

Journal of Plant Protection and Pathology

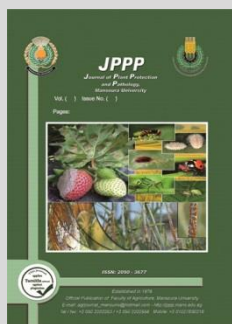
Journal homepage: www.jppp.mans.edu.eg
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Life Table and Morphometric Studies of *Aulacaspis tubercularis* Infesting Mango Trees in Egypt (Diaspididae: Hemiptera)

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ABSTRACT

White mango scale, *Aulacaspis tubercularis* Newstead (Hemiptera: Diaspididae) is a serious pest on mango (*Mangifera* spp.), (Sapindales: Anacardiaceae) which became recently a trouble some pest in all mango orchards in Egypt. Biology of the scale insect *A. tubercularis* (Hemiptera: Diaspididae) was studied on mango saplings (*Mangifera* sp.) at mean temperature of 30°C and relative humidity (RH) of 64 % at the laboratory during summer and winter seasons in Department of Agriculture Ain shams university, Government of Qalyubiya, Egypt. Observations of developmental stages and morphometry of *A. tubercularis* were conducted using a head lens and an ocular and stage micrometers. In the laboratory conditions, mature females laid 85-200 eggs in 10–12 days under the scale cover; the eggs hatched after 6–7 days. *A. tubercularis* males passed through two feeding instars then pre-pupal, pupal and adult stages while females had two immature instars with pre-oviposition, oviposition and post-oviposition periods. Mean developmental span (egg to adult) of male insect was 53.5 days and for female was 67 days. The periods of the age and survival stages were almost close to the point of congruence in some stages. Mean developmental periods on mango saplings in summer were 8, 32, 2, 4, and 2 days for stages of males and 8, 32, 10, 12 and 8 days for stages of females, respectively while in winter were 8, 30, 2, 4, and 3 days for stages of males and 8, 30, 8, 12 and 12 days for stages of females, respectively.

Keywords: *Aulacaspis tubercularis*; biology; Population fluctuations; distribution; sex ratio

INTRODUCTION

Aulacaspis tubercularis Newstead (Hemiptera : Diaspididae) (White mango scale insect) Spread widely in the most tropical and subtropical countries. This scale infests several plants of commercial value, including avocado (*Persea americana*, coconut (*Cocos nucifera* L.), ginger (*Zingiber officinale* Roscoe), pumpkins (*Cucurbita* spp.) and mango in Egypt. In Egypt the pest has 3-4 annual, partially overlapping population peaks, in spring, summer, autumn and winter. The pest is more abundant on lower, south-facing aspects of trees, and its crawlers are probably dispersed by wind currents. An important pest of mango in Egypt. This scale injures mangoes by feeding on the plant sap through leaves, branches and fruits, causing defoliation, drying up of young twigs, poor blossoming and so affecting the commercial value of fruits and their export potential especially to late cultivars where it causes conspicuous pink blemishes around the feeding sites of the scales. In nurseries, severe early stage infestation retards growth. Young trees are particularly vulnerable to excessive leaf loss and death of twigs, during hot dry weather. The heavily infested premature fruits dropping and the mature fruits became small in size with lacking of juice. *A. tubercularis* is a tropical species that may have originated in Asia. It has been recorded mainly from hosts belonging to four plant families: Palmae, Lauraceae, Rutaceae, Anacardiaceae, particularly on mangoes and cinnamon (Borchsenius, 1966). Its population densities were recorded on mangoes in few parts of the world (Annecke, 1963; Almeida, 1972 and Labuschagne *et al.*, 1995). It has been spread by the transport of infested plant material and is

now widespread in many mango- growing countries. It presents as a significant pest problems on mangoes in South Africa (Colyn and Schaffer, 1993; Joubert *et al.* 2000a), in Australia, East and West Africa, North and South America and the Caribbean Islands (Peña *et al.*, 1997). It has not been recorded in the most of tropical Pacific islands. (Tao, 1999; Porcelli, 1990; Longo *et al.*, 1995; International Institute of Entomology (IIE), 1993 and Danzig and Pellizzari, 1998). This insect became an economic pest all over Egypt, after it was restricted in Minia Governorate under quarantine regulations then crept to Beni-Suif Governorate, so population fluctuations and role of its natural enemies in regulating its abundance have not wide studied until now in Egypt, (Morsi *et al.*, 2002). The role of white mango scale insect natural enemies in regulating its abundance was discussed by some authors (Quednau, 1964; Viljoen, 1986; Schoeman, 1987; Labuschagne, 1993; Labuschagne and Pasques, 1994; Labuschagne and Beer, 1995; Labuschagne *et al.*, 1996; Daneel and Dreyer, 1997 and 1998 and Joubert *et al.*, 2000b).

Scale insects are usually considered as the most important pests which infesting mango trees in many countries of the world. Gallardo (1983), Williams and Watson (1988) reported that a heavy infestation of *Aulacaspis tubercularis* (Newstead) (Diaspididae : Hemiptera) occurred on mango in an experimental orchard containing 84 varieties in Puerto Rico. This scale insect injures the leaves and fruits, affecting the commercial value of the fruits and its export potential. Colyn and Schaffer (1993), Peña *et al.* (1997) and Joubert *et al.* (2000) mentioned that *A. tubercularis* injures the

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DOI:10.21608/jppp.2020.135337

leaves and fruits, affecting the commercial value of the fruits and their export potential. Infested mango fruits have conspicuous pink blemishes around the feeding sites of the scales. In nurseries, severe early-stage infestation retards growth. Young trees are particularly vulnerable to excessive leaf loss and death of twigs due to scale, during hot dry weather. *A. tubercularis* presents significant pest problems on mango in South Africa. It is also a problem on mango in Australia, East and West Africa, North and South America and the Caribbean Islands. Ascher *et al.* (1995) studied the ecological aspects of this pest on mango trees using data gathered from two localities, Kaapmuiden and Nelspruit, South Africa. They revealed that the highest infestation rate occurred on the shady south-facing lower aspect of the tree. The population peak at Kaapmuiden, with a higher mean temperature, occurred in August, much earlier than at Nelspruit, where it occurred in November. Radwan (2003) and Kwaiz (2009) in Egypt reported that *A. tubercularis* had three generations on mango trees. This pest was not deepened in terms of biological studies except (van Halteren, (1970) who studied the biology of the scale insect *Aulacaspis mangiferae* on mango. So we had to dig deeper into biological studies in order to be side by side with ecological studies to help us design an integrated management program (IPM) to control the number of pests on mango trees in Egypt.

MATERIALS AND METHODS

A mango tree, *Mangifera indica*, heavily infested with *Aulacaspis tubercularis* at the Farm of Faculty of Agriculture, Ain Shams University, Qalyubiya Governorate was chosen to use as stock culture for this scale insect. This tree was used as a resource to infest mango seedlings to follow some biological studies for this species under insectary conditions. Twenty mango seedlings of the same age (2 years old) height (60-70 cm), vegetation and free of any insect infestation were obtained from Fruit Nursery at the same faculty. These seedlings transferred in plastic pots (15 x20 cm) and received similar cultural practices throughout experimental period.

Ten mango seedlings were put under the mango tree during May, 2018 (Summer generation) and another ten seedlings during October, 2018 (Fall generation). These seedlings were exposed to heavily infested leaves of mango trees for 24 h. During these two exposure periods upper surface of some seedling leaves were attached with leaves of the infested mango tree. Crawlers of *A. tubercularis* of the same age were transferred to seedling leaves. The infested seedlings were transferred to insectary for daily observations (fig. 1). A sketch for each seedling was drawn and leaves were counted. Also, settling crawlers were counted on each leaf.

Regular daily observations were carried out to observe any changes in shape size and color and recorded for each individuals throughout the two generations. These observations were conducted using stereoscopic microscope or lens (10x), Measurements for different developmental stage were done using ocular micrometer. Also, temporary mounts for all stages were done to measure dimension of each instar or stage. To obtain data for life table parameters after setting the crawlers on seedling leaves, any changes of wax secretion were recorded. Durations of all developmental stages for both female and male as well as number of dead individuals were recorded. Life table parameters were calculated according to Birch (1948). Symbols definitions and formula for calculations are given in Tables 2, 3.

For adult female, durations of preoviposition, oviposition and post-oviposition periods were estimated. Also, fecundity was estimated. For male, duration of prepupa and pupa were estimated. Sex ratio throughout the two generations was calculated. Mean temperature and percentage of relative humidity during experimental period were recorded using thermohygrograph. biology of mango scale insect was studied in the laboratory on mango nursery plants in pots at 22.9 to 31.1°C (mean temperature 27°C) and 60.9 to 84.2 % RH (mean 74 %) in summer season, while was 12 to 19.1°C (mean temperature 15°C) and 56.9 to 74.2 % RH (mean 64 %) in winter season.

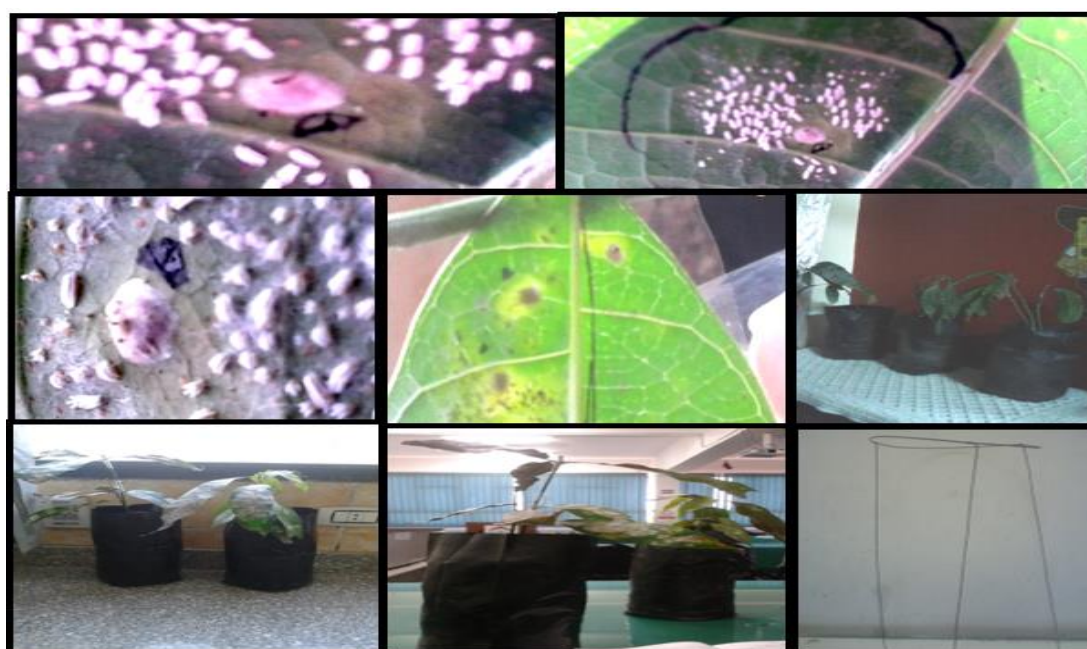


Fig 1. *A. tubercularis* infested mango plant in laboratory.

RESULTS AND DISCUSSION

Laboratory study

Developmental stages of *Aulacaspis tubercularis*

Eggs

Mature females laid eggs in concentric circles in 3–4 batches, each 18–21 eggs which were easily observed under scale cover of the body. Newly laid eggs were yellowish, smooth and elongated-oval. Afterwards, eggs change to dark red (Cochineal), (Fig. 2). This provides an opportunity to differentiate between females who lay eggs and those who did not lay eggs. Mean length and width of freshly laid eggs were 0.3 and 0.09 mm, respectively (Table 1). The eggs hatched after 4–6 days in the laboratory at 25–28°C and 64 % RH.



Fig.2. *A. tubercularis* eggs under scale cover.

Crawlers

Crawlers emerged from underneath the scale cover and moved on the leaf for 24–48h searching for a suitable place for fixation. At this instar, the body of the crawler was dark red (Cochineal), very small, elongated- oval, totally bare of any wax secretion. The crawler moves about until it find a suitable place to settle on (Fig. 3). Mean length and width were 0.42 and 0.2 mm, respectively (Table 1). Their body is a single block and undivided or unsegmented including legs, antennae. More than 85 % of the crawlers settled on the upper surface of mango leaf, while the remainder settled on lower surfaces of the sapling leaves. . In Tables. 2,3 and Fig 9, 10 the rate of apparent mortality (%AM) in summer was 7.15% as same as the rate of real mortality (%RM) while in winter rates of apparent and real mortalities increased to reach 51% .



Fig. 3. transferring crawlers from infested mango plants to sapling plants.

White cap stage

After feeding of crawlers with their piercing and sucking mouth parts, they started to secrete a white waxy substance over their body. The body began to exudate white wax filaments which appears cottony and continued in secretions until the insect is completely covered with the white filaments. Hence the common name is “white cap” (Fig. 4). The ‘white cap’ instar began after 24 h of settlement and could be observed by naked eye. Mean length and width were 0.43 and 0.23 mm, respectively (Table 1). It lasted for

4–6 days in the laboratory at 25–28°C and 64 % RH. In summer rate of apparent mortality (%AM) decreased significantly to reach 2.2 % and the rate of real mortality (%RM) was 2.1% while, in winter increased rates apparent mortality (%AM) significantly to reach 74.46 %, while decreased the rate real mortality (%RM) was 32.18 % (Tables. 2,3 and Fig 9, 10).

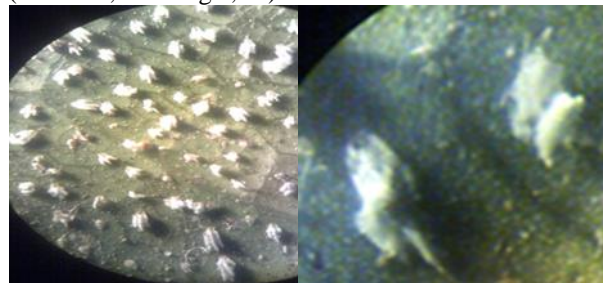


Fig. 4. white cap stage.

First instar

The external surface of the scales changed from white grey to dark white. The terminal exuviae has a waxy stellar shape with three angles (Fig. 5). The slide mounted first instar body female was elongate–oval, widest at thoracic region, flat, about 0.3 mm long and 0.2 mm wide while, The slide mounted instar body was elongate–oval, widest at thoracic region, about 0.2 mm long and 0.1 mm wide (Table 1) . First instar stayed 8 days in summer and winter. Molting process continued for 4–5 days before 2nd instar started. At the molting time, color changed to yellow and the body became oblong with one pointed end and pygidium developed. In summer rates of apparent (%AM) and real mortalities (%RM) were 15.3 and 14.21 %, respectively. While in winter increased these rates were 35% and 20 % , respectively (Tables 2,3 and Fig 9, 10).

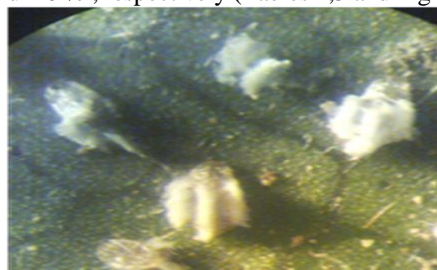


Fig. 5. first instar

Second instar

The second instar of the nymph is longer than other instars or stages, reaching 31–32 days. Scale cover rectangular in shape, white, with three raised longitudinal ridges (Fig. 6). The mounted second instar body female was elongate–oval, increased widest at thoracic region, flat, about 0.4 mm long and 0.3 mm wide. The mounted second instar body male was elongate–oval, increased widest at thoracic region, about 0.3 mm long and 0.2 mm wide (Table 1) . Second instar of the scale insect was marked with reinsertion of its stylets of mouth parts into the leaf surface for feeding purpose and remained for 30–32 days (Tables 2, 3). The main diagnostic character of this stage was the presence of yellow-orange colour . In summer rate of apparent mortality (%AM) 53.3% and the rate real mortality (%RM) were 53.3% and 41.91%, respectively. While, in winter the rate of apparent mortality (%AM) was increased to 61%, while the rate of real mortality (%RM) was decreased to (23 %) (Tables 2, 3 and Fig 9, 10).



Fig. 6. second instar

Male:

Male crawlers settled in groups of 10– 80 individuals, often near females. These groups are conspicuous due to the white scale covers that they produce (van Halteren, 1970). Accordingly, individuals were revealed to pre-pupa and pupa in the male colonies according to the age stage they represent.

After second instar, the body of males was elongated and the color changed to brown/orange with two black spots of eyes appearing at one end. Males transformed to pre-pupa, pupa and then adult. At the pupal stage, Scale cover of male was smaller in size, rectangular in shape, white and exuviae terminal with three raised longitudinal ridges. Eyes could be clearly identified, genitalia were well developed and the body tapered (v-shaped) towards the posterior end (Fig. 7 a,b,c). Genitalia was smaller in pre-pupa than pupa and compound eye developed. The wide of thoracic region increased and differentiation of male body begin. After 4–5 days, adult males emerged from pupae having slender body, winged (Fig. 7 d,e), orange brown head, two well-developed black eyes, one pair of long

membranous wing, three pairs of jointed legs and filiform antennae. Total adult life stage of males lasted for 2–3 days and mean total life cycle (eggs to adult) was completed in 53 days (Tables 2, 3 and Fig 9, 10). In summer, rates of apparent (%AM) and real mortalities of pre-pupa were 10 and 2.60 % while, in winter rate of apparent mortality (%AM) was increased to 21.61 % and rate of real mortality (%RM) was decreased to 1.95 % (Tables 2, 3 and Fig 9, 10), In case of pupa in summer, rates of apparent (%AM) and real mortalities were 21.39 and 4.13% (Table, 2) while, in winter rate of apparent mortality (%AM) was increased to 25.53 % and rate of real mortality (%RM) was decreased to 1.58 % (Table, 2).

Table 1. Morphometry (length and width) of developmental stages infested mango nursery plants in laboratory conditions at temperature of 30 °C and RH of 64 %.

Scale insect Stages	Length (mm)		Width (mm)	
	Range	Mean ± SE	Range	Mean ± SE
Egg	0.2-0.4	0.3 ±0.006	0.08-0.1	0.09 ±0.002
Crawler	0.3-0.5	0.42 ±0.005	0.1-0.3	0.2 ±0.002
White cap	0.3-0.5	0.43 ±0.004	0.1-0.3	0.23 ±0.002
1 st Instar Nymph	0.2-0.4	0.3 ±0.005	0.1-0.3	0.2 ±0.002
2 nd Instar Nymph	0.3-0.5	0.4 ±0.006	0.2-0.4	0.3 ±0.002
Male	0.5-0.7	0.6 ±0.007	0.3-0.5	0.3 ±0.002
Pre-pupa	0.3-0.5	0.4 ±0.003	0.2-0.4	0.3 ±0.002
Pupa	0.4-0.6	0.5 ±0.003	0.2-0.4	0.4 ±0.002
Pre oviposition period	0.8-1	0.91 ±0.016	0.5-0.7	0.65 ±0.015
Oviposition period	0.8-1	0.92 ±0.016	0.6-0.8	0.7 ±0.016
Post oviposition period	0.8-1	0.91 ±0.016	0.5-0.7	0.6 ±0.015

SE, Standard error; RH, Relative Humidity.

Data based on 30 individuals.

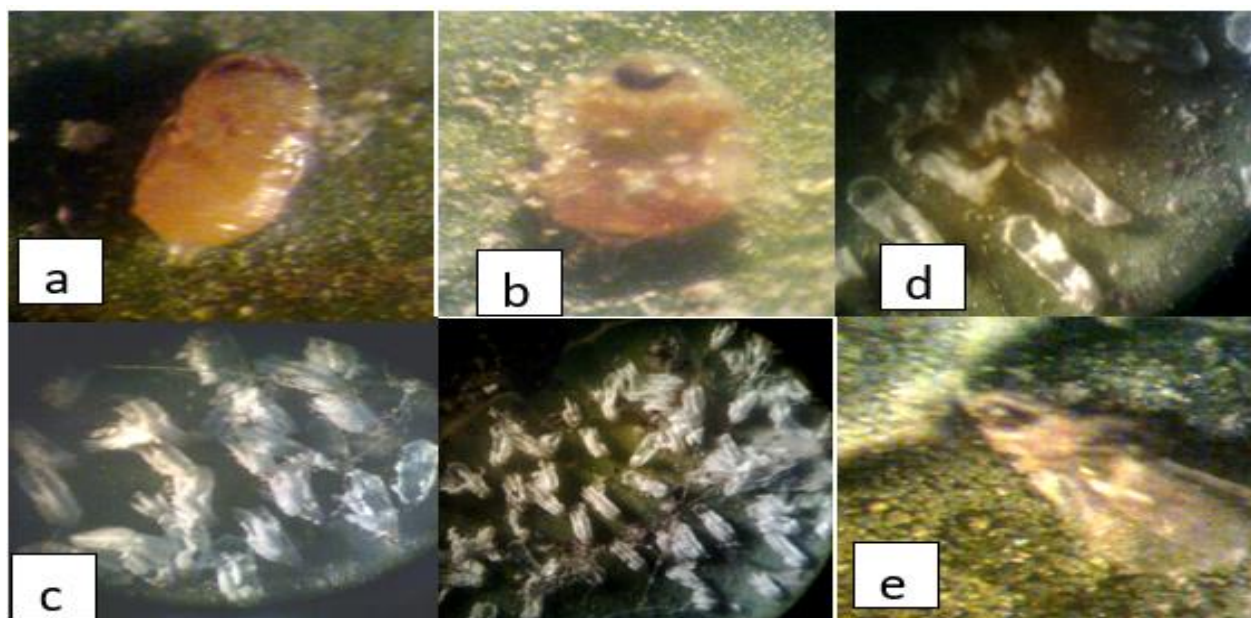


Fig 7. a, prepupa; b, pupa; c, cortex cover scale to pupal stage ; d,cortex cover scale by male exit; e, adult male.

Female

Sexual variation in *A. tubercularis* started after the second molt, when male developed into prepupa and pupa, while female transformed to mature adult (pre-oviposition, oviposition and post-oviposition periods) (Fig. 8 a,b,c,d,e,f,g).

Scale cover of female was nearly circular in shape, white and transparent in colour. Exuviae was submarginal, black in colour, oval in shape. Female body was pentagonal in shape, dark red in colour in case of sexual immaturity and yellow in the case of sexual maturity.

Adult female (Female virgins)

After 1 to 2 days, female body and its cover separated. At this stage, mating with males occurred. Fully mature females were apterous (without wings), apodous (without legs), soft bodied, dark red in color, and wide anteriorly. Mean length and width of mature female were 0.91 mm and 0.65 mm, respectively (Table 1).

Pre-oviposition period

In this period, female was brownish, swollen with angular, and quadrate prosoma. They remained for 7–9 days at 30°C and 64 % RH. Females in this stage are dark red in color and did not carry eggs in their bodies. The female's mean dimensions were 0.91 and 0.65 mm in terms of length and width, respectively (Table 1).

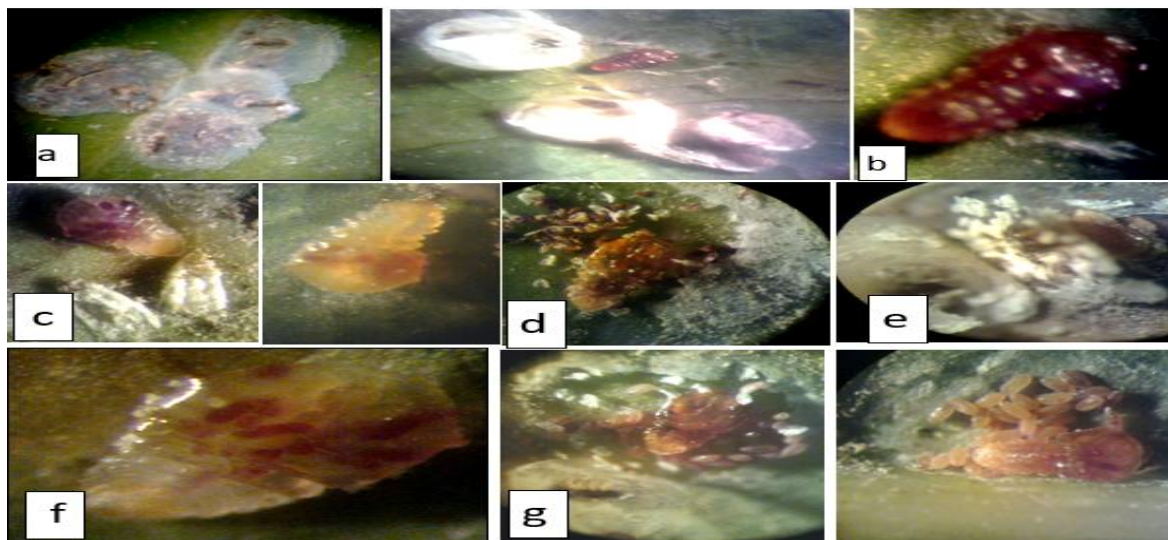


Fig 8. a, scale cover of female; b, female virgins; c, mature female; d, parasitoid egg on female; e, Females superimposed (overlapping females) on top of each other; f, Female eggs holder; g, Females laid eggs in 3–4 batches in the form of circles or monolithic rings around the mother female.

Reproduction (Oviposition) period

At oviposition period, female increased in size. The female's mean dimensions were 0.92 and 0.70 mm in terms of mean length and width, respectively (Table, 1). In this period, female started egg laying. Female color begins to change from dark red to yellowish color, and eggs start forming inside its body.

This period lasted about 10–12 days at 30° and 19° C, respectively and 64% RH conditions (Tables 2, 3 and Fig 9, 10). Females laid 85- 200 (mean 142.5) eggs in 3–4 batches in the form of circles or monolithic rings around the mother's body female.

Pre-oviposition period

This period lasted 8–12 days at 30° and 19° C, respectively and 64% RH (Tables 2, 3 and Fig 9, 10). The recorded sex ratio on nursery plants was 1.43:1 (male: female). Amongst a total of 1748 individuals of 2nd instar nymphs, 236 were female adults and 338 were male adults in summer while, in winter was 1:1.27 male: female. Amongst a total of 1161 of 2nd instar nymphs, 178 were females and 140 were males. Mean total of female life cycle (from eggs to gravid female) was 76 days at 30°C and 64 % RH. Laboratory study of developmental durations of different stages of *A. tubercularis* on mango saplings were similar, in summer and winter. The life span of the insect was prolonged by 2 to 3 days (Tables 2, 3 and Fig 9, 10). In laboratory, egg, crawler, white cap, 1st and 2nd instars and oviposition periods remained for 6–7, 2, 4, 8, and 30–32 days, respectively. While the male phases were prepupa (4), pupa (2-3) and male (2) days, at 25°C and 60 % RH.

Table 2. Life table of *Aulacaspis tubercularis* infested mango sapling planted at the farm of Faculty of Agriculture , Ain Shams University during summer 2018.

Stage (x)	Number of individual (x)	Number of individual dead(Dx)	%Apparent Mortality (%AM)	%Real Mortality (%RM)	Duration
Crawler	2223	159	7.15	7.15	2
White cap	2175	48	2.2	2.1	4
1st Instar Nymph	2064	316	15.3	14.21	8
2nd Instar Nymph	1748	932	53.3	41.91	32
Male	–	–	–	–	2
Pre-pupa	580	58	10	2.60	4
Pupa	430	92	21.39	4.13	2
Pre oviposition period	236	30	21.71	1.3	10
Oviposition period	227	12	4.33	0.53	12
Post oviposition period	209	12	5.74	0.53	8
Incubation eggs	3762	214	17.57	–	6

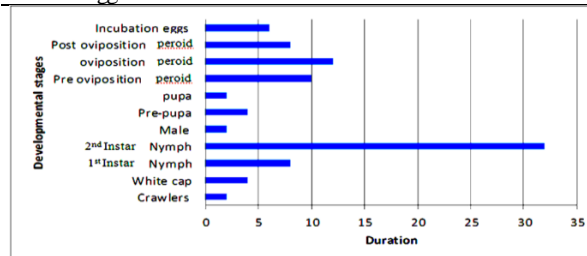


Fig. 9. Developmental durations of *Aulacaspis tubercularis* stages, from newly hatched nymph to adult , reared on Mango saplings under insectary conditions at Faculty of Agriculture , Ain Shams University, Shoubra El Kheima, Qalyubiya, summer 2018 .

Table 3. Life table of *Aulacaspis tubercularis* infested mango sapling planted at the farm of Faculty of Agriculture , Ain Shams University during winter 2018

Stage (x)	Number of individual (x)	Number of dead (Dx)	%Apparent Mortality (%AMf)	%Real Mortality (%RMf)	Duration
Crawler	3023	1234	51	51	2
White cap	2050	973	74.46	32.18	4
1st Instar Nymph	1789	628	35	20	8
2nd Instar Nymph	1161	710	61	23.4	30
Male	--	--	--	--	2
Pre-pupa	273	59	21.61	1.95	4
Pupa	188	48	25.53	1.58	3
Pre oviposition period	178	39	21.91	1.29	8
Oviposition period	164	12	7.31	0.39	12
Post oviposition period	139	25	17.85	0.82	12
Incubation eggs	1668	558	33.45	--	7

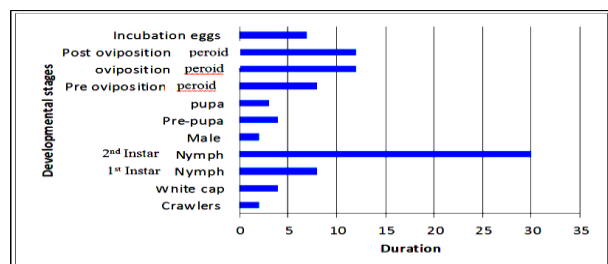


Fig. 10. Developmental durations of stages of *Aulacaspis tubercularis*, from New hatched to adult , reared on Mango saplings under insectary conditions at Faculty of Agriculture , Ain Shams University, Shoubra El Kheima, Qalyubiya, winter 2018 .

Discussion

The white scale insect *A. tubercularis* on the mango trees is considered to a high vital pest , based on the results obtained, which belong to biological study of this insect during the summer and winter seasons, during year 2018. In this study,the population was not affected by high or low temperatures during the two seasons. This pest developed and survived under moderately hot of 20– 35°C and RH of 50–70 % .These results were in agreement with Hamdy(2016); Abo-Shanab (2012); Nabil *et al.* (2012) ; Kwaiz (2009) ; Radwan (2003) who recorded 3-4 overlapping generations of this pest during the year .

Population fluctuations of *A. tubercularis* had been studied in mango orchards located at two governorates, (Damietta and Gharbya) in the northern of Egypt during 2010 (*El-Metwally et al.*, 2011).This study was done in two different climates which increases the risk of this insect to the mango crop in Egypt. This is consistent with the biological studies that we conducted during the summer and winter seasons.

This study was conducted from August 2018 to June 2019, the relationship for female laying eggs during the summer and winter seasons was a linear relationship, which gave a clear indication of how dangerous is this pest for mango.

Results of the present study revealed that after settlement of the crawler on leaf surface, female of *A. tubercularis* remained sessile throughout its life but its male in the last stage had well-developed wings and were able to fly. Females passed through two instars and transform to female while males had two feeding instars then pre-pupal, pupal and adult stages.This results in agreement with description of the first and second female and male instars of white mango scale *Aulacaspis tubercularis* by Moharum (2011)

In addition, Moharum (2011) studied morphometry of *A. tubercularis* It was added that during development, color, shape, length and width of *A. tubercularis* changed as the insect developed to the next stage.

In this laboratory conditions, mature females laid 85-200 eggs in 10–12 days under the scale cover; the eggs hatched after 6–7 days. *A. tubercularis* males passed through two feeding instars with pre-pupal, pupal and adult stages while females had two immature instars with pre-oviposition, oviposition and postoviposition periods. Mean developmental span (egg to adult) of male insect was 53.5 days and for female was 67 days. This periods of the age and survival stages are almost close to the point of congruence in some stages, mean developmental times on mango saplings in summer were 8, 32, 2, 4, and 2 days for male stages and 8, 32, 10, 12 and 8 days for female stages, respectively while in winter were 8, 30, 2, 4, and 3 days for male stages and 8, 30, 8, 12 and 12 days for female stages, respectively. What is more, the presence of insects during the summer and winter seasons not only, but that the periods of the age and survival stages are almost close to the point of congruence in some stages, so we find that in the egg stage ,the incubation period was (6 days) in the summer and (7 days) in the winter. There was a match in the white caps phase (4 days) during the two seasons. The age of the first nymph (8 days) and the age of the second nymph (32) in summer and (30 days) in winter, were the females whose ages ranged between (30 days) and (32) during the two seasons, either. Males, the presence rates for them in the summer were higher than the winter and the sexual ratio was in favor of the males during the summer season compared to the females (1.43 male:1 female) , while was favor of the females during the winner season compared to the males (1 male:1.27 female) and this corresponds to some degree with the biological study conducted by van Halteren (1970) who found that the incubation period is 7-8 days and another 28-32 days for the females to mature, making the generation time 35-40 days; the males takes 23-28 days to develop from egg to maturity which is a shorter maturity period than that of the females.

The sexual ratio may change according to environmental conditions, it may increase to reach (11: 1) in favor of males compared to females as mentioned by van Halteren(1970)Also this percentage increases in southern Egypt, to reach thirty and twenty times, where it was found The sex ratio had been recorded as 34.6:1 (male: females) at Damietta district, while, at Gharbayia governorate, was 20.5:1.(*El-Metwally et al.* ,2011), this coverage for the numbers of males versus females can predict the sexual abilities of this insect with the thermal variation that can keep pace with and acclimatize with it to the highest degree of acclimatization

It is surprising that the survival period for females during the two seasons gives an indication of the extent of the overlapping of generations that may happen, so it is clear that this pest has 3-4 generations (Hamdy,2016

From the study, it was found that the rates of apparent and real death in both seasons were high in some stages and low in another stages, and when looking at the rates of real death in both seasons ,the age of the second nymphal instar was higher in summer, where it was 41.91, whereas in the winter it was 23.4. The real death rates of the white cap stage and the first age of the nymph were higher in winter (32.18,20%, respectively), while in the summer they were 2.1, 14.21%, ,respectively. From the abovementioned results , death rates increase in each of the explored phases, such as the white cap phase, as well as for the first and second age of the nymph, and as a more special feature of the second phase of the nymph, which lasts for a long period (31-32 days, respectively) in both seasons, so it is prone to death from environmental factors.

REFERENCES

- Abo-Shanab, A. S. H. (2012). Suppression of white mango scale, *Aulacaspis tubercularis* (Hemiptera: Diaspididae) on mango trees in El-Beheira Governorate, Egypt. *Egypt. Acad. J. Biolog. Sci.*;5: 43-50.
- Almeida, D.M. (1972): Pests of mango (pragas da mangueira). *Gazeta do Agricultor*, 24:2-5.
- Annecke, D.P. (1963): Observation on some citrus pests in Mozambique and Southern Rhodesia. *J. Ent. Soc. S. Afr.*, 26 (1):194-225.
- Ascher, K. R. S.; Y. Ben-Dov; T. I. Labuschagne; H. Van Hamburg and I. J. Froneman (1995). Population dynamics of the mango scale, *Aulacaspis tubercularis* (Newstead) (Coccoidea: Diaspididae), in South Africa. *Israel J. Entomol.*; 29:207-217.
- Borchsenius, N.S. (1966): A catalogue of the armored scale insects (Diaspididea) of the world. (In Russian.) Nauka, Moscow, Leningrad, Russia, 449 pp.
- Brich, I.c (1948). The intrinsic rate of natural increase of an insect population. *J. Amin. Ecol.*;86 (5): 15-26
- Colyn, J. and Schaffer, B. (1993): The South African mango industry. Fourth International Mango Symposium, Miami, Florida, USA, 5-10 July 1992. *Acta Horticulturae*, 341: 60-68.
- Daneel, M.S. and Dreyer, S. (1997): Further studies on the establishment *Aphytis* sp. and *Cybocephalus binotatus* in mango orchards for the control of the mango scale. *Yearbook- South African - Mango Growers' Association*, 17: 144-146.
- Daneel, M.S. and Dreyer, S. (1998): Biological control of mango scale, *Aulacaspis tubercularis*, in South Africa. *Yearbook- South African-Mango Growers' Association*, 18: 52-55.
- Danzig, E.M. and Pellizzari, G. (1998): Diaspididae. In: F. Kozár (ed.), *Catalogue of Palaearctic Coccoidea*. Hungarian Academy of Sciences. Akaprint Nyomdaipari Kft., Budapest, Hungary, 172-370.
- El-Metwally, M.; Moussa, S.F.M.; and Ghanim, N.M.(2011). Studies on the population fluctuations and distribution of the white mango scale insect, *Aulacaspis tubercularis* Newstead within the canopy of the mango trees in eastern of Delta region at the north of Egypt. *Egypt, Acad. J. biolog. Sci.*, 4 (1): 123- 130.
- Gallardo-Covas, F. (1983). Mangoes (*Mangifera indica* L.) susceptibility to *Aulacaspis tubercularis* (Newstead) (Homoptera: Diaspididae) in Puerto Rico. *J. Agric. Univ.Puerto Rico.*; 67 (2): 179.
- Hamdy,Nagwan, . M (2016) Some ecological aspects on mango white scale, *Aulacaspis tubercularis* and associated natural enemies infesting mango trees in qalyubiya govmmorate [(Hemiptera :Sternorrhyncha :Diaspididae)] *J. Plant Prot. and Path., Mansoura Univ., Vol.7 (6), 377– 383.*
- International Institute of Entomology (1993): *Distribution Maps of Pests. Series A, No. 540*, CAB International, Wallingford, UK., 2 pp.
- Joubert, P.H.; Daneel, M.S.; Grove, T.; and Pichakum, A. (2000a): Progress towards integrated pest management (IPM) on mangoes in South Africa. *Acta Horticulture No. 509: 811-817.*
- Joubert, P.H.; Daneel, M.S.; Grove, T.; Subhadrabandhu, S. and Pichakum, A. (2000b): Progress towards integrated pest management (IPM) on mangoes in South Africa. *Proceedings of the Sixth International Symposium on Mango, Pattaya City, Thailand, 6-9 April, 1999, Volume 2. Acta Horticulture, 509: 811-817.*
- Kwaiz, Fayza, A. (2009).Ecological studies on the mango scale insect, *Aulacaspis tubercularis* (Newstead) (Homoptera: Diaspididae) infesting mango trees under field conditions at Qalyubiya Governorate. *Egypt. J. Agric. Res.*; 87 (1):71–83.
- Labuschagne, T.I. (1993): Progress with integrated control of the mango scale, *Aulacaspis tubercularis* Newstead. *Yearbook- South African - Mango Growers' Association*, 13: 134-135.
- Labuschagne, T.I. and de Beer, M.S. (1995): First successful import of parasitoids of mango scale (*Aulacaspis tubercularis* Newstead) to South Africa. *Yearbook- South African - Mango Growers' Association*, 15: 106–108.
- Labuschagne, T.I.; Daneel, M.S. and De Beer, M.S. (1996): Establishment of *Aphytis* sp. (Hymenoptera: Aphelinidae) and *Cybocephalus binotatus* Grouvelle (Coleoptera: Nitidulidae) in mango orchards in South Africa for control of the mango scale, *Aulacaspis tubercularis* Newstead (Homoptera: Diaspididae). *Yearbook- South African – Mango Growers' Association*, 16 : 20-22.
- Labuschagne, T.I.; Van-Hamburg, H. and Froneman, I.J. (1995) : Population dynamics of the mango scale, *Aulacaspis tubercularis* (Newstead), (Coccoidea: Diaspididae), in South Africa. *Israel J. Entomol.*, 29: 207 – 217.
- Labuschagne, T. I. and Pasques, B. P. (1994): Imported parasites of the mango scale, *Aulacaspis tubercularis*, and the effect of Fenthion on the mango parasitoid, *Aspidiotiphagus citrinus*. *Yearbook-South African-Mango Growers' Association*, 14: 75 – 77.
- Longo, S.; Marotta, S.; Pellizzari, G.; Russo, A. and Tranfaglia, A. (1995) : An annotated list of the scale insects (Homoptera: Coccoidea) of Italy. *Israel J. Entomol.*, 29: 113-130.
- Moharum , F. A. (2012). Description of the first and second female and male instars of white mango scale *Aulacaspis tubercularis* (Newstead) [Coccoidea: Diaspididae] *.Journal of Basic & Applied Zoology;* 65:29–36.

- Morsi, G.A.; Girgis, M.F. and Abdel-Aziz, M. A. (2002): The Population density of the mango scale, *Aulacaspis Tubercularis* (Newstead) (Homoptera: Diaspididae) and its parasitoids in Middle Egypt. 2nd International Conference, Plant Protection Research Institute, Cairo, Egypt, 21-24 December, 2002.
- Nabil, H. A.; Shahein, A. A.; Hammad, K.A.A.; and Hassan, A.S. (2012). Ecological studies of *Aulacaspis tubercularis* (Diaspididae: Hemiptera) and its natural enemies infesting mango trees in Sharkia Governorate, Egypt. *Egypt Acad. J. Biolog. Sci.*; 5(3): 9-17.
- Peña, J.E.; Mohyuddin, A.I. and Wysoki, M. (1997): The current mango pests management in the tropics and subtropics. *Acta Horticulturae*, 455: 812-820.
- Porcelli F. (1990): New Italian scales. *Frustula Entomologica*, 13: 31-38.
- Quednau, F. W. (1964): A contribution on the Genus *Aphytis* Howard in South Africa. (Hymenoptera: Aphelinidae). *J. Ent. Soc. Sth. Afr.*, 27 (1): 86-116.
- Radwan, S. G. A. (2003). Toxicological studies on some scale insects infesting mango and guava trees. Ph.D. Thesis, Fac. Agric., Cairo Univ.
- Tao, C. (1999): List of Coccoidea (Homoptera) of China. Taiwan Agricultural Research Institute, Wufeng, Taichung, Taiwan, China, 176 pp.
- Van Halteren, P. (1970). Notes on the biology of the scale insect *Aulacaspis mangiferae* Newst. (Diaspididae, Hemiptera) on mango. *Ghana J. Agric. Sci.* 3, 83-85.
- Viljoen, H. (1986): Natural enemies of mango scale. *Information Bulletin. Citrus and Subtropical Fruit Research Institute, South Africa*, 164: 8-9.
- Williams, D. J. and Watson, G. W. (1988). The scale insects of the tropical South Pacific region. Part I: The armoured scales (Diaspididae). CAB International, Wallingford, UK.

دراسة جداول الحياه و القياسات الشكلية لحشرة المانجو القشريه البيضاء التي تصيب اشجار المانجو بمصر نجوان محمد حمدي ابراهيم قسم وقاية النبات كلية الزراعة جامعه عين شمس

حشره المانجو القشريه البيضاء *Aulacaspis tubercularis* Newstead تعتبر أفة خطيرة على اشجار المانجو (*Mangifera sp.* (Sapindales: Anacardiaceae) والتي شكلت مؤخرًا اضرارًا بالغه في جميع بساتين المانجو في مصر. تم اجراء دراسات بيولوجيه وحدد جداول الحياه لحشره *A. tubercularis* على شتلات المانجو *Mangifera sp.* في المعمل بمتوسط درجة حرارة 30 درجة مئوية ورطوبة نسبية 64 (RH)٪ خلال فصلي الصيف والشتاء في مزرعه و قسم وقاية النبات كلية الزراعة جامعه عين شمس ، محافظة القليوبية ، مصر. تم تسجيل المراحل المختلفه لنمو حشره *A. tubercularis* و قياساتها الشكلية (الطول و العرض) للاطوار المختلفه لكلا من الذكور و الاناث باستخدام المجهر الميكروسكوبي المزود بالعدسه الراسيه والميكرومتر البصري. و قد تمت الدراسات البيولوجيه في ظروف المعمل ، وكانت النتائج المتحصل عليها كالتالي حيث وضعت الإناث الناضجة 85-200 بيضة في 10-12 يوما تحت الغطاء الشمعي وتم قفس البيض بعد 6-7 أيام. وقد مرت ذكور *A. tubercularis* بمرحلتين مرحله تغذيه (التمثله في الحوريات في عمرها الاول والثاني) ومرحلة سكون متمثله في طور ما قبل العذراء و طور العذراء و يليها طور الذكر البالغ، بينما كان للإناث طوران غير ناضجان (التمثله في الحوريات في عمرها الاول والثاني) مع مراحل الانثى البالغه المتمثله في (فتره ما قبل البيض ، فتره وضع البيض ، ومرحلة ما بعد وضع البيض). متوسط العمر النهائي للذكور الحشرة (من بيضة إلى الفرد البالغ) كان 3,5 يوم ولانثى 6,7 يوم. تقترب فترات العمر ومراحل البقاء تقريبًا و قد تصل الى التطابق في بعض المراحل ، متوسط فترات النمو على شتلات المانجو في الصيف كانت 8 و 32 و 2 و 4 و 2 أيام للذكور و 8 ، 32 ، يوم بالنسبه للاطوار غير الكامله، 10 ، 12 و 8 يوم لفترات ما قبل وضع البيض ، فتره وضع البيض ، فتره ما بعد وضع البيض للانثى على التوالي بينما في الشتاء كانت 8 و 30 و 2 و 4 و 3 أيام للذكور و 8 ، 30 ، يوم بالنسبه للاطوار غير الكامله و 8 ، 12 ، 12 ، 12 يوم لفترات ما قبل وضع البيض ، فتره وضع البيض ، فتره ما بعد وضع البيض للانثى على التوالي. و بناء على الدراسات البيولوجية ، إلى جانب الدراسات البيئية ، أصبح من الممكن تصميم برنامج مكافحة متكامل لمكافحة هذه الآفة في مصر.