

Biodiversity and Seasonal Fluctuation of Mite Families Associated with the Red Palm Weevil, *Rhynchophorus ferrugineus* Oliver (Coleoptera: Curculionidae) in Egypt

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ABSTRACT

Ten mite families belong to 2 suborders were collected from the red palm weevil *Rhynchophorus ferrugineus* (Oliver) (Coleoptera: Curculionidae) and their habitats from Ismailia Governorate, Egypt. Suborder Gamasida included 8 families (Trachyuropodidae Trematuridae, Uropodidae, Macrochilidae, Ascidae, Lealapidae, Sejidae and Digamasellidae). Thirteen mite species were isolated from adults, cocoon and core of palm tree. Trachyuropodidae was the most abundant family. Suborder Oribatida included 2 families (Oppiidae and gluminidae). Most of the surveyed families were found to be biological control agents against the red palm weevil.

Key words: Acari, Red palm weevil, *Rhynchophorus ferrugineus*, Biodiversity, Seasonal fluctuation, Egypt.

INTRODUCTION

The red palm weevil (RPW), *Rhynchophorus ferrugineus* (Oliver) (Coleoptera: Curculionidae), is an economically important tissue boring pest of date palm in many parts of the world. It has become the major pest of palm trees in the Mediterranean (EPPO, 2008). Adults are aggressive and capable of undertaking long flights (Salama *et al.*, 2009).

The pest penetrates the crown initially and later most of the parts of the trunk, making tunnels. Trunk of the palm tree may be easily decapitated. Larvae of the weevil feed on the trunk until develop to pupae. The damaged tissues soon turn necrotic, decay and mixed with the waste materials of the pest, consisting dark gummy material with unpleasant odor. Gomaa (2006) isolated three mite species associated with RPW from Sharkia and Ismailia Governorates, Egypt. *Hipoaspis queenslandicus* (Womersly) was the most abundant mite species on pupa and on the body of the adult weevil. El-Bishlawi and Allam (2007) recorded new genus and species of the family Trachyuropodidae, *Aegyptus rhynchophorus* associated with the pupae and adults of the red palm weevil when the weevil was inside the palm tree. Abdelhamed (2009) recorded 14 mite species on various stages of the red palm weevil in Egypt.

The objective of this study was to evaluate the biodiversity and seasonal fluctuation of the mite species associated with the red palm weevil and core of the palm tree in Egypt.

MATERIALS AND METHODS

Last larval instar, pupae and adults of RPW were collected from their habitats, using a hatchet, from the trunk of the infested palm trees at Ismailia Governorate, Egypt during spring, summer and fall seasons throughout the years 2009/10. Collected adult and immature stages of *R. ferrugineus*, in addition to material from their habitats, were transferred to the laboratory for inspection.

Adults were kept at 26±2 °C, 60-70% R.H. and 14 L photoperiod. Samples of the pest were placed in plastic boxes (20x10x10 cm) containing shredded sugarcane stems, whereas samples from the insect habitat were placed in polyethylene bags for laboratory investigation.

Extraction of mites

- a- **From RPW:** insects were examined individually by using a dissecting microscope. Detected mites were removed gently with a fine brush or needle from different parts of the insect cadavers via spiracular plates, under elytra, wing axillaries, antennal bases, coxal cavity, thorax region, abdomen and inner elytra. The cocoons were ruptured searching for the mites on the pupae surface.
- b- **From insect habitat:** Each sample was mixed carefully and placed in a Petri dish and was examined using a dissecting microscope. Collected specimens were cleared in Nesbitt's solution and mounted in Hoyer's medium for identification and morphological characteristics.

Identification and description

Identification and description of orders, suborders, families, genera and species of the mites were based

mainly on those given by Barker and Wharton (1952), Zaher (1959), Evans *et. al.*, (1961), Lindquist and Evans (1965), Barker (1968), Hirschmann (1972 a & b & c), Hughes (1976), Karg (1986), Wisniewski *et. al.*, (1992), El-Bishlawi *et. al.*, (2007), EPPO (2008) and Abdelhamed (2009).

Seasonal fluctuation

- 1- Experimental procedure: from the samples collected from October 2009 to September 2010. Each sample consisted of number of adults ranged between 5-20 individuals, number of pupae ranged between 5-20 individuals and core of the palm ranged between 500-1000 gm. In each sample, mite species found associated with the red palm weevil on adults, pupae and cocoons were classified, counted and identified.
- 1- Source of food: two types of food were used in the present study; pupae of RPW collected from the samples, and pieces of sugar-cane stems.
- 2- Rearing culture: each sample was placed in a plastic unit (20 cm length, 10 cm width and 15 cm height) with core of palm trees and sugar-cane stems to examine, determine and count alive individuals. Each unit was placed in an incubator on $\pm 25^{\circ}\text{C}$. and 70% R H.

RESULTS AND DISCUSSION

A) Biodiversity

Thirteen mite species belong to 10 families and 2 suborders were found associated with the adults, pupae of *R. ferrugineus* and the cores around the tunnel bored by larvae inside the palm. The 2 suborders and mite families were; suborder Gamasida included 8 families (Trachyuropodidae, Trematuridae Uropodidae, Macrochilidae, Ascidae, Lealapidae, Digamasellidae and Sejidae). 11 mite species were found belong to the previous families. The most abundant family was Trachyuropodidae, recorded on RPW adults, cocoons and cores of the palm. Suborder Oribatida included 2 families (Oppiidae and Galuminidae) which included two mite species.

As shown in table (1), family Trachyuropodidae was the most abundant family that included 2 species, belong to genus *Aegyptus* (*A. rynchophorus* and *A. zaheri*). Family Uropodidae included only one species belong to genus *fascuoropoda*. Family Macrocheilidae included one genus *Macrocheles* and two species (*Macrocheles merdarius* and *Macrocheles* sp.). Family Ascidae included two genus and two species (*Protogamasellus denticus* and *Proctalealaps steriatus*). Family Sejidae included one genus and one species (*Sejus paloghli*). Family Lealapidae included one genus and one species (*Cosmolealaps keni*). Family Digamasilidae was the seventh family isolated from adults, pupae and cores of palm. The first and second families were parasitic on adults and pupae of RPW, while the other five families were predacious mites. Obtained data agree with El-Beshlawi and Allam 2007 who recorded *Urobovella marginata* and *Aegyptus rynchophorus* on RPW. Family Trematuridae, represented by (*Oodinychus agepti*) and family Uropodidae represented by (*Fascuoropod marginata* (Koch) were also recorded associated with adults, pupae of RPW and core of the palm (Figs.1&2). They also reported that these two species were parasitic on pupae of the RPW. Abdelhamed (2009) recorded family Trachyuropodidae represented by (*Aegyptus rynchophorus* and *A. zaheri* (Abdelhamed) and *Urpodidae* represented by (*Urobovella* sp.), family *Ascidae* represented by (*Protogamasellus* sp.), family *Digamasellidae* represented by (*Dendrolealaps* sp.) and family *Sejidae* represented by (*leroaspis* sp.). The same author recorded also two families belong to Oribatida. All the families and species recorded above are in agreement with the findings of the present study, regarding *Trachyuropodidae*, *Uropodidae* and suborder *oribatida*, but some different species of the families; *Ascidae*, *Digamasellidae*, *Sejida* were noted.

B) Seasonal fluctuation

Order: Parasiform, Suborder: Gamasida

1- Family: Trachyuropodidae Berlese

Mites of this family were collected from Ismailia Governorate associated with *R. ferruginues*. 71 adults plus 106 pupae were found infested by 1142 and 4763 Trachyuropodid mites, respectively, represented 75.5 and 84.3% of all families of mite collected associated with adults and pupae, respectively (Fig. 1). Maximum number of mites recorded was 877 and 213 individuals on pupae and adults in December and October, respectively. 944 individuals collected from the core of the palm represented 50.6%. A peak of (211 individual) was recorded in October. Among the families, this family was represented by the highest number of mites throughout the whole season.

This family is common in the soil rich in organic manure and seems to have a wide range of diets, including decayed organic materials, fungi, acarid mites, house-fly egg or larvae, Collembola and free living nematodes (Bhattacharyya, 1962; Ahmed, 1984 and Krag, 1986). Dutonymphs of this family often attach phrotically to the cuticle of insects and other animals by means of an anal pedical leaving the carrier only

Table (1): Biodiversity of mite families associated with adults, pupae of red palm weevil, *Rynchophorus ferrugines* and core of palm at Ismailia Governorate, Egypt

Suborder	Family	Mite species
Gamasida	Uropodidae	- <i>Fascuoropod marginata</i>
	TrachyUropodidae	- <i>Aegyptus rynchophorus</i> - <i>Aegyptus zaheri</i>
	Trematuridae	- <i>Oodinychus</i> sp.
	Macrochellidae	- <i>Macrocheles merdarius</i> - <i>Macrocheles</i> sp.
	Ascidae	- <i>Protogamasellus denticus</i> - <i>Proctalealaps steriatus</i>
	Sejidae	- <i>Sejus paloghi</i>
	Lealapidae	- <i>Cosmolealaps keni</i> - <i>Dendrolealaps</i> sp.
	Digamaselidae	- <i>Digamasellus</i> sp.
	Opiidae	- <i>Multioppia wilsoni aoki.</i>
Oridatida	Galuminidae	-----

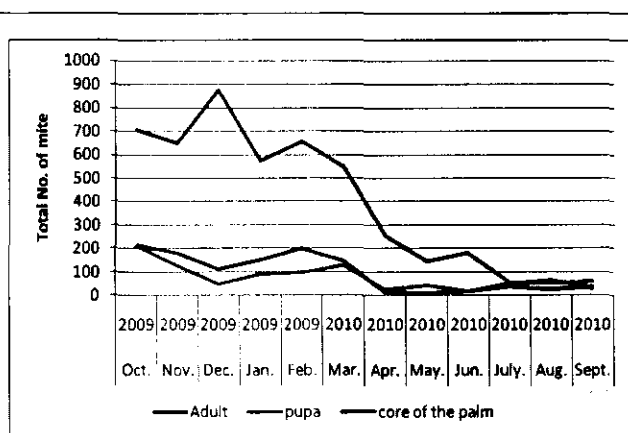


Fig. (1) Seasonal fluctuation of Trachyuropod mites associated with adults, pupae of RPW and core of the palm at Ismailia Governorate during 2009/10.

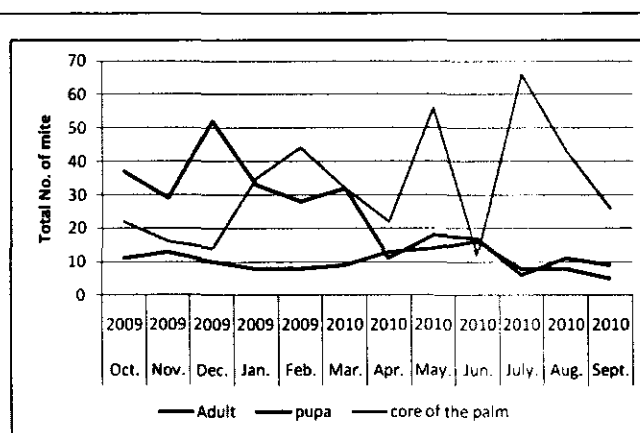


Fig. (2): Seasonal fluctuation of macrochelid mites associated with adults, pupae of RPW and core of the palm at Ismailia Governorate during 2009/10.

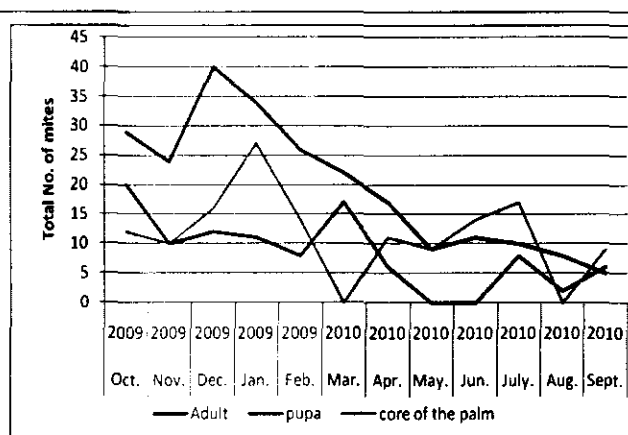


Fig. (3): Seasonal fluctuation of ascid mites associated with adults, pupae of RPW and core of the palm at Ismailia Governorate in 2009/10.

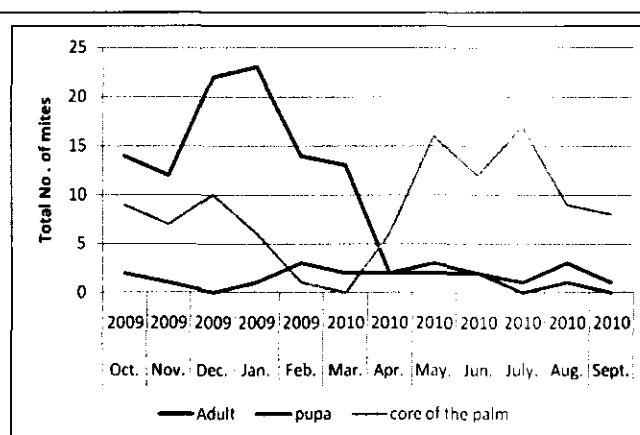


Fig. (4): Seasonal fluctuation of Sejid mites associated with adults, pupae of RPW and core of the palm at Ismailia Governorate in 2009/10.

often molting to the adult stage. Many uropodids occur commonly in forest litter and detritus (Hirshman, 1972a). Some others were collected from soil, moss, rotting wood and the nests or galleries of insects (Hirshman, 1972 b and c). El-Beshlawi and Allam, 2007 reported that *A. rhynchophorus* can feed and live on the active pupae of the weevil, the previous mentioned fungi and the fruit fly larvae, but the number of progeny in the two last cases were found low in comparison with that reared on RPW pupae, where it reproduced and caused deformation in wings and death when found in great numbers (500-1000). In the case of the dead pupae, the mite individuals can live on the fungi which grow on their surface, but cannot reproduce. The mite failed to feed on the larvae of the meat fly, while it fed on the 1st, 2nd and 3rd larval instars of RPW. So, this uropodid mite is a facultative parasite.

2- Family: Macrochelidae Vizthum

This family was existed in all samples, collected from Ismailia Governorate. 379 individuals were collected from core palm, representing 20.3% from all the families of mites. The family was recorded by high numbers during the three months; February (44), May (56) and July (66 individuals) (Fig. 2).

Macrochelid mite number reached 283 individuals (out of 106 pupae) and 123 individuals (out of 71 adults). These numbers of mites represented 5 and 8.1% of all the families of mites collected on pupae and adults, respectively. Highest number of Macrochelid mites (52 individuals) was found in December on the pupae and (16 individuals) on adults during January. Many macrochelids are predators on housefly larvae and eggs, acarid mites and free living nematodes. This family was represented by two species. This family can play a double role against pupae and eggs of RPW, especially in December when the peak of macrochelid mites is on pupae. The peak of mite in core of palm was found in August.

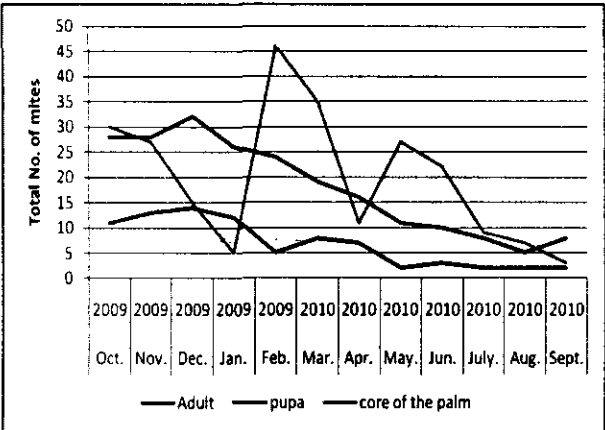


Fig. (5): Seasonal fluctuation of lealapid mite adults, pupae of RPW and core of the palm at Ismailia Governorate in 2009/10.

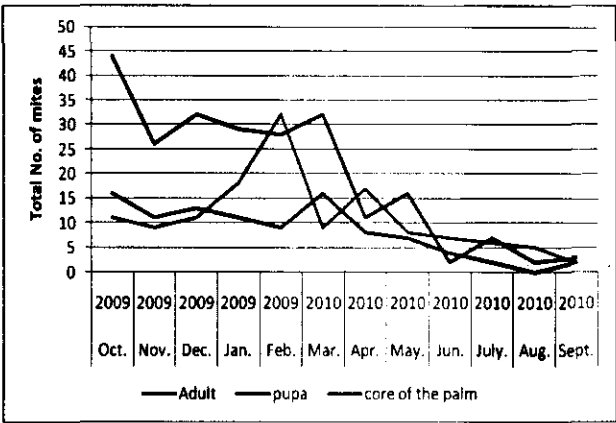


Fig. (6): Seasonal fluctuation of digamasilid mites associated with adults, pupae of RPW and core of the palm at Ismailia Governorate in 2009/10.

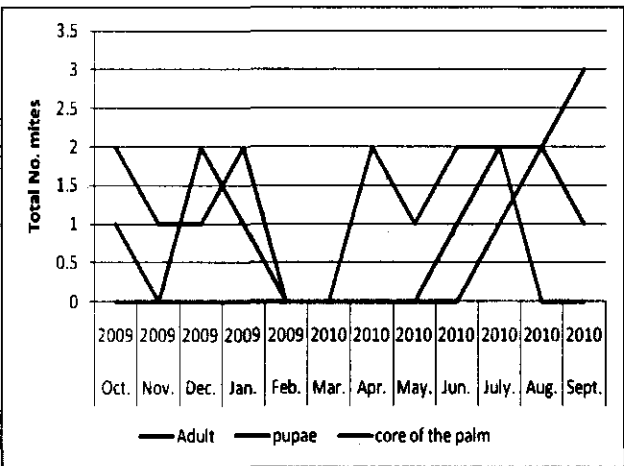


Fig. (7): Seasonal fluctuation of Opiidae mites associated with adults, pupae of RPW and core of the palm at Ismailia Governorate in 2009/10.

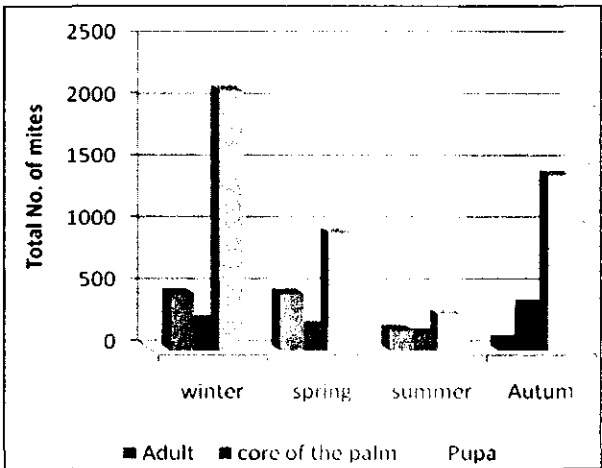


Fig. (8): Occurrence of trachyuropodid mites associated with adults, pupae of RPW and core of the palm at Ismailia Governorate, season 2009/10.

3- Family: Ascidae Voigts and Oudemans

This family was collected from Ismailia Governorate (106 pupae and 71 adults of *R. ferruginus*) were found infested by 235 and 100 ascid mites, represented 4.2 and 6.6% of all the families of mite collected, respectively. Peaks of (40 and 20 mites on pupa and adults of RPW) were recorded in December and October, respectively (Fig. 3). 139 individuals, collected from core of the palm, represented 7.5% of all the families of mite collected. Maximum number (27 individuals) was found in January. This family did not occur in core of the palm in March, May and August. The ascid mites are mostly predators, occur in soil, humus, moss, stored products, bee nests and plants. They prey on acarid mites, eggs of insects and also can feed on fungi, saprophytic arthropods and pollen. Some species of the family are parasitic (Egan and Moss, 1969) and (Lindquist and Evans, 1965). This family can play a double role against pupae and eggs of RPW, especially in December, when maximum number of mites is on pupae. Maximum number of mites was found in January in core of palm. This mite was recorded on adults in high numbers in spring. This phenomenon may play an important role in transmission of mites from infested palm to another.

4- Family: Sejidae Berlese

This family was represented by one genus and one species (*S. paloghi*). 101 individuals were collected from core of the palm at Ismailia Governorate, represented 5.4% of all the families of mite collected. Highest numbers (16, 12 and 17 individuals) were recorded in May, June and July, respectively. It was also represented by 110 and 16 individuals on adults and pupae, represented 2 and 1.1% of all the families of mite collected, respectively (Fig. 4). Highest numbers (22 and 23 individuals) were recorded associated with pupae during December and January and (3 individuals) with adults in February and was not recorded December, July and September. This family can play a double role against pupae and eggs of RPW, especially in January, when maximum number of mites is on pupa. Maximum number of mites was in May and July in core of palm.

Liroaspids were found mostly in tropical countries, but the species of *Liroaspis* was collected from Northern Europe and North America. The structure of its stout chelicerae indicates that it is a predaceous. Specimens were also collected from plants. Fox (1947) collected two specimens from two rats in Puerto Rico. It may prey on the large fauna of ecto-parasites that infests rats (Baker and Whiston, 1952)

5- Family: Lealapididae Berlese

This family was collected from Ismailia Governorate. The samples were found infested by members of lealapid mites. 237 individuals collected from core of the palm, represented 12.7% of all the families of mite collected. 215 and 81 individuals represented with 3.8 and 5.4% on pupae and adults, respectively. Highest number (46 individuals) was recorded in February, associated with core of the palm (Fig. 5). In case of the pupae and adults, it was recorded by 32 and 14 individuals in December, respectively. Genus *Cosmolealaps* of this family is a predator of RPW stages. Abdelhamed (2009) stated that the species, *A. casali* was found associated with core of the palm. This family can play a double role against pupae and eggs of RPW, especially in December, when maximum number of the mite is on pupae. Maximum number of mites was found in February in core of palm which can be affected by the numbers of RPW during spring.

6- Family: Digamasellidae Evans

This family was collected from Ismailia Governorate associated with 99 of RPW adults and 223 pupae. This family was found in small numbers, represented 0.6 and 0.2% of all the families of mite collected associated with adults and pupa of *R. ferruginus*. Maximum number of mites (2 individuals) was recorded in January and September and (3 individuals) recorded in April and June (Fig. 6). 14 individuals of this family were collected from core of the palm, represented 0.8% of all the families of mite collected. Maximum number of this family (3 individuals) was recorded in August. Members of this family are wide spread on surface and subsurface of the soil and in organic compost where they fed on collembolan, nematodes, arthropod eggs and possibly on fungi (Lindquist, 1965) and may be phrotic on gub beetles. Genus *Dendrolaps* are found on soil or in litter (Coineau, 1974). Many are found in the galleries of bark beetles (Hirschman, 1972 a & b; McGrow and Farriers 1969 and Kin, 1971). *Dendrolaps* species feed readily on nematodes in the beetle galleries. Dutonymphs of the nematophage *D. fallax* are phrotic on associated (Binns, 1973). This family can play a double role in winter and spring against pupae and eggs of RPW, especially in October, November and March. Maximum number of the mite was on pupae but the number of mite was highest in February in core of palm.

Suborder: Oribatida

7- Family: Oppiidae Grand jean

Seven individuals from this family were collected from core of the palm at Ismailia Governorate. These mites are recorded from April to July and they occupied 0.3% of all the families of mite collected. 12 and

10 individuals were recorded on pupae and adults, represented by 0.2 and 0.6% of all the families of mite collected, respectively. Highest number of mites was (3 individuals) recorded in September and in July and December (2 individuals) in pupae and adults, respectively (Fig. 7).

These mites are exclusively microphyto phagous, although one genus *Oppia* seems to be an obligate coprophage on wood bores faces. They are common inhabitants of moss, humus, litter and pasture both in moist and dry situations. Feeding studies involving these mites indicated that fungi comprise a bulk of their diet. Fluctuation of the numbers of oribatid mites may play a role in transmitting entomopathogenic fungi to RPW.

In conclusion, data given in table (1) and (Figs. 1-7) indicated that 10 mite families were found to be associated with the pupae and adult stages of the pest. Highest number of the collected mites was recorded from the family Trachyropodidae (1142), (4763) on the adults and pupae, respectively. However there were 10 mite families were found to inhabit core of the palm tree. Highest numbers were recorded from the mite families; Trachyropodidae, Macrochilidae and Lealapididae, with an average total numbers of 944 to 237 individuals/ 300 gm. The lowest numbers were recorded from the mite families; Glumenidae and Digamasellidae, with total numbers of 51 and 14 individuals, respectively.

Data given in (Fig. 8) revealed that the trachyropodid mites dominated during autumn and winter seasons, with a total of (1417 and 2108 individuals), (432 and 459 individuals) and (370 and 239 individuals) on pupae, adults and core of the palm tree, respectively. The lowest numbers (291, 83 and 138 individuals) were recorded during summer season, respectively.

Maximum seasonal fluctuation was in winter therefore, the percentage of deformed adults of RPW was higher than any other season, especially in spring when maximum infestation activities of RPW occur. Obtained results are supported by the findings of Sobhi (2006) and Abdelhamed, (2009) who mentioned that trachyropodid mite *Aegyptus* sp. affected significantly some biological activity of the red palm weevil. Also, El-Beshlawi and Allam (2007) found that when *A. rhynchophorus* was added to RPW pupae, it caused deformation in wings and death, especially when found in great numbers (500-1000 individual insect stage). These results may be due to the suitable conditions of relative humidity, degree of temperature, components for feeding, dark hours, way of parasitism, suitable host (morphological, physiological and ecological specification in host), especially inside cocoon on the surface of pupae. The suitable conditions for the success of feeding and reproduction lead to efficient bio-control agents against the pupae of the red palm weevil.

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