Incidence of mite species associated with different leguminous plants at Dakahlia and Cairo governorates

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ABSTRACT

Because of their ability to form symbiosis relationships with soil rhizobia that fix atmospheric nitrogen, legumes play an important role in agro-ecosystems. Mites can live on a wide range of plants, including field and greenhouse crops, ornamental plants, and fruit orchards. However, due to differences in nutritive, morphological, and toxic constituents, these mites do not accept all leguminous plants to the same extent. This study was carried out to identify mite species at Dakahlia and Cairo governorates from March 2018 to October 2019. Data showed that the incidence of 62 species in 42 genera and 23 families in four mite groups. Suborder Prostigmata was represented by 14 families, 27 genera, and 40 distinct species. Order Mesostigmata had 18 species in 11 genera and six families. Suborder Oribatida had only two mite species belonging to two genera in two families, while Cohort Astigmatina had two species in two genera of one family.

Keywords: Ecology, phytophagous mites, predacious mites, Egypt, field crops, mite frequency.

INTRODUCTION

Leguminous plants are one of the largest families of flowering plants, with approximately 730 genera and 19,400 species (Lewis et al. 2005). It is a hugely diverse family with worldwide distribution that includes everything from arctic alpine herbs and temperate or tropical perennial shrubs to annual xerophytes and equatorial giant trees (Van Rhijn and Vanderleyden 1995).

It plays an important role in agro-ecosystems due to their ability to form symbiosis relationships with soil rhizobia that fix atmospheric nitrogen (Mortier et al. 2012).

In terms of economic and nutritional value, grain legumes (pulses) such as soybean are second only to cereals (O'Rourke et al. 2014). Grain legumes are increasingly being recognized as having advantages over cereals, both in agriculture and in the human diet (Foyer et al. 2016). Soybean (*Glycine max* (L.) Merr., Fabaceae) is a good source of oil and protein for humans and livestock. Soybean cultivation in Egypt increased significantly in the second half of the twentieth Century (Sawires 1985).

Therefore, the aim of the current study is carried out to identify mite species inhabiting leguminous plants at Dakahlia and Cairo governorates from March 2018 to October 2019.

MATERIALS AND METHODS

During 2018–2019, an incidence study was conducted for mite species inhabiting field crops, ornamental, aromatic and medicinal plants of family Fabaceae at Dakahlia governorate and New Cairo region, Cairo governorate, Egypt. Random samples of leaves, different parts of shoot system, roots, debris and soil were collected a fortnightly interval from each plant.

The studied plants are aromatic, medicinal and ornamental plants such as Orange Wattle, *Acacia saligna* (Labill.) Wendl., Camel's Foot Tree, *Bauhinia purpurea* L., Bauhinia, *Bauhinia variegate* L., Dichrostachys, *Dichrostachys cinerea* (L.) Wight & Arn., Poinciana, *Delonix regia* (Boj & Hook.), and Erythrina, *Erythrina variegate* L. The samples were immediately kept in paper or polyethylene bags, along with all necessary information. Samples of 20 leaves were transferred to the laboratory to detect the presence of mites. The collected leaves were examined directly using a stereo-

microscope (MBS-10, Russian). However, mites occurring in litter and soil underneath each plant, weighing about 0.250 kg, were immediately placed into the modified Tullgren funnels for extraction. All extracted mites were kept for 24 hr in Nesbitt's solution, afterwards mounted in Hoyer's medium on a clean microscopic slide (Krantz and Walter 2009). All necessary information such as name of region, host plant, date of collection was labeled on each slide. All slides were placed on a hot plate at 40ºC for two weeks. Mite specimens were identified to the genus or species level using a research microscope (XSZ-107 BN, China) and referring to the key of taxonomic references according to Ameroseiidae (Abo-Shnaf et al. 2022), Ascidae and Blattisociidae (Moraes et al. 2015), Bdellidae (Eghbalian et al. 2016), Cheyletidae (Negm and Mesbah 2014), Cunaxidae (Skvarla et al. 2014), Melicharidae (Abo-Shnaf and Moraes 2016), Phytoseiidae (Abo-Shnaf and Moraes 2014), other Mesostigmata (Evans 1963; Lindquist and Evans 1965; Evans and Till 1966, 1979; Zaher 1986), Tetranychidae and Oribatidae (Krantz and Walter 2009).

To compare the occurrence of the identified mite species on each plant, the percentage of relative frequency was calculated using the following formula:

$$\text{Frequency of occurrence (F.O.) \%} = \frac{\text{No of sample containing a species}}{\text{No of collected sample}} \text{X100}$$

RESULTS AND DISCUSSION

Result proved that there are 62 mite species representing 42 genera and 23 families in four mite groups. Among of them, 40 species in 14 families and 27 genera belong to the Suborder Prostigmata. While Order Mesostigmata had 18 species in 11 genera and six families, however Suborder Oribatida had only two mite species in two genera and two families. Cohort Astigmatina was consisted of two species from two genera in one family (Tables 1–3).

The collected mites were classified into three groups based on their feeding habits, with the first group consisting of phytophagous mites, the second of predacious mites, and the third of mites with miscellaneous feeding habits.

A.1. Phytophagous mites

1- Family Tenuipalpidae Berlese

This family includes only one species, *Brevipalpus phoenicis* (Geijskes), which occurred in a small number.

2- Family Tetranychidae Donnadieu

This family contains three species *Eutetranychus orientalis* (Klein), *Tetranychus urticae* Koch, and *Panonychus ulmi* (Koch), all of which feed on leaf sap and cause several damages to host plants. *Tetranychus urticae* is investigated to be the most common species, with large numbers collected from all locations.

3- Family Tarsonemidae Kramer

Members of this family have a wide range of feeding habits, with some species feeding on algae, fungi, and plants (Krantz and Walter 2009). *Tarsonemus setifer* Ewing, which was recorded in moderate numbers on Soybean and Cowpea, *Phytonemus pallidus* (Banks), and *Polyphagotarsonemus latus* (Banks) were all members of this family. The later species was found abundant on eaves, litter, and soil of Green bean and Cowpea.

A.2. Predaceous Mites

Predacious mites collected from leaves, litter, and soil of field crops represented by a total of 46 species in 28 genera and 14 families belonging to Prostigmata and Mesostigmata (Table 3).

Prostigmatid mites consist of nine families as follows:

1- Family Bdellidae Duges

Cyta latirostris (Hermann), *Cyta coerulipes* (Duges), *Spinibdella bifurcata* Atyeo, and *Spinibdella* spp. are members of this family. They are active predators of small arthropods in litter and soil underneath Alfalfa plants.

2- Family Caligonellidae Grandjean

Molothrognathus minutus Soliman, *Neognathus attiahi* Soliman & Gomaa, and *Neognathus* spp. are the three species collected in this family. These species were collected in moderate numbers from litter and soil in Alfalfa crops. Some species are associated with spider mites in the family Tetranychidae (Zaher 1986).

Table 1. Incidence of phytophagous mites associated with different leguminous plants at Dakahlia and Cairo governorates.

Families	Species	Host	Habitat	Region	Abundance
Suborder Prostigmata					
Tenuipalpidae Berlese	*Brevipalpus phoenicis* (Geijskes)	Broad bean	Leaves	Talkha	(+)
Tetranychidae Donnadieu	*Tetranychus urticae* Koch	Soybeen Been nutus Alfalfa Faba bean Cowpea Green bean Camel's Foot Dickrostachys Orange Wattle	Leaves, roots, soil &debris	All regions	**(++++)** **(+++)** **(+++)** **(++)** **(++++)** **(++++)** (+) (++) (+)
	Eutetranychus orientalis (Klein)	Soybean Green bean	Leaves, roots, soil & debris	Belkas	+++ + +
	Panonychus ulmi (Koch)	cowpea pen nut	Debris Soil	Belkas	(++) (++)
Tarsonemidae Kramer	*Polyphagotarsonemus latus* (Banks)	Green bean Cowpea	Leaves, soil &debris	Belkas Belkas	(+++) (++++)
	Phytonemus pallidus (Banks)	Green bean	Leaves	Belkas	(++++)
	Tarsonemus setifer Ewing	Soybean Cowpea	Leaves	Belkas Belkas	(++) (++)

+: Rare (less than 3 ind.); ++: few numbers (less than 5 ind.); +++: moderate (less than 10 ind.); ++++: High (more than 10 ind.).

3-Family Camerobiidae (Southcott)

Camerobia gonzali Zaher & Gomaa, *Camerobia aegyptium* Soliman & Zaher, and *Camerobia mangiferus* Zaher & Gomaa are the camerobiid mites collected in the current study. Camerobiids are commonly found on plants and in litter, where they feed on small arthropods. *Camerobia* species was the most numerous in this family, feeding on scale insects (Zaher and Gomaa 1979; Bolland 1986).

4-Family Cheyletidae Leach

Cheyletus malaccensis Oudemans, *Cheletogenes ornatus* (Canestrini & Fanzago), *Cheletomorpha lepidopterorum* (Shaw), and *Cheletomimus bakeri* (Ehara) are all members of this family. The current study revealed that the majority of cheyletid mites are predators. They were collected on plants, in soil, and in stored products, where they feed on mites and small insects (Negm and Mesbah 2014).

5-Family Cunaxidae Thor

This family includes six species: *Cunaxa capreolus* (Berlese), *Cunaxa hermanni* Den Heyer, *Coleoscirus buartus* Den Heyer, *Coleoscirus mizunoi* (Shiba), *Coleoscirus breslauensis* Den Heyer, and *Neocunaxoides andrei* (Baker & Hoffmann). Cunaxids are generalist predators that prey on small arthropods on diverse crops, in stored products (Skvarla et al. 2014), and in litter. They may feed on root-knot nematodes in the soil (Zaher et al. 1975).

6-Family Erythraeidae Oudemans.

There is only one unidentified species in genus *Balaustium* collected from this family.

7-Family Eupodidae Koch

Eupodes niloticus Abou-Awad & El-Bagoury is a member of this family. This species was found in the top layers of grassland and woodland soils

underneath leguminous crops, where it prefers moist habitats.

8-Family Raphignathidae Kramer

The two free-living predators, *Raphignathus gracilis* (Rack) and *Raphignathus niloticus* Rakha & Mohamed are members of this family. These species are biological control agents for spider and eriophyid mites, as well as scale insects which is similar with those of Zaher (1986).

9-Family Stigmaeidae Oudemans

Agistemus exsertus Gonzalez, *Stigmaeus africanus* Soliman & Gomaa, *Stigmaeus banksi* Gomaa & Hassan, *Stigmaeus triramus* Soliman & Gomaa, and *Stigmaeus zaheri* Gamaa & Hassan are all members of this family. They live on plants and in soil, where they feed on the eggs and immature of tetranychid, tenuipalpid and other mite species that infest commercial leguminous crops. A few species have been recorded to feed on scale insects or parasitic flies (Farag et al. 1990).

Mesostigmatid mites consist of five families as follows:

1-Family Blattisociidae Garman

Lasioseius africanus Nasr, *Lasioseius bispinosus* Evans, and *L. youcefi* Athias-Henriot were all found in large numbers. They are free-living predators live in the upper soil layer, on plants and in stored products, feeding on nematodes and small arthropods (Abdelgayed et al. 2019).

2-Family Macrochelidae Vitzthum

This family contains a single species, *Macrocheles matrius* (Hull) collected in litter with small arthropods (Zaher 1986).

3-Family Melicharidae Hirschmann

Only *Proctolaelaps aegyptiacus* Nasr is collected in the current work in this family of six *Proctolaelaps* species reported from Egypt, they were found as free-living soil-borne predators (Abo-Shnaf and Moraes 2016). They have most likely live in highly humid environments (Moraes et al. 205). Similar results obtained by Fouly and Al-Rahiyani (2011) and Fouly and Abdel-Baky (2015).

4-Family Laelapidae Berlese

Androlaelaps casalis (Berlease), *Androlaelaps reticulus* Hafez, El-Badry & Nasr are comprised this family. They were investigated as free-living soil-borne predators. The provenance of the latter has most likely predisposed them for thrive in highly humid environments, particularly greenhouses. Fouly and Al-Rahiyani (2011) and Fouly and Abdel-Baky (2015) obtained comparable results.

5-Family Phytoseiidae Berlease

Because it included nine species, this family was recorded to be the most dominant family among mesotigmatid mites collected in the current study, represented by: *Amblyseius swirskii* Athias-Henriot, *Cydnoseius negevi* (Swirski & Amitai), *Euseius scutalis* (Athias-Henriot), *Neoseiulus barkeri* Hughes, *Neoseiulus mumae* (Shehata & Zaher), *Neoseiulus cucumeris* (Oudemans), *Neoseiulus californicus* (McGregor), *Typhlodromus* (*Typhlodromus*) *athiasae* Porath & Swirski, and *Phytoseiulus persimilis* Athias-Henriot. Phytoseiid mites were mostly occurred on plants and in upper soil layers. They are proactive predators that feed primarily on mites but also on small insects, nematodes, fungi, pollens, plants, and plant exudates (Zaher 1986; Abo-Shnaf and Moraes 2014). Phytoseiids are the most well-known and studied group of predatory mites. They have been observed eating spider mites, scale insects, whiteflies and thrips (McMurtry and Scriven 1964). Similar results were obtained by several authors, i.e., Zaher (1986); Fouly and Hassan (1991); Fouly et al. (2013, 2019).

A.3. Mites of miscellaneous feeding habits

The present study cleared that mite of miscellaneous feeding habits are presented by three families from Suborder Prostigmata as bellow (Table 3):

1-Family Pyemotidae Oudemans

This family was represented by *Pyemotes herfsi* (Oudemans), which was observed attaching a large number of larvae and adults of lepidopteran insects.

2-Family Tydeidae Kramer

There are three species in this family, i.e, *Paralorryia aegyptiaca* Rasmy & El-Bagoury, *Paralorryia bakeri* Zaher & El-Bagoury, and *Tydeus californicus* (Banks). Tydeid mites are common; fast-moving that live inhabits different parts of plants and soil, feeding on plant and animal foods (Walter 2004).

Table 2. Incidence of predacious mites associated with different leguminous plants at Dakahlia and Cairo governorates.

Families	Species	Host	Habitat	Region	Abundance
Suborder Prostigmata					
Bdellidae Duges	*Cyta letirostris* (Herman*)*	Camele foot tree Dickrostachys Erythrina Poinciana Orange Wattle	soil &debris	5th settlement	(++) (++++) (+++) (+++) (++)
	Cyta coerulipes (Duges)	Alfalfa	soil& debris	Belkas	(++)
	Spinibdella bifurcata Atyeo	Alfalfa	soil &debris	kalabsho station	(++)
	Spinibdella spp.	Alfalfa	soil &debris	kalabsho station	(+)
Caligonellidae Grandjean	*Molothrognathus minutes* Soliman	Alfalfa	soil & debris	kalabsho station	(++)
	Neognathus attiahi Soliman & Gomaa	Alfalfa	roots and debris	Belkas	(++)
	Neognathus spp.	Alfalfa	soil & debris	kalabsho station	(++)
Camerobiidae Southcott	*Camerobia gonzali* Zaher & Gomaa	Poinciana	debris	5th settlement	(++++)
	C. aegyptium Soliman & Zaher	Soybean	debris	Belkas	(+++)
	C. mangiferus Zaher & Gomaa	Alfalfa	roots, leaves and debris	kalabsho station	(++)
Cheyletidae Leach	*Cheyletus malaccensis* Oudemans	Soybean	Leaves, soil& debris	Satamony	(++++)
	Cheletogenes ornatus (Canestrini & Fanzago)	Erythrina	debris	5th settlement	(++)
	Cheletomorpha lepidopterorum (Shaw)	Peanuts	leaves and debris	Kalabsho Station	(+++)
	Cheletomimus bakeri (Ehara)	Peanuts Camel's Foot Tree	leaves and debris debris	kalabsho station 5th settlement	(++) (+)
Cunaxidae Thor	*Coleoscirus buartus* Den Heyer	Peanuts	roots and debris	kalabsho station	(++)
	C. mizunoi (Shiba)	Faba bean	roots and debris	Belkas	(++)
	C. breslauensis Den Heyer	Alfalfa	soil& debris	El-Sinbalween	(++)
	Cunaxa capreolus (Berlese)	Faba bean	roots and debris	Dekrins	(+++)
	C. hermanni Den Heyer	Faba bean	Roots and debris	Belkas	(++)
	Neocunaxoides andrei (Baker & Hoffmann)	Orange Wattle Dickrostachys Camele foot tree	debris	5th ettlement	(++) (+++) (+)
Erithraeidae Oudemans	*Balaustium* spp.	Green bean Soya been	Leaves Leaves	Shrbein Belkas	(+) (++)
Eupodidae Koch	*Eupodes niloticus* Abo Awad & El-Bagoury	Alfalfa Gulmehr	debris	Belkas 5thsettlement	(++++) (+++)

Table 2. ***Continue***

Families	Species	Host	Habitat	Region	abundance
Raphignathidae Kramer	*Raphignathus gracilis* (Rack)	Faba bean	Roots and debris	ElSinbalween	(+)
	R.s niloticus Rakha & Mohamed	Faba bean Alfalfa Glomar	roots &debris debris	Talkha Belkas 5th settlement	(+) (+++) (+++)
Stigmaeidae Oudemans	*Agistemus exsertus* Gonzalaz	Peanuts camel's Foot Tree Dickrostachys	roots and debris Debris	kalabsho 5th settlement	(++) (++) (+)
	Stigmaeus africanus Gomaa & Soliman	Faba bean	leaves, soil &debris	satamony	(++)
	S. banksi Gomaa & Hassan	Faba bean Alfalfa	leaves &debris	satamony kalabsho	(+) (++++)
	S. triramus Soliman & Gomaa	Alfalfa	soil &debris	kalabsho	(+) (++++)
	S. zaheri Gamaa & Hassan	Faba bean Alfalfa	leaves, soil &debris	satamony kalabsho	(+) (++++)
Order Mesostigmata					
Blattisociidae Garman	*Lasioseius africanus* Nasr	Soybean	Leaves	Mansoura	(+++)
	L. bispinosus Evans	peanut	debris	Shrbein	(++)
	L. youcefi Athias-Henriot	Soybean Peanut	Leaves, roots, debris	TemyElamdid	(+++) (+++)
Macrochelidae Vitzthum	*Macrocheles matrius* (Hull)	Soybean	Debris	Belkas	(+++)
Melicharidae Hirschmann	*Proctolaelaps aegyptiacus* Nasr	Green bean	Soil	TemyElamdid	(+++)
Laelapidae Berlease	*Androlaelaps casalis* (Berlease)	Peannut	Debris	Belkas	(++)
	A. reticulus Hafez, El-Badry & Nasr	Peannut	Debris	El-Sinbalween	(++) (++)
Phytoseiidae Berlese	*Amblyseius swirskii* Athias-Henriot	Soybean peanut	Leaves leaves	Belkas	+++
	Cydnoseius negevi (Swirski & Amitai)	peanut	Leaves	ElSinbalween	(+)
	Euseius scutalis (Athias-Henriot)	Soybean & Cowpea	Leaves Leaves	Kalabsho	(++) (+++)
	Neoseiulus barkeri Hughes	Soybean	Leaves	TemyElamdid	
	Neoseiulus cucumeris (Oudemans)	Soybean	Leaves	Kalabsho station	(+++)
	Neoseiulus californicus (McGregor)	Peanut	Leaves	Kalabsho station	(+++)
	Neoseiulus mumae (Shehata & Zaher)	Soybean	Leaves	Talkha	(+++)
	Typhlodromus athiasae Porath & Swirski	Peanut	Leaves	Kalabsho station	(+)
	Phytoseiulus persimilis Athias-Henriot	Green bean Soybean, Peanut	Leaves	Belkas Kalabsho kalabsho	(++++) (+++) (+++)

+: Rare (less than 3 ind.); ++: few numbers (less than 5 individuals); +++: moderate (less than 10 individuals); ++++: High (more than 10 individuals).

3-Family Ameroseiidae Evans

Members of this family are fungivorous (Flechmann 1985; Zaher 1986) which represented by 12 species in Egypt (Abo-Shnaf et al. 2022) including *Kleemannia plumosa* (Oudemans) that recorded in the current study as well as an unidentified species *Kleemannia* spp.

The present survey also revealed that there are mites with various feeding habits in two families from the Suborder Oribatida, as follows:

1-Family Oppiidae Grandjean.

Oppia sticta Popp is the only species represents this family in the current work.

2-Family Oribatulidae Thor.

This family includes only a single species, *Scheloribates laevigatus* (Koch) in the present study.

3-Cohort Astigmatina

Family Acaridae Latreille

This is the only family collected in the present study from this cohort, and contains two species, *Tyrophagus putrescentiae* (Schrank) and *Rhizoglyphus robini* Claparède. The first species was abundantly collected, however the second was rarely observed.

Occurrence and frequency of mite families associated with leguminous plants at Dakahlia governorate in 2018

Based on the current result, it can be concluded that the highest abundance of the collected mite species is in Suborder Prostigmata (66.85%), followed by mites in Suborder Oribatida (18.03%), and those in Order Mesostigmata (9.07%), while the lowest abundance is for mites in Cohort Astigmatina (6.05%) (Figure1). These findings are consistent with previous results, i.e., Fouly (1982); Zaher (1986); Ohno *et al*. (2009); Romeih *et al.* (2013); Kalmosh and Yassin (2018); Yassin *et al.* (2018); Ibrahim (2020).

CONCLUSION

The present study indicated that the leguminous plants (e.g. field and greenhouse crops, ornamental plants, and fruit trees) harbored a diverse of mite species that cause significant damage. However, very little research has been conducted on the converse of the different relationships, i.e., treating mites as the causative agents of changes in the host plant components.

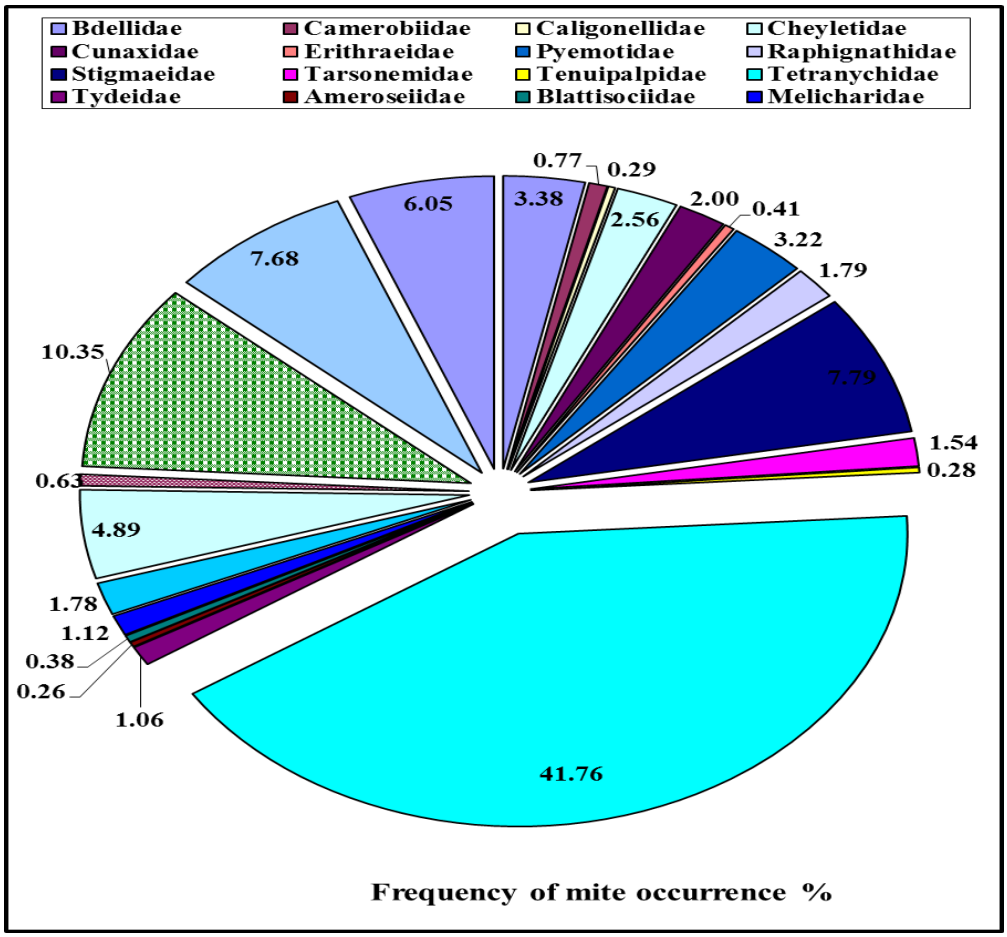

Figure 1. Occurrence and frequency of mite families associated with leguminous crops at Dakahlia and Cairo governorates

Table 3. Incidence of mites of miscellaneous feeding habits associated with different leguminous plants at Dakahlia and Cairo governorates.

Families	Species	Host	Habitat	Region	Abundance
Suborder Prostigmata					
Pyemotidae Oudemans	*Pyemotes herfsi* (Oudemans)	Peanuts	Debris	kalabsho station	(++++)
Tydeidae Kramer	*Paralorryia aegyptiaca* Rasmy & El-Bagoury	Camel's Foot Tree	Debris	5th sttlement	(++)
	P. bakeri Zaher & El Bagoury	Poinciana	Debris	5th sttlement	(+)
	Tydeus californicus (Banks)	Orange Wattle	Debris	5th sttlement	(+)
Cohort Astigmatina					
Acaridae Latreille	*Tyrophagus putrescentiae* (Schrank)	Alfalfa Cowpea Soybean	Soil &debris	Belkas stamony Kalabsho	(++++) (++++) (++++)
	Rhizoglyphus robini Claparède	Orange Wattle	Soil	5th settlement	(+)
Order Mesostigmata					
Ameroseiidae Evans	*Kleemannia* spp. *K. plumosa* (Oudemans)	Alfalfa Camel foot tree	Leaves& debris debris	Belkas 5th settlement	(+) (+)
Suborder Oribatida					
Opiidae Grandjean	*Oppia sticta* Popp.	Peannut Soybean Cowpea Alfalfa Green bean	Soil & debris	Kalabsho kalabsho satamony kalasho satamony	(+++) (+++) (+++) (+++) (++++)
Oribatulidae Thor	*Scheloribates laevigatus* (Koch)	Peanuts Soya been	Soil	Belkas Kalabsho	(+) (+)

+: Rare (less than 3 ind.??); ++: few numbers (less than 5 individuals); +++: moderate (less than 10 individuals); ++++: High (more than 10 individuals).

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