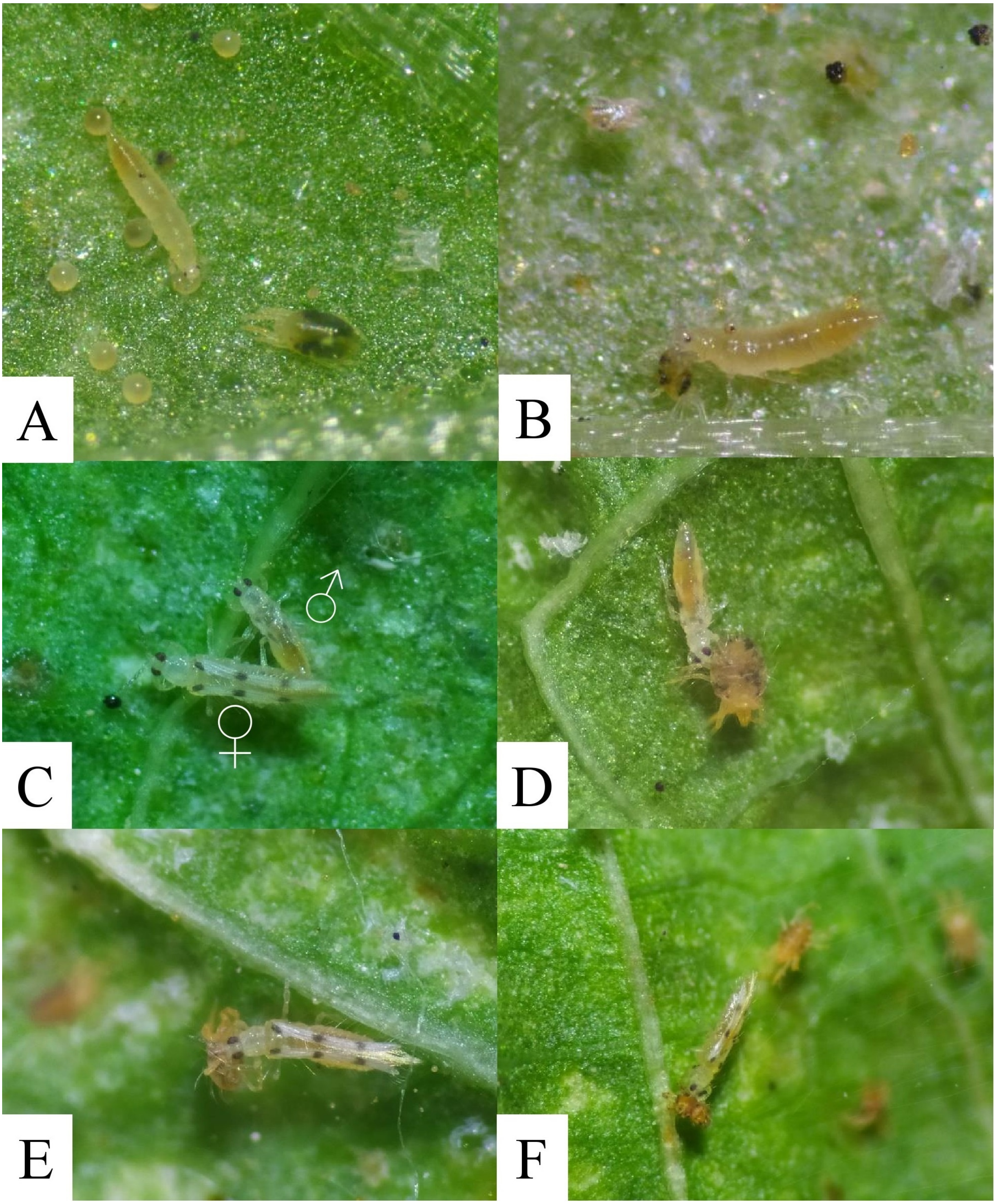

Figure 2 *Scolothrips longicornis*: A, B – Larvae feeding on egg and female *T. evansi*; C – Male and female mating; D – Male feeding on adult of *T. evansi*; E, F – Female feeding on adult of *T. evansi*.

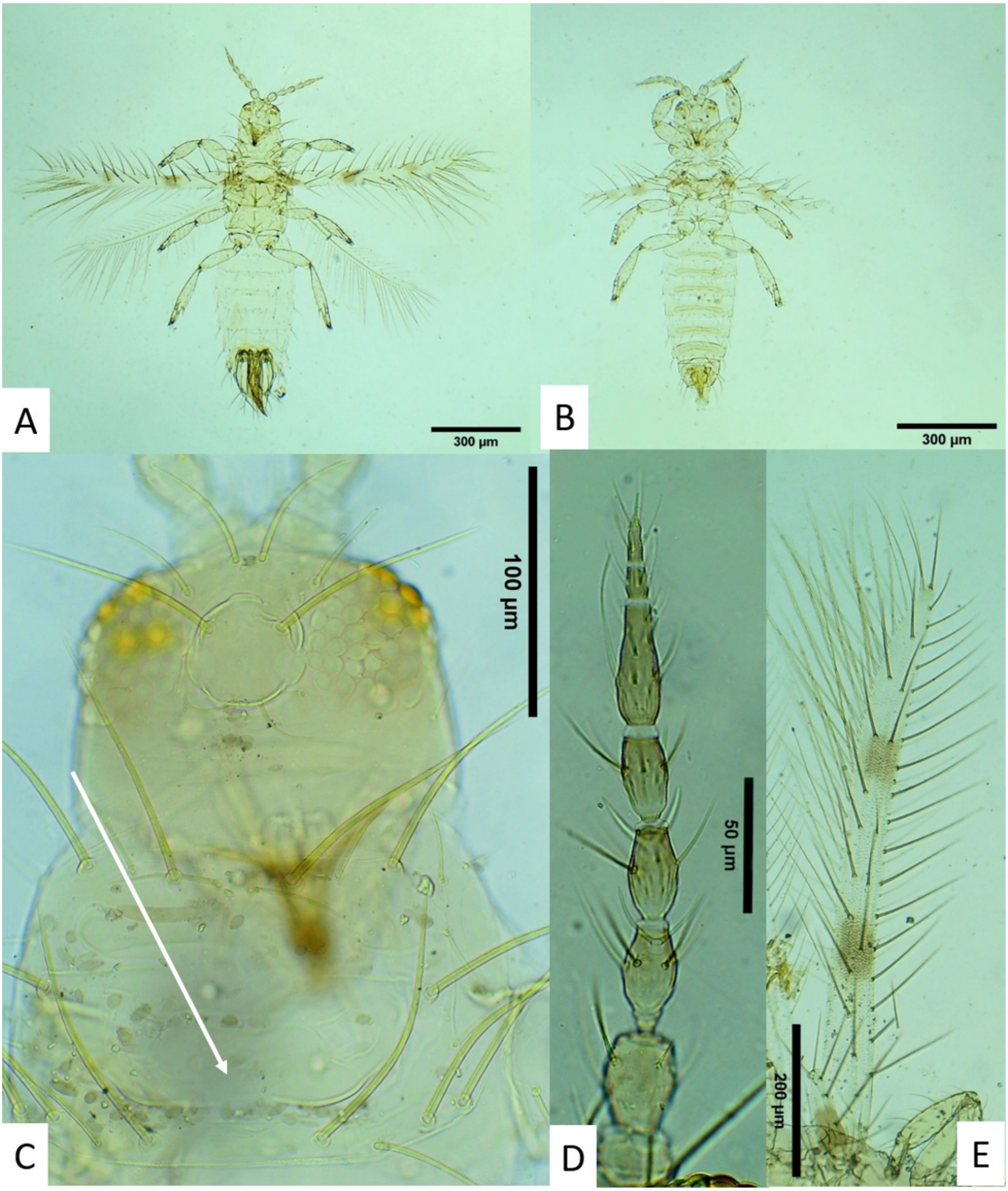

Figure 3 *Scolothrips longicornis*, A, C-E Female, B Male. A, B – habitus, C – Pronotum (arrow indicates approximate position of posteromesad discal setae); D – Antenna; E – Fore wing.

plains to high altitudes in the Coastal Mountain Range. Our current data on the occurrence of *T. evansi* in this region agree with predictions by Migeon *et al.* (2009) using CLIMEX® model. The Syrian coastal region was categorized as a very suitable habitat for *T. evansi*, owing to its Mediterranean climate, particularly mild winters, which favor the establishment of this mite (Migeon *et al.* 2009). According to this model, that would be the case for large areas of northwestern, northeastern, and southwestern Syria. Therefore, additional surveys are needed to investigate the distribution of this mite in these regions, where solanaceous crops are also grown.

In this study, *T. evansi* was collected from wild and cultivated solanaceous plants. Its frequent occurrence, at high population levels, on black nightshade is of particular interest, as this plant is very common at the Syrian coast, especially in irrigated fields and alongside watercourses, and could serve as a reservoir of *T. evansi*, threatening nearby solanaceous crops. However, it could also serve as a reservoir of natural enemies of this mite.

On field-cultivated tomato, eggplant, and potato plants, *T. evansi* was observed at very high population levels at some sites of Latakia and Tartus governorates (i.e., Al-Dakleyiah and Besaysin). The absence of *T. evansi* in samples from greenhouses is puzzling, but it could be due to the heavy usage of various synthetic acaricides (up to 10 sprays a month) (AMD, personal observations) in these agricultural systems. Previous studies showed the sensitivity of *T. evansi* to different acaricides (Blair 1989; Migeon 2007; Gotoh *et al.* 2011; Toroitich *et al.* 2014). However, the potential selection for resistance when relying heavily on synthetic pesticides for controlling spider mites should not be disregarded (Azandémè-Hounmalon *et al.* 2015). Therefore, finding alternative, effective, and sustainable methods to manage *T. evansi* populations, such as the use of biological control agents, is necessary.

The presence of *F. acarisuga*, *S. gilvifrons*, and *S. longicornis* at various developmental stages on cultivated and wild solanaceous plants infested with *T. evansi*, mostly in the absence of any other prey on the same plant, suggested that they were developing solely on this mite. Their biology and efficacy as control agents of *T. evansi* should be the subject of future research.

The gall midge *F. acarisuga* has been mentioned as an important cosmopolitan predator of Tetranychidae (Gagné 1995; Gagné and Jaschhof 2017). It is considered a key natural enemy that reduces the population density of spider mites in diverse cropping systems (Gillespie *et al.* 1997; Sharaf 1984). *Feltiella acarisuga* is commercially mass-reared in many countries for use in augmentative biological control programs (Van Lenteren 2012). This predator was also found in association with *T. evansi* in other invaded regions, viz. Spain (Escudero *et al.* 2005) and Japan (Abe *et al.* 2011). In northeastern Brazil, where the mite has been considered to have originated, larvae of *Feltiella curtistylus* Gagné were found preying on *T. evansi* on tomato plants (Gagné 1995).

Stethorus gilvifrons is an indigenous species widely distributed in the Middle East and southern Europe (Kovář 2007). Earlier surveys in the Syrian coastal region suggested this species to be an important predator of *T. urticae* on several solanaceous plants (Mofleh 2010), as well as of *Panonychus citri* (McGregor) and *Eutetranychus orientalis* (Klein) in citrus orchards (Qerhili 2015). The tropical congener, *Stethorus tridens* Gordon, is considered a promising biocontrol agent of *T. evansi.* This voracious predator can develop and reproduce when feeding on *T. evansi* under laboratory conditions (Britto *et al.* 2009; Fiaboe *et al.* 2007).

In this study, the predatory thrips *S. longicornis* was recorded for the first time in Syria. Species of the genus *Scolothrips* Hinds are obligate predators of tetranychid and tenuipalpid mites and have the potential for use in the biological control of these mites. Two *Scolothrips* species were previously reported from Syria in local publications: *S. latipennis* Priesner (Obeid 2007) and *S. sexmaculatus* (Pergande) (Mofleh 2010). However, there are probably misidentifications in earlier studies under the name *S. sexmaculatus* in areas outside North America (Masumoto 2010; Laurence Mound, personal communication), and no voucher specimens are available to confirm the identity of previous *Scolothrips* records in Syria.

This is also the first report of *S. longicornis* preying upon *T. evansi*. Species of *Scolothrips* are commercially available and distributed under the name "six-spotted thrips" (Mound 2011).

Scolothrips longicornis is a native beneficial thrips in the Mediterranean and Middle East areas (Fathipour and Maleknia 2016). The potential of this predatory thrips for the biological control of several spider mites, including *T. urticae*, has also been reported (García-Marí and González-Zamora 1999; Pakyari *et al.* 2011; Heidarian *et al.* 2012).

Regarding phytoseiids, previous evaluations of 12 species, including the two most common in the present study, *P. persimilis* and *Typhlodromus* (*Anthoseius*) *recki* Wainstein, have reported *T. evansi* to be an unsuitable prey (de Moraes and McMurtry 1985; Escudero and Ferragut 2005; Tixier *et al.* 2020). In contrast, Brazilian and Argentine populations of the phytoseiid species *Phytoseiulus longipes* Evans, which were found in association with *T. evansi* on solanaceous plants, showed promising results in the biological control of *T. evansi* under laboratory and greenhouse conditions (Ferrero *et al.* 2007, 2011; Furtado *et al.* 2006, 2007). However, because *P. longipes* is a neotropical species, its introduction into Syria will encounter regulatory and environmental challenges. Therefore, efforts should be concentrated on testing promising natural enemies identified in this study (i.e., *F. acarisuga*, *S. gilvifrons*, and *S. longicornis*) and on the detection of additional biocontrol candidates.

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