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Abundance and generation determination of the seychelles fluted scale, *Icerya seychellarum* (Monophelibidae: Hemiptera) infested mango trees at Qaluybyia Governorate

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Abstract:

The seasonal abundance of the seychelles fluted scale, *Icerya seychellarum* (Westwood) (Monophelibidae: Hemiptera) was studied for two years (September first, 2012 until mid-August, 2014) on mango trees at Qaluybyia Governorate. The obtained results showed that *I. seychellarum* has four peaks and presence of three overlapping generations in both years under field conditions. Over the first and second years the first generation (winter/autumn) started from September first until mid-February, 2013 as the terminal of the first generation (marked by maximum population of adult females). The following count showed that most of these females were in ovipositing stage in a much-synchronized fashion (which indicates the optimal condition for the development of *I. seychellarum*. The second generation (spring) started from mid- February and continued until the date of mid- May 2013. Therefore, the mid- May was considered as the end point of this generation and start point for the third generation (summer) which continued to the next year. Reviewing proved that the obtained results, it could be that the first generation continued over 165 days, also the second generation continued 90 days compared with the third one which continued 90 days. Also, there were positive relationship between metrological factors and the total population of *I. seychellarum* (The higher the temperature, the greater total population of *I. seychellarum*, while the lower the temperature, the lower total population of *I. seychellarum*). Four peaks of *I. seychellarum* total population simultaneous with moderate and high temperatures. While the low temperatures (from December first until the end of February) the population of *I. seychellarum* was low due to its hibernation as adult females. The data showed simultaneous occurrence of the total population of *I. seychellarum* and its associated predator, *Rodalia cardinalis* (Mulsant) (Coleoptera: Coccinellidae).

Introduction

Mango (*Mangifera indica* L.) is of the most important and popular fruits in Egypt (Attia, 2010). Mango is tropical/sub tropical fruit with highly significant economic importance, the fruit rich in antioxidants and recommended to be include in the daily diet due to its health benefits such as reduce risk of cardiac disease, anti cancer, and anti viral activities (Sivakumar and Yahia, 2011).

The seychelles fluted scale, *Icerya seychellarum* (Westwood) is a polyphagous phloem-feeding coccid belongs to the family: Monophelibidae, order: Hemiptera. They feed on the underside of leaves sucking out plant sap. At high infestation levels, serious damage resulting in early leaf drop and yield reduction is caused by the feeding of this insect, but the major damage is caused by the production of large amount of honeydew upon which saprophytic fungi develop, which fluctuates with photosynthesis and respiration (Zaki *et al.,* 2013 and El-Sayed, 2015) and otherwise reduces the quality of the plant causing considerable economic injury, moreover, high population of *I. seychellarum* can reduce the vigor of the plant, making it susceptible to other pests (Osman, 2005). Population of *I. seychellarum* showed four and three annual generations on mango trees in Giza and Qena Governorates, respectively (Abdel-Rahman *et al.*, 2007 and Bakry, 2009). Also, the four tested factors (maximum temperature, mean temperature, minimum temperature and mean relative humidity) simultaneously were responsible for about 32.8-65% of this insect activity (Sayed, 2008).

Rodalia cardinalis (Mulsant) (Coleoptera: Coccinellidae) is a specialist predator that has a very restricted prey range, one that is probably limited to the family Monophlebidae, and possibly the tribe Iceryini. Strong prey fidelity by *R. cardinalis* has two major advantages in a classical biological control program: (1) high safety results because little threat is posed to non-target species because they are unsuitable food sources, and (2) high levels of population suppression occur because tight ecological and biological linkages ensure that maximum feeding and reproductive pressure are maintained on the target because *R. cardinalis* is unable to attack and breed on other prey species (Hoddle, 2004).

The present work was carried out to study ecological aspects of *I. seychellarum* determines its generations under the studied conditions using age structure method and the proper timing for its control as well as dynamics of R. *cardinalis*.

Materials and methods

1. **Seasonal fluctuation of** *Icerya seychellarum* **in Qaluybyia Governorate:**

The present work was carried out for two successive years in heavy infested mango orchards during (September first, 2012 to mid-August, 2014) in (El-Qanater area) Qaluybyia Governorate.

The seasonal fluctuation of *I. seychellarum* population was carried out on 12 trees similar in size, shape and vegetation. Biweekly samples of 120 leaves were picked up (10 leaves/tree) from the four directions of each tree divided in three replicates. The collected samples were put in paper bags and transferred to the laboratory for inspection with stereo-microscope. The population of *I. seychellarum* per each sample was sorted into their developmental stages (nymphs, adult females and oviposting females). The total number of the individuals in each sample was taken as the population index. Obtained data was pooled for each inspection, direction and leaf surface. Any observed predator individual was recorded and counted. Identification of true mealybugs insects and their predator was done by taxonomy specialists at Scale Insects and Mealybugs Research Department, Plant Protection Research Institute, Agricultural Research Center, Dokki, Giza, Egypt.

2. Age structure calculation:

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 presented insects (*i.e.* population density). The number of generations was determined using the obtained data throughout the two successive years using the age-structure technique per sample over the year.

Generation was defined, as the time required for an insect to complete its life cycle (*i.e.* egg to egg). In the case of monophelibid, eggs were oviposited under the female in ovisac until they hatch and crawl out. Oviposting females were defined as females with ovisac. The presence of oviposting females (*i.e.* the transformation of adult females to oviposting females) was considered in this study as presence of the egg stage. This phenomenon was used to determine the end of each generation and the beginning of the next one (El-Amir, 2009).

3. **Meteorological factors**

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 Qaluybyia 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

1.Seasonal abundance of *Icerya seychellarum*:

Data in (Figures, 1 and 2) illustrated that nymphs, adult females and oviposting female stages curves had four peaks during two years. Nymphs recorded on [(mid - October, March first, mid- June and August first with 45, 37, 30 and 34 nymphs/leaf) and (mid - October, mid - March, June first and August first with 52, 38, 35 and 37 nymphs 4/leaf)], respectively.

Also, adult females recorded [(on mid (September, December and April) and October first with 5, 9, 12 & 10 adult females/leaf) and (on mid (September, November and April) and October first with 9, 17, 12 and 10 females/leaf)], respectively. Finally, oviposting females recorded on (first of October, March, June and August with 11, 5, 9 and 10 oviposting females/leaf) and (first of October, March, June and August with 12, 8, 9 and 9 oviposting females/leaf), respectively.

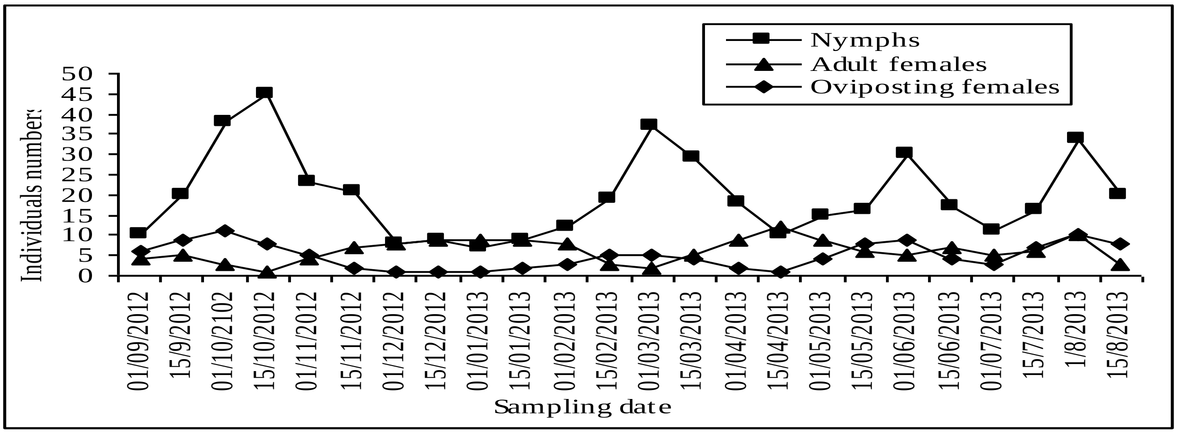

Figure (1): Seasonal abundance of *Icerya seychellarum* on mango trees during 2012-2013.

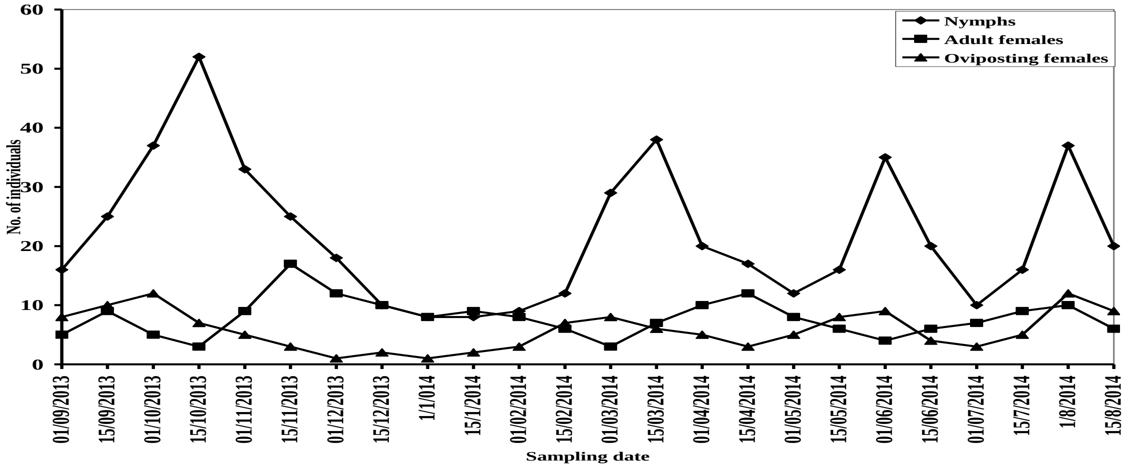

Figure (2): Seasonal abundance of *Icerya seychellarum* on mango trees during 2013 2014.

Population of *I. seychellarum* had four annual peaks on five mango cultivars during the two successive seasons at Giza Governorate (El-Said, 2006). Seasonal fluctuations of *I. seychellarum* recorded four activity peaks on mango. These peaks occurred in March, June, August and Sepetmber/ October during the two successive seasons at Giza governorate, Egypt (Abdel-Rahman *et al*., 2007).

2.Age structure:

The results of applying the age structure technique to the seasonal data of *I. seychellarum* obtained from the Qaluybyia location over the two years on mango were graphically illustrated in Figures (3 and 4). Obtained trend over both years indicated the occurrence of three generations for *I. seychellarum* on mango trees at this location. Over the first and second years the first generation (winter/autumn) started from 1st September first 2012 until mid-February 2013 as the terminal of the first generation (marked by maximum population of adult females). The following count showed that most of these females were in ovipositing stage in a much-synchronized fashion (which indicates the optimal condition for the development of *I. seychellarum*. The second generation (spring) started from mid-February and continued until the date of mid-May 2013. Therefore, the mid-May was considered as the end point of this generation and start point for the third generation (summer) which continued to the next year. Reviewing proved that the obtained results, it could be that the first generation continued over 165 days, also the second generation continued 90 days compared with the third one which continued 90 days. *I.seychellarum* had three generations in May, August and October on mango during the two successive seasons at Qena Governorate (Bakry, 2009).

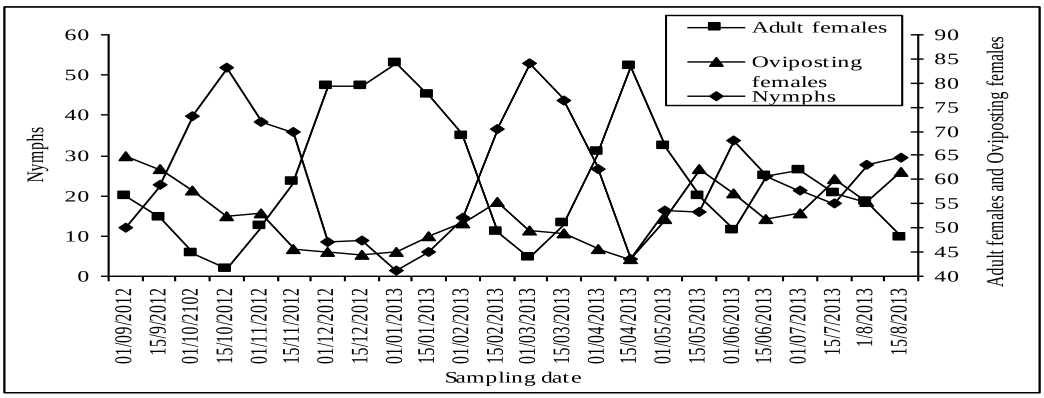

Figure (3): Age structure of *Icerya seychellarum* on mango trees 2012/2103

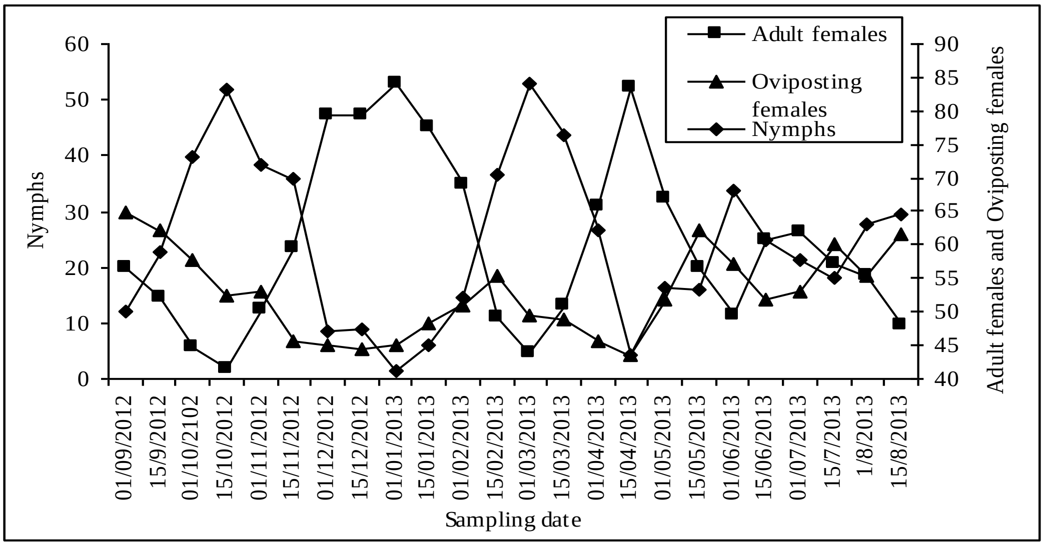

Figure (4): Age structure of *Icerya seychellarum* on mango trees 2013/2014

3.Relationship between the metrological factors and total population of *Icerya seychellarum*:

Ilustrated data in (Figures, 5 and 6) proved that there was positive relationship between metrological factors and the total population of *I. seychellarum* (The higher the temperature, the greater total population of *I. seychellarum,* while the lower the temperature, the lower total population of *I. seychellarum*). Four peaks of *I. seychellarum* total population simultaneous with moderate and high temperatures. While the low temperatures (from December first until the end of February) the population of *I. seychellarum* was low due to its hibernation as adult females after this time the adult females transformed to ovipositing females as an indicator to next peak and generation.

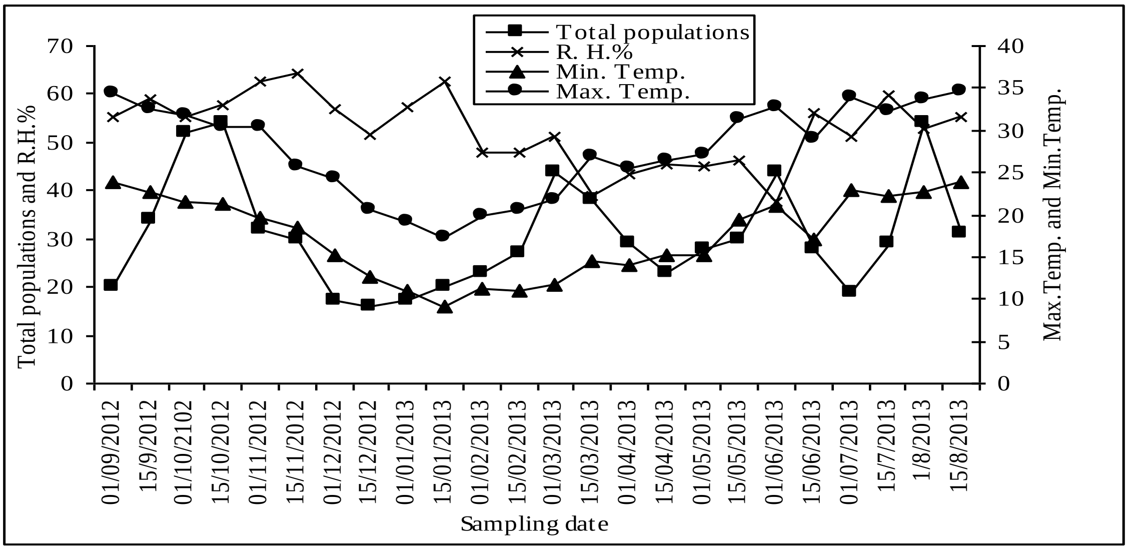

Figure (5): Relationship between Max., Min. Temp., R.H. % and total population of *Icerya seychellarum* during 2012/2013

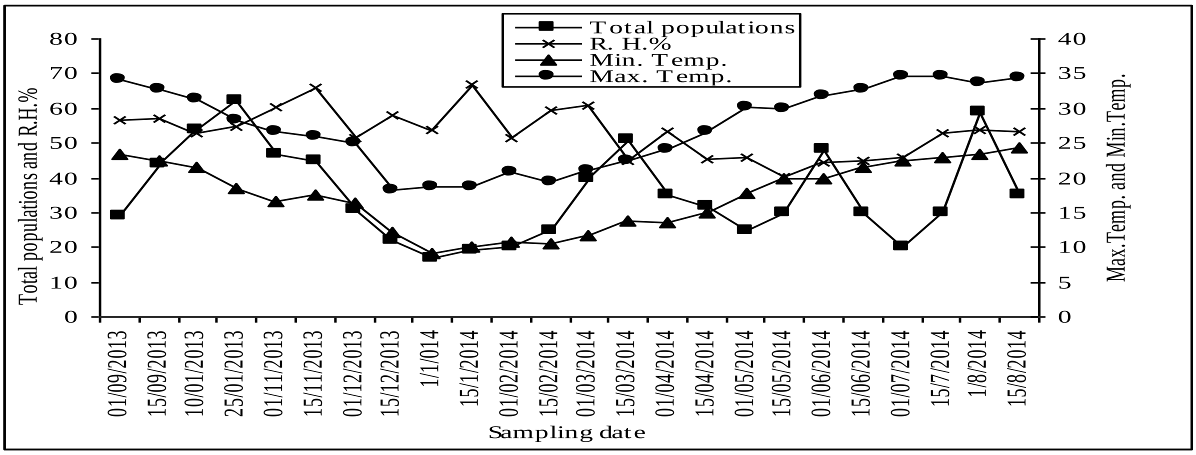

Figure (6): Relationship between Max., Min. Temp., R.H. % and total population of *Icerya seychellarum* on mango 2013/2014

The effect of temperature on *I. seychellarum* activity on five mango cultivars was positive and the effect of the daily mean relative humidity was negative during the two successive seasons of investigation at Giza Governorate (El-Said, 2006). Population density of *I. seychellarum* on mango trees showed positive with temperature during the two successive seasons at Giza governorate. The effect of daily mean relative humidity was negative for both years of investigation (Abdel-Rahman *et al*., 2007).

4. Relationship between the total population of *Icerya seychellarum* and *Rodalia cardinalis*:

Data in (Figures, 7 and 8) illustrated that there was simultaneous occurrence of the total population of *I. seychellarum* and its associated predator *R. cardinalis*.

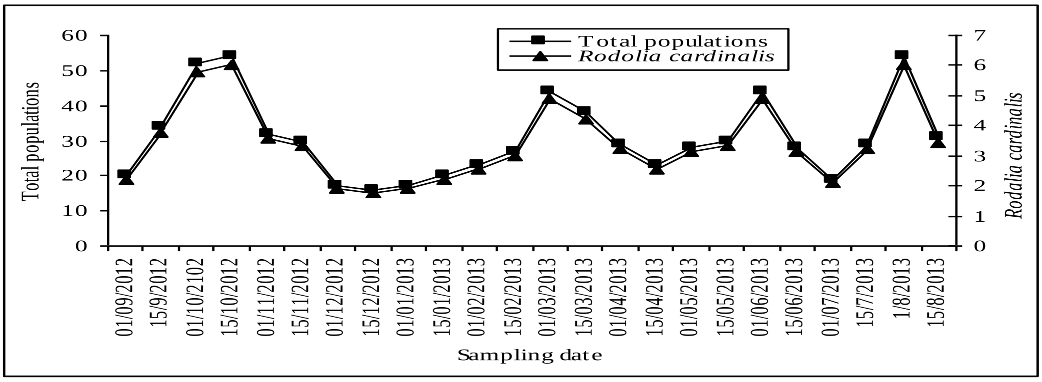

Figure (7) Relationship between the total population of *Icerya seychellarum* and *Rodalia cardinalis* during 2012-2013.

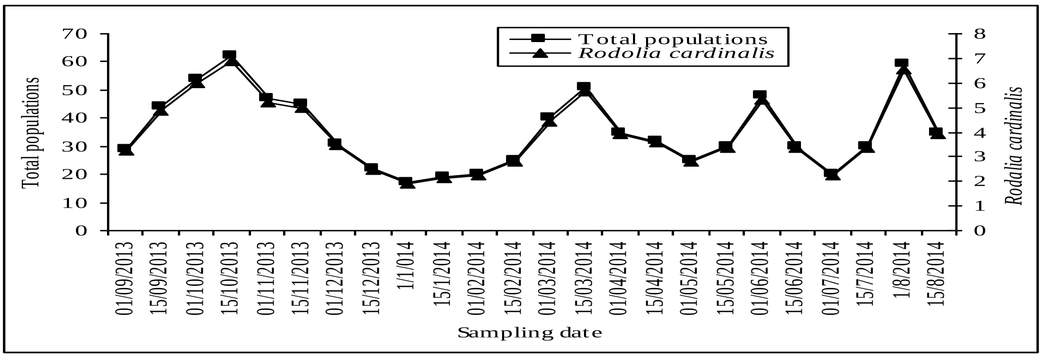

Figure (8) Relationship between the total population of *Icerya seychellarum* and *Rodalia cardinalis* during 2013-2014

R. cardinalis has four peaks annually were recorded in 15th Mar. 15th Jul., 15th Oct. and 1st Nov. during the two years on guava leaves in associate on with *I. seychellarum* at Egypt (El-Sherbeny, 2004). *R. cardinalis* the main dominant insect predator on *I. seychellarum* (Abdel-Mageed, 2005). Predators, *Rodalia* spp. are highly effective for the control of *Icerya* spp. (Hirose, 2006).

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