Review Article

Mites Associated with Red Palm Weevil *Rynchophorus ferrugines* Oliv. in Arabian Countries

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ABSTRACT

The red palm weevil (RPW), *Rhynchophorus ferrugineus* Olivier (Coleoptera: Curculionidae) is an economically importance problem invasive tissue borer to date palm trees in Arabian countries mostly young trees less than20 years old, where the stem of the young palm was soft, juicy and easily penetrated.. Biodiversity of mites associated with the red palm weevil *R. ferrugineus*is varying degrees of bio-relationship between mites and RPW, ectoparasitic, endoparasitic, predaceous, phoretic and fungivorus mites. The relationships of predatism and parasitism play an important role as biocontrol agents in the biological control program against R.P.W. Some families from mites were isolated from adults, pupae (cocoons) and cores around tunnel borded and larvae inside the palm trees in Egypt, Saudi Arabian, and Emirates. Such as Trachy Uropodidae Trematuridae, Uropodidae, Macrochilidae, Ascidae, Lealapidae, Sejidae, Digamasellidae.

Key words: *Trachyuropodidae*, *Trematuridae*, *Uropodidae*, *Macrochilidae*, *Ascidae*, *Lealapidae*, *Sejidae*, *Digamasellidae*, Mite, Red Palm Weevil, Oribatida, Curculionidae, Egypt, Saudi Arabia, Emirates.

INTRODUCTION

The adult of Red palm weevil *R. ferrugineus* (Olivier) penetrate the crown initially and later to most parts of the trunk, making tunnels and as the galleries become more extensive, the trunk weakens and the tree may be easily decapitated. Inside the trunk, the larvae of the weevil feed and developed to pupae. The damaged on turn necrotic, decay and mixed with the waste materials of the insect consisting dark gummy material with unpleasant odor. Some fauna such as mites of *Fascuoropoda marginata* (koch), the new species of Uropodid mite *Aegyptus rhynchophorus* and the fruit fly insect *Ceratitis capitata* wied were found associated with the weevils wastes. Specimens of a new uropodoid mite species were found associated with pupae and adults of the red palm weevil, R. ferrugineus, inside the date palm tree were reviwed here. Since this species could not be assigned to any of the named genera in the family Trachyuropodidae to which it was assigned, a new genus was proposed. Studies on some mites associated with the red palm weevil have been reported by Gomaa, 2006 who isolated three mite species associated with R.P.W. El-Bishlawy and Allam(2007) Studies on parasitic mites associated with the red palm weevil, Rhynochophorus Ferrugineus olivier (coleoptera: curculionidae) recorded new genus and new species, Aegyptus rhynchophorus (Trachyuropodidae) associated with pupae and adults of red palm weevil. Abde El-Hamed (2009) recorded 14 mite species, associated with differ stages of RPW in Egypt. Hassan et al., (2011) studied the biodiversity and seasonal fluctuation of mite families associated with the red palm weevil in Egypt and Al-Dhafar and Al- Qahtani (2012) recorded three mite species associated with RPWone of which Aegyptus alhessa n. sp. (Gamasida, Trachyuropodidae) as a parasite on pupae, cocoons and adults of RPW. Red palm weevil was firstly discovered attacking palm in the Arabian peninsula especially United Emirates at 1986 and progressively spread to Gulf states and crossed the red sea into North Africa as the latest recording. Since 1992 in Egypt. The present review aims to shed the light on some gamasid mites associated with different red palm weevil stages, all mites recorded in Arabian countries with red palm weevil and its The relationships of predatism and parasitism play an important role as biocontrol agents in the biological control program against R.P.W.

a- Economic importance and spread through Arabian countries:

The date palm, Phoenix dactylifera (Palmae) was the most common and widely cultivated plant in the arid regions of the Middle East and North Africa where, in many areas, its fruit has provided the staple carbohydrate food of local people for nearly 5000 years (Jones, 1995). In the Arabian peninsula, the tree is grown by small holder farmers and commercially in large plantations; it also grows wild on steep hillsides (Collenette, 1985). For example, it is the main agricultural crop in Oman, occupying 83% of the total area grown under fruits and 50% of the total cultivated land. The date palm crop in these countries is now under threat. Inthe mid 1980s the red palm weevil, *Rhynchophorus ferrugineus* (Olivier) (Col., Curculionidae) was discovered attacking palms in the Arabian Peninsula (Abraham et al., 1998). The larval stages of this insect feed within the trunk of

palms and this behaviour frequently kills the trees. Since its discovery, the weevil had expanded its range very rapidly. It was recorded for the first time in the United Arab Emirates in 1986; it was then found in Saudi Arabia in 1987. However, it has now crossed the Red Sea into North Africa, as the latest record is from the Sharqiya region of Egypt (Cox, 1993). By 1995, it had infested over 10,000 farms across Arabia. In infested plantations, yields have been estimated to have dropped from 10 tonnes to 0.7 tonnes per hectare (Gush, 1997). Despite efforts such as the above, an estimated 80,000 palm trees in Saudi Arabia were infested with RPW and it continues to pose a danger to other surrounding plants (Al-Sheaby 2010). There were strong indications that regional movement of infested plant material is one of the major sources for the spread of this insect. (Falerio2006) determined the years that R.P.W arrived and infested date palm in some Arabian countries from 1986 until 2011 (Table 1).

Table (1): Geographical distribution of RPW recorded in Arabian countries

Country	Frist recorded
Arab Emirates	1986
Saudi Arabia	1987
Egypt	1992
Oman,Kuwait	1993
Qatar	1985
Jordan, Palestine	1999
Syria	2007
Morocco	2008
Libya	2009
Lebanon	2010
Tunisia	2011

Biorelationships between red palm weevil and mites:

Relationships start from phoritic and the end parasitic between **red palm weevil** and mites:

A- Phoretic mites with red palm weevil

Allam *et al.* (2012) (Table 4) Identified uropodid mite deutonymphs have been attached by anal pedicels to different places of adult red palm weevil.The behaviour of hyperphorsey of phoretic dutonymph was observed. The synchronization between dutonymph of *Agyptus rhyncophorus* and life cycle of RPW were studied. Anal glands were examined and photographed by using light and scanning electron microscope, the structure of dutonymph and factor affecting attaching were determined in Egypt. In Al Ain, United Arab Emirates (UAE) AlDeeb *et al.* (2011) Weevils were collected from randomly selected infested date palms Mites from three families were recorded. Uroobovella sp. (Acari: Urodinychidae) were the most common phoretic mites. Curculanoetus sp. (Acari: Histiostomatidae) were second in abundance. Uropoda orbicularis (Acari: Uropodidae) was recorded on one beetle. The abundance of phoretic mites varied among body parts of R. ferrugineus, and the maximum numbers occurred in the subelytral space. The mean intensity, mean abundance, and prevalence of Uroobovella and Curculanoetus mites did not differ between male and female weevils. Uroobovella had significantly greater intensity, abundance and prevalence compared to Curculanoetus. Most Uroobovella and Curculanoetus aggregated under the subelytral space, which presumably offers protection from the hot and dry environment. This study was the first to document the presence of phoretic mites on *R. ferrugineus* in UAE and will help to direct future research on their interactions.

B- Prasitic mites with red palm weevil

Among the various natural enemies of R.P.W the parasitic mite were reported on pupae and adult of R.P.W. Gomaa (2006) Isolated three mite associated with red palm weevil from Sharqiya and Ismailia Governorates during 2005, she found*Urobovella krantzi*. El-Bishlawi and Allam (2007) isolated and described the new genus and species of Uropodid mite in the family Trachyuropodidae , *Aegyptus rhynchophorus* associated with pupae and adults of the red palm weevil, *Rhynchophorus ferrugineus* (Olivier) inside palm trees in Ismailia, Also found *Urobovella marginata* in Egypt. They reported that most rearing of parasite mites on pupae of red palm weevil but they reared on sugarcane with naturally fungi (*Aspergillus niger, penic*illum digitatum*)* which growth naturally on sugarcane. They determined that parasite mite developed, reproduced and dialy oviposition rate on sugarcane respectively. Thus these Facultitive parasite Also Abdelhamed (2009) found that, family Trachyuropodidae new species *Agyptus zaheri, Urobovella* (*Fuscuropoda sp.*), on stages of red palm weevil *Rhynchophorus ferrugineus and* studied Food preference and some biological aspects of mite *Aegyptus zaheri* by using different type of food such as the acarid mite *Rhyzoglyphus* sp., yeast, sugarcane and entomopathogenic nematode (*Heterorhabditis bacterophora*). The previous obtained results indicated that *A. zaheri* fed and development on different types of food .Yeast proved to be the most suitable food than other types. From these results, *Aegyptus zaheri* was Facultitive parasite. Hassan *et al.* (2011) found that family Trachy uropodidae, *Aegyptus rhynchophorus, Agyptus zaheri, Uropovella (Fuscuropoda) marginata* on stages of red palm weevil *Rhynchophorus ferrugineus.* Al-Dhafar and Al-Qahtani (2012) found family Trachy uropodidae new species *Aegyptus alhassa n. sp* in Al-Hassa Eastern Province of Saudi Arabia (table 3). Allam *et al.* (2014) reared *Agyptus rynchophorus* on pupae of red palm weevil and sugar cane pieces, these resulted supported *Agyptus rynchophorus* was Facultitive parasite.

C- Predacious mites with red palm weevil

Gomaa (2006) isolated two predacious mite associated with red palm weevil from Sharqiya and Ismailia Governorates during 2005, she found; *Hipoaspis queenslandicus* (Womersly), and *Eutogenes punctata* Zaher and Soliman. The first species was the most abundant especially on pupa and on the body of the weevil.. Abdelhamed (2009) found that, family *Ascidae* (*Protogamasellus sp.*), family Digamasellidae (*Dendrolealaps sp*.), Sejidae (*Liroaspis sp.),* Ameroseiidae (*Ameroseius sp.),* Ologamasidae (*Gamasiphis parpulchellus*). Hassan *et al.* (2011) collected from the red palm weevil *Rynchophorus ferrugines* (Order: Coleoptrea) and their habitat from Ismailia Governorate in Egypt. suborder Gamasida included 5 families Macrochilidae , Ascidae , Lealapidae, Sejidae , Digamasellidae isolated from adult , cocoon and core of palm. The previous families contained 8mite species (table 2). Also, Al-Dhafar and Al-Qahtani (2012) recorded family Sejidae genus *Sejus sp.* in Al-Hassa Eastern Province of Saudi Arabia Predacious mite for small larvae-pupae of red palm weevil (table 3).

Table (2): mite families associated with adult, pupae of red palm Weevil *Rynchophorus ferrugines* and Core of palm at 2005-2013 Egypt

Suborder	Family	Mite species	Kind of relationship
Gamasida	Uropodidae	*-Fascuoropod marginata* *-Urobovella krantzi*	Facultitive parasite
	Trematuridae	*-Oodinychus egypti*	Facultitive parasite
	TrachyUropodidae	*- Aegyptus rynchophorus* *- Aegyptus zaheri*	Facultitive parasite +phortic on adult ofR.P.W
	Macrochellidae	*- Macrocheles merdarius* *- Macrocheles sp*	Predacious mite for egg- small larvae -pupae ofR.P.W
	Ascidae	*- Protogamasellus denticus* *- Proctalealaps steriatus*	Predacious mite for egg- small larvae -pupae ofR.P.W
	Sejidae	*-Sejus paloghi* *- Liroaspis sp*	Predacious mite for egg- small larvae -pupae ofR.P.W
	Lealapidae	*-Cosmolealaps keni* *-Hypoaspis ueenslandicus*	Predacious mite for egg- small larvae -pupae ofR.P.W
	Digamaselidae	*- Dendrolealaps sp.* *-Digamasellus sp.*	Predacious mite for egg- small larvae- pupae ofR.P.W
	Ameroseiidae	*Ameroseius sp.*	Predacious mite for egg- small larvae- pupae ofR.P.W
	Ologamasidae	*Gamasiphis parpulchellus*.	Predacious mite for egg- small larvae-pupae of R.P.W
Actinedida	Scutacaridae	*Scutacarus sp.*	
	Tarsonemidae	*Tarsonemus sp.* *Rhizoglyphus sp.*	Fungiphorus
Oridatida	Opiidae	*-Multioppia wilsoni Aoki. -,Oppia sp*	Fungiphorus
	Galumenaidae	*-Galumna sp.*	Fungiphorus
Acaridida	Acaridae	-. Histiostoma sp.	Fungiphorus

Table (3): mite families associated with adult, pupae of red palm Weevil *Rynchophorus ferrugines* inAl-Hassa (Eastern Province of Saudi Arabia) in 2012

Suborder	Family	Mite species	Kind of relationship
Gamasida	TrachyUropodidae	*Aegyptus alhassa n. sp.*	Facultitive parasite collected from eggs, larvae, pupae cocoons and under the elytron of insect adult
	Sejidae	*Sejus sp.*	Predacious mite for egg- small larvae-pupae of R.P.W
Acaridida	Acaridae	acarid hypopial stage	may feed on dead insects

Table (4): Mite families associated with adult, pupae of red palm Weevil *Rynchophorus ferrugines* in Emaretes 2013

Suborder	Family	Mite species	Kind of relationship
Gamasida	Uropodidae	*Uropoda orbicularis*	phoretic mites.
	Urodinychida	*Uroobovella sp*.	phoretic mites.
Astigmata	Histiostomatidae	*Curculanoetus sp*.	phoretic mites.

D- Fungiphorus mites with red palm weevil

Abdelhamed, D. M. (2009) scutacaridae (*Scutacarus sp.),* Tarsonemidae (*Tarsonemus sp. and Rhizoglyphus sp.*), Acaridae (*Histiostoma sp*.), Galumenaidae (*Galumna sp.)* And Oppidae (*Oppia sp.)* on stages of red palm weevil *Rhynchophorus ferrugineus.* Also, Hassan *et al.* (2011) collected from core of the palm at Ismailia Governorate. Suborder Oribatida included two families Oppiidae genus *Multioppia wilsoni Aoki.* and gluminidae.they reported that These mites are recorded from April to July, and it occupied 0.3% from all different families of mites, 12 and 10 individuals recorded on pupa and adult by 0.2% and 0.6% from all different families of mites , respectively . Feeding studies involving these mites indicate that fungi comprise to bulk of their diet (Krantz, 1978).the fluctuation of numbers of oribated mites may be play role in transporting Entomophathogenic fungi to red palm weevil.

3- Mass production of mites as biocontreol agents of the red palm weevil

El-Bishlawi and Allam (2007) propagate the parasite and predacious mites on the same pieces of the sugar cane .They use of beneficial mites forms part of integrated crop management and integrated pest management programs, combining with cultures ,biological and chemical control. Allam *et al.* (2014) investigated mass rearing of *Agyptus rynchophorus and Cosmolealaps keni* mites as biological control agents for reducing damage to palm by R.P.W in particularly it relates to a new method for rearing parasite and predacious mites and easy method that can be applied by Egyptian farmers. *Agyptus rynchophorus (trachyuropodidae)* was reared on pupae of R.P.W. and sugar cane ,*Cosmolealaps keni(lealapidae)*was reared on sugarcane and determined the duration of tray was 30 days ,the unit was one tray . The number of predators increased 150-fold in that period And 20 fold in the parasite in Egypt. Allam and El-Badwy (2017) investigated mass production of *Aegyptus rhynchophorus* on Sugar cane inoculated with fungi *Memmoniella*s spp. and artificial culture from *Memmoniella*s spp. they determined the duration of tray (Tray = Correct as reviewer) was 30 days. The unit was one tray. Every unit had five piecesfrom sugarcane inoculated with fungi, the number of facultative parasite mite increased two fold, Also, they foundthat in one fold the lifecycle ranged from 13-15 days in female, 9-16 in male, type of progeny five females per one male, and number of deposited eggs ranged from 30 to 64 in one fold on sugar cane and culture of fungi only respectively.

5- Role of mites as biocontreol agents of the red palm weevil

Most of these previous families were promised as biological control agents against *Rynchophorus ferrugines.* Specially in winter in Arabian countries which the degree of tempreture ranged from 20 to 30 degree these range were suitable for all of species from different mites. Hassan et. al. (2011) illustrated that 10 mite families were found to be associated with pupa and adult stage. The highest number of the collected mites was recorded to the family Trachyurpodidae (1142), (4763) on the adult and pupa , respectively .However there were 10 mite families were found to inhabit with core of the palm tree. The highest numbers were recorded to mite families Trachyuropodidae , Macrochilidae and Lealapidae with a total numbers were recorded from 944 to 237 individuals/ 300 gm . in average . While the lowest numbers were recorded to mite families Glumenidae and Digamasellidae a total number 51 and 14 individuals, respectively They revealed that the Trachyuropodid mites were dominate during autum and winter season with a total (1417 and 2108 individuals), (432 and 459 individuals) and (370 and 239 individuals) in case of pupa , adult and core of the palm tree respectively . The lowest number was recorded during summer season (291, 83and 138 individuals, respectively.Results clearly indicated that the Trachyuropodid mites were the most dominate among all the recorded mite families either with the adult stage or the pupa and its cocoons in addition to the core of the palm.the curve of the seasonal fluctuation was maximum in winter so that the percentage of deformed adult of red palm weevil was higher than the other season specially in this period in spring which the maximum infestation activities concern the red palm weevil. Also results supported by the finding of Sobhi, (2006) and Abdelhamed, (2009) they mention that Trachyuropodid mite Aegyptus sp. affected significantly on some biological activity of red palm weevil also El-Beshlawi and Allam (2007) found that when *A. rynchophorus* was put with the red palm weevil pupa it caused deformation in wings, and death when found in great numbers (500-1000/individual insect stage).These result may be due to the suitable conditions from relative humidity ,degree of temperature ,component for feeding ,hours of dark, way of parasitism , suitable host(morphological ,physiological and ecological specification in host) ,especially inside cocoon on the surface of pupae . the suitable conditions for success feeding and reproduction lead to excellent bio-control agent against pupae of red palm weevil by Arabian farmers and also easy way for application . The other families can help these trachyuropodidae mites in biological control of the red Palm weevil especially with egg and small larvae, in lowest numbers of these mites. The most of families can play double role against

pupa and egg of red palm weevil especially in different seasons during the year which affected on seasonal fluctuation of RPW .that gigantism the role of predacious and parasite mites in control of RPW and criminal using the pesticide against RPW.

6- Future research

Isolation, identification, Mass production and application ways of parasitic and predacious mite which play role as biocontreol agents against red palm weevil in Arabian countries.

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