

Mite fauna on *Dittrichia* species (Asteraceae) in Syrian costal region: new records and primary observations on the behavior of *Typhloseiella isotricha* (Athias-Henriot) (Meostigmata: Phytoseiidae)

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Original research

ABSTRACT

Surveys of mite fauna on *Dittrichia viscosa* and *D. graveolens* (Asteraceae) were conducted at multiple locations in Tartous and Latakia governorates, Syria, in 2021 and 2022. A total of 13 mite species belonging to seven families (Acaridae, Camerobiidae, Erythraeidae, Phytoseiidae, Raphignathidae, Tenuipalpidae, and Tetranychidae) were collected. Among them, *Erythraeus* (*Zaracarus*) *passidonicus* (Erythraeidae), *Raphignathus collegiatus* (Raphignathidae), and *Brevipalpus rotai* (Tenuipalpidae) are recorded for the first time in Syria. The most abundant family observed on *Dittrichia* species was Phytoseiidae with four species representing about 86% of total collected mite specimens. Among them, *Typhloseiella isotricha* was the dominant species. It was mainly observed on big leaves of *D. viscosa*, highly infected by the rust spots of *Coleosporium inulae*. Results suggest that rust spores could be a potential food for this predator.

Keywords survey; *Typhloseiella isotricha*; *Coleosporium inulae*; aggregation; abundance; Syria

Introduction

Predatory mites of the family Phytoseiidae (Acari: Mesostigmata) are of great importance for integrated pest management in various agroecosystems. Some Phytoseiidae species are widely used as biological agents for controlling phytophagous mites and other pests (Chant and McMurtry 2007; McMurtry *et al.* 2013). Researches about this family were progressively advanced in Syria during the last years. In total, thirty-one species of these predators were recorded until now, particularly in Latakia governorate (Barbar and Negm, 2022). These predators were almost collected from citrus orchards, vegetables crops, and from about forty plant species of natural vegetation surrounding agro-ecosystems (e.g. Barbar, 2013, 2014, 2016; Barbar *et al.* 2022). Of these natural vegetation, *Dittrichia viscosa* (L.) Greuter (Asteraceae) seems to be one of the most abundant species in the coastal region of Syria, and *D. graveolens* (L.) Greuter is another species accompanied the former in few localities. The two *Dittrichia* species are common in the Mediterranean region (Gökbulut *et al.* 2013; Parolin *et al.* 2014) and the former has been investigated against insects and phytophagous mites, and as the host plant of efficient generalist predators (Topakci *et al.* 2005; Alexenizer and Dorn, 2007; Ingegno *et al.* 2011). However, the number of predatory mite species (in particular those of the family Phytoseiidae) collected from these plant species were very low worldwide. In fact,

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only *Amblyseiella setosa* Muma and *Typhloseiella isotricha* (Athias-Henriot) were observed on *D. graveolens* and *D. viscosa*, respectively (Demite *et al.* 2022). In Syria, *T. isotricha* is the unique species collected from *D. viscosa* (Barbar, 2016). Although this predator was observed in 13 countries of the Mediterranean region (Demite *et al.* 2022), nothing is known about its ecology or associated prey.

The objectives of the present work were to determine phytophagous and predatory mites on *D. viscosa* and *D. graveolens* plants in the coastal region of Syria (Tartous and Latakia governorates), and to identify, the eventual source of feeding of most abundant predator for future evaluations of predation capacity and feeding habits.

Material and methods

Sampling and identification of mites

Surveys of mite fauna present on *D. viscosa* and on *D. graveolens* were conducted in Tatus and Latakia governorates in June, August and September 2021, and in June, July and August 2022. About 150 leaves of *Dittrichia* species were collected in each locality. Sampling dates, geographic coordinates and altitude above sea level (a.a.s.l. in meter) for each sampling location are presented in table 1.

The mites were collected from leaves of *Dittrichia* species using the “dipping-checking-washing-filtering” method (Boller, 1984), and then mounted on slides in Hoyer’s medium and dried at 45-50 °C for a week.

Mite taxa were identified to family levels using the key of Krantz and Walter (2009). Identification to infra-family level was carried out mainly using the following works: **(1)** for Mesostigmata: Phytoseiidae (Chant and McMurtry, 2007); **(2)** for Sarcoptiformes: Acaridae (Smiley 1991; Zhang 2003); **(3)** for Trombidiformes: Camerobiidae (Du Toit *et al.* 1998; Khanjani and Ueckermann, 2002) Erythraeidae (Southcott, 1961; Xu *et al.* 2019); Raphignathidae (Khanjani and Ueckermann, 2003; Fan and Zhang, 2005; Nasrollahi *et al.* 2018), Tenuipalpidae (Meyer 1979; Mesa *et al.* 2009), and Tetranychidae (Bolland *et al.* 1998). The specimens were deposited in the Arthropod Collection of the Department of Plant Protection, Faculty of Agriculture, Al-Baath University, Homs, Syria.

Phytoseiids on leaves infected by the rust fungus *Coleosporium inulae*

In the above surveys, relatively high number of phytoseiid specimens was observed in some collected samples of *D. viscosa* leaves infected by the rust fungus *Coleosporium inulae* Rabenhorst. To verify the effect of the presence of this fungus on phytoseiid mite abundances, a sample of 160 *D. viscosa* leaves were collected, divided them into four groups (40 leaves in each group): 1. small leaves (dimensions ranged from 1.8-6.0 long X 0.4-1.3 cm wide) without rust spots, 2. small leaves with rust spots, 3. big leaves (dimensions ranged from 6.4-10.3 long X 1.8-3.4 cm wide) without rust spots, and 4. big leaves with rust spots. The number of phytoseiid mites and rust spots were then counted on each leaf in each group using a binocular microscope. As no mite specimens were observed on small leaves without rust spots, this group of leaves was excluded from statistical analysis. As data were not normally distributed, a Kruskal-Wallis non-parametric analysis of variance followed by multiple comparisons between ranks (IBM® SPSS® version 20, 2011) were carried out to compare phytoseiids abundance between the three remaining groups of leaves. Generalized linear models initially showed that the mites on the three groups of *D. viscosa* leaves mentioned above followed a negative binomial distribution. Therefore, two aggregation indexes were studied. The first index was the variance/mean ratio (I), ($I = s^2/m$), in which $I = 1$ indicates a random spatial distribution; $I < 1$, uniform distribution and $I > 1$, aggregate distribution. The second index was the k exponent of the negative binomial distribution ($k = m^2/S^2 - m$), in which negative value of k indicates a uniform distribution, low and positive value ($0 < k < 2$) suggests a highly aggregate distribution,

value between two and eight refers to a moderate aggregation, and value higher than eight is related with random distribution (Fernandes *et al.* 2019). To describe quantitatively the eventual effects of the presence of *C. inulae* rust spots on patterns of phytoseiids distribution, the data (numbers of mites and rust spots) were used to estimate the coefficient of negative binomial distribution (B) and its exponent [Exp (B)].

Table 1 Sampling locations of *Dittrichia* species in the coastal region of Syria in 2021- 2022

Tartous governorate				
Location	Date of sampling	Geographic coordinates	aasl (m)	<i>Dittrichia</i> species
Alsheikh-Badr bridge	17-VII-2021	35°01'32"N 35°54'18"E	16	<i>D. viscosa</i>
Al-Einnazeh bridge	17-VII-2021	35°13'12"N 35°58'58"E	66	<i>D. graveolens</i>
Banias Refinery	17-VII-2021	35°12'59"N 35°57'29"E	19	<i>D. viscosa</i>
Al-Matin	17-VII-2021	35°00'06"N 35°53'53"E	9	<i>D. viscosa</i>
Markyah bridge	17-VII-2021	35°01'27"N 35°54'20"E	16	<i>D. viscosa</i>
Almarkeb Citadel	17-VII-2021	35°09'02"N 35°56'57"E	338	<i>D. viscosa</i>
Borj Al-sabi	17-VII-2021	35°09'15"N 35°55'47"E	80	<i>D. viscosa</i>
Tartous city Entrance	17-VII-2021	34°52'46"N 35°54'44"E	12	<i>D. viscosa</i>
Masken al-esmant	17-VII-2021	34°58'10"N 35°53'10"E	20	<i>D. viscosa</i>
Blata Gharbiyyeh	17-VII-2021	34°56'47"N 35°53'12"E	9	<i>D. viscosa</i> + <i>D. graveolens</i>
Al-Tali'y-Safita	08-VII-2021	34°44'04"N 36°06'26"E	182	<i>D. viscosa</i>
Serges	15-VIII-2021	35°05'07"N 36°00'46"E	319	<i>D. viscosa</i>
Kherbet Almaazeh	15-VIII-2021	34°47'58"N 36°00'25"E	147	<i>D. viscosa</i>
Beit Nour-Elddin	1-IX-2021 and 06-VI-2022	34°48'46"N 36°00'49"E	190	<i>D. viscosa</i>
Miaar Shaker	06-VI-2022	34°47'23"N 35°59'25"E	86	<i>D. viscosa</i>
Bowidat Massllam	08-VI-2022	34°56'23"N 36°10'52"E	534	<i>D. viscosa</i>
Al-Jammaseh	09-VI-2022	34°43'09"N 35°58'54"E	36	<i>D. graveolens</i>
Amrit	12-VI-2022	34°50'52"N 35°54'15"E	16	<i>D. viscosa</i>
Hosn Souliman	13-VI-2022	34°55'45"N 36°14'28"E	786	<i>D. viscosa</i>
Beit Kamoonah	16-VI-2022	34°52'18"N 35°55'40"E	51	<i>D. viscosa</i>
Kornish Albaher-Tartous	16-VI-2022	34°52'17"N 35°53'02"E	3	<i>D. viscosa</i>
Beit Kammonah	16-VI-2022	34°52'18"N 35°55'40"E	49	<i>D. viscosa</i>
Al-Mastabeh	20-VI-2022	34°53'39"N 36°01'01"E	306	<i>D. viscosa</i>
Albarkiyaaeh	24-VI-2022	34°49'48"N 36°13'39"E	399	<i>D. viscosa</i>
Safita Alshakiyyeh	25-VI-2022	34°50'16"N 36°07'26"E	230	<i>D. viscosa</i>
Sendyaneh-Obin	25-VI-2022	34°51'22"N 36°09'46"E	478	<i>D. viscosa</i>
Almderjat	25-VI-2022	34°47'54"N 36°04'08"E	203	<i>D. viscosa</i>
Al-Kafroun	25-VI-2022	34°51'54"N 36°14'20"E	433	<i>D. viscosa</i>
Zook Brakat	25-VI-2022	34°49'32"N 36°09'52"E	217	<i>D. viscosa</i>
Marmarita	27-VI-2022 and 24-VIII-2022	34°46'46"N 36°15'39"E	562	<i>D. viscosa</i>
Dwier-Almaloa	28-VI-2022	34°50'56"N 36°13'28"E	471	<i>D. viscosa</i>
Mashta-Alholo	28-VI-2022	34°52'37"N 36°15'12"E	500	<i>D. viscosa</i>
Deir Hbash	05-VII-2022	34°47'58"N 36°00'28"E	147	<i>D. viscosa</i>
Latakia governorate				
Location	Date of sampling	Geographic coordinates	aasl (m)	<i>Dittrichia</i> species
Jableh bridge	17-VII-2021	35°21'25"N 35°56'37"E	27	<i>D. viscosa</i>
Al-Kerdaha bridge	17-VII-2021	35°26'14"N 35°54'54"E	31	<i>D. graveolens</i>
Al-bassa Bridge	17-VII-2021	35°29'56"N 35°50'48"E	28	<i>D. viscosa</i>
Attabiyyat	21-VI-2022 and 27-VII-2022	35°50'71"N 35°78'38" E	5	<i>D. viscosa</i>
Alktalbiyeh	26-VIII 2022	35°17'19"N 36°00'57" E	160	<i>D. viscosa</i>

Results and discussion

New mite records

Mites were found in 31 of 38 sampled localities. A total of 13 mite species belonging to seven families (Acaridae, Camerobiidae, Erythraeidae, Phytoseiidae, Raphignathidae, Tenuipalpidae, and Tetranychidae) are reported on *Dittrichia* species in the present study (Table 2). Of these, three identified species are recorded for the first time from Syria and belong to Raphignathidae (one species), Erythraeidae (one species) and Tenuipalpidae (one species). These new records are presented thereafter.

Erythraeus (Zaracarus) passidonicus Haitlinger, family Erythraeidae: two larvae were collected from *D. viscosa*, Al-Matin, Tartous governorate, 17.7.2021. This species was

Table 2 Number of specimens of mite species found on *Dittrichia viscosa* and *D. graveolens* in Tartous and Latakia governorates (Syria) in 2021 and 2022.

Locations and mite species	<i>Phytoseiulus persimilis</i>	<i>Typhlodromus rhenanus</i>	<i>Typhlodromus athiasae</i>	<i>Typhloseiella isoricha</i>	<i>Tyrophagus putrescentiae</i>	<i>Neophyllobius</i> sp.	<i>Erythraeus adanaensis</i>	<i>Erythraeus passidonicus</i>	<i>Raphignathus collegiatus</i>	<i>Raphignathus gracilis</i>	<i>Brevipalpus obovatus</i>	<i>Brevipalpus rotai</i>	<i>Tetranychus</i> sp.
Al-Einnazeh bridge							2g,v						2g
Banias Refinery													2v
Al-Matin								2v					
Markyah bridge					2v								
Masken al-esmant		2v											
Al-Tali'y-Safita		3v											
Kherbet Almaazeh	1v												
Beit Nour-Elddin		4v	6v										
Miaar Shaker		2v		1v									
Bowidat Massllam				1v									
Al-Jammaseh				3g									
Amrit		3v	5v										
Hosn Souliman			1v									1v	
Beit Kamooneh			25v										
Kornish Albaher-Tartous		3v	5v										
Al-Mastabeh		2v											
Albarkiyayeh		2v	6v										
Safita Alshakiyyeh			6v										
Sendyaneh-Obin			4v		1g								
Almderjat									3v				
Al-Kafroun			3v	2v									
Zook Brakat													1v
Marmarita		2v	2v	1v							1v		
Dwier-Almaloa			5v										
Mashta-Alholo			2v										
Deir Hbash			3v										
Jableh bridge													1v
Al-Kerdaha bridge													2g
Al-bassa Bridge					1v				1v				
Attabiyyat			50v										1v
Alktalbiyeh		1v	15v								2v		

(*) number of specimens followed by the letter "v" and/or the letter "g" indicates that the specimens were collected from *D. viscosa* and/or *D. graveolens* respectively.

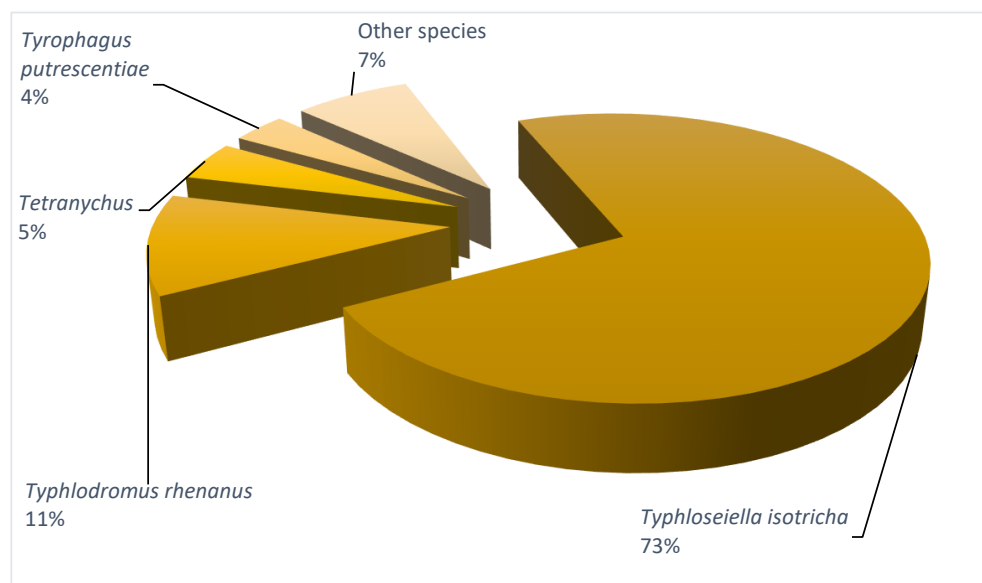


Figure 1 Relative abundance of mite species on *Dittrichia* leaves in Tartous and Latakia governorates (Syria) in 2021 and 2022

described from a unique larva in Greece and was re-described from three larvae in Turkey (Haitlinger, 2006, 2010).

Raphignathus collegiatus Atyeo, Baker and Crossley, family Raphignathidae: one female and two males were collected from *D. viscosa*, Almderjat, Tartous governorate, 25.6.2022. This species is known from China, Egypt, former USSR, USA and Turkey (Doğan and Ayyildiz, 2003).

Brevipalpus rotai (Castagnoli & Pegazzano), family Tenuipalpidae: one female was collected from *D. viscosa*, Hosn Souliman, Tartous governorate, 13.6.2022. This species is known from Greece, Italy and Turkey on *Olea europaea* L. (Castro *et al.* 2022). This is the first report of this species on *D. viscosa* although the absence of olive orchards near plants from which the samples were taken.

Domination of Phytoseiidae on *Dittrichia* species

The most abundant family observed on *Dittrichia* species was Phytoseiidae with four species representing about 86% of total collected mite specimens. *Typhloseiella isotricha* (Athias-Henriot) was the dominant species with about 73% and 85% of total collected mite specimens and total collected phytoseiids, respectively (Figure 1). This species was collected from *D. viscosa* in 16 locations and from *D. graveolens* in one location (Table 2). It was found in association with the phytophagous mite, *B. obovatus*, *B. rotai* and *Tetranychus* sp. It has been already reported on *D. viscosa* in Latakia governorate, Syria (Barbar, 2016) and was exclusively found on *D. viscosa* worldwide (Demite *et al.* 2022).

Typhlodromus (Anthoseius) rhenanus (Oudemans) was relatively abundant. All specimens of this species were collected from *D. viscosa* in nine locations in Tartous governorate (Table 2). These specimens represent 11% and 15% of total collected mite specimens and total collected phytoseiids, respectively (Figure 1). This is the first record of this predator on *D. viscosa* in the world (Demite *et al.* 2022). It was found in association with the phytophagous mite *B. obovatus* in the present study and it has been already reported on various herbaceous, shrub and arboreal plants in Syria (Barbar and Negm, 2022). Other phytoseiid species were sporadic and its presence on *Dittrichia* seems to be accidental.

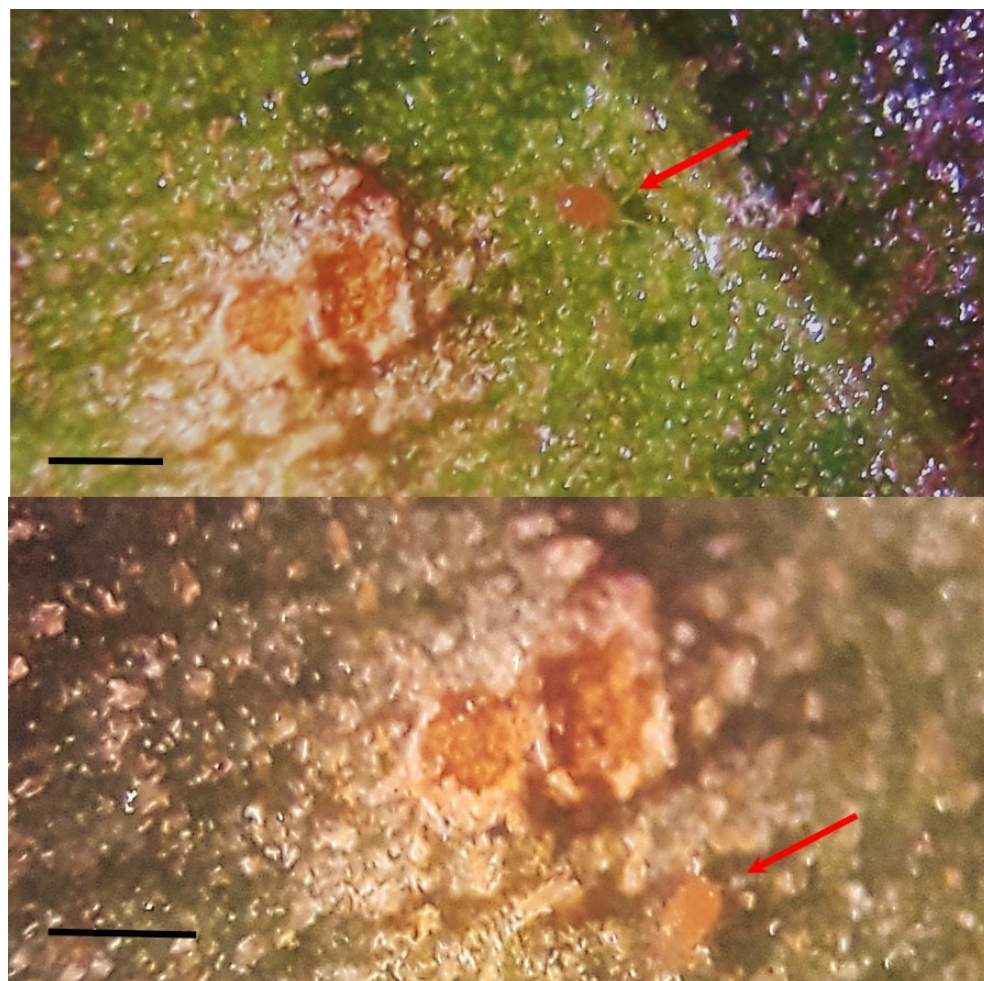


Figure 2 *Typhloseiella isotricha* specimens close to rust spots of *C. inulae* infested leaves of *D. viscosa* (scale bar = 1mm)

Other mites on *Dittrichia* species

Excluding the mite species mentioned above, three predaceous and three phytophagous mite species were also recorded on *Dittrichia* in the present study. For the first group, only one female of the predatory mite *Neophyllobius* sp. (Camerobiidae) was collected from *D. graveolens* in Tartous governorate. As some leg segments were missed in the collected specimen and the failed tentative to re-collect additional ones, it was impossible to identify this specimen to species level. A unique species of this predatory mite family is known from Syria: *Neophyllobius persiaensis* Khanjani & Ueckermann, collected from *Citrus limon* (L.) Osbeck and from soil litter in Latakia governorate (Barbar, 2016). The second species was *Erythraeus* (*Erythraeus*) *adanaensis* (Saboori & Çobanoğlu) (Erythraeidae). Two larvae were observed on *D. graveolens* and *D. viscosa* (Table 2). It has been already collected from leaves of eggplant *Solanum melongena* L. in Latakia governorate (Barbar, 2018). The third species, *Raphignathus gracilis* (Rack) (Raphignathidae) was collected only on *D. viscosa* (Table 2). This predator was reported also from *C. limon* and from ground litter in Latakia governorate (Barbar, 2016).

Concerning phytophagous mite species, seven specimens of the mould mite *Tyrophagus putrescentiae* (Schränk) (Acaridae) were collected from *D. viscosa* in five locations (Table 2). It has already been observed on some plant species, and was collected from ground litter in Latakia governorate (Barbar, 2016). The second species was *B. obovatus* (Tenuipalpidae)

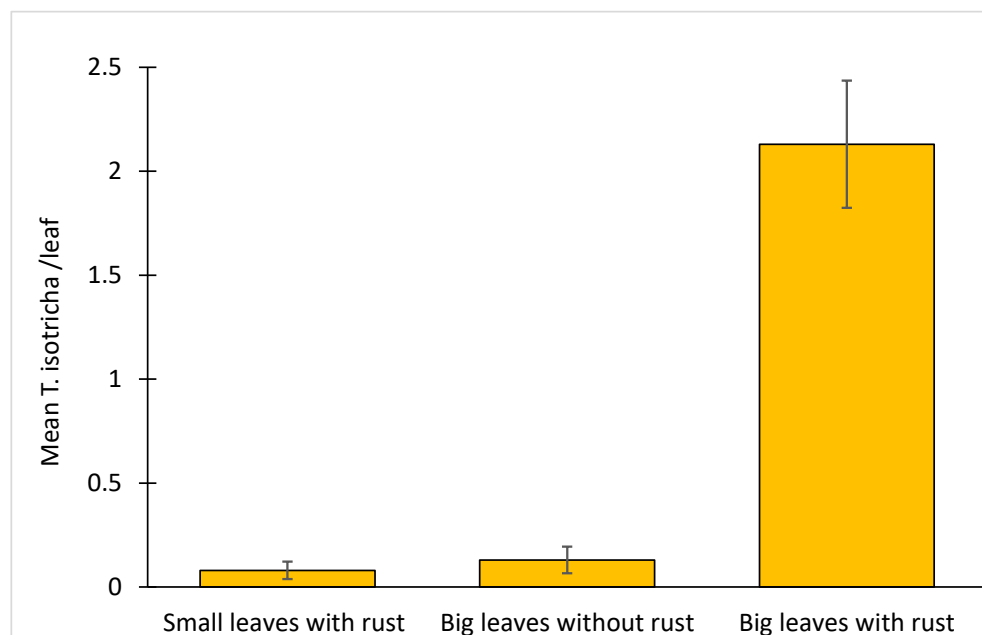


Figure 3 Mean abundance ($\pm$ SE) of *T. isotricha* on different groups of *D. viscosa* leaves (small leaves = 1.8-6.0 X 0.4-1.3 cm; big leaves = 6.4-10.3 X 1.8-3.4 cm).

found only on *D. viscosa* (Table 2). It has already been collected from *Eriobotrya japonica* (Thunb.) Lindl. and *Punica granatum* L. in Latakia governorate (Barbar, 2016, 2018). On the other hand, nine *Tetranychus* sp. (Tetranychidae) specimens were collected from *D. graveolens* and *D. viscosa* in six locations (Table 2). It was impossible to identify the specimens to species level as they were collected in female stage.

Coleosporium inulae* seems as eventual source of alimentation of *T. isotricha

Typhloseiella isotricha was observed on *D. viscosa* near or close to the opened spots of rust (Figure 2). The highest density of this predator was observed on big leaves (mean $\pm$ SE mites per leaf: 2.13 ± 0.31) (Figure 3) having high density of rust spots (3.30 ± 0.24 spot per leaf). It was significantly different from big leaves without rust spots (0.13 ± 0.06 mites/leaf) ($H = 61.1$; $df = 1$; $P < 0.001$), but also from small leaves with low density of rust spots (0.13 ± 0.07) (0.08 ± 0.04 mites/leaf) ($H = 57.8$; $df = 1$; $P < 0.001$). No significant differences were recorded between small leaves with rust and big leaves without rust ($H = 3.5$; $df = 1$; $P < 1.00$).

The distribution of *T. isotricha* on different groups of *D. viscosa* leaves follows a negative binomial distribution and very similar to this of rust spots (Figure 4). The value of the index of aggregation ($I = 2.9$; $S^2 = 2.226$ and $m = 0.77$) is > 1 , and the k exponent of the negative binomial distribution ($k = 0.41$) suggests a highly aggregate distribution. Moreover, the presence of rust spots on leaves of *D. viscosa* seems a significant predictor of the number of *T. isotricha* on this plant. Actually, the coefficient estimate “B” = 0.752, SE = 0.01, $P < 0.001$ and the incidence rate ratio, Exp (B) = 2.12, indicates that for every one unit increase on the predictor (rust spots), the number of *T. isotricha* increases by a percent of 21.2%.

These results seem to show that *T. isotricha* prefers big leaves of *D. viscosa* that are highly infested by the rust spots of *C. inulae*. These results suggest that rust spores could be a potential food source for *T. isotricha*. The presence of all developmental stages of this predator on leaves infected by the rust and, the absence of other sources of feeding such as phytophagous mites on examined leaves would indicate that the predator could feed, survive, develop and probably

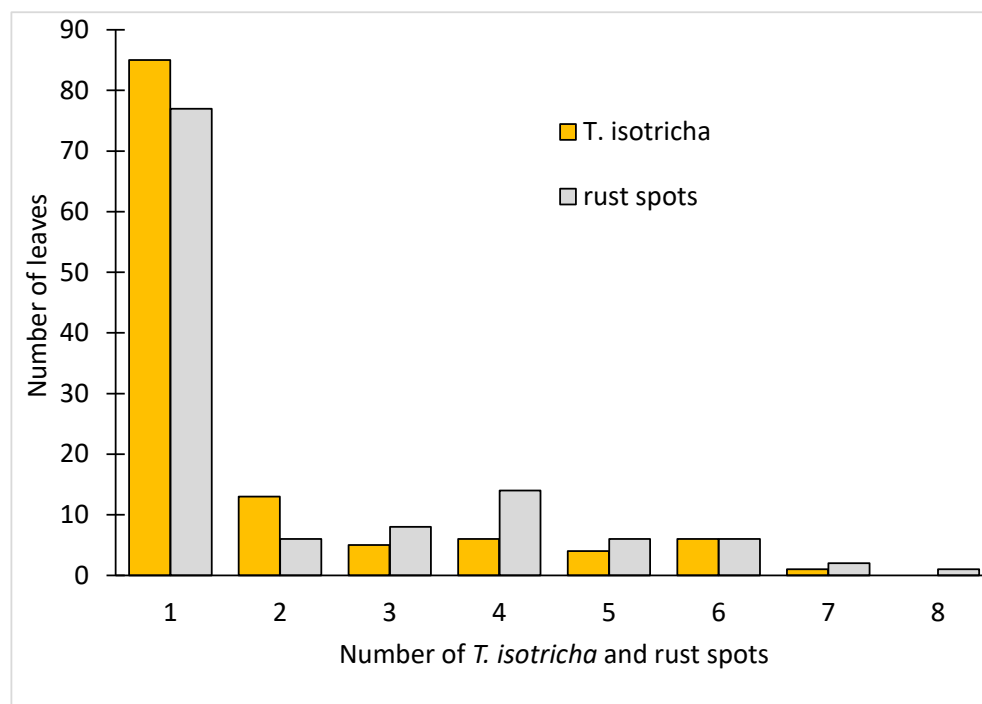


Figure 4 Number of *T. isotricha* and rust spots of *C. inulae* on leaves of *D. viscosa* leaves

reproduce on rust spores. As already reported, several phytoseiid species have the ability to feed on fungi: *Typhlodromus pyri* Scheuten and *Amblyseius andersoni* (Chant), for example, could survive, develop and oviposit on grape downy mildew *Plasmopara viticola* (Berk. & Curtis) Berlese & De Toni (Pozzebon and Duso, 2008) and *Ricoseius loxochelae* (De Leon) can feed and develop successfully when feeding exclusively on coffee rust *Hemileia vastatrix* Berk. & Broome (Oliveira, 2012). Therefore, experiments under laboratory conditions should be carried out in order to clarify the biology and to test the predation ability and feeding habits of *T. isotricha* on different preys and sources of alimentation.

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