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Scale insects (Coccoidae: Hemiptera) infested citrus trees and thier natural enemies, with a key of these pests in Egypt

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ABSTRACT

Scale insects (Coccoidae: Hemiptera) are the most important pests infested citrus trees in Egypt. The present work dealt with the scale insects infested citrus trees and thier natural enemies as well as a key of these pests in Egypt . The results indicated that seven species of scale insects were recorded infested citrus trees in Egypt. Also taxonomic key of the seven species of scale insects was included. During the present work the results indicated that the populations of red scale, *Aonidiella aurantii* (Maskell) has two peaks one in April and the second one in October. In this work two parasitoids recorded associated with red scale. Theses are *Aphytis lingnanensis* Compere and *Habrolepis aspidioti* Compere and Annecke.It is recorded here two peaks for each parasitoid in April and October for *A. lingnanensis* and in July and November for *H. aspidioti* in Beni- Suef. Also this work indicated that citrus wax scale, *Ceroplastes floridensis* Comstock has two peaks the first in May and the second in October. In the present work two parasitoids recorded associated with citrus wax scale. These are *Metaphycus helvolus* (Compere) and *Microterus flavus* (Howard). It is recorded here two peaks for each parasitoid in May and October for in Gharbiya .The present work observed , black scale *Chrysomphalus aonidum* (L.) has two peaks the first in May and the second in November. In the present work two parasitoids recorded associted with the black scale. These are *Aphytis chrysomphali* (Mercet) *and Encarsia citrina* (Craw). It is recorded here two peaks for each parasitoid in May and November in Qalyubyia. The present work recorded seychellarum mealybug, *Icerya seychellarum* (Westwood) infested citurs trees in Demmyat and has two annual peaks one in June and the other in November. Also here *Rodalia cardinalis* Mulsant associated with seychellarum mealybug, *I. seychellarum*. During the presnt work the results indicated that he purple scale, *Lepidosaphes beckii* (Newman) has two peaks on citrus trees in Ismaillia . Also one parasitoid, *Aphytis lepidosaphes* Compere and one predator *Chilocorus bipustulatus* L. were recorded. During the present work the results indicated that parlatoria black scale, *Parlatoria ziziphi* (Lucas) has two peaks on citrus trees in Cairo. Two parasitoids, *A. lingnanensis* and *E. citrina* were recorded. During the presnt work the results indicated that citrus mealybug, *Planococcus* citri (Risso) has two peaks on citrus trees in Behira . Two parasitoids, *Anagyrus pseudococci* (Girault) and *Leptomastix dactylopii* Howard .

Key words: scale insects, citrus trees, natural enemies**,** Egypt.

INTRODUCTION

Citrus is the most important fruit in Egypt as far as its acreage, production and exportation potentials are concerned (El-Kassas, 1984). Scale insects are often inconspicuous pests of many evergreen and deciduous plants. They can occur on leaves, twigs, branches or trunks. Their small size and general lack of mobility make them difficult to notice by the casual observer. Scales derive their name from the shell-like, protective covering they form over themselves (Wawrzynski and Ascerno, 2009). Scale insects can weaken plants when they suck their juices, causing leaves to yellow and fall off, resulting in the eventual death of the plant. Honeydew on plants may attract ants as well as sooty mold, which is a black fungus that can result in the death of the plant. Citrus trees are at risk of sustaining damage by scale insect infestations. Scale insects damage citrus trees by extracting vital fluids from the tree, resulting in poor fruit quality and tree health. Hafez *et al.* (1970a) mentioned that *Chrysomphalus aonidum* (Linnaeus) (Hemiptera *:* Diaspididae) was found to have 4 peaks. Salman (1970) reported that the population of *C. aonidum* on orange and mandarin, was relatively low from April to August, followed by gradual increase during September and reached its peak during October. The period of big numbers extended to the next January. *Aonidiella aurantii* (Maskell) has 3-4 generations on citrus trees (Habib *et al.,* 1971). The population peaks of *A. aurantii* occurred during the period, October, December, January-Febrauray, April-June and August-September (Abul-Nasr *et al.* 1975). Darwish (1976) found that *A. aurantii* had 3 annual peaks of abundance. This pest had five overlapping generations per year in Middle Egypt (Hussein, 1976). Abul-Nasr *et al.* (1977) recorded that the peaks of *C. aonidum* occurred during October, December, Febrauary-May and May-September. *A. aurantii* had 3-4 annal generation on citrus in Daqahlyia throughout the two years under investigation (Selim, 1993). Osman, Evon (1996) recorded four overlapping generations for *A. aurantii* at Beni-Suef governorate. Morsi (1999) studies seasonal abundance of some armored scale insects and the effect of weather factors on these scales in Beni-Suef. He observed *A. aurantii* and *C. aonidum* had 3-4 peaks and 3-4 peaks annually, respectively. The parasitoid, *Habrolepis pascuorum* Mercet (Hymenoptera : Encyrtidae) played the major role in biological control of *C. aonidum* (Hafez *et al.,*1970b). Abdel-Megeed (1977) studied the efficiency of the parasitoids, *Aphytis lepidosaphes* Compere and *Encarsia citrina* (Craw) (Hymenoptera: Aphelinidae) in controlling the purpal scale, *Lepidosaphes beckii* (Newman) (Hemiptera : Diaspididae) on citrus trees at Menofiya. The effect of parasitism was low during summer and winter, while it was high during autumn. It reached its maximum in October and its minimum occurred in February. Karam (1979) recorded two parasitoids from purple scale, *L. beckii,* namely, *A. lepidosaphes* and *Encarsia* sp. Two external parasitoids were reared from the red scale, *A. aurantii.* These were *Aphytis nr. coheni* DeBach and *A. Hispanicus* (Mercet). A hyperparasitoids*, Marietta leopardina* Motschulsky (Hymenoptera: Aphelinidae) parasitizing, *Aphytis* spp. was recorded in very few cases. Hafez *et al.* (1987) studied the abundance of the virous stages of ectoparasite, *Aphytis* sp. on *L. beckii* in an orange orchard of *Citrus sinensis.* Osman (1996) mentioned that the ectoparasitoid, *Aphytis lingnanensis* Compere had four overlapping activity periods with four peaks in Qalyubiya governorate when associated of *A. aurantii*). While *Aphytis chrysomphali* (Mercet) manifested the highest parasitism rate on *C. aonidum* during autumn season in both years under

consideration . Abd-Rabou (1997) studied the parasitoids attacking some species of scale insects. He mentioned that total parasitism of *A. aurantii* by *A. chrysomphali, A. lingnanensis, E. citrina* and *Encarsia lounsburyi* (Berlese & Paoli) reached a maximum during September at South Sinai and Qalyubiya and total parasitism of *L. bekii* and *Parlatoria ziziphi* (Lucas) by different aphelinid species reached a maximum during August in Behira and Giza, respectively. Predatory mite *Typhlodromus* sp. and cocinellid species associated with *A. aurantii* (Mohamed, 2002). Tawfik *et al.* (1970) recorded the insect predators associated with the black scale, *C. aonidum* in Egypt. These predators are *Chilocorns bipustulatus* L., *Scymnus syriacus* Muls., *Pharoscymnus varius* Kirsch., *Rodalia cardinalis* Muls. and the larvae of *Chrysopa carnea* Steph., *C. bipustulatus* L. seem to be the most important predator of this scale infesting citrus orchard. The wax scale, *Ceroplastes floridensis* Comstock (Hemiptera : Coccdidae) occurs in a high population from September to January, and then the numbers go down (Hendawy, 1999). The citrus wax scale, *C. floridensis* on *Ficus nitida* had three generations (Abd El-Razak, 2000). Hafez *et al.* (1987) recorded four species of hymenopterous parasitoids attacking *C. floridensis,* namely *Tetrasticus ceroplastae* Girault*, E. citrina* (Craw) and *Microterus flavus* (Howard). Abd El-Razak (2000) recorded *T. ceroplastae* as a parasitoid of *C. floridensis.* The coleopterous insect predators feeding on soft scale infesting citrus, mango and ledge plants in Mansoura region were *Cydonia vicina isis Cr., Coccinella septempunctata* L., *C. undecimpunctata, Scymnus interruptus* Goez, *S. cyriacus, Exochomus flavipes* Thunb., *Rodalia cardinalis* Muls. and *Paederus alfierii* Koch. He added two neuropetrous predators, *Chrysopa carnea* Steph. and *C. septempunctata* Wesm.; two hemipterous predators, *Orius laevigatus* Fieb. and *O. albidipennis* (Reuter) and two dipterous predators, *Metasyrphus corollae* Fab. and *Paragus compeaitus* Wied. (Abd Allah, 1988). The predators, *C. bipustulatus, S. syriacus, Pharaoscymnus varius* Kirsch and *R. cardinalis* were found feeding on some soft scale insects and *Chrysop* sp. larvae are very common and polyphagous predators feeding on many soft scale insects (Hamed and Hassanein, 1991)**.** *C. bipustulatus, S. syriacus, C. carnea, C. septempunctata* and *O. laevigatus* , recorded associated with different species of soft scale insects in Kafr El-Sheikh **(**El-Agamy *et al.*, 1994). The range of host plants of the monophlebid, *Icerya seychellarum* (Westwood) includes 44 host plant species (Assem , 1991). Mangoud (2000) found that the margarodid, *I. sechellarum* has two brood peaks (activity period)/year, on branches in during two seasons. Abd-Rabou (2001a) constructed keys to 26 hymenopterous parasitoid species that attack twenty mealybug species. He mentioned that twenty-five species of mealybugs have no records of parasitoids. The predator *R. cardinals* recorded associated with *Icerya* spp. (Hamid and Hassanian, 1991) .

The aim of this work is to study the scale insects infested citrus trees and thier natural enemies as well as a constructed key of these species in Egypt.

MATERIALS AND METHODS

Infested leaves of citrus were examined in the field using a pocket magnification lens. Infested leaves and twigs were collected from different locations in Egypt during 2010 - 2011. Identification of scale insects was done by examining adults in Canada Balsam. Also infested leaves and twigs will be examined in the field, using a pocket lens. The leaves and twigs will be collected and placed separately in paper bags for

further examination in the laboratory. Materials will be kept in a well-ventilated container until the emergence of any natural enemies. Identification of natural enemies will be made by examining mounted adults in Hoyer's medium. Abundance of the populations of scale insects and their natural enemies infested citrus trees were carried out on citrus during 2009-2010 and 2010-2011 in Behira, Beni-Suef, Cairo, Demmyate, Gharbiya, Ismaillia, Qalyubyia. The plant areas selected for these investigations received no chemical control measures for several years. Twenty trees of citrus almost similar in age, size, shape and growth condition were randomly chosen for sampling at a month intervals for each location. On each sampling, 30 leaves and 15 twigs of citrus were chosen at random. Thereafter, the leaves and twigs were kept in a closed paper bags and transferred to the laboratory for further examination and counting. Each leave was stored in a well-ventilated emergence glass tube and monitored daily for parasitoid emergence. Rate of parasitism was determined by dividing the number of emerging parasitoid from each by the number of hosts existing. Predators were counted in filed and transferred to the laboratory for further examination. Simple correlation and regression values were calculated to obtain information about the relationships between the three tested weather factors and the population of the pest and its natural enemies. The constructed key of some parts specially armored scale insects was modified after Miller and Davidson (2005).

Results and Discussion

List of scale insects infested citrus in Egypt:

1. *Aonidiella aurantii* (Maskell) (Red scale) (Hemiptera: Diaspididae)
2. *Ceroplastes floridensis* Comstock (Citrus wax scale) (Hemiptera: Coccidae)
3.*Chrysomphalus aonidum* (L.) (Black scale) (Hemiptera : Diaspididae)
4.*Icerya seychellarum* (Westwood) (Seychellarum mealybug) (Hemiptera: Monophlebidae)
5. *Lepidosaphes beckii* (Newman) (Purple scale) (Hemiptera : Diaspididae)
6. *Parlatoria ziziphi* (Lucas) (Parlatoria black scale) (Hemiptera : Diaspididae)
7. *Planococcus* citri (Risso) (Citus mealybug) (Hemiptera : Pseudococcidae)

Key to Scale insects infested citrus in Egypt

1. With legs.....5
- Without legs.....2
2. With at least one pore near posterior or anterior spiracels ….....3
- Without pores near spiracels.....4
3. Body elongate, length usually two times or more that greatest width, widest part of body usually located and metathorax or abdomen. Bodymargin with only one lateral spure on each side of abdomen..... *Lepidosaphes beckii*
- Body oval or turbinate, length usually less than two times greatest width, widest part of body usually located at head, prothorax or mesothorax. Plate or gland spines in space between median and second lobes with at least two apical fimbriations, with conspicuous ear-like lobes on body margin laterad of mouth parts.....*Parlatoria ziziphi*
4. With privulvar pores, at paraphyses conspicuous, at least one paraphysis as long as or longer than length of median lobes, with cluster of macroduct on submarginal areas of abdominal segment two only..... *Chrysomphalus aonidum*

- Without privulvar pores, with two conspicious sclerses associated with apophyss anterolaterad of vulva, longest macroduct in the first space 81µ long, duct between median lobes 78 µ long ….....*Aonidiella aurantii*

5. With ostioles, many ventral oral-collar tubular ducts between the antennae and on the head and by having many ventral oral collars latered of the middle coxa..... *Planococcus* citri

- Without ostioles.....6

6. Eversible anal ring set at end of anal tube; spiracular atrium connected to body margin by furrow containing wax pores; Posterior stigmatic wax bands present, wax normally not divided into plates, Wet wax we thought a horn; dry wax present dorsomedially, wet wax white or white with a pink tinge, Wet wax either flattened or hemispherical, with dorsomedial dry wax not tilting or tilting posterior; posterolateral wax filaments each with a bifid apex….....*Ceroplastes floridensis*

-Anal tube well developed, with a simple sclerotized ring or band of pores at inner end; thoracic spiracles without pores in atrium, 3 pairs of abdominal spiracles; 3 cicatrices posterior of vulva; body covered with long hairs.....*Icerya seychellarum*

1. *Aonidiella aurantii* (Maskell) (red scale) (Hemiptera : Diaspididae)

The seasonal abundance of the red scale *A. aurantii* was studied for two successive years from 2010 to 2011 on citrus trees in Beni-Suef .The obtained results in Figs (1 and 2) showed that, the insect population reached maximum during April (1750 and 2280/ 30 leaves and 15 twigs) in the first and second years, respectively. Numbers by *Aphytis lingnanensis* Compere and *Habrolepis aspidioti* Compere and Annecke reached maximum (32 and 11/ 30 leaves and 15 twigs) during April and November of the first year, respectively. While in the second year reached maximum (35 and 9/ 30 leaves and 15 twigs) during April and October, respectively.

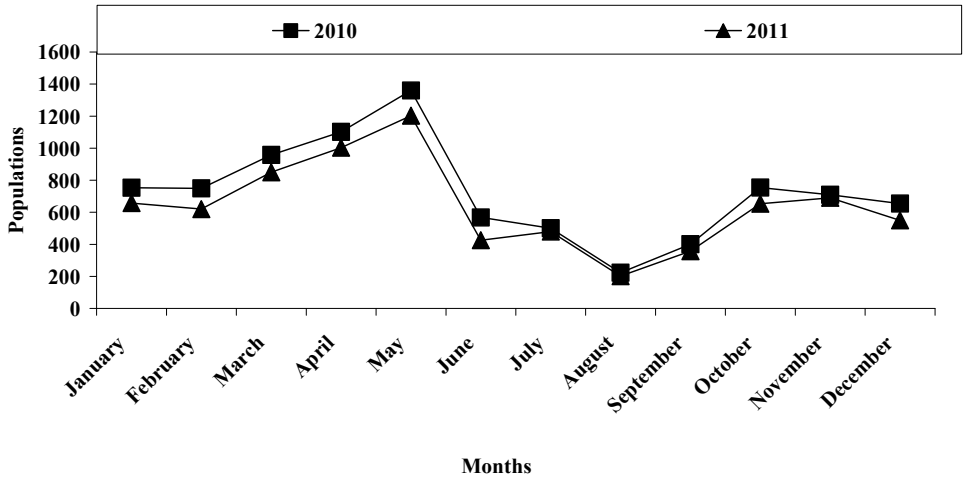

Fig. (1): Population dynamics of *Aonidiella aurantii* on citrus trees in Beni-Suef Governorate during 2010 and 2011 seasons.

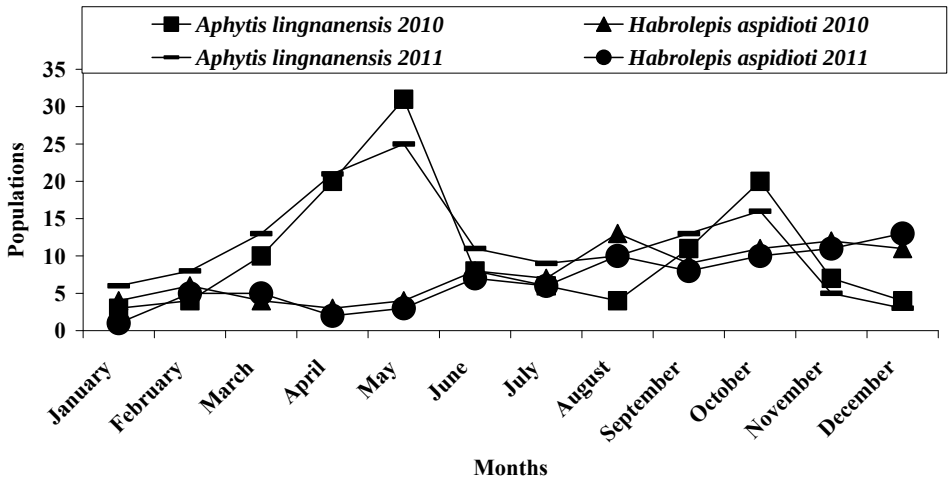

Fig. (2): Population dynamics of *Aonidiella aurantii* parasitoids on citrus trees in Beni-Suef Governorate during 2010 and 2011 seasons.

Data in table (1), showed that the simple correlation between the population of parasitoids *Aphytis lingnanensis*, *Habrolepis aspidioti*, maximum, minimum temperatures and % of relative humidity and the mean number of pest were significant or highly significant (r = 0.75, 0.55, 0.90, 0.71 and 0.50), respectively during 2010 . Also, results in Table (1), showed that the simple regression for changing the population of parasitoids *Aphytis lingnanensis*, *Habrolepis aspidioti*, maximum, minimum temperatures, % of relative humidity and the mean number of pest were significant or highly significant (b = 0.74, 0.51, 0.88, 0.70 and 0.52), respectively during 2010 .

Table 1: Simple correlation and regression values of the population dynamics of *Aonidiella aurantii* and its parasitoids on citrus trees in Beni-Suef Governorate during 2010 season.

Variable	Simple correlation "r"	Probability "P"	Regression	Probability "P"
Aphytis lingnanensis	0.76	**	0.74	**
Habrolepis aspidioti	0.55	*	0.51	*
Maximum	0.90	***	0.88	***
Minimum	0.71	**	0.70	*
R.H. %	0.50	*	0.52	*

Data in Table (2), showed that the simple correlation between the population of parasitoids *Aphytis lingnanensis*, *Habrolepis aspidioti*, maximum, minimum temperatures and % of relative humidity and the mean number of pest were significant or highly significant (r = 0.77, 0.54, 0.87, 0.71 and 0.50), respectively during 2011. Also, results in Table (2), showed that the simple regression for changing the population of parasitoids *Aphytis lingnanensis*, *Habrolepis aspidioti*, maximum, minimum temperatures and % of relative humidity and the mean number of pest were

significant or highly significant (b = 0.75, 0.51, 0.86, 0.72 and 0.52), respectively during 2011.

Table 2: Simple correlation and regression values of the population dynamics of *Aonidiella aurantii* and its parasitoids on citrus trees in Beni-Suef Governorate during 2011 season.

Variable	Simple correlation "r"	Probability "P"	Regression	Probability "P"
Aphytis lingnanensis	0.77	**	0.75	**
Habrolepis aspidioti	0.54	*	0.51	*
Maximum	0.87	***	0.86	***
Minimum	0.71	**	0.72	**
R.H. %	0.50	*	0.52	*

During the present work (Figs1&2) the results indicated that the populations of red scale has two peaks one in April and the second one in October. The peaks of this pest recorded by Habib *et al. (*1971). They stated that *A. aurantii* has 3-4 generations on citrus trees. Hosny *et al.* (1972) detretmined the economic threshold at different infestation denisties of *A. aurantii* on mandarin trees and found that during June and October, more than 0.24, 0.18 females/leaf decreased the yield of mandarin significantly, Abul-Nasr *et al.* (1975) reported the population peaks of *A. aurantii* occurred during the period, October, December, January-Febrauray, April-June and August-September, Darwish (1976) found that *A. aurantii* had 3 annual peaks of abundance, the first occurred during November, the second during May and the third in July, Abd El-Fattah *et al. (*1978) also stated that the red scale, *A. aurantii* had 3 annual peaks, in November, May and July , Osman, Evon (1996) recorded four overlapping generations for *A. aurantii* at Beni-Suef governorate. The first generation occurred from early July to early September. The second occupied the period from early September to early January. While the third one lasted from early January to early April. The fourth generation containued between early April and Mid-June.

In this work two parasitoids recorded associated with red scale. Theses are *A. lingnanensis* and *H. Aspidioti.* it is recorded here two peaks for each parasitoid in April and October for *A. lingnanensis* and in July and November for *H. aspidioti* in Beni- Suef. While,Osman, Evon (1996) mentioned that the ectoparasitoid, *A. lingnanensis* had four overlapping activity periods with four peaks in Qalyubiya governorate. The highest rate of parasitism took place in spring in the two years under investigations (25.4 and 28.1%, respectively) who also added that the same parasitoid had four overlapping activity periods with four annual peaks in Beni-Suef. The highest parasitism rate occurred during spring in the two years under investigations (17.5 and 23.5%, respectively on *A. aurantii*). While *A. chrysompahli* manifested the highest parasitism rate on *C. aonidum* during autumn season in both years under consideration (16.3 and 19.5%, respectively). Later Abd-Rabou (1997) studied the parasitoids attacking some species of scale insects. He mentioned that total parasitism of *A. aurantii* by *A. chrysomphali, A. lingnanensis, E. citrina* and *E. lounsburyi* reached a maximum during September with parasitism rates 77 and 80% at South Sinai and Qalyubiya. Morsi (1999) recorded fourteen hymenoptrous parasitoid species of some armored scale insects. He mentioned that the highest percentage of parasitism on *A. aurantii* ranged between 20-45%.

2. *Ceroplastes floridensis* Comstock (citrus wax scale) (Hemiptera : Coccdidae)

Abundance: The seasonal abundance of the citrus wax scale, *C. Floridensis* was studied for two successive years from 2010 to 2011 on citrus trees in Gharbiya .The obtained results in Figs (3 & 4) showed that, the insect population reached maximum during June (1360 and 1820/ 30 leaves and 15 twigs) in first and second years, respectively. Numbers by *Metaphycus helvolus* (Compere) *and Microterus flavus* (Howard) reached maximum (68 and 74/ 30 leaves and 15 twigs) during June of the first year, respectively. While in the second year reached maximum (35 and 62/ 30 leaves and 15 twigs) during June, respectively.

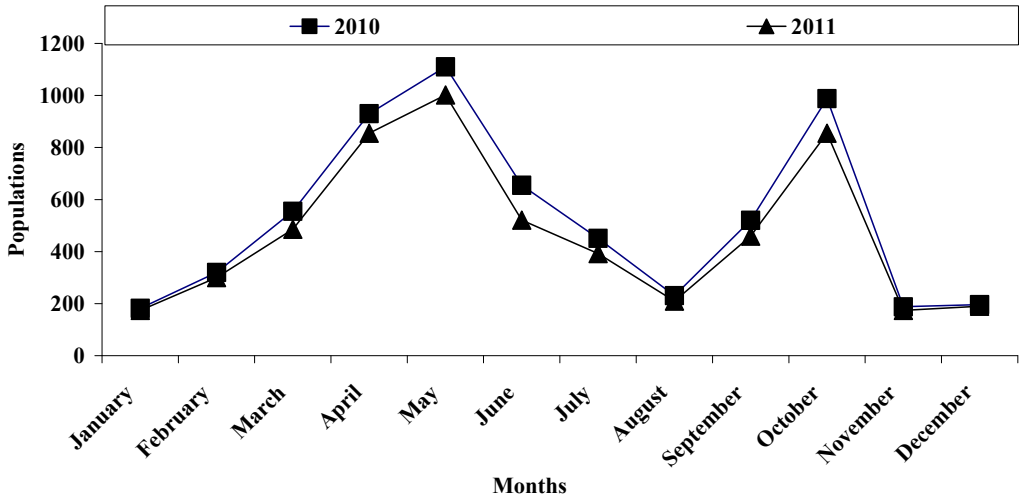

Fig. (3): Population dynamics of *Ceroplastes floridensis* on citrus trees in Gharbiya Governorate during 2010 and 2011 seasons.

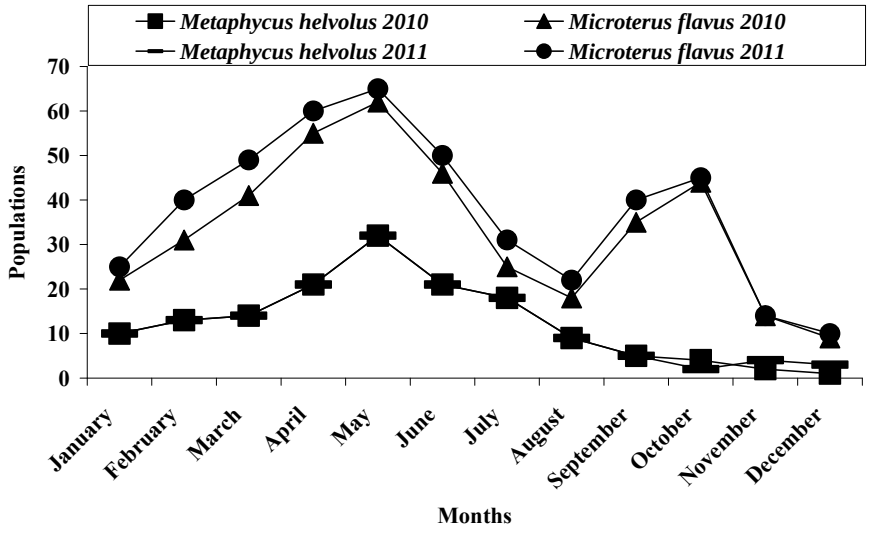

Fig. (4): Population dynamics of *Ceroplastes floridensis* parasitoids on citrus trees i Gharbiya Governorate during 2010 and 2011 seasons.

Data in Table (3), showed that the simple correlation between the population of parasitoids *Metaphycus helvolus*, *Microterus flavus*, maximum, minimum temperatures , % of relative humidity and the mean number of pest were significant or highly significant (r = 0.65, 0.79, 0.94, 0.66 and 0.67), respectively during 2010 . Also, results in table (3), showed that the simple regression for changing the population of parasitoids, *Metaphycus helvolus*, *Microterus flavus* , maximum, minimum temperatures, % of relative humidity and the mean number of pest were significant or highly significant (b = 0.61, 0.78, 0.91, 0.65 and 0.63), respectively during 2010.

Table 3: Simple correlation and regression values of the population dynamics of *Ceroplastes floridensis* and its parasitoids on citrus trees in Gharbiya Governorate during 2010 season.

Variable	Simple correlation "r"	Probability "P"	Regression	Probability "P"
Metaphycus helvolus	0.65	*	0.61	*
Microterus flavus	0.79	**	0.78	**
Maximum	0.94	***	0.91	***
Minimum	0.66	*	0.65	*
R.H. %	0.67	*	0.63	*

Data in Table (4), showed that the simple correlation between the population of parasitoids, *Metaphycus helvolus***,** *Microterus flavus***,** maximum, minimum temperatures, %of relative humidity and the mean number of pest were significant or highly significant (r = 0.61, 0.74, 0.90, 0.64 and 0.52), respectively during 2011. Also, results in table (4), showed that the simple regression for changing the population of parasitoid, *Metaphycus helvolus***,** *Microterus flavus***,** maximum, minimum temperatures, % of relative humidity and the mean number of pest were significant or highly significant (b = 0.59, 0.72, 0.89, 0.66 and 0.55), respectively during 2010.

Table 4: Simple correlation and regression values of the population dynamics of *Ceroplastes floridensis* and its parasitoids on citrus trees in Gharbiya Governorate during 2011 season.

Variable	Simple correlation "r"	Probability "P"	Regression	Probability "P"
Metaphycus helvolus	0.61	*	0.59	*
Microterus flavus	0.74	**	0.72	**
Maximum	0.90	***	0.89	***
Minimum	0.64	**	0.66	**
R.H. %	0.52	*	0.55	*

The results of the present work indicated that citrus wax scale, *C. floridensis* has two peaks the first in May and the second in October. These data agree with the findings of Habib *et al.* (1971). They recorded two annual generations of *C. floridensis,* on citrus, the first occurred in May-June and the second in September-October. The conducted work recorded this pest in a high infestation in Gharbiya.

Swailem *et al.* (1976) found that population of *C. floridensis* proved to be considerably higher in Alexandria and Beheira than in Sharqyia and Gharbiya governorates. The population density which causes the damage threshold was around 24.4, 26.6-28.4 and 25.1-27 scales per twig in June, October and December, respectively (Salem and Zaki, 1985 and Helmy *et al.* 1986). Abd El-Fattah *et al., (*1991) recorded contradecting data with the present results. They recorded 3 peaks of *C. floridensis,* mid-April, late-june and eraly November on mandarin. Kamel (2010) reported the occurence of this pest in Qalyubiya on citrus was *C. floridensis* with the percent of infestaion 0.7 and 1.29 % of the two year under investigation.

In the present work two parasitoids recorded associated with citrus wax scale. These are *M.helvolus* and *M. flavus*. It is recorded here two peaks for each parasitoid in May and October for in Gharbiya .While, Hafez *et al.* (1987) recorded four species of hymenopterous parasitoids attacking *C. floridensis,* namely *T. ceroplastae, E. citrina* , *M. flavus* , *Mi. flavus* and Abd El-Razak (2000) recorded *T. ceroplastae* as a parasitoid of *C. floridensis.* Later Abd-Rabou (2001b) studied the abundance of the parasitoids attacking *C. floridensis.* He recorded eight primary parasitoids *C. lycimnia* (Walker), *Diversinervus elegans* Silvestri, *Metaphycus barteletti* Annecke and Mynhardt, *M. flavus, Metaphycus zebratus* (Mercet), *Mi. flavus, Scutellista cyaneae* Motschulski, *Tetrasticus* sp. and 2 hyperparasitoids, *Cheiloneurus sp.* and *Marietta leopardina* Motschulsky. The *Coccophagus lycimnia*. (Walker) was the dominant parasitoid of *C. floridensis* with maximum parasitism rates of 27 and 21% in October and November in Gharbiya and Beheira. The parasitism rates reached maximum during October and November with parasitism rates of 49 and 48% in Gharbiya and Beheira, respectively.

3. *Chrysomphalus aonidum* (L.) (black scale) (Hemiptera : Diaspididae)

Abundance: The seasonal abundance of the black scale, *C. aonidum* was studied for two successive years from 2010 to 2011 on citrus trees in Qalyubyia .The obtained results in Figs (5 & 6) showed that, the insect population reached maximum during May (1826 and 1747/ 30 leaves and 15 twigs) in first and second years, respectively. Numbers by *Aphytis chrysomphali* (Mercet) and *Encarsia citrina* (Craw) reached maximum (65 and 15/ 30 leaves and 15 twigs) during May of the first year, respectively. While in the second year reached maximum (41 and 8 / 30 leaves and 15 twigs) during May, respectively.

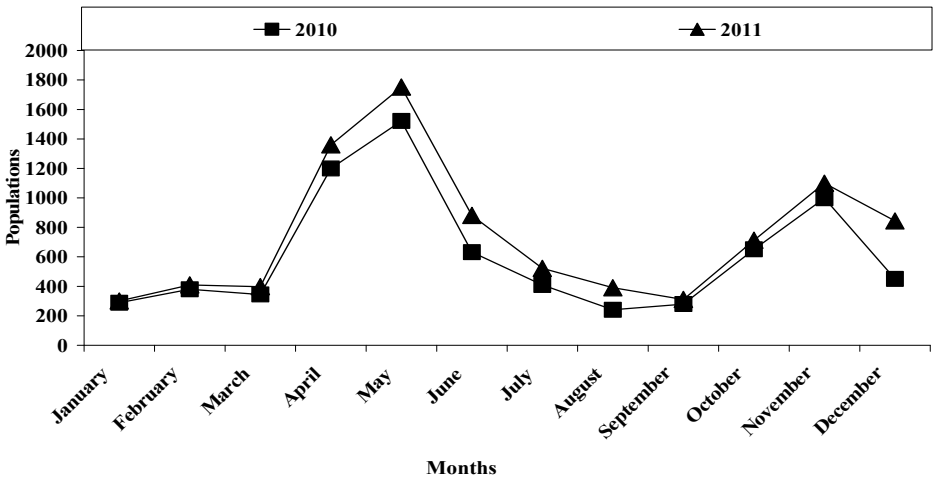

Fig. (5): Population dynamics of *Chrysomphalus aonidum* on citrus trees in Qalyubyia Governorate during 2010 and 2011 seasons.

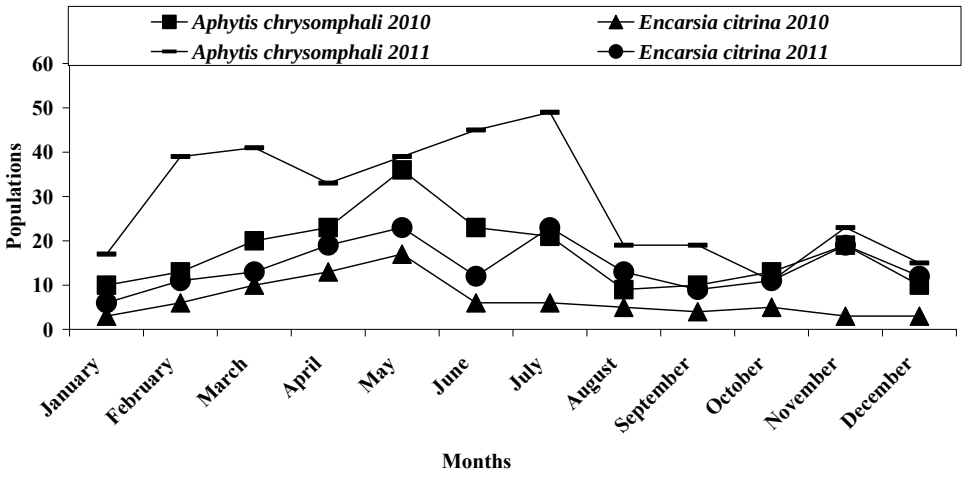

Fig. (6): Population dynamics of *Chrysomphalus aonidum* parasitoids on citrus trees in Qalyubyia Governorate during 2010 and 2011 seasons.

Data in table (5), showed that the simple correlation between the population of parasitoids , *A. chrysomphali*, *E. citrina* , maximum, minimum temperatures, % of relative humidity and the mean number of pest were significant or highly significant (r = 0.72, 0.49, 0.79, 0.51 and 0.50), respectively during 2010 . Also, results in table (5), showed that the simple regression for changing the population of parasitoids, *A. chrysomphali*, *E. citrina* , maximum, minimum temperatures, % of relative humidity and the mean number of pest were significant or highly significant (b = 0.70, 0.48, 0.75, 0.46 and 0.50), respectively during 2010 .

Table 5: Simple correlation and regression values of the population dynamics of , *Chrysomphalus aonidum* and its parasitoids on citrus trees in Qalyubyia Governorate during 2010 season.

Variable	Simple correlation "r"	Probability "P"	Regression	Probability "P"
Aphytis chrysomphali	0.72	**	0.70	**
Encarsia citrina	0.49	*	0.48	*
Maximum	0.79	**	0.75	**
Minimum	0.51	*	0.46	*
R.H. %	0.50	*	0.50	*

Data in Table (6), showed that the simple correlation between the population of parasitoids, *A. chrysomphali*, *E. citrina*, maximum, minimum temperatures, % of relative humidity and the mean number of pest were significant or highly significant (r = 0.74, 0.47, 0.81, 0.55 and 0.50), respectively during 2011. Also, results in table (6), showed that the simple regression for changing the population of parasitoids, *A. chrysomphali*, *E. citrina*, maximum, minimum temperatures. % of relative humidity and the mean number of pest were significant or highly significant (b = 0.70, 0.45, 0.79, 0.51 and 0.48), respectively during 2011.

Table 6: Simple correlation and regression values of the population dynamics of *Chrysomphalus aonidum* and its parasitoids on citrus trees in Qalyubyia Governorate during 2011 season.

Variable	Simple correlation "r"	Probability "P"	Regression	Probability "P"
Aphytis chrysomphali	0.74	**	0.70	**
Encarsia citrina	0.47	*	0.45	*
Maximum	0.81	**	0.79	**
Minimum	0.55	*	0.51	*
R.H. %	0.50	*	0.48	*

The present work observed, black scale *C. aonidum* has two peaks the first in May and the second in November. Salman (1970) reported that the population of *C. aonidum* on orange and mandarin, was relatively low from April to August, followed by gradual increase during September and reached its peak during October. The period of big numbers extended to the next January. While, Hafez *et al.* (1970a) mentioned that *C. aonidum* was found to have 4 peaks being in March, August, September and November. Also Abul-Nasr *et al.* (1977) recorded that the peaks of *C. aonidum* occurred during October, December, Febrauary-May and May-September. The population was largest during late summer in Gharbiya and during winter in Menoufeia, Qalyubiya, Giza and Sharqyia.

In the present work two parasitoids recorded associated with the black scale. These are *A. chrysomphali* and *E. citrina* . It is recorded here two peaks for each parasitoid in May and November in Qalyubyia. While Hafez *et al.* (1970b) relized that the parasitoids played the major role in biological control of *C. aonidum. Habrolepis pascuorum* proved to be the most important parasitoid of the scale and represented alone about 80% of the total number of emerging parasitoids. Later, Sakr (1994) stated that the parasitoids *A. holoxanthus, E. citrina* and *E. lounsburyi* seemed to be more effective on the different developmental stages of *C. aonidum* during winter and spring, while they were less effective during summer and autumn.

4.*Icerya seychellarum* (Westwood) (seychellarum mealybug) (Hemiptera: Monophlebidae)

Abundance: The seasonal abundance of the seychellarum mealybug, *I. seychellarum* was studied for two successive years from 2010 to 2011 on citrus trees in Demmyate. The obtained results in Figs (7 & 8) showeded that, the insect population reached maximum during June (78 and 89/ 30 leaves and 15 twigs) in first and second years, respectively. Numbers by *R.cardinalis* reached maximum (18 and 22/ 30 leaves and 15 twigs) during June of the first and second years, respectively.

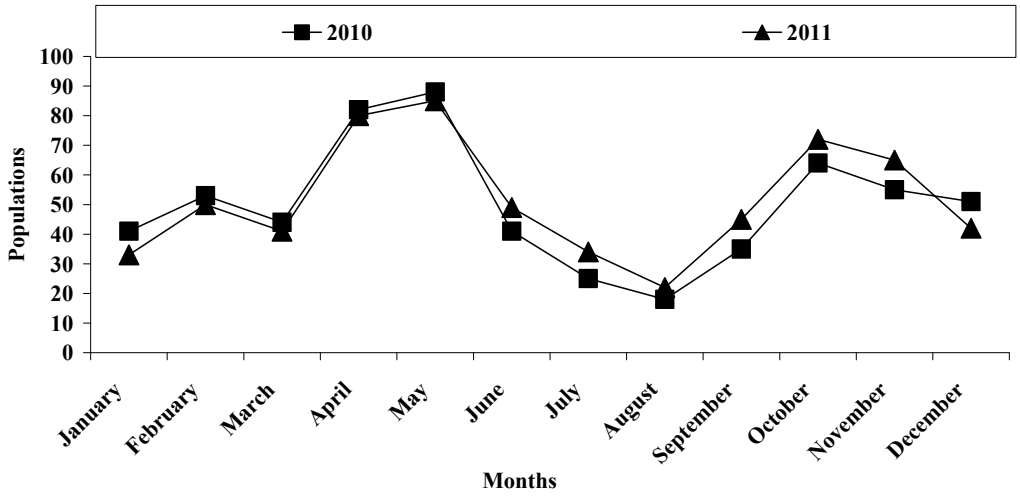

Fig. (7): Population dynamics of *Icerya seychellarum* on citrus trees in Demmyate Governorate during 2010 and 2011 seasons.

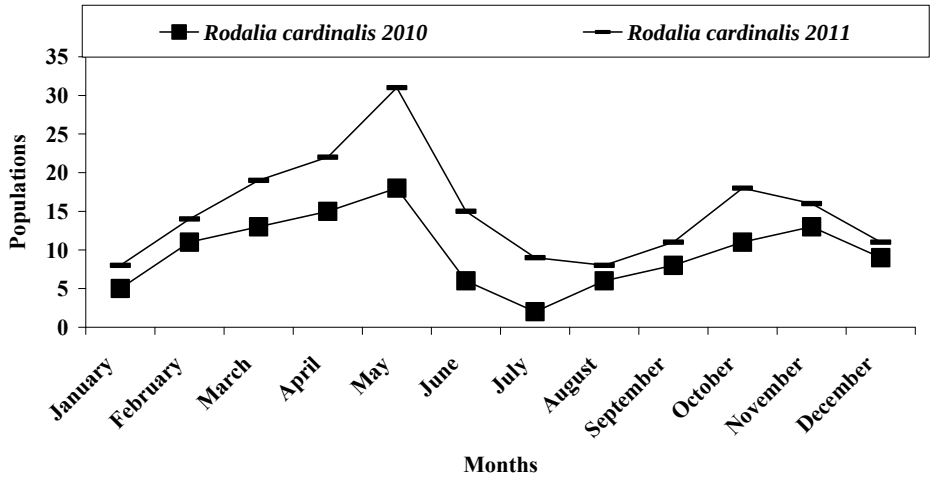

Fig. (8): Population dynamics of *Icerya seychellarum* predator on citrus trees in Demmyate Governorate during 2010 and 2011 seasons.

Data in Table (7), showed that the simple correlation between the population of *R.cardinalis*, maximum, minimum temperatures, % of relative humidity and the mean number of pest were significant or highly significant (r = 0.69, 0.91, 0.71 and 0.50), respectively during 2010. Also, results in table (7), showed that the simple regression for changing the population of *R.cardinalis*, maximum, minimum temperatures, % of relative humidity and the mean number of pest were significant or highly significant (b = 0.67, 0.90, 0.70 and 0.51), respectively during 2010 .

Table 7: Simple correlation and regression values of the population dynamics of *Icerya seychellarum* and its predator on citrus trees in Demyaata Governorate during 2010 season.

Variable	Simple correlation "r"	Probability "P"	Regression	Probability "P"
Rodalia cardinalis	0.69	**	0.67	**
Maximum	0.91	***	0.90	***
Minimum	0.71	**	0.70	*
R.H. %	0.50	**	0.51	**

Data in Table (8), showed that the simple correlation between the population of *R.cardinalis*, maximum, minimum temperatures, % of relative humidity and the mean number of pest were significant or highly significant (r = 0.67, 0.87, 0.66 and 0.49), respectively during 2011 . Also, results in table (8), showed that the simple regression for changing the population of *R. cardinalis* maximum, minimum temperatures and % of relative humidity and the mean number of pest were significant or highly significant (b = 0.63, 0.85, 0.65 and 0.47), respectively during 2011.

Table 8: Simple correlation and regression values of the population dynamics of *Icerya seychellarum* and its predator on citrus trees in Demyaata Governorate during 2011 season.

Variable	Simple correlation "r"	Probability "P"	Regression	Probability "P"
Rodalia cardinalis	0.67	**	0.63	**
Maximum	0.87	***	0.85	***
Minimum	0.66	**	0.65	*
R.H. %	0.49	**	0.47	**

The present work recorded this species infested citurs trees and has two annual peaks one in June and the other in November. Abou El-Khair (1999) reported and studied *I. seychellarum* on *Ficus* spp. and *Lantania commersoni.* Mangoud (2000) found *I. sechellarum* has two brood peaks (activity period)/year, on branches in during two seasons. The first brood contained two peaks on mid and late-November and the second brood also contained two peaks on first and late-June. On leaves it had two peaks/year on mid-December and late-June. While in the second season, he found two broods/year on branches, the first brood contained two peaks on late-November and mid-December and the brood was noticed in the early-July. On leaves it was found three broods, the first brood contained two peaks on late-October and mid-November, the second brood contained one peak was noticed on mid-December and the third brood contained one peak on early-July. He also studied the distribution of *I. seychellarum* on apple trees 61.9% of the monophlebid were concentrated on old branches, 31.7% on new branches, 4.2% on old leaves and 2.2% on new leaves (an average of the two seasons, 1994/1995 and 1995/1996). Later Kamel (2010) reported the occurence of this pest in Qalyubiya on citrus was *I. Seychelarum* with the percent of infestaion 2.09 and 2.16% of the two year under investigation. Hamid and Hassanian (1991) recorded *R. cardinals* associated with monophlebid, *Icerya* spp. This work agree with the findinds here.

5. *Lepidosaphes beckii* (Newman) (purple scale) (Hemiptera : Diaspididae)

Abundance: The seasonal abundance of the purple scale, *L. beckii* was studied for two successive years from 2010 to 2011 on citrus trees in Ismaillia .The obtained results in Figs (9 & 10) showeded that, the insect population reached maximum during July (185 and 167/ 30 leaves and 15 twigs) in first and second years, respectively. Numbers by *Aphytis lepidosaphes* Compere and *Chilocorus bipustulatus* L. reached maximum (25 and 11/ 30 leaves and 15 twigs) during July and December of the first year, respectively. While in the second year reached maximum (28 and 8 / 30 leaves and 15 twigs) during July, respectively.

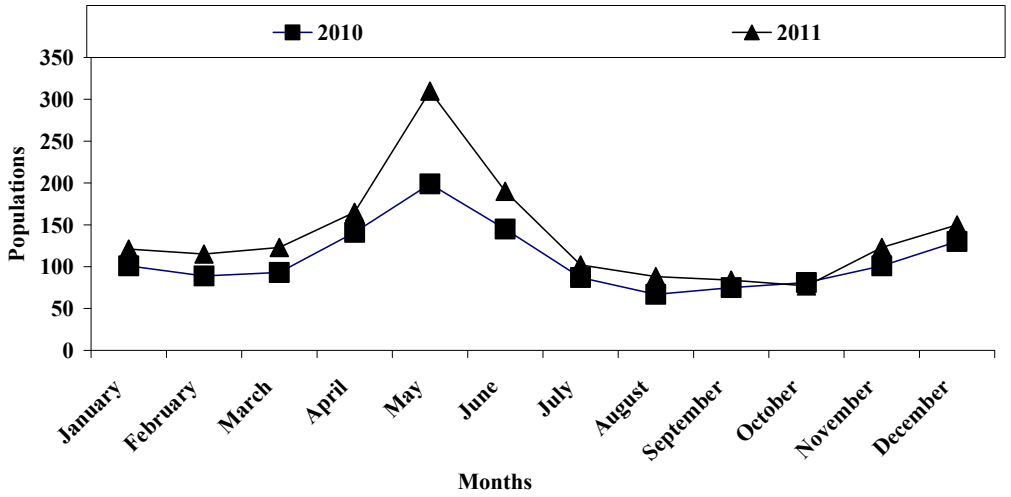

Fig. (9): Population dynamics of *Lepidosaphes beckii* on citrus trees in Ismaillia Governorate during 2010 and 2011 seasons.

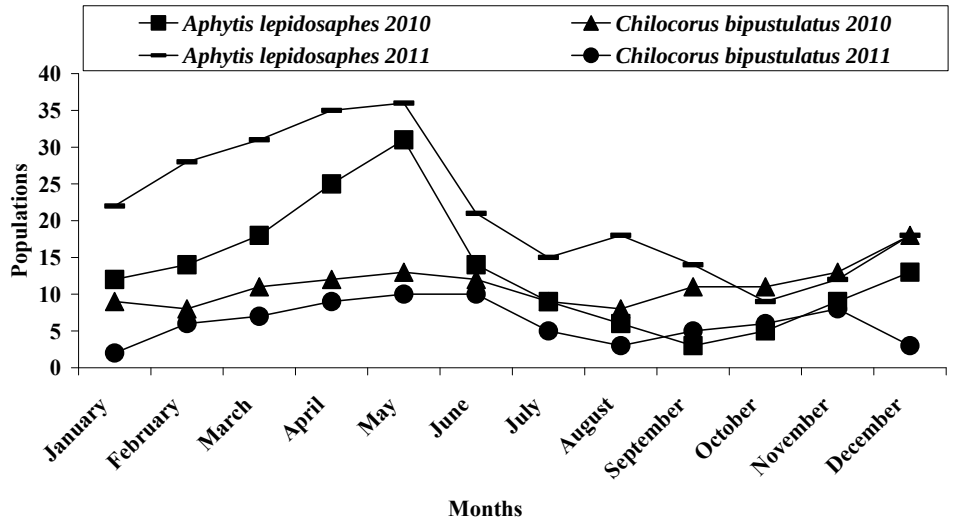

Fig. (10): Population dynamics of *Lepidosaphes beckii* parasitoids on citrus trees in Ismaillia Governorate during 2010 and 2011 seasons.

Data in Table (9), showed that the simple correlation between the population of *Aphytis lepidosaphes*, *Chilocorus bipustulatus*, maximum, minimum temperatures. % of relative humidity and the mean number of pest were significant or highly significant (r = 0.51, 0.48, 0.91, 0.74 and 0.50), respectively during 2010. Also, results in table (9), showed that the simple regression for changing the population of *Aphytis lepidosaphes*, *Chilocorus bipustulatus*, maximum, minimum temperatures, % of relative humidity and the mean number of pest were significant or highly significant (b = 0.49, 0.47, 0.94, 0.72 and 0.51), respectively during 2010 .

Table 9: Simple correlation and regression values of the population dynamics of *Lepidosaphes beckii* and its parasitoid and predator on citrus trees in Ismailia Governorate during 2010 season.

Variable	Simple correlation "r"	Probability "P"	Regression	Probability "P"
Aphytis lepidosaphes	0.51	*	0.49	*
Chilocorus bipustulatus	0.48	*	0.47	*
Maximum	0.91	***	0.94	***
Minimum	0.74	**	0.72	**
R.H. %	0.50	*	0.51	*

Data in Table (10), showed that the simple correlation between the population of *Aphytis lepidosaphes*, *Chilocorus bipustulatus*, maximum, minimum temperatures and % of relative humidity and the mean number of pest were significant or highly significant (r = 0.51, 0.49, 0.92, 0.75 and 0.51), respectively during 2011. Also, results in table (10), showed that the simple regression for changing the population of *Aphytis lepidosaphes*, *Chilocorus bipustulatus*, maximum, minimum temperatures, % of relative humidity and the mean number of pest were significant or highly significant (b = 0.48, 0.46, 0.91, 0.69 and 0.50), respectively during 2011.

Table (10): Simple correlation and regression values of the population dynamics of *Lepidosaphes beckii* and its parasitoid and predator on citrus trees in Ismailia Governorate during 2011 season.

Variable	Simple correlation "r"	Probability "P"	Regression	Probability "P"
Aphytis lepidosaphes	0.51	*	0.48	*
Chilocorus bipustulatus	0.49	*	0.46	*
Maximum	0.92	***	0.91	***
Minimum	0.75	**	0.69	**
R.H. %	0.51	*	0.50	*

During the presnt work the results indicated that the purple scale, *L. beckii* has two peaks on citrus trees in Ismaillia . Also one parasitoid, *A. lepidosaphes* Compere and one predator *C. bipustulatus* were recorded. Abdel-Megeed (1977) studied the efficiency of the parasitoids, *A. lepidosaphes* and *E. citrina* in controlling the purpal scale, *L. beckii* on citrus trees at Menofiya. The effect of parasitism was low during summer and winter, while it was high during autumn. It reached its maximum in October and its minimum occurred in February. In Alexandria, Karam

(1979) studied the armored scale insects and their hymenopterous parasitoids on the grapefruit trees. Who found two parasitoids from purple scale, *L. beckii,* namely, *A. lepidosahes* and *Encarsia* sp. In Kafr El-Sheikh El-Agamy (1981) recorded *A. lepidosaphes* associated with *L. beckii*. The abundance of the various stages of ectoparasitoid, *Aphytis* sp. on *L. beckii* in an orange orchard of *Citrus sinensis.* The highest percentage of parasitism was 19.5-30% by immature stages of *Aphytis* during the winterseason (November-February), with lower levels present during the rest of the year. The rate of adult emergence of *Aphytis* was in March through August (26.5-58.6%) and lower during the remainder of the year (Hafez *et al.,*1987).

***6. Parlatoria ziziphi* (Lucas) (parlatoria black scale) (Hemiptera : Diaspididae)**

The seasonal abundance of the parlatoria black scale, *P. ziziphi* was studied for two successive years from 2010 to 2011 on citrus trees in Cairo. The obtained results in Figs (11 & 12) showed that, the insect population reached maximum during April (3250 and 2850/ 30 leaves and 15 twigs) in first and second years, respectively. Numbers by *A. lingnanensis* e and *E, citrina* reached maximum (46 and 22/ 30 leaves and 15 twigs) during April and July of the first year, respectively. While in the second year reached maximum (50 and 25/ 30 leaves and 15 twigs) during April and November, respectively.

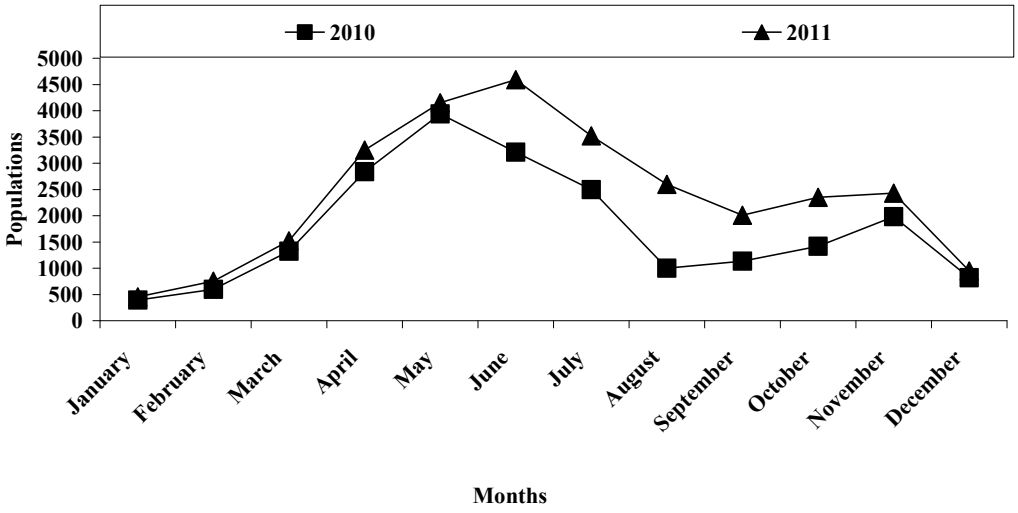

Fig. (11): Population dynamics of *Parlatoria ziziphi* on citrus trees in Cairo Governorate during 2010 and 2011 seasons.

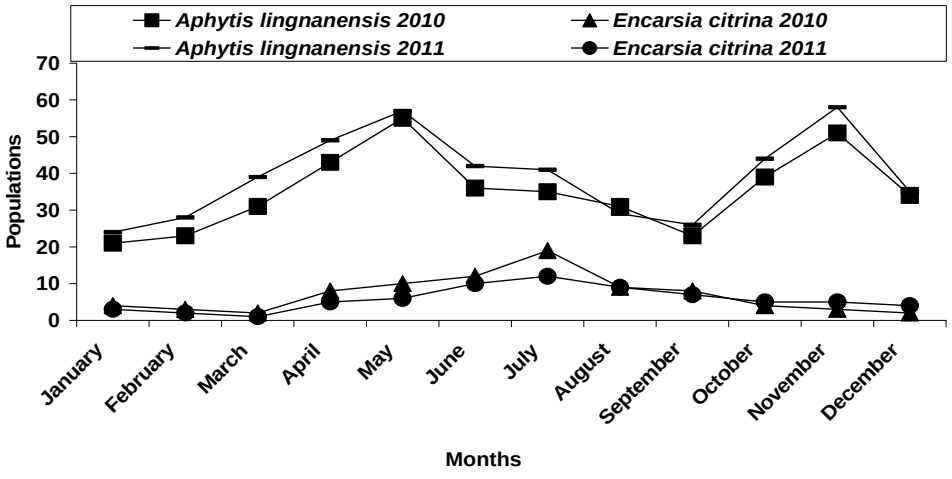

Fig. (12): Population dynamics of *Parlatoria ziziphi* parasitoids on citrus trees in Cairo Governorate during 2010 and 2011 seasons.

Data in Table (11), showed that the simple correlation between the population of parasitoids *A. lingnanensis*, *E, citrina* , maximum, minimum temperature, % of relative humidity and the mean number of pest were significant or highly significant (r = 0.81, 0.45, 0.80, 0.79 and 0.39), respectively during 2010. Also, results in table (11), showed that the simple regression for changing the population of parasitoids *A. lingnanensis*, *E, citrina* , maximum, minimum temperature, % of relative humidity and the mean number of pest were significant or highly significant (b = 0.79, 0.43, 0.77, 0.76 and 0.36), respectively during 2010.

Table (11): Simple correlation and regression values of the population dynamics of *Parlatoria ziziphi* and its parasitoids on citrus trees in Cairo Governorate during 2010 season.

Variable	Simple correlation "r"	Probability "P"	Regression	Probability "P"
Aphytis lingnanensis	0.81	**	0.79	**
Encarsia citrina	0.45	*	0.43	*
Maximum	0.80	**	0.77	**
Minimum	0.79	**	0.76	*
R.H. %	0.39	*	0.36	*

Data in Table (12), showed that the simple correlation between the population of parasitoids *A. lingnanensis*, *E, citrina*, maximum, minimum temperatures and % of relative humidity , the mean number of pest were significant or highly significant (r = 0.85, 0.39, 0.94, 0.71 and 0.70), respectively during 2011 . Also, results in Table (12), showed that the simple regression for changing the population of parasitoids *A. lingnanensis*, *E. citrina* , maximum, minimum temperatures, % of relative humidity and the mean number of pest were significant or highly significant (b = 0.81, 0.36, 0.91, 0.69 and 0.67), respectively during 2011 .

Table (12): Simple correlation and regression values of the population dynamics of *Parlatoria ziziphi* and its parasitoids on citrus trees in Cairo Governorate during 2011 season.

Variable	Simple correlation "r"	Probability "P"	Regression	Probability "P"
Aphytis lingnanensis	0.85	**	0.81	**
Encarsia citrina	0.39	*	0.36	*
Maximum	0.94	***	0.91	***
Minimum	0.71	**	0.69	**
R.H. %	0.70	**	0.67	**

During the present work the results indicated that parlatoria black scale, *P. ziziphi* has two peaks on citrus trees in Cairo . Also two parasitoids, *A. lingnanensis* and *E, citrina* were recorded. Kamel (2010) reported the occurence of this pest in Qalyubiya on citrus with the percent of infestaion 1.3 and 1.7 % of the two year under investigation. Abd-Rabou (1997) mentioned that total parasitism of *P. ziziphi* by different aphelinid species reached a maximum during August in Giza, respectively.

7. *Planococcus citri* (Risso) (citus mealybug) (Hemiptera : Pseudococcidae)

The seasonal abundance of the citus mealybug, *P. citri* was studied for two successive years from 2010 to 2011 on citrus trees in Behira. The obtained results in Figs (13 & 14) showed that, the insect population reached maximum during May (1520 and 1021/ 30 leaves and 15 twigs) in first and second years, respectively. Numbers by *Anagyrus pseudococci* (Girault) and *Leptomastix dactylopii* Howard reached maximum (18 and 12/ 30 leaves and 15 twigs) during May of the first year, respectively. While in the second year reached maximum (14 and 9/ 30 leaves and 15 twigs) during May, respectively.

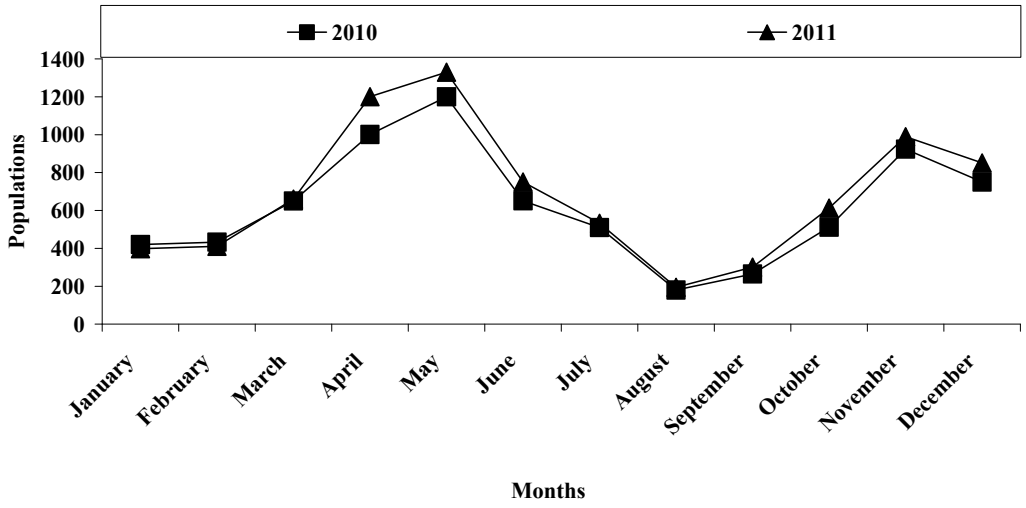

Fig. (13): Population dynamics of *Planococcus citri* on citrus trees in Behira Governorate during 2010 and 2011 seasons.

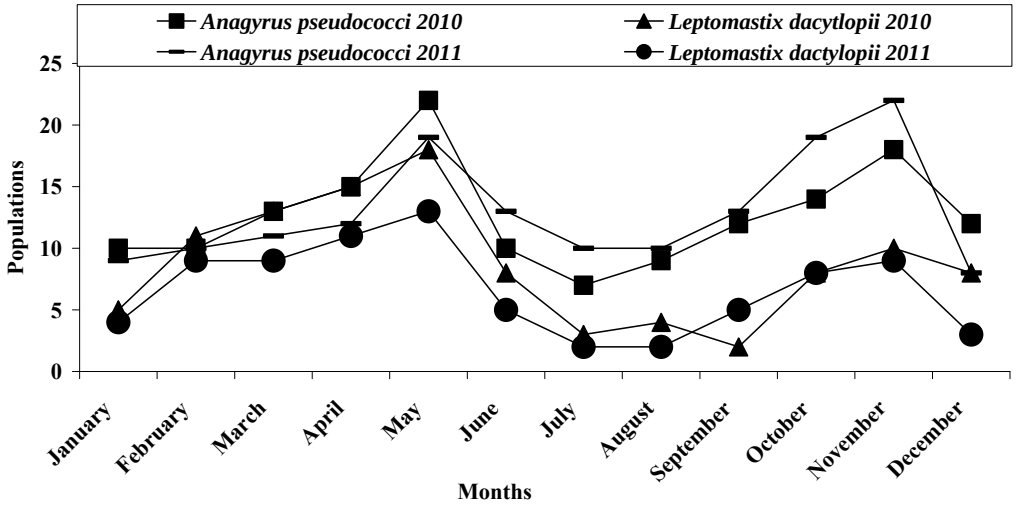

Fig. (14): Population dynamics of *Planococcus citri* parasitoids on citrus trees in Behira Governorate during 2010 and 2011 seasons.

Data in Table (13), showed that the simple correlation between the population of parasitoids, *A. pseudococci*, *L. dactylopii*, maximum, minimum temperatures, % of relative humidity and the mean number of pest were significant or highly significant (r

= 0.74, 0.51, 0.88, 0.72 and 0.53), respectively during 2010. Also, results in table (13), showed that the simple regression for changing the population of parasitoids, *A. pseudococci*, *L. dactylopii*, maximum, minimum temperatures, % of relative humidity and the mean number of pest were significant or highly significant (b = 0.71, 0.52, 0.85, 0.74 and 0.54), respectively during 2010.

Table 13: Simple correlation and regression values of the population dynamics of *Planococcus citri* and its parasitoids on citrus trees in Behira Governorate during 2010 season.

Variable	Simple correlation "r"	Probability "P"	Regression	Probability "P"
Anagyrus pseudococci	0.74	**	0.71	**
Leptomastix dactylopii	0.51	*	0.52	*
Maximum	0.88	***	0.85	***
Minimum	0.72	**	0.74	*
R.H. %	0.53	**	0.54	**

Data in table (14), showed that the simple correlation between the population of parasitoids *A. pseudococci*, *L. dactylopii*, maximum, minimum temperatures and % of relative humidity and the mean number of pest were significant or highly significant (r = 0.71, 0.51, 0.92, 0.76 and 0.56), respectively during 2011 . Also, results in Table (12), showed that the simple regression for changing the population of parasitoids *A. pseudococci*, *L. dactylopii*, maximum, minimum temperatures, % of relative humidity and the mean number of pest were significant or highly significant (b = 0.68, 0.49, 0.90, 0.77 and 0.54), respectively during 2011.

Table 14: Simple correlation and regression values of the population dynamics of *Planococcus citri* and its parasitoids on citrus trees in Behira Governorate during 2011 season.

Variable	Simple correlation "r"	Probability "P"	Regression	Probability "P"
Anagyrus pseudococci	0.71	**	0.68	**
Leptomastix dactylopii	0.51	*	0.49	*
Maximum	0.92	***	0.90	***
Minimum	0.76	**	0.77	**
R.H. %	0.56	**	0.54	**

During the presnt work the results indicated that citus mealybug, *P. citri* has two peaks on citrus trees in Cairo. Two parasitoids, *A. pseudococci* and *L. dactylopii* was recorded. Abd-Rabou (2001a) recorded 11 parasitoids associated with *P. citri*.

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ARABIC SUMMARY

الحشرات القشرية التى تصيب الموالح و أعدائها الحيوية مع مفتاح تصنيفى لهذه الأفات فى مصر

منى مصطفى
معهد بحوث وقاية النباتات - مركز البحوث الزراعية- الدقي- الجيزة- مصر

الحشرات القشرية من الآفـــات الرئيســـــية التى تصيب الموالح فى مصر. هذا العمل يهدف الى دراسة تواجد هذه الآفات على الموالح فى مصر بالأضافة الى مفتاح تصنيفى لهذه الأفات. و قد أشارات النتائج الى أن الموالح تصيب ٧ أنواع من الحشرات القشرية. و أن الحشرة القشرية الحمراء لها قمتين واحدة فى شهر أبريل و الثانية فى أكتوبر وأن هذه الأفة مصاحبة لعدد أثنين من الطفيليات هم أفيتس لنجاننسس و هابروليبس اسبيديوتى وكل منهم له قمتين فى شهرى أبريل و أكتوبر والأخر فى شهرى يوليو و نوفمبر على الترتيب فى محافظة بنى سويف. و أن حشرة الموالح الشمعية لها قمتين واحدة فى شهر مايو و الثانية فى أكتوبر وأن هذه الأفة ايضا مصاحبة لعدد أثنين من الطفيليات هم ميتافيكس هيلفولس و ميكروتيرس فلافس وكل منهم له قمتين فى شهرى أبريل و أكتوبر على الترتيب فى محافظة الغربية. و قد تضمن العمل أن حشرة الموالح السوداء لها قمتين واحدة فى شهر مايو و الثانية فى نوفمبر وأن هذه الأفة مصاحبة لعدد أثنين من الطفيليات هم أفيتس كريزومفالى و أنكارسيا سترينا وكل منهم له قمتين فى شهرى مايو و نوفمبر على الترتيب فى محافظة القليوبية. وقد أتضح أن بق السشيلارم الدقيقى له قمتين واحدة فى شهر يونيو و الثانية فى نوفمبر على المـــوالح فى محافظة دمياط وأن هذه الأفة مصاحبة لعدد واحد مفترس وهو روداليا كارديناليس . أثناء هذا العمل وجد أن حشرة المانجو القشرية أتضح أن لها قمتين على الموالح فى محافظة الأسماعيلية وأن هذه الأفة مصاحبة لعدد أثنين احدهما من الطفيليات و هو أفيتس ليبدوسافيس والاخر من المفترسات وهو مفترس كيلوكورس بيبستيولاتس.و أيضا حشرة البارلاتوريا القشرية لها قمتين على الموالح فى محافظة القاهرة وأن هذه الأفة مصاحبة لعدد أثنين من الطفيليات هم أفيتس لنجاننسس و أنكارسيا سترينا. أما بالنسبة لبق الموالح الدقيقى فله قمتين على الموالح فى محافظة البحيرة وأن هذه الأفة مصاحبة لعدد أثنين من الطفيليات هما أناجيرس بسيدوكوكسى و ليبتوماستكس ديكتيلوبى.