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Abundance and Generation Determination of the Mango Shield Scale *Milviscutulus mangiferae* (Green) (Coccidae: Homoptera) an Invasive Coccid Infesting Mango Orchards at Qaliobiya Gevernorate

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ABSTRACT

The obtained results showed that the population fluctuation of *Milviscutulus mangiferae* (Green)was studied on mango trees for the two successive years (2016/2017) and (2017-2018) in Qalubyia Governorate, the activity of *M. mangifrae* took place from early April until January with three periods of high activity synchronized with the three growth flushes of mango trees, these periods of the activity of the tree and the studied pest recorded in spring, summer and autumn. *Milviscutulus mangiferae* on mango trees indicated the occurrence of three generations per a year. The first generation (spring), with duration of 4.5 and 4 months during two years. The second generation (summer) with duration of (2&3 months). The third generation (autumn/wnter) with duration of (5&4.5 months), (marked by hibernated adult females).There were abnormal relationship between the total population and the metrological factors.The activity of the associated parasitoid *Coccophagus scutellaris* (Dalman) started from May until Feb. with synchronization of the pest occurrence, the high activity of the two years of study recorded on [(mid May, 1st Aug., mid Oct. and 1st Jan.) with (12, 16, 35 and 12 individuals)] and [(mid May, mid Jul., 1st Oct. and mid Nov.) with (14, 11, 28 and 23 individuals)] respectively.The rate of parasitism of *C. scutellaris* had a four generations (period of parasitism) per a year of study in spring, summer, autumn and winter (parasitized on over wintered stages).

INTRODUCTION

Mango (*Mangifera indica* L.) a member of family Anacardiaceae, is one of the most important tropical fruits of the world (Karar *et al*., 2015). It is the most popular and best loved fruits worldwide and is known as king of fruits. The oil of mango seed kernel consist of about 44–48% saturated fatty acids (majority stearic) and 52–56% unsaturated, in addition, mango seed kernel could be used as a potential source for functional food ingredients, antimicrobial compounds and cosmetic due to its high quality of fat and protein as well as high levels of natural antioxidants, (Kittiphoom, 2012).

Soft scale insects (Hemiptera: Coccidae) constitute one of the most important group of pest in agriculture, many species are destructive especially to fruit trees and ornamental plants, (Abd-Rabou, 2011).

The mango shield scale *Milviscutulus mangiferae* (Green) (coccidae: Homoptera) is soft scale with old names as following; *Lecanium mangiferae* Green, 1889; *Coccus mangiferae* (Green); *Lecanium psidii* Green, 1904; *Saissetia psidii* (Green); *Lecanium wardi* Newstead, 1922; *Coccus wardi* (Newstead); *Lecanium desolatum* Green, 1922; *Lecanium ixorae* Green, 1922; *Protopulvinaria mangiferae* (Green); *Coccus ixorae* (Green); *Coccus kuraruensis* Takahashi, 1939; *Protopulvinaria ixorae* (Green); *Coccus desolatum* (Green); *Kilifia mangiferae* (Green); *Udinia psidii* (Green), (Text book, 2004). The studied pest *M. mangiferae* identified by Prof. Dr. Jean-François Germain, Unité entomologie et plantes invasives, Laboratoire de la Santé des Végétaux and recorded in Egypt for the first time as a new pest attacking mango orchard in Ismaeliya Governorate (Abd-Rabou and Evans, 2017). *M. mangiferae* is polyphagous soft scale insect attacking plants belonging to over 65 genera placed in 40 families including Anacardiaceae, Euphorbiaceae, Moraceae, Myrtaceae and Rutaceae among of them *Mangifera indica* (mango) (Ben-Dov *et al*., 2001). The mango shield scale damages mangoes as a result of the amount of honeydew and the subsequent growth of sooty mould. Heavy infestation will result in reduced tree vigor and leaf size, causing yellowing of the leaves, leaf drop and death of the branches (Grimshaw and Donaldson, 2007)

Coccus mangiferae (Green) [*M. mangiferae*] had three generations per year on mango and recorded on spring, summer and autumn (Avidov and Zaitzov, 1960).

Coccus longulus (Douglus) has three overlapping generations a year on mulberry in Qaliobiya Governorate. The 1st generation occurred from early May to mid-July, the 2nd generation started from mid-July to mid-October and the 3rd generation occurred from mid-October to late April (Radwan, 2008).

The genus *Coccophagus* Westwood is comprised of many of the most frequently encountered parasitoid of soft scale insects and used in their biological control program, (Abd-Rabou, 2011).

Coccophagus scutellaris (Dalman) (Hymenoptera : Aphelinidae) is one of the best known species in the family Aphelinidaeis specific parasitoids that attack soft scale insects in Egypt with maximum parasitism rates reaching 26% and 22% in Nov. and Aug. 1999, respectively (Abd-Rabou, 2002).

MTERIALS AND METHODS

The study was carried out in the Farm of the horticultural research station Qaliobiya Governorate during two successive seasons from 1st Mar. 2016 till 15th Feb. 2018. The normal agricultural practices were performed and no insecticides were used during the period of study.

12 trees similar in size, shape and vegetation were chosen randomly for biweekly samples of 120 leaves were picked up (10 leaves/tree) from the four directions of each tree and divided in three replicates, leaves were picked up randomly and kept in

polyethylene bag, then transferred to the laboratory for examination. The both sides of plant leaves (upper and lower surface) were examined under a stereomicroscope to count the number of the live (nymphs, adults and gravid females) of the pest and Parasitized (larvae and pupae of the parasitoid). The rate of parasitism was calculated according to the formula of Orphanides (1982)

$$\%\text{Parasitism} = \frac{\text{No. parasitized scale insects}}{\text{Total No.parasitized and non parasitized scale insects}}$$

The numbers of nymphs and adults of each inspected leave were recorded at the front of each date.

The associated parasitoid of the studied pest was identified by Prof, Dr. Angel R. Attia Department of Scale Insects and Mealy bugs, Plant Protection Research Institute, Giza, Egypt.

To calculate the age structure per sample, the mean number of each stage was divided by the total and multiplied by 100. This way gave each stage a percent proportion of the total per sample regardless the total number of the present insects (i.e. population density).

Generation is defined, as the time required for an insect to complete its life cycle. The number of annual generations and their durations of *M. mangifera*e were estimated by applying age structure, through out the two successive years of investigation.

Weather factors data assumed to affect studied insects (*i.e.* maximum and minimum daily temperatures and mean percentage of daily relative humidity) were obtained for the Qaliobiya area from the Egypt-Weather Underground https://www.wunderground.com/global/EG.html. Obtained data was summarized for each fourteen days previous to the sampling date. Considered weather factors means over each determined generation was calculated and presented.

RESULTS AND DISCUSSION

Seasonal density monitoring:-

Data illustrated Fig (1&2) showed the abundant population counts and the monthly incidence of *M. mangiferae* (nymphs, adult and gravid females) on mango leaves during both seasons of 2016 and 2017.

Milviscutulus mangiferae nymphs, adult females and gravid females' stages curves had three and four peaks during two years. Nnymphs recorded on [(mid May., 1st Aug. and mid Oct. with 511.7, 556 and 1613.4 nymphs/leaf) and (mid May., 1st Aug. and1st Dec. with 543.6, 552 and 740 nymphs/leaf)], respectively.

Adult females had four peaks during the two years per a year recorded on [(1st Apr., mid Jul., 1st Oct. & 1st Dec., with 82, 86.6, 145 & 224 adult females/leaf) and (mid Apr., 1st Jul., 1st Nov & mid Dec, with 143.2, 97, 140.4 & 298 adult females/leaf)], respectively.

Finally gravid females recorded on (1st (May, Aug & Oct.) with 90.3, 60.3, & 136 gravid females/leaf) and ((1st May., mid Aug. & mid Nov. with 91.2, 89.4, & 130.4 gravid females/leaf), respectively.

From the previous data there were three period of pest activity recorded in spring, summer and autumn, these three activity period were synchronized with the three growth flushes of mango trees which also occurred in spring, summer and autumn (Dahshan, 1977) who mentioned that mango trees have three successive growth flushes about 34% of these shoots were developed in spring (Mar.-May), more than 45% in summer (Jun-Aug.) and about 19% in early autumn (Sep.-Oct.).

The activity period of *Kilifia acuminata* (Green) coincided with the phenology of mango trees, where it was abundant from October to December when the trees showed a good vegetative growth, and also in April when flowering and early fruiting took place (Attia and Radwan. 2013).

Coccus mangiferae (Green) population reached its peak in October, but there were also considerable in June and the maximum number of scales per leaf was 600(Avidov and Zaitzov, 1960).

The long brown scale, *Coccus longulus* (Douglus) infest mulberry trees in Qaliobiya Governorate nymphal population peaked three times per year and the highest peaks occurred in spring and summer seasons whereas the lowest peak occurred in autumn season (Raradwan, 2008).

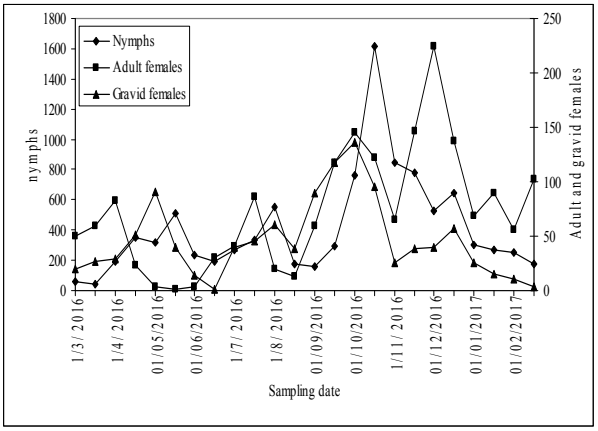

Fig. 1. Seasonal abundance of *Milviscutulus mangiferae* on mango trees 2016-2017

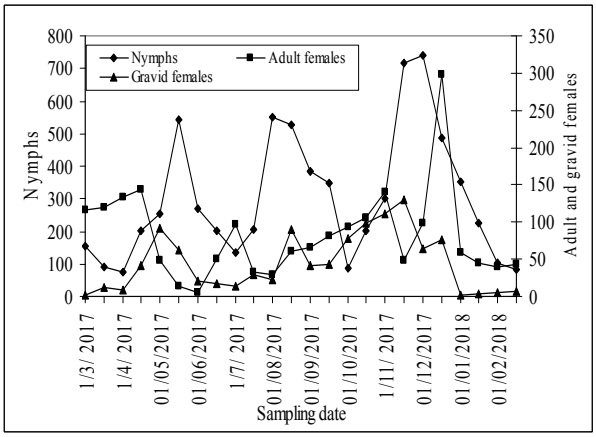

Fig. 2. Seasonal abundance of *Milviscutulus mangiferae* on mango trees 2017-2018

Age structure and generation determination

The age structure technique to the seasonal data of *M. mangiferae* obtained from the Qalubiya governorate over the two years on mango trees were graphically illustrated in Figs. (3 and 4).

Obtained trend over both years indicated the occurrence of three generations for *M. mangiferae* on mango trees at this location.

Over the two years the first generation (spring), with a duration of 4.5 and 4 months during two years of study started from (1st Mar. until mid Jul. 2016 and1st Mar. until 1st Jul. 2017), respectively .

The second generation (summer) with a duration of (2&3 months) and started from (mid Jul. until mid Sep. 2016 and 1st Jul. until 1st Oct. 2017), respectively.

The third generation (Autumn/Winter) which started from (mid Sep. and 1st Oct.) respectively and continued to the next year with a duration of (5&4.5 months), (marked by hibernated adult females). The following count showed that most of these females were in gravid stage in a much synchronized fashion (which indicates the optimal condition for the development of *M. mangiferae*).

Coccus mangiferae (Green) had three generations per year on mango and recorded on spring, summer and autumn (Avidov and Zaitzov, 1960)

Coccus longulus (Douglus) has three overlapping generations a year on mulberry in Qaliobiya governorate. The 1st generation occurred from early May to mid-July, peaked in May/June with duration of 76 days; the 2nd generation started from mid-July to mid-October, peaked in mid-August with duration of 92 days whereas the 3rd generation occurred from mid-October to late April, peaked in December and prolonged to about 197 days (Radwan, 2008).

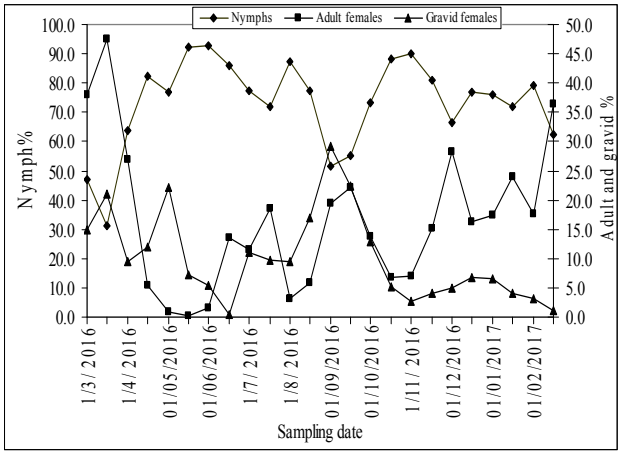

Fig. 3. Age structure of *Milviscutulus mangiferae* on mango trees 2016- 2017

Kilifia acuminata (Green) had three overlapping generations /year on mango trees, each generation lasted about four months on mango trees at Qaluobyia governorate, (Attia and Radwan. 2013).

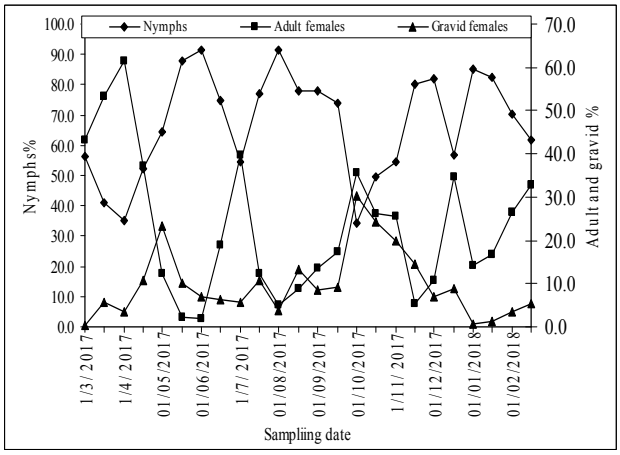

Fig. 4. Age structure of *Milviscutulus mangiferae* on mango trees 2017-2018.

From the previous study we can concluded that also the three recorded generations of studied pest *M. mangifrae* was synchronized with the three main flushes growing periods of mango trees (the high population of the pest, the high nutrients content of the trees.

Relationship between the meteorological factors and total population of *M. mangiferae*

Data presented in (Figs. 5 and 6) showed that there were abnormal relationship between meteorological factors and the total population of *M. mangiferae*, where the total population synchrony with moderate and high temperatures during the first two peaks of *M. mangiferae*, but during the third peak (from 1st October till 1st Jan.) the population highly increased when the temperature started to decreased (moderate temperatures). On the other side, the low temperatures (from 1st Jan. until end of Feb.) synchrony with low population of *M. mangiferae* due to its hibernation as adult females after this time the adult females transformed to gravid females as an indicator to first peak (Spring peak)and generation.

The activity of nymphs and adult *Kilifia acuminata* give the highest peak in November when the temperature started to decreased (moderate temperature) and the second one (lowest) in April when the temperature started to increase (Attia and Radwan. 2013).

The parasitoids role of *Coccophagus scutellaris* (Dalman) (Hymenoptera: Aphelinidae) as biotic mortality factor influencing *M. mangiferae* population density:

Data illustrated in Figs. (5 and 6) clearly showed that the abundant population counts of *C. scutellaris* [total population and its two stages (larva & pupa)] and the rate of parasitism during both seasons.

The total count of parasitoid during the second year was higher than the first year.

The total population of *C. scutellaris* curve had four peaks per a year of study recorded on [(mid May, 1st Aug., mid Oct. and 1st Jan.) with (12, 16, 35 and 12)] and [(mid May, mid Jul., 1st Oct. and mid Nov.) with (14, 11, 28 and 23)], respectively.

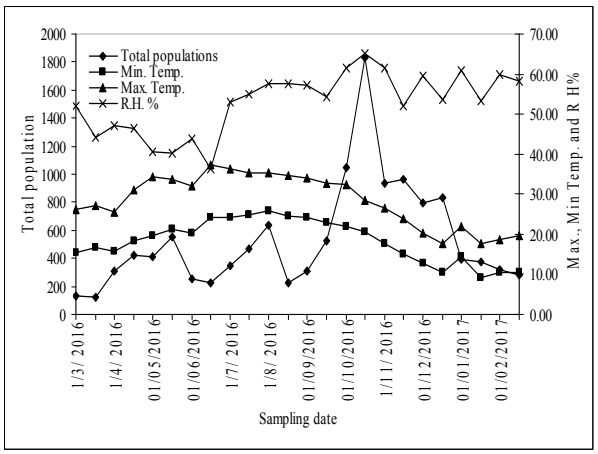

Fig. 5. Relationship between Min., Max. Temp. & R.H. % and total population of *Milviscutulus mangiferae* during 2016/2017.

The rate of parasitism of *C. scutellaris* had a four generations (period of parasitism) per a year of study.

The first period started from (1st Mar. till 1st Jun.) and (1st Mar. till mid Jun.), respectively. The rate of parasitism reached to 2.4 and 5.5% through the first period of the two years, respectively.The second period started from [(1st Jun. till 1st Sep.) with 3.3%] and (mid Jun. till mid Aug.) with 4%], respectively.

The third period started from [(1st Sep. till mid Nov.) with 2.1%] and (mid Aug. till 1st Dec.) with 9.7%], respectively.

The fourth period started from [(mid Nov till. The end of the year) with 3.7%] and (1st Dec. till the end of the year) with 7.1%], respectively (*C. scutellaris* parasitized on over wintered stages).

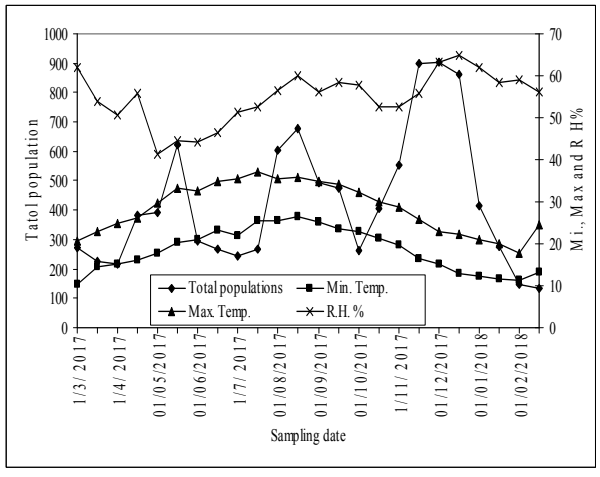

Fig. 6. Relationship between Min., Max. Temp. & R.H. % and total population of *Milviscutulus mangiferae* during 2017/2018.

Coccophagus scutellaris was a dominant parasitoid species of *Coccus hesperidum* and *Ceroplastes floridensis* with peak parasitism rates of 11 % and 10% during Nov. 1999 and 2000, respectively (Abd-Rabou, 2002).

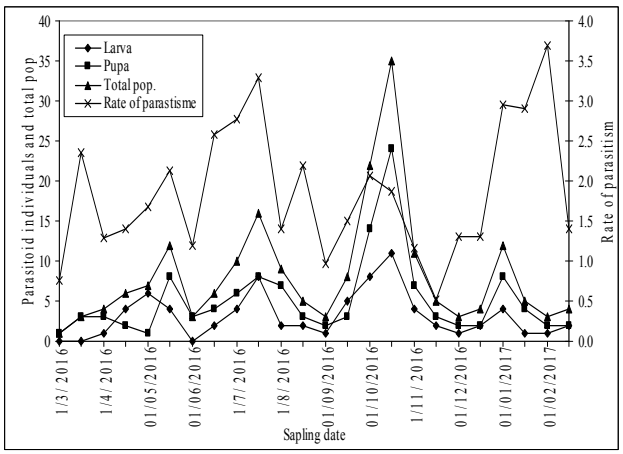

Fig 7. Seasonal fluctuations parasitoids of *Coccophagus scutellaris* (Dalman) 2016-2017.

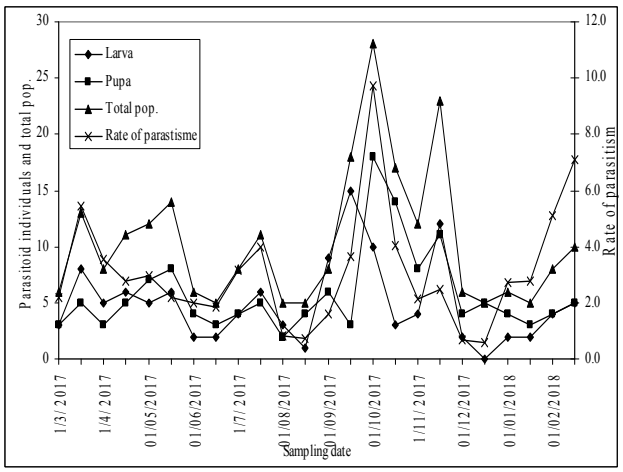

Fig 8. Seasonal fluctuations parasitoids of *Coccophagus scutellaris* (Dalman) 2017-2018.

Coccophagus scutellaris recorded maximum parasitism rates (28%) when associated with S . *coffeae* and *C* . ***hesperidum***(Abd-Rabou ***et al.*** 2001) and (Abd-Rabou, 2001**)**.

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التعرف على تعداد و عدد أجيال حشرة المانجو الرخوة الغازية لبساتين المانجو فى محافظة القليوبية

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تم دراسة التعداد الكلى لحشرة المانجو الرخوة على أشجار المانجو فى محافظة القليوبية خلال عامين متتاليين (٢٠١٦-٢٠١٧) و (٢٠١٧-٢٠١٨) حيث بدأ نشاط الحشرة من بداية إبريل و حتى شهر يناير حيث كان لها ثلاث فترات نشاط تزامنت مع فترات و فرة النمو فى أشجار المانجو و سجلت هذة الفترات للحشرة فى الربيع و الصيف و الخريف.سجلت حشرة المانجو الرخوة ثلاث أجيال لكل سنة من سنوات الدراسة ، الجيل الأول (جيل الربيع) و كانت مدتة ٤.٥ و ٤ أشهر خلال سنتى الدراسة الجيل الثانى (جيل الصيف) و كانت مدتة ٢ و ٣ أشهر و هو أقصر الأجيال نظرا لأرتفاع درجات الحرارة الت تسرع من نمو الحشرات. الجيل الثالث و أطول الأجيال ٤.٥ و ٥ أشهر نظرا لأنخفاض درجات الحرارة و يتميز بوجود الاناث البالغة فى حالة البيات الشتوى.وجد أن العلاقة بين التعداد الكلى للآفة و العوامل الجوية كانت علاقة غير منطقية حيث كان خلال الجيل الأول و الثانى ترابط طردى بين إرتفاع درجات الحرارة و تعداد الآفة بينما خلال الجيل الثالث سجلت الآفة أعلى تعداد لها مع بدء الآنخفاض فى درجات الحرارة. سجل طفيل كوكوفاجس سكوتيولارز المصاحب لحشرة الوانجو الرخوة حيث تزامن نشاط الطفيل مع نشاط الآفة الذى بدأ من شهر مايو و إستمر حتى شهر فبراير. حيث سجلت أربع قمم لنشاط فى منتصف مايو، أول أغسطس، منتصف أكتوبر و أول يناير و كانت قيمتها (١٢، ١٦، ٣٥، ١٢ فرد/ورقة) و منتصف مايو، منتصف يونيو، أول أكتوبر و منتصف نوفمبرو كانت قيمتها (١٤، ١١، ٢٨ و ٢٣ فرد/ورقة)خلال سنتى الدراسة على التوالى. و سجل أيضا منحنى معدل التطفل لطفيل كوكوفاجس سكوتيولارز أربعة أجيال (فترات تطفل) فى الربيع و الصيف و الخريف و الشتاء لكل سنة من سنوات الدراسة.