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Redescription and population dynamic of some genera from subfamily Phyllocoptinae (Prostigmata: Eriophyoidae)

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Abstract:

Four species of eriophyoid mite belonged to three genera from subfamily Phyllocoptinae Nalepa (Prostigmata: Eriophyoidae) are redescribed. In addition, the population dynamics of two species, *Oxycenus maxwelli* (Keifer) and *Tegonotus mangiferae* (Keifer) was conducted at El-Fayoum Governorate on olive and mango trees during two successive years 2017 and 2018. The samples were collected from leaves, buds, branches and grass. The obtained results showed that, four species were recorded and illustrated then arranged in taxonomical key, while the population dynamics were recorded two peaks *O.maxwelli* and *T. mangiferae*. The mentioned species were varied in their occurrence rate according to different locations and host plants. On the other hand, the population was positively correlated with the prevailing temperatures and was negative significant correlation with the relative humidity for two successive seasons.

Introduction

The subfamily Phyllocoptinae (Prostigmata) is one of the most specious taxa in Eriophyoidea. It includes more than 1100 species belonging to nearly 100 genera (Oldfield, 1996 and Chetverikov, 2006). So far sixty eight of eriophyid species have been recorded in Egyptian fauna, twenty nine species and nineteen genera of them are belonging to subfamily Phyllocoptinae varied in their hosts where sixteen species are reported on fruit trees, nine species reported on ornamental plants, two species reported on vegetable crops and two species on grasses (Hassan, 1934; Attiah, 1955; Soliman and Abou-Awad, 1978; Zaher *et al*., 1978; Zaher and Abou-Awad, 1979; Abou-Awad, 1981; Zaher, 1984; Abou-Awad and Nasr, 1983; Abou-Awad and Elsawi, 1993 and Abou-Awad *et al*., 2011. The tribe Tegonotiniwas established by Bagdasarian (1978) and

consists of about 146 species in 25 genera. Among them, 46 species belonged to genus *Tegonotus* Nalepa. They are easy to differentiate from all other Phyllocoptinae by the presence of lateral spines or lobes on the opisthosoma. The olive bud mite *Oxycenus maxwelli* (Keifer) causes enough damage in bud andleaves. Furthermore, *O. maxwelli*as the common name reveals falls into the bud mite category because they lay their eggs near buds and feed on bud tissue. On the other hand, *Tegonotus mangiferae* (Keifer) attacks the lower surface of mango leaflets causing leaves deformations (Zaher, 1984).Therefore, the present study aims to throw a light on the taxonomical changes in subfamily Phyllocoptinae according to the Egyptian agroecosystem changesduring the few recent decades and also, the role of environmental fluctuation on the populations of the eriophyoid mites *O. maxwelli* and *T. mangiferae*.

Materials and methods

Survey of certain species belonging to tribe Tegonotini Bagdasarian, family Phytoptidae Murray were conducted at four Egyptian Governorates, Qualiubiya, Giza, EL-Fayoum and El Behera Governorates during two successive years 2017 and 2018. This study was as a part of a comprehensive work on eriophyoid mites .The samples were collected during two years (2017 and 2018) from leaves, buds, branches and grass. The samples were individually bagged in tightly-closed plastic bags and transported the same day to the laboratory. Collected mites were removed using a fine hair brush under dissection stereo-microscope, then preserved in 70% ethanol. Selected mites were cleared and mounted on micro-slides by using Keifer medium according to Keifer (1975), then dried at 40°C for one week (Zhang, 2003) and finally examined under a Carl Zeiss compound microscope. The type materials are deposited as slide mounted specimens in the mite collection of the Agricultural Research Center (ARC), Plant Protection Research Institute (PPRI), Fruit Acarology Department, Dokki, Egypt.

Identification to a specific family, subfamilies and genus of subfamily Phyllocoptinae were described using the genera world key by Amrine (2003). The species was identified using the published descriptions of family Phytoptidae species. In addition, the identification specimens were compared with the collection specimens' mite which, located in Plant Protection Research Institute (ARC).

On the other hand, the population dynamics of two Eriophyoids mites, *O. maxwelli* and *T. mangiferae* were conducted at EL-Fayoum Governorate during the two successive years 2017 and 2018.

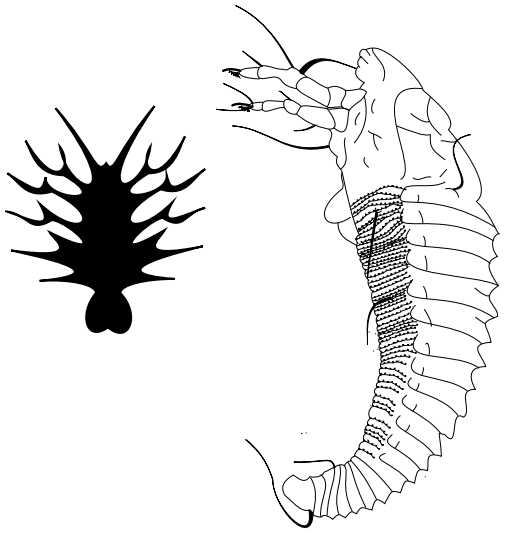
Results and discussion

1. Taxonomical studies:

Data in Table (1) shows the taxonomical differences between three tribes, Tegonotini Bagdasarian, Phyllocoptini Nalepa and Anthocoptini Amrine and Stasny belonged to subfamily Phyllocoptinae in Egypt which provided as follow:

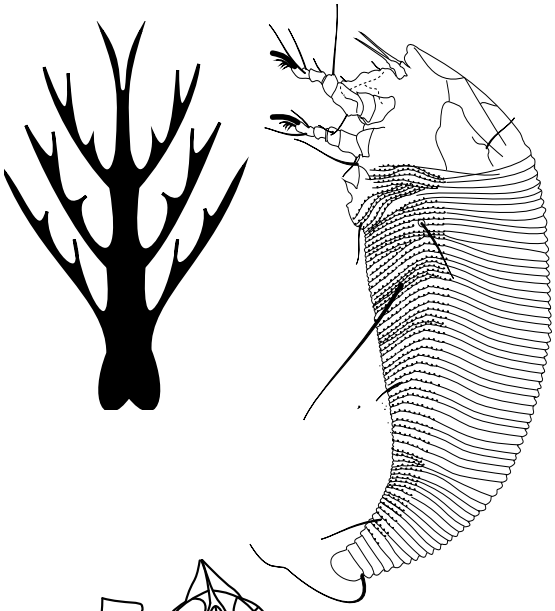
Table (1): Key (1), tribes' subfamily Phyllocoptinae Nalepa1892 in Egypt

1. Empodium entire; scapular tubercles and setae present; opisthosoma, viewed dorsally, with lateral lobes or pointed projections from some or all annuli, or with a plate behind prodorsal shield bearing lateral extensions…….**Tegonotini Bagdasarian 1978 (Key2).**

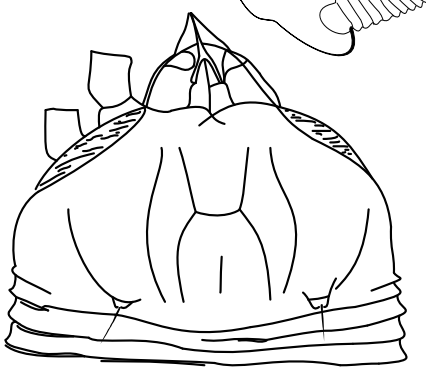


- Empodium entire; Scapular tubercles and setae present; opisthosoma viewed dorsally with annuli evenly downcurved over lateral opisthosomal margins; dorsum varying from evenly arched in cross section to flattened, ridged or furrowed……..2

2. Scapular setae usually with well-formed, often plicate, tubercles placed ahead of rear shield margin, directing setae forward, up or centrad; if tubercles and setae are near rare shield margin, thin tubercles are subscylindrical and bent forward or the alignment of their bases is longitudinal or diagonal to the body **……..……..Phyllocoptini Nalepa 1892**



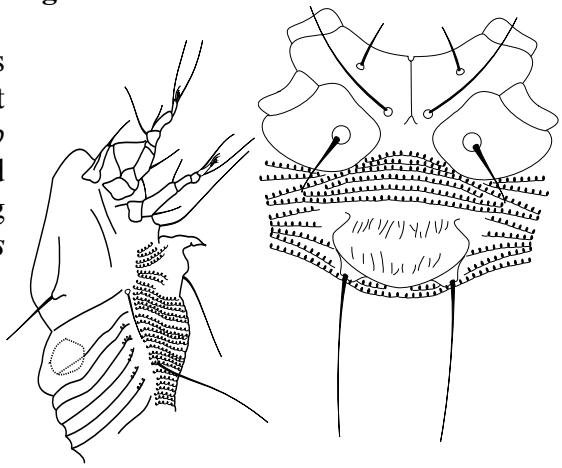
- Scapular setae with tubercles on or very near the rear shield margin, directing setae to rare, usually divergently; scapular tubercles either subcylindrical, or the alignment of their bases is transverse to the body…**…….Anthocoptini Amrine and Stasny 1994**



The presented study was concentrated on tribe Tegonotini Bagdasarian that included three genera and four species (Table, 2).

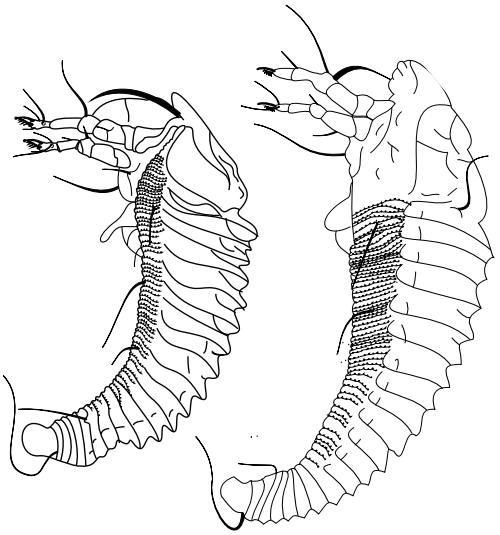
Table (2): Key (2), genera of tribe Tegonotini Bagdasarian 1978

1. Prodorsal shield and annular projections rounded, not spin-like. Prodorsal shield without posterior lobe over opisthosoma. Coxal setae *1 b* present. A deep cleft between prodorsal shield and opisthosoma; first annuals large, projecting higher than other annuli **.....*Neotegonotus* Newkirk and Keifer 1971.....Key(3)**



- Prodorsal shield and opisthosoma not separated by a deep cleft; first annulus not enlarged**…….....**2

2. Posterior opisthosoma with a dorsal depression just above setae *f*; *sc* near rare shield margin, directed posteriorly ***Oxycenus*** **Keifer 1961……...…….Key (4)**
- Posterior opisthosoma without rear depression; *sc* variable; scapular setae ahead of rear shield margin direction variable; Tibial setae present; *sc* directed up, medially or laterally. Frontal lobe not emarginated**.....*Tegonotus* Nalepa 1890.....(Key5)**



Key (3): Species of genus *Neotegonotus* Newkirk and Keifer 1971

Genus *Neotegonotus* represented by only one species (*Neotegonotus sycamori* Abou-Awad, 1984) in Egypt.

***Neotegonotus sycamori* Abou-Awad, 1984 (Figure, 1):**

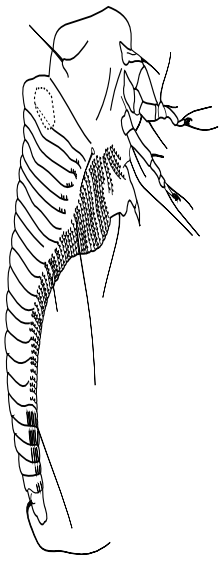
This species was recorded on leaves of *Ficus sycamorus* L. (Moraceae).

The common taxonomic characters are:

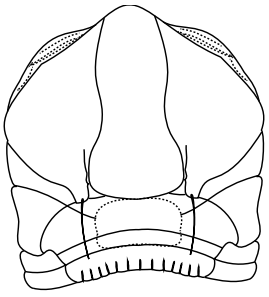
1. 4 rayed featherclaw.
2. Dorsal shield with prominent anterior lobe.
3. Shield design tending to be obscure and marked by internal line from each tubercle, extending around shield margin to form as semicircular disc.
4. Complete admedian line, meeting and forming nearly Jug shape.
5. Coverflap genitalia of female with close-set longitudinal ribs in two series ,

Synonyms: *N/A*

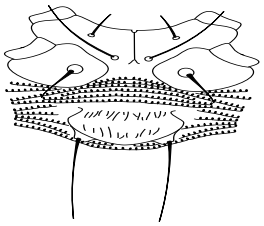
Host plant: Recorded on leaves of *F. sycamorus*.



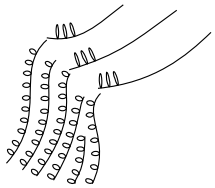
lateral of male



Anterior dorsal

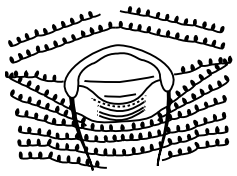


Genetal of female



Lateral

Empodium



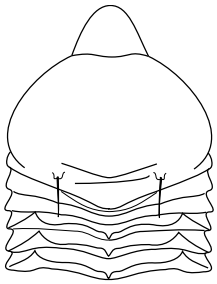
Genetal of male

Figure (1): *Neotegonotus sycamori*

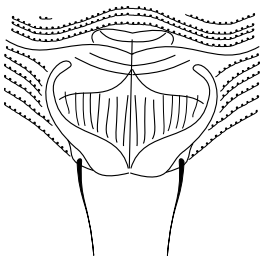
Key (4): Species of genus *Oxycenus* Keifer 1961

Genus *Oxycenus* represented by two species (*Oxycenus maxwelli* (Keifer, 1939) and *Oxycenus niloticus* Zaher and Abou-Awad, 1979) in Egypt.

1.Dorsal shield without any pattern except two transverse lines posteriorly; ventral microtubercles oval shape; coverflap genetalia with 16 longitudinal idges**.....*Oxycenus niloticus* Zaher and Abou-Awad 1979**

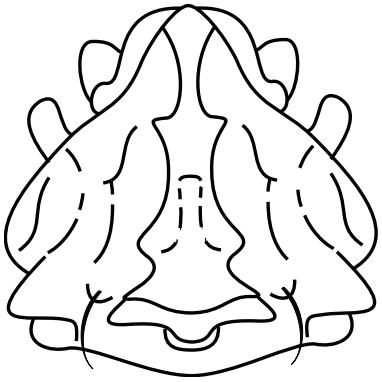


Anterior dorsal

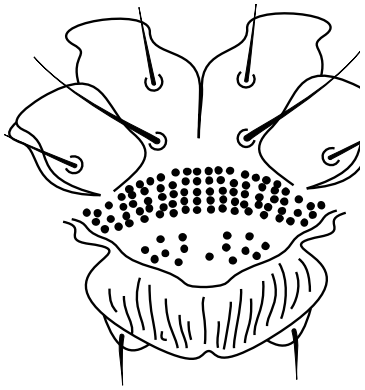


Genetal of female

- Dorsal shield with longitudinal broken lines ; ventral micro tubercles not oval; coverflap genetalia with 17 longitudinal ridges…….***Oxycenus maxwelli* (Keifer1939)**



Anterior dorsal



Genetal of female

***Oxycenus niloticus* Zaher and Abou-Awad, 1979) (Figure, 2):**

Synonyms: *N/A*

Host plant: Recorded on leaves and buds of *Olea europaea* L. (Oleaceae)

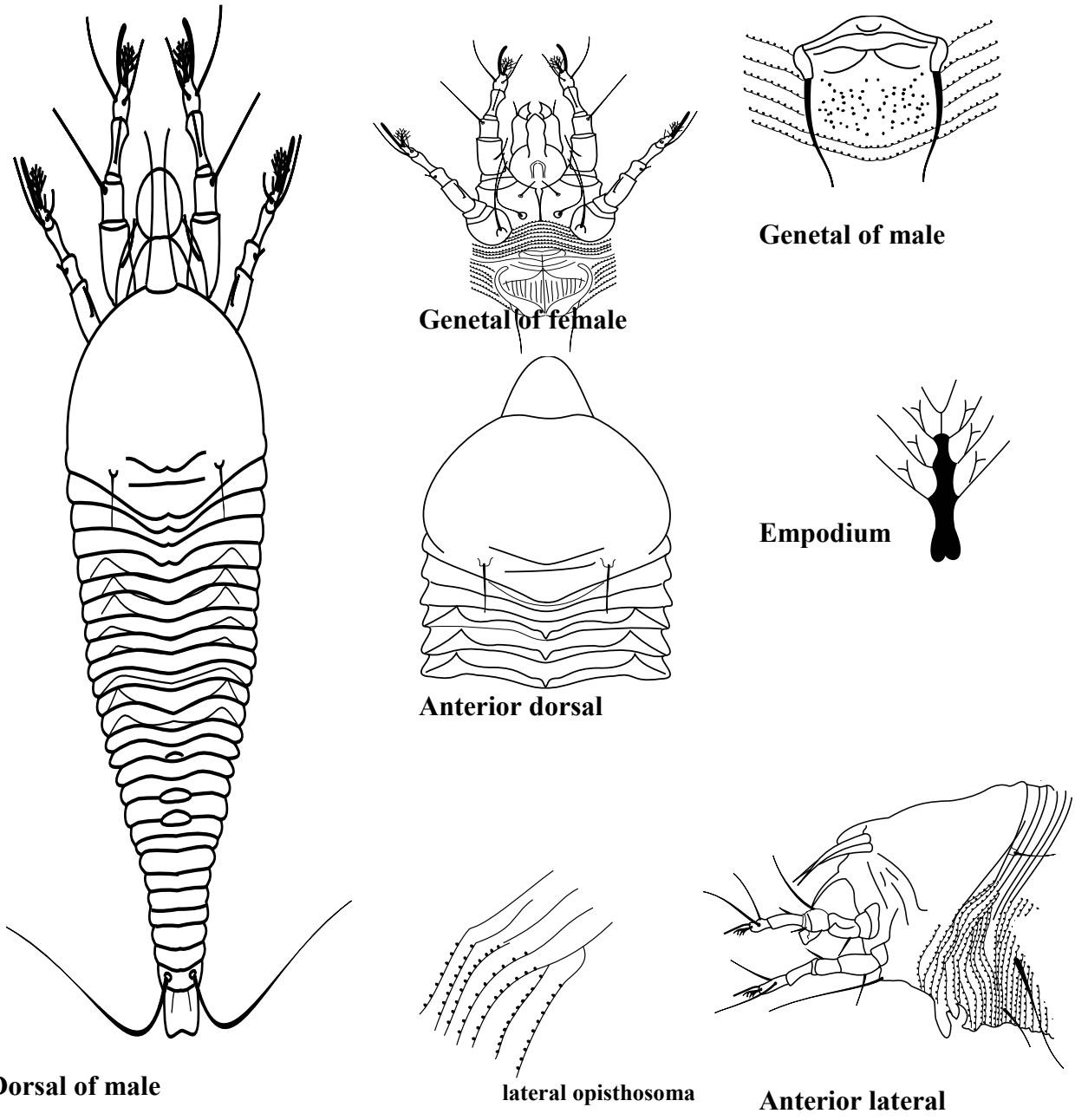


Figure (2): *Oxycenus niloticus*

***Oxycenus maxwelli* (Keifer 1939) (Figure,3):**

Synonyms: *Oxypleurites maxwelli* (Keifer 1939)

Host plant: Recorded on buds of*Olea europaea* L. (Oleaceae)

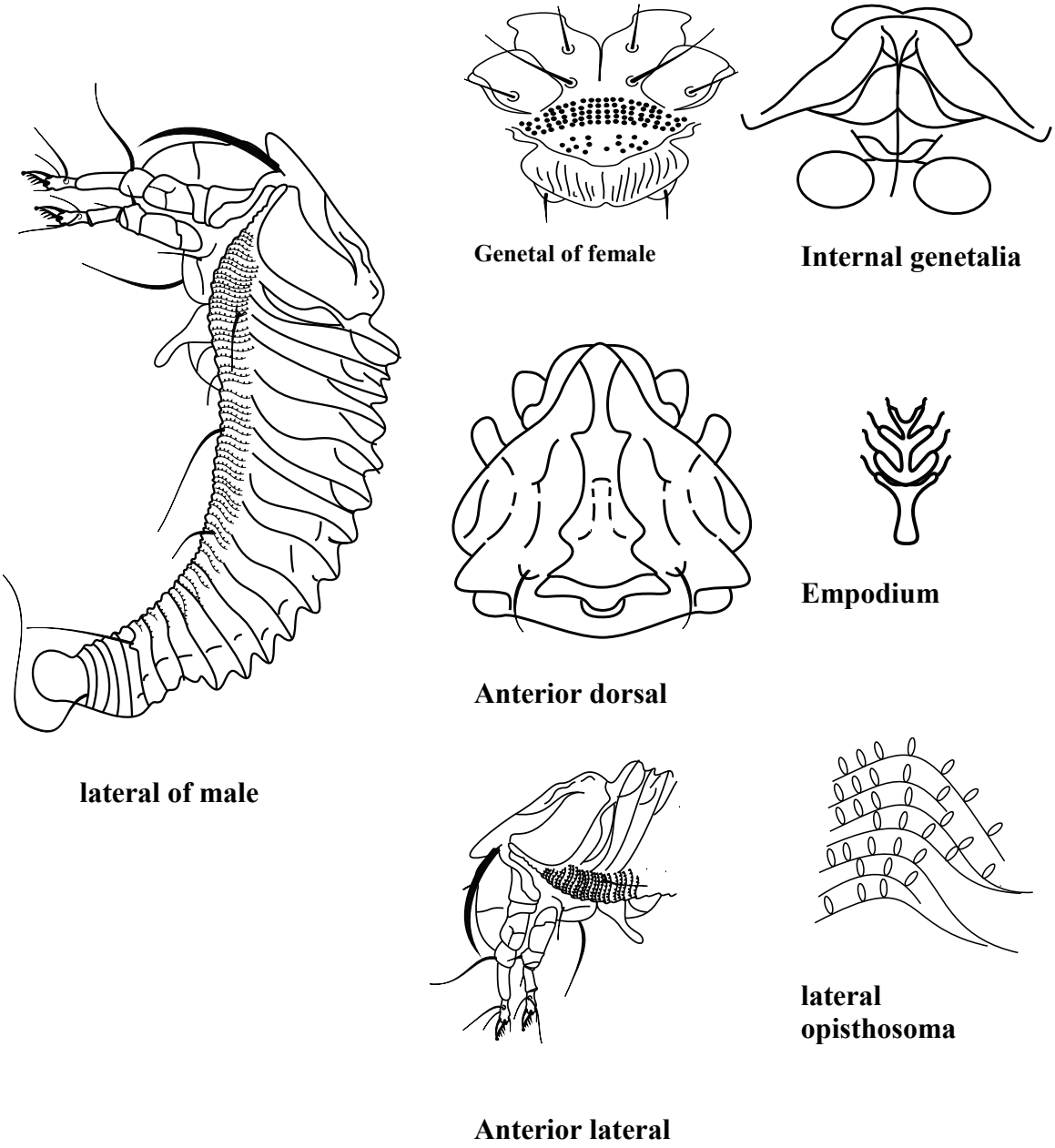


Figure (3): *Oxycenus maxwelli*

Key (5): Species of genus *Tegonotus* Nalepa 1890

Genus *Tegonotus* represented by only one species (*Tegonotus mangiferae* (Keifer, 1946)) in Egypt.

***Tegonotus mangiferae* (Keifer 1946) (Figure, 4):**

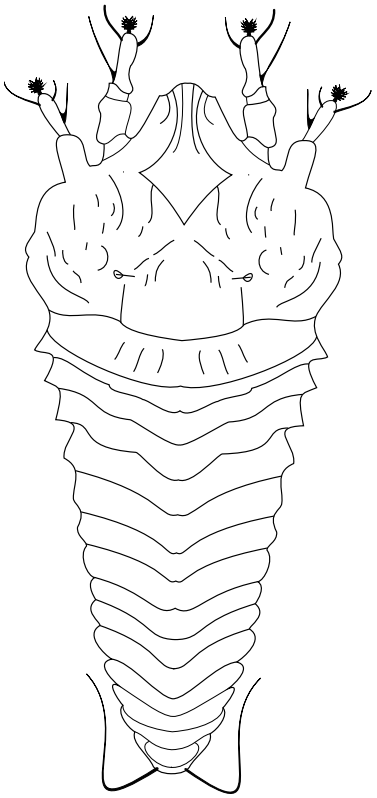
This species was recorded on leaves of *Mangifera indica* L.(Anacardiaceae)

The common taxonomic characters are:

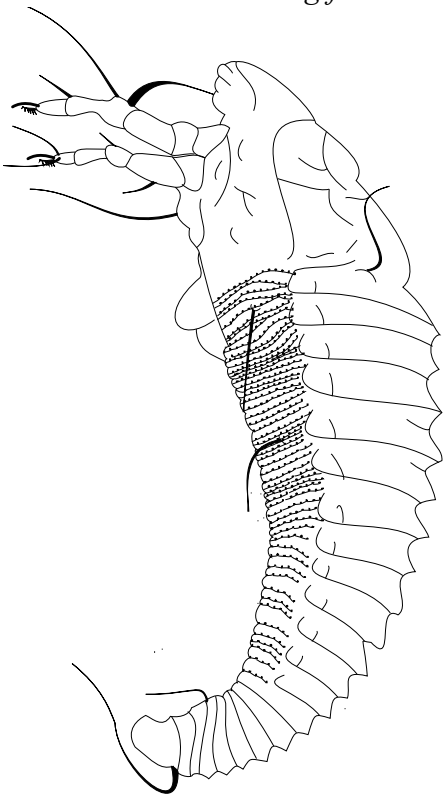
1. 6 rayed featherclaw.
2. Dorsal shield sub triangular and rough, dorsal tubercles a head of the rear margin, middorsal longitudinal ridges on thanosome.
3. Lateral tergal lobes pointed especially the anterior one.
4. Complete admedian line, meeting and forming nearly Jug shape.
5. Side of coverflape genitalia centrally converging ribs, base of coverflape with granulated lines.

Synonyms: *Oxypleurites mangiferae* Keifer 1946

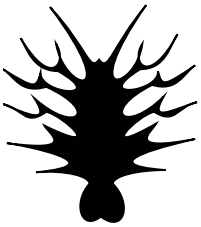
Host plant: Recorded onleaves of *Mangifera indica* L.(Anacardiaceae)



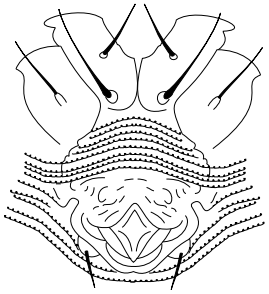
Dorsal of male



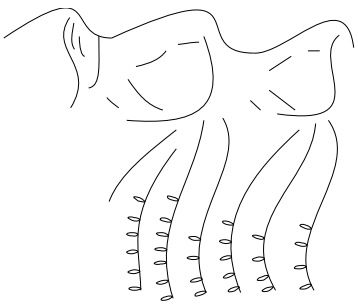
lateral of male



Empodium



Genetal of female



lateral opisthosoma

Figure (4): *Tegonotus mangiferae*

2. Ecological studies:

2.1. Population dynamics of *Oxycenus maxwelli* :

Figure (5) showed monthly average population number of *O. maxwelli* during year 2017. It showed that, the population started with low individuals number, then increased gradually by the temperature increasing from January, 2017 till reached the first peak population level at 70 individuals per 20 leaves in May, 2017when the temperature and relative humidity were recorded 32°C and 30% at the first peak, respectively.Then the population decreased gradually by the temperature increasing fromJune, 2017 till reached the minimum population levels at 35 *O. maxwelli* individuals in July, 2017, while the temperature and relative humidity were recorded 36°C and 33% , respectively. The *O. maxwelli* population returned to increase again by the temperature decreased from August, 2017 till reached 100 individuals in September, 2017. While the temperature and relative humidity were 31°C and 41%, respectively. This was the second peak level of *O. maxwelli* individuals. On the other hand, the population number of *O. maxwelli* began to decrease again from October, 2017, by the temperature decreased, till reached the 22 individuals at the end of year 2017, while the temperature and relative humidity were 20 and 49%, respectively.

Figure (6) showed monthly average population number of *O. maxwelli* during year 2018. It shows that, there was no differentiation between the data obtained for either year 2017 and 2018. The two peaks levels were recorded 68 and 160 individuals at May and September 2018. While the temperature were 32 and 33°C, respectively and the relative humidity were 29 and 40%, respectively.

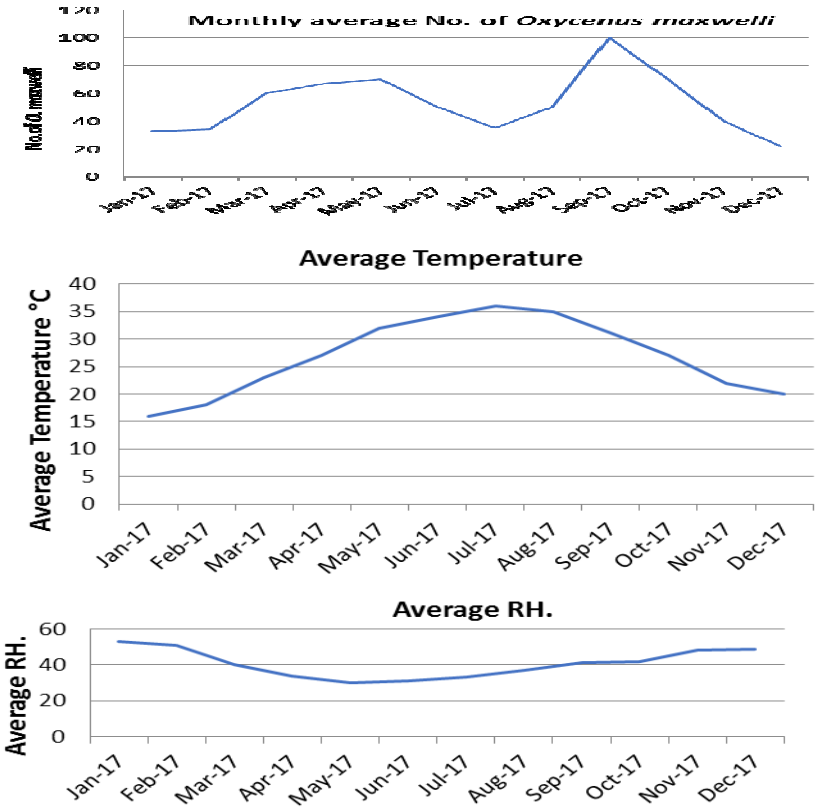


Figure (5): Monthly average numbers of *Oxycenus maxwelli* during year 2017

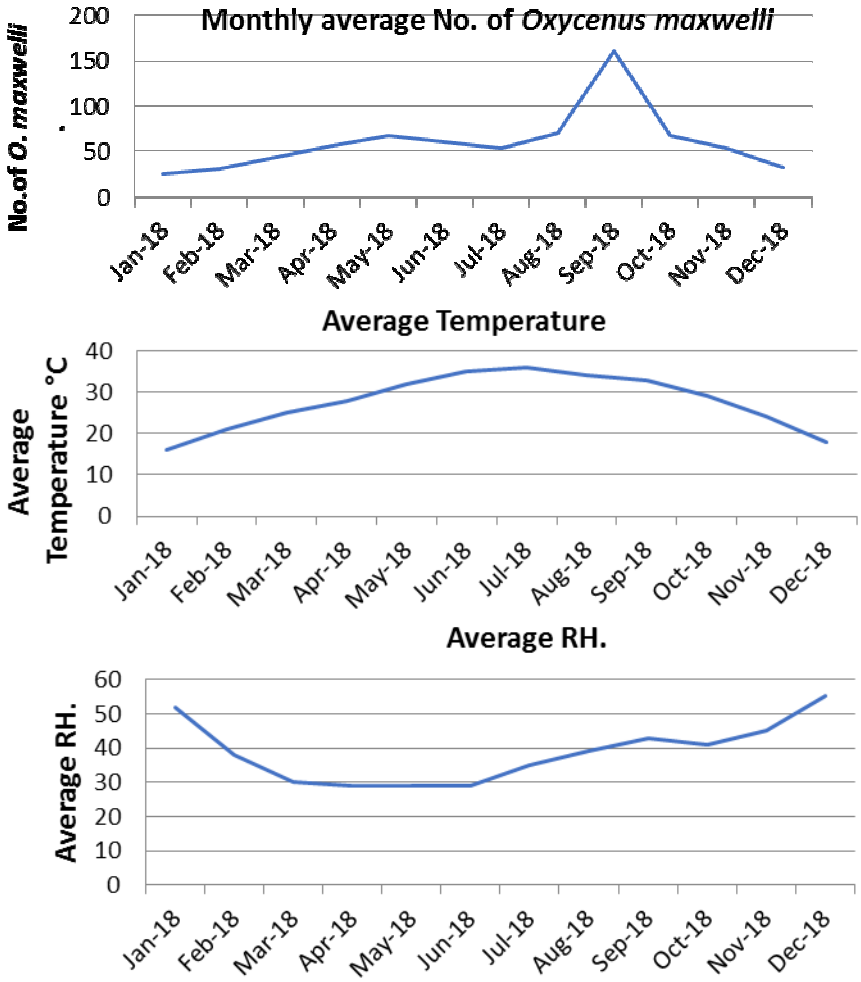


Figure (6): Monthly average numbers of *Oxycenus maxwelli* during year 2018

2.2.Population dynamics of *Tegonotus mangiferae*:

The population trend of the eriophyid mite species *T. mangiferae* was differed from the eriophyid mite *O. maxwelli* that mentioned above, whereas the Figure (7) showed that, the population was started with high numbers, 312 individual, at temperature 16°C and relative humidity 53 %. Then the population was decreased gradually from February , 2017 till reached the minimum population level at 132 individual in June, 2017 when the temperature and relative humidity were recorded 34°C and 31%, respectively. The population began to build up his number again until reached the peak levels at 724 individuals in October, 2017, while the temperature and relative humidity were 27°C and 42%, respectively. Finally, the population returned to decrease again in November (544 individuals) and December (404 individuals), 2017. While the temperature was 22°C and 20°C and relative humidity were 48%and 49%, respectively. On the other hand, Figure (8) showed monthly average population number of *T. mangiferae* during year 2018, which shows no different from obtained data in year 2017. The peak level was recorded 872 individuals at October when the temperature was 29°C and the relative humidity 41%.

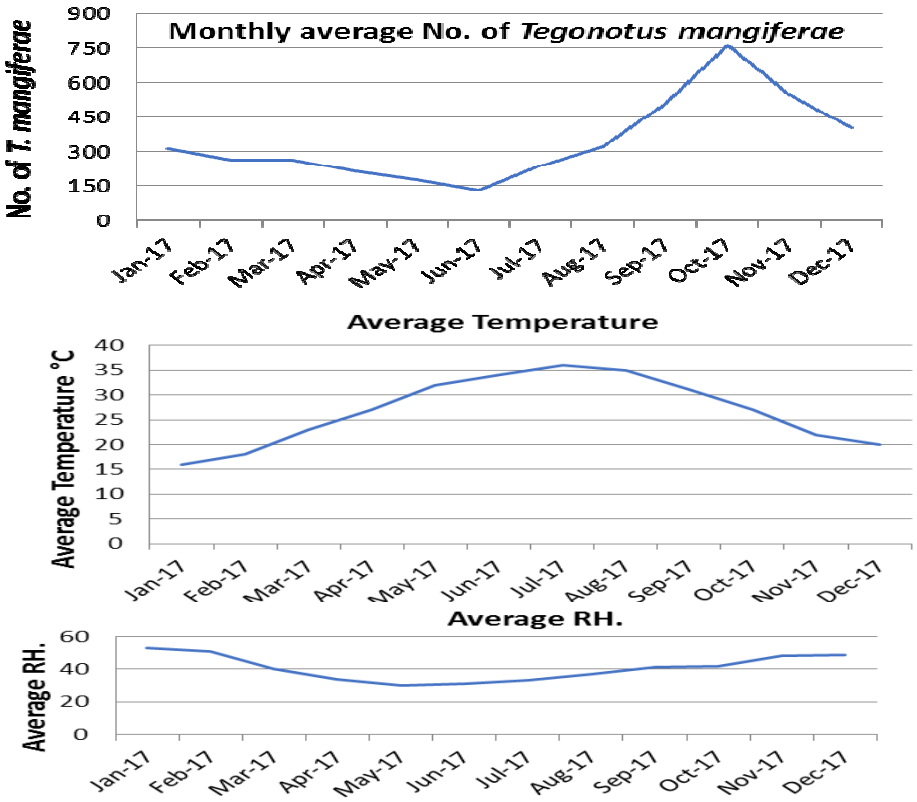


Figure (7): Monthly average numbers of *Tegonotus mangiferae* during year 2017

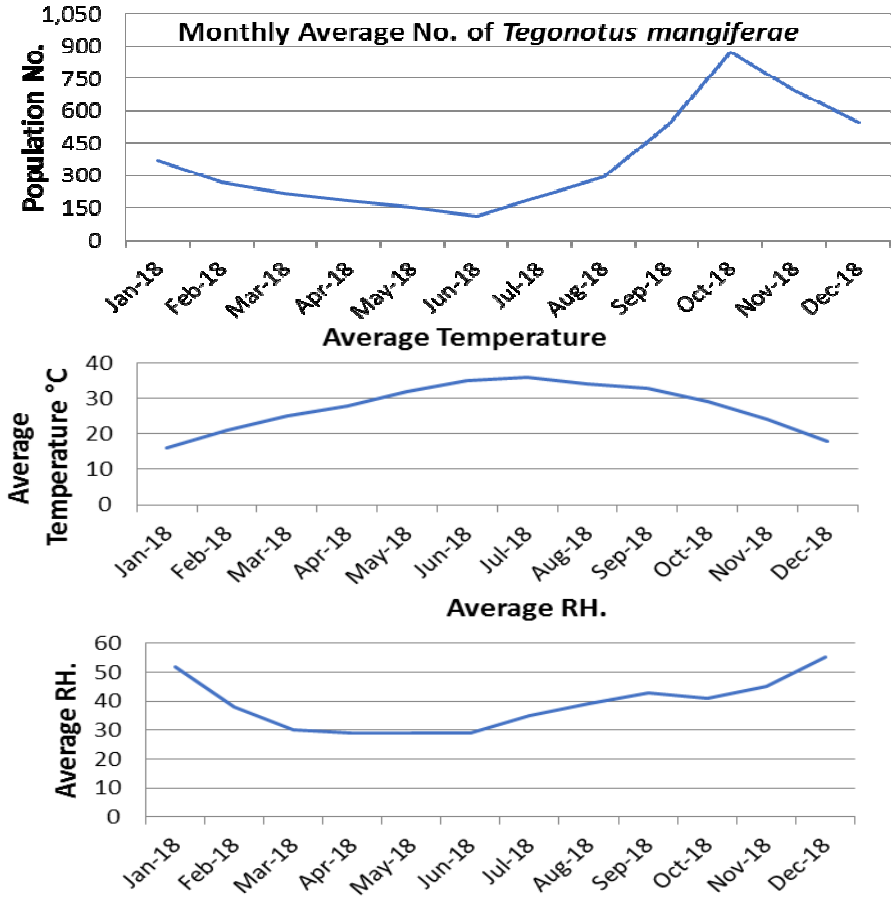


Figure (8): Monthly average numbers of *Tegonotus mangiferae* during year 2018

Although the subfamily Phyllocoptinae is one of the important group in terms of their economic damage, it included twenty nine species in Egypt while, it included 1100 species world wide. Only one collective work had been conducted by Zaher (1984). This work was included subfamily Phyllocoptinae which, contents of three tribes i.e.: *Tegonotini* Bagdasarian; *Phyllocoptini* Nalepa and *Anthocoptini* Amrin & Stasny. Our studies indicated that Tribe Phyllocoptini has three genera i.e: *Neotegonotus* Newkirk and Keifer, *Oxycenus* Keifer, Tegonotus Nalepa. Ancient studies were placed the two genera *Tegonotus* and *Oxycenus* into genus *Oxypleurites* (Keifer, 1939 and 1946). These during his reported the two species *Oxypleurites maxwelli* (Keifer, 1939) and *Oxypleurites mangiferae* Keifer, 1946. Actually, our studies placed the two species under genera *Oxycenus* Keifer (*Oxycenus niloticus* Zaher and Abou-Awad 1979 and *Oxycenus maxwelli* (Keifer) 1939 on leaves and buds of Olea *europaea* L.) and *Tegonotus* Nalepa (*Tegonotus mangiferae* (Keifer, 1946 on leaves *Mangifera indica* L.). Table (3) showed the correlation coefficient between average temperatures and relative humidity on population of mites on olive and mango trees during two successive years 2017 and 2018. The population was positively correlated with the prevailing temperatures for two successive seasons, while it was negative significant correlation with the relative humidity for two successive seasons (Table, 3). Although the data indicates that the temperature between 25 and 31°C is most convenient for increasing the population numbers of either *O. maxwelli* or *T. mangiferae* which achieved during the two months may and September, 2017, there were some months have the same temperature ranges which are suitable for increasing the eriophyid mites. It may be concluded that during certain periods, the population numbers of either *O. maxwelli* or *T. mangiferae* are affected with other ecological factors. In addition, it may become more predominant so as to over shadow other factors. These results concur with those of previous studies showing that aerial dispersal of eriophyid mites occurs throughout the season and seems to be independent of population density or host plant quality (Sabelis and Bruin 1996). Lawson *et al.* (1996) reported similar observations for the European red mite, *Panonychus ulmi* (Koch.) and speculated that a density-independent proportion of mites committed to disperse. Sabelis and Bruin (1996) made the same tentative interpretation from data on vagrant species of eriophyids. The underlying mechanisms that trigger dispersal in some proportion of females in every population remain unknown. However, dispersal-related mortality is probably high and may be partially affected by within-tree for either *O. maxwelli* or *T. mangiferae* distributions. Allen and McCoy (1979) found high eriophyid populations in the northand south-bottom quadrants of trees, where temperatures were favorable for development and the lowest mite densities in the south-top quadrant, where lethal temperatures were recorded.Most leaflets of mango trees are infested with powdery mildew of mango, *Oidium mangiferae* Berthet that gives a reason for this distribution pattern, research on the aerial dissemination of fungal spores from a plant canopy may help our understanding of the dispersal success of eriophyid. Aylor (1990) reviewed the dissemination of fungal pathogens by wind. The majority of fungal spores are often produced in the lower portions of the plant canopy because of favorable conditions there. Lower wind-speed and less turbulence in the lower canopy limit the escape of those spores except during a period around midday, when wind-speed and turbulence near the ground are usually

highest. Gradients of disease severity typically decrease rapidly with increasing distance from the source of spores. However, eriophyid mites carried upward from the canopy and transported long distances would likely suffer extremely high mortality as a function of prolonged exposure to the elements, and a greatly reduced probability of being deposited on a suitable host plant. Regardless of the mortality that occurs during dispersal which affect on the achieved the eriophyid mited beak point, these data show that some mites were carried from a grove to an adjacent grove downwind and that the percentage of mites arriving at the downwind location depended on the distance between the groves.

Table (3): Correlation coefficient between average temperatures and RH% on the population of mites on olive and mango trees during two successive years 2017 and 2018.

Correlation factors	Population correlation coefficient values of			
	O. maxwelli		*T. mangiferae*	
	2017	2018	2017	2018
Temperature	0.425	0.580	0.438	0.646
Rh	-0.443	-0.104	-0.204	-0.283

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