SURVEY OF SUBORDER STERNORRHYNCHA (HEMIPTERA) INFESTING OLIVE TREES AT GIZA GOVERNORATE WITH EMPHASIS ON POPULATION DYNAMICS OF THE SOFT BROWN SCALE, *SAISSETIA COFFEAE* (HEMIPTERA: COCCIDAE)

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Abstract

Suborder Sternorrhyncha (Hemiptera) are the major pests infested olive orchards in Egypt. Recently, the soft brown scale, *Saissetia coffeae* (Walker) (Hemiptera: Coccidae) is one of the most important pest on olive trees. The aim of the present work is to study a survey of Suborder Sternorrhyncha infesting olive trees in Egypt with emphasis on population dynamics of the soft brown scale, *S. coffeae* and its natural enemies. A survey of Suborder Sternorrhyncha on olive trees was carried out during 2014 -2016. The results indicate that the olive trees were infested by 22 insect species. Also population dynamics of the soft brown scale, *S. coffeae* and it´s natural enemies was carried out at Giza Governorate during 2015 and 2016. During this work the soft brown scale has two activity preiods. Four species of parasitiods and five predators were recorded and collected from concerned specimens under investigation. Parasitiods are *Coccophagus scutellaris* (Dalman) (Hymenoptera : Aphelinidae), *Metaphycus helvolus* (Compere), *Metaphycus zebratus* (Mercet) and *Diversinervus elegans* Silvestri (Hymenoptera : Encyrtidae) and the species of predators: *Chilocorus bipustulatus* L. , *Exochomus flavipes* Thunb and *Scymnus syriacus* Marseul (Coleoptera: Coccinellidae).; *Orius laevigatus* Fieb. (Hemiptera : Anthocoridae) and *Chrysoperlla carnae* Steph (Neuroptera : Chrysopidae). The dominant natural enemy, *C. scutellaris* occurred during all seasons, the maximum parasitism was in October 1st and September 1st during the first and second year, respectively.

INTRODUCTION

Olive (*Olea europaea* L.) is evergreen tree in the family Oleaceae, native to the coastal areas of the eastern Mediterranean Region, from Lebanon and the coastal parts of Asia. Olive is one of the economically important crops in the Mediterranean Region (Oteros *et al.*,2014). Also it is grown in North America, South Africa, China, Japan and Australia. Olive tree is subjected to infest by different insect species causing considerable yield losses in quality and quantity. The Mediterranean basin is the largest olive production area worldwide; more than 125 arthropod species attack olive trees and cause quantitative and qualitative losses of yield (Haniotakis, 2003).

Suborder Sternorrhyncha (Hemiptera) comprises to five superfamily; Aphidoidea (aphids), Aleyrodoidea (whiteflies), Phylloxeroidea (phylloxerans); Psylloidea (jumping plant lice) and Coccoidea (scale insects). Sternorrhyncha is excrete honeydew, a sweet, sticky liquid produced by sucking insects that ingest large quantities of plant sap. Sticky honeydew and the blackish sooty mold growing on honeydew can bother people even when Sternorrhyncha populations are not harming plants. When plants are heavily infested with Sternorrhyncha, leaves may look wilted, turn yellow, and drop prematurely. It   sometimes result in curl leaves or cause deformed blemishes or discolored halos in fruit, leaves, or twigs (Gill, 1997).

Surveys of Suborder Sternorrhyncha attacking olive trees in Egypt have been conducted by many researchers and scientists, e.g., Abd-Rabou (2003a) and Amin *et al.* (2013).

The soft brown scale, *Saissetia coffeae* (Walker) (Hemiptera: Coccidae) is an important olive pest in Egypt and different parts of the world. *S. coffeae* are the most serious soft scale insects infesting olive trees in Egypt (Abd-Rabou, 2005 and Abd-Rabou *et al.* ,2009). The damage of *S.coffeae* feed on plant juices , cause a loss of vigor, spots on the foliage due to toxins in the scale saliva, deformation of infested plant parts, loss of leaves, retarded plant growth, even death of the plant and causing premature death of pointed gourd vines   (Carvalho *et al.*, 2003).

The soft brown scale, *S. coffeae* had three generations (El-Agamy *et al.* ,1994) and two duration's of activity (Hendawy,1999) and the parasitoids are considered one of the most effective bioagents of *S. coffeae (*Abd-Rabou, 2001). Many Predators recorded associated with *S. coffeae* (Hendaway,1999)˒

The aim of present work is to study incidence of the soft brown scale, *S. coffeae* and its natural enemies with a survey of Suborder Sternorrhyncha infested olive trees in different locations in Egypt.

MATERIALS AND METHODS

1. Survey of Suborder Sternorrhyncha infested olive trees:

A survey on Suborder Sternorrhyncha infested olive trees was carried during 2014-2016. Infested trees with Sternorrhyncha species of insects were inspected in the field, using a hand lens. Leaves, stems and twigs were collected and placed separately in paper bags for further examination in the laboratory. Identification of Suborder Sternorrhyncha was made by examining it´s adult in Canada Balsam according to Noyes (1982).

2. Population dynamics of *Saissetia coffeae* and its natural enemies :

Seasonal abundance of *S. coffeae* and its natural enemies was conducted on olive trees during 2015 and 2016 at Giza governorate. Olive trees area used in the study did not receive chemical pesticide application for several years. For samples collection, 20 olive trees similar in their phenology were selected and the samples were randomly collected of leaves biweekly (60 leaves each). Then leaves sample were kept in closed paper bags and transferred to laboratory for inspection. The total number of *S. coffeae* (eggs, nymphs and adults) was counted by binocular microscope. Then the average number of *S. coffeae* individuals per leaf was determined.

The abundance of the soft brown scale, *S. coffeae* natural enemies was also carried out through 2015 and 2016 seasons at Giza, while the number of parasitiods and predators were determined in olive samples (60 leave each).

Meteorological data, mainly the daily means of minimum (D.Min.T.), maximum (D. Max.T.) temperatures and (D.Min.T.) and (D. Max.T.) relative humidity were obtained from Central Laboratory for Agriculture Climate (CLAC). The daily records of these factors were recalculated to get the daily averages within two weeks prior to sampling date. Simple correlation and regression coefficients, and the partial regression values were calculated to determine the individual and the combined effect of the tested weather factors on the activity and abundance of *S. coffeae*.

Statistical analysis :

Simple correlation and regression coeffient were calculated to represent the relationship between the insect population and the tested weather factors (RH% and temperature).

RESULTS AND DISCUSSION

1. **Survey of Suborder Sternorrhyncha species infested olive trees in Egypt:**

As shown in Table (1) data represented that there are 22 species of Suborder Sternorrhyncha on olive trees. These species include 13 species belonging to family Diaspididae, 4 species from family Coccidae, two of Aleyrodidae family , two from Asterlecaniidae and one species related to family psyllidae.

Nada and Mohammed (1984) recorded *Leucaspis riccae* (Targioni Tozzetti) and *Parlatoria oleae* (Colvée) (Hemiptera: Diaspidiade) in Tora, Fayoum and Alexandria infested olive trees. *Hemiberlesia lataniae* (Signoret) (Hemiptera: Diaspidiade) is considered as a common pest of olive in the Nile Delta, Egypt. *Aspidiotus hederae* (Dietz & Morrison) (Hemiptera: Diaspidiade) and *S. coffeae* were the main species of hemipterans attacking olive trees. The Mediterranean black scale, *S. oleae* is the most important pest of olive in Egypt (Abd-Rabou, 2004). The soft

brown scale, *S. coffeae*, is one of the most important pests attacking olive trees in Egypt (Abd-Rabou, 2005 and Abd- Rabou *et al.* ,2009).

2. Population dynamics of *Saissetia coffeae* and its natural enemies:

2. 1. Dynamics of *Saissetia coffeae*:

The results of *S. coffeae* population dynamics on olive trees over 2015 and 2016 years are presented in Figs (1 and 4). During 2015, the average number of individuals were 1407.5, 805.67 and 362.71 individuals/60 leaves for eggs , nymphs and adults of *S. coffeae*, respectively. Eggs density reached its maximum on October 1st, 2015, showing 4010 eggs/60   leaves. Lowest eggs density occurred during the period of December 15 showing 185 eggs/60 leaves . Nymphs density was highest on October 1st,2015 as 2100 Nymphs/60 leaves . Lowest population of nymph was observed during December 15, 2015 with 103 nymphs/60 leaves . While, adults density reached its maximum on October 1st, 2015, showing 1012 adults/60 leaves   .

Table 1. List of Suborder Sternorrhyncha species infesting olive trees in Egypt:

Species	Family	Vernacular names
1. *Aleurolobus olivinus* Silvestri	Aleyrodidae	Olive whitefly
2. *Aonidiella aurantii* (Maskell)	Diaspididae	Red scale
3. *Aonidiella orientalis* (Maskell)	Diaspididae	Yellow scale
4. *Aspidiotus destructor* Signoret	Diaspididae	
5. *Aspidiotus nerii* Bouche	Diaspididae	Oleander scale
6. *Chrysomphalus aonidum* (L.)	Diaspididae	Black scale
7. *Chrysomphalus dictyospermi* (Morgan)	Diaspididae	Dictyospermum scale
8. *Coccus hesperidum* Linnaeus	Coccidae	soft scale
9. *Euphyllura straminea* Loginova	Psyllidae	Cottony olive insect
10. *Hemiberlesia latania* (Signort)	Diaspididae	Latania scale
11. *H. rapax* (Comstock.)	Diaspididae	Apple Scale
12. *Lepidosaphes ulmi* (L.)	Diaspididae	Oyster shell mango scale
13. *Leucaspis riccae* Targioni- Tozzetti	Diaspididae	Oyster shell olive scale
14. *Parlatoreopsis longispinus* (Newstead)	Diaspididae	Long spine scale
15. *Parasaissetia nigra* (Nietner)	Diaspididae	Nigra soft scale
16. *Parlatoria oleae* (Colvee)	Diaspididae	Olive scale
17. *Pollinia pollini* (Costa)	Asterolecanidae	Ornate pit olive scale
18. *Pseudaulacaspis pentagona* (Targioni-Tozzetti)	Diaspididae	White peach scale
19. *Russellaspis pustulans* (Cockerell)	Asterolecaniidae	Fig pit scale
20. *Saissetia coffeae* (Walker)	Coccidae	Hemispherical soft scale
21. *S. oleae* (Olivier)	Coccidae	Mediterranean soft black scale
22. *Siphoninus phyllireae* Haliday	Aleyrodidae	Pomegranate whitefly

The lowest adults density occurred during the period of Jan. 1st showing 51 adults /٦٠ leaves (Fig. 1). During 2016, the Average number of individuals were 1845.08, 997.54 and 471.718 individuals/٦٠ leaves for eggs , nymphs and adults of *S. coffeae*, respectively. Eggs density reached its maximum on October 15th , 2016, showing 5340 eggs/٦٠ leaves . Eggs density reached it´s lowest level (226 eggs/٦٠ leaves) December 15th ,2015, while the nymphs revealed the highest on September 15th , 2016 , where the number of nymphs 2915 nymphs/٦٠ leaves.

Nymphs population   represented the lowest level during Jan. 1st , 2016 with 170 nymphs/٦٠ leaves   . While, adults density reached its maximum on October 1st , 2016, showing 1369 adults/٦٠ leaves . The lowest adults density occurred during the period of Jan. 1st showing 78 adults /٦٠ leaves (Fig. 4).

   During the   present work *S. coffeae* had two main periods of abundance   per season (during July and October). The same results conducted by Hendawy (1999), He recorded two and three & two periods of activity, respectively.

2.2. Dynamics of natural enemies:

    Four species of parasitiods and five species of predators   were recorded and collected from concerned specimen under investigation found at Giza, Egypt. These four parasitiods are *Coccophagus scutellaris* (Dalman) (Hymenoptera : Aphelinidae), Metaphycus *helvolus* (Compere), *Metaphycus zebratus* (Mercet)   and *Diversinervus elegans* Silvestri (Hymenoptera : Encyrtidae) whereas, the predators are *Chilocorus bipustulatus* L. , *Exochomus flavipes* Thunb and *Scymnus syriacus* Marseul (Coleoptera: Coccinellidae).; *Orius laevigatus* Fieb. (Hemiptera : Anthocoridae) and *Chrysoperlla carnae* Steph (Neuroptera : Chrysopidae).

     The most dominant parasitoid is   *C. scutellaris* while it was found occurred during all seasons, with the maximum parasitism in October 1st and September 1st during the first and second years, respectively (Figs, 2-4). The parasitoids, *M. helvolus* was reached maximum during August and September with numbers of individuals 233 and 421 per 60 leaves of the two seasons, respectively. The third parasitoid , *M. zebratus* was reached its maximum level during October 1st in the two years under consideations (2015 and 2016). with numbers of individuals 9 and 22 per sample, respectively. While, the last one , *D. elegans* revealed maximum level during August1st and September1st with numbers of individuals 19 and 35 per 60 leaves of the two seasons under considerations .

     The parasitoids are considered one of the most effective bioagents of *S. coffeae* (Abd-Rabou, 2001). Abd-Rabou (2001) recorded the total rate of parasitism reached 27.0%, out of which *M. helvolus* was responsible for 13.%%. Also during the

present work this parasitiods recorded as an effective parasitiods of *S. coffeae* with maximum numbers during August and September were 233 and 421 individuals per 60 leaves of the two seasons under considerations, respectively.

The numbers of the predators: *C. bipustulatus*, *E. flavipes* , *S. syriacus* , *O. laevigatus* and *C.carnae* were 46,34,15, 25 and 23 individuals/ sample for the year 2015, respectively. While the numbers of the predators during 2016 were 36,32,11,29 and 12 individuals / sample, respectively (Figs ,3-6).

Abd Allah (1988) recorded that the coleopterous insect predators feeding on soft scale infesting citrus, mango and ledge plants in Mansoura region were *Cydonia vicina isis Cr., C. v. nilotica* (Muls.), *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* and two dipterous predators, *Metasyrphus corollae* Fab. and *Paragus compeaitus* (Wied.).

Hendawy (1999) mentioned that the highest peak of soft scale insects was detected in November, which coincided with the highest peak of predator. Then the population of predators gradually declined and peaked in May before the peak of scale insects. However, the last peak of the predators occurred during August, directly after a peak of scale insects. He concluded that, peaks of scale insects and those of the predators were coincided. Our data agreement with the pevious resultus of Hendawy (1999). Badary (2010) stated taht genus *Saissetia* was recorded associated with 16 predator species. Numbers by the predator *Scymnus syriacus* Mars., (Coleoptera: Coccinellidae) reached maximum (2/60 leaves) during August, in the first year and during September in the second year. The results conducted here was contadcting with the previous results Badary (2010). The predators*, Coccinella undecimpunctata* L. and *E. flavipes* reached maximum of 5.8 and 28/ 60 leaves and 30 twigs during September and August, in the first year, respectively and 24, 19.4 and 22 / 60 leaves and 30 twigs during September in the second year, respectively. The abundance of the predator, *S. syriacus* of *S. coffeae* reached maximum during October during two successive years. The predator *E. flavipes* (Coleoptera: Coccinellidae) reached maximum during October during two successive years, respectively (Abd-Raboou, 2011). The results conducted here was agreement with the previous results.
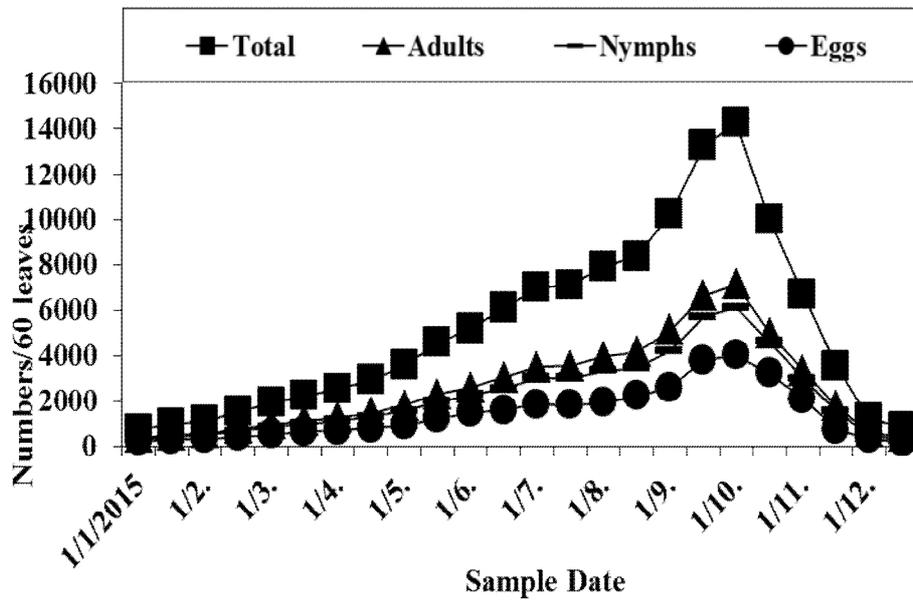
Fig. (1): Population dynamics of the soft brown scale, *S. coffeae* on olive trees at Giza Governorate) during 2015 season.
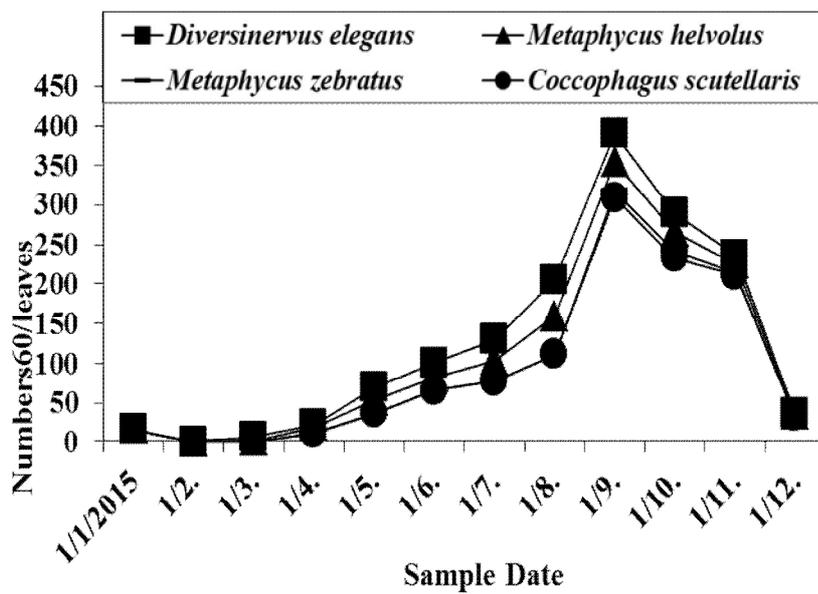

Fig. (2): Population dynamics of parasitoids associated with the soft brown scale, *S. coffeae* on olive trees at Giza Governorate during 2015 season.
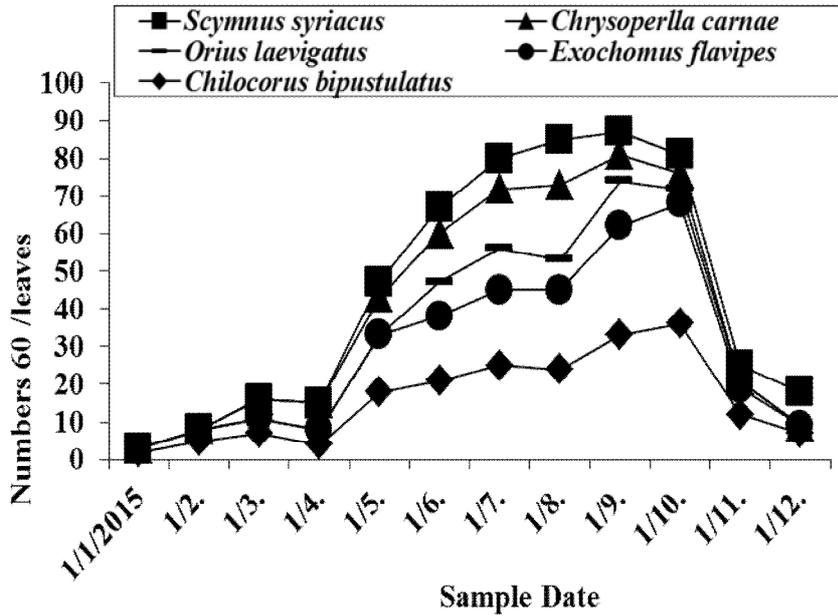
Fig. (3): Population dynamics of predators associated with the soft brown scale, *S. coffeae* on olive trees at Giza Governorate during 2015 season.
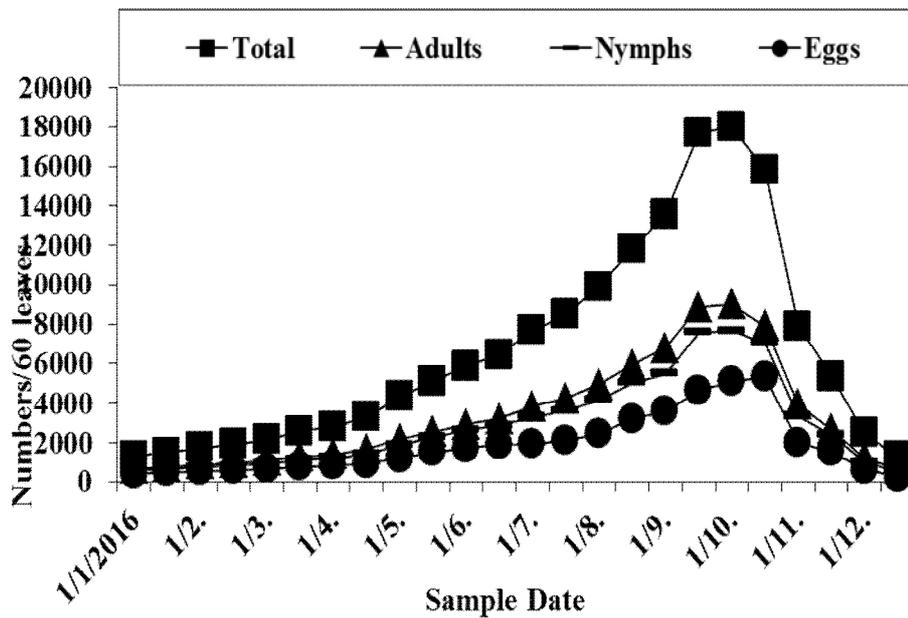

Fig. (4): Population dynamics of the soft brown scale, *S. coffeae* on olive trees at Giza Governorate) during 2016 season.
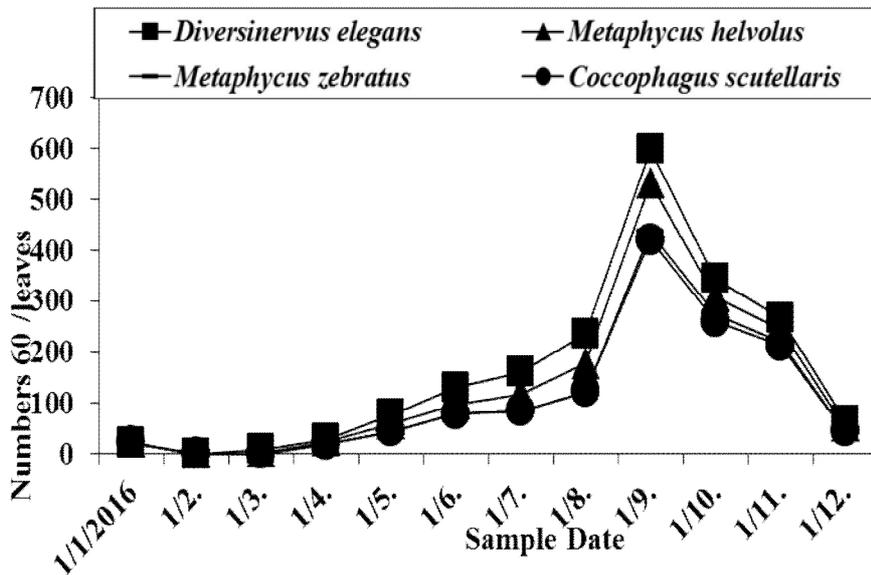
Fig. (5): Population dynamics of parasitoids associated with the soft brown scale, *S. coffeae* on olive trees at Giza Governorate during 2016 season
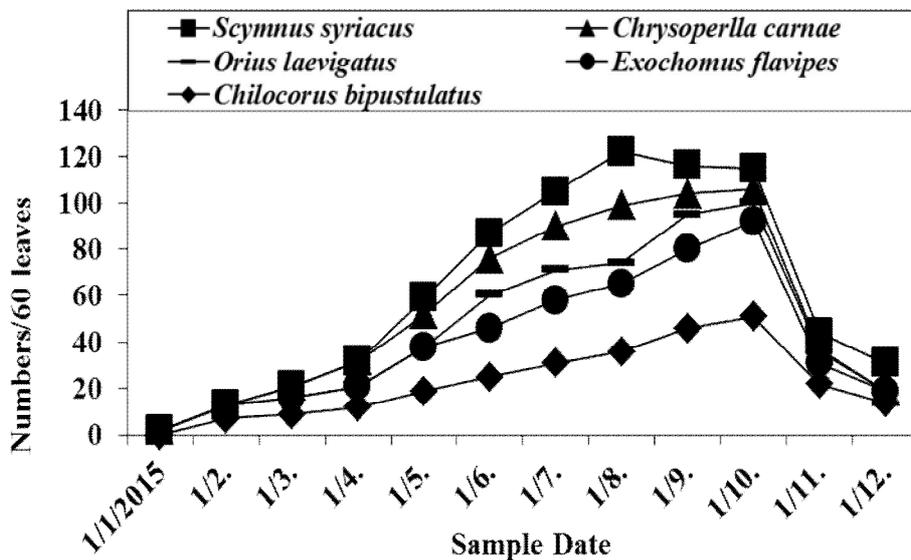

Fig. (6): Population dynamics of predators associated with the soft brown scale, *S. coffeae* on olive trees at Giza Governorate during 2016 season

3. Effect of weather factors on the seasonal activity of *S. coffeae* adults :

3.1. Effect of day maximum temperature:

Table (2), gives the simple correlation and partial regression indicating the relationships between the seasonal activity of *S. coffeae* adults and the day maximum temperature. The correlation coefficient "r" (+ 0.716) was positive and highly

significant at (0.01 level of probability) during 2015. The same result was obtained during 2016 as the coefficient "r" was (+ 8102).

On the other hand, the partial regression values of the factor indicate that, the effect of this factor was not quite significant. This insignificance suggests that, the average day max. temp. during 2015 (26.9 $^{\circ}$C) and 2016 (31.96°C) was quite close to the factor's optimum for the activity of *S. coffeae* adults

Table 2. Simple correlation (r) and partial regression (pb) values indicating the relation between anf effect of 4 weather factors on the seasonal catches of *S. cofeae* at Giza Governorate during 2015 and 2016.

Season	Weather Factors	R	pb	S.E.	t	Prop.
2015	Day max. temp.	0.8102	-1.243	34.642	-0.04	0.972
	Night Min. Temp.	0.86345	48.408	37.979	1.27	0.243
	Day max. R.H. %	0.17085	-28.45	56.819	-0.50	0.632
	Night min R.H. %	0.13112	17.308	33.589	0.52	0.622
2016	Day max. temp.	0.7163	-48.85	85.335	-0.57	0.59
	Night Min. Temp.	0.7637	115.75	98.574	1.17	0.28
	Day max. R.H. %	0.2486	7.849	30.534	0.26	0.805
	Night min R.H. %	0.35778	-7.775	20.484	-0.38	0.716

3.2. Effect of day minimum temperature:

The simple correlation "r" between the activity of S. cofeae and the night minimum temperature as shown in Table (2), was significantly positive during each of the two years of investigation (+8634 in 2015) and (0.7637 in 2016). The partial regression values however, was positive (48.408) during 2015 and (115.75) during 2016. The two values were insignificant. The latter result means that the general average of this factor (14.4°C) in 2015 and (20.27°C) in 2016 are slightly below the range of the optimal activity of this insect.

3.3. Effect of day maximum relative humidity:

The small insignificant positive simple correlation "r" values (0.17085 in 2015 and 0.2486 in 2016) suggest that, no relation existed between the day maximum relaive humidity and the seasonal activity of *S. cofeae*. The insignificant partial regression "Pb" values (-28.45 in 2015 & +7.849 in 2016) indicate that, while the day maximum relative humidity was slightly above the optimal range of the insect activity during 2015, it was slightly below this optimal range during 2016.

3.4. Effect of day minimum relative humidity:

There is no relation between the day minimum relative humidity and the seasonal activity of the pest under investigation as the "r" values are (0.2486) in 2015 and (0.35778) in 2016. The insignificantly positive "Pb" value of 17.308 in 2015 suggests that the average of this factor was slightly closed and below the optimal range of the insect activity. While during 2016 "Pb" value of -7.775 was above the optimal range of this factor for insect activity.

3.5 Combined effect of the four weather factors on the seasonal activity of S. cofeae:

Table (3) shows that, the amount of variance in the monthly catch explained by the four weather factors (47.1% in 2015 and 62.3 % in 2016) were highly significant, indicating the strong influence of the four factors on the seasonal activity of S. cofeae adults. The remaining unexplained variance (about 52.9% in 2015 and 37.7% in 2016) could be attributed to the influence of othe biotic factors not considered in the analysis. The highly significant multiple correlation "R2" values (0.7455 in 2015 and 0.5131 in 2016) substantiate this conclusion.

Table 3. Analysis of variance of the seasonal activity of S. cofeae on 4 main weather factors along with the percentages of explained variance, Giza 2015 and 2016

Year	Sources	Analysis of variance					Explained
		D.F	S.S.	M.S.	F	Prob.	variance
2015	Regression	1	557592	557592	19.11	0.001	47.1%
	Error	10	291839	29184			
	Total	11	849432				
2016	Regression	1	910525	910525	10.5	0.009	62.3%
	Error	10	863916	86392			
	Total	11	1774441				

R^2 = 0.6564 in 2015 R^2 = 0.5131 in 2016

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حصر لتحت رتبة Sternorrhyncha التى تصيب الزيتون فى مصر مع التركيز على التعداد الحشرى للحشرة البنية الرخوة واعدائها الحيوية

ممدوح محمد السباعى و نها احمد

معهد بحوث وقاية النباتات – ٧ نادى الصيد – الدقى – جيزة

تحت رتبة Sternorrhyncha تعتبر من أهم الآفات التى تصيب الزيتون فى مصر . حديثا الحشرة البنية الرخوة من اهم الآفات التى تصيب الزيتون . الهدف من هذا العمل هو دراسة التعداد الحشرى للحشرة البنية الرخوة واعدائها الحيوية. وقد تم حصر تحت رتبة Sternorrhyncha التى تصيب الزيتون فى كل انحاء مصر اثناء الفترة من ٢٠١٤-٢٠١٦.   وقد اشارت النتائج ان الزيتون يصاب ٢٢ نوع من رتبةSternorrhyncha وقد تم ايضا دراسة التعداد الحشرى للحشرة البنية الرخوة واعدائها الحيوية خلال عامى ٢٠١٥-٢٠١٦ فى محافظة الجيزة . واتضح من النتائج ان هذه الآفة لها فترتين نشاط خلال عامى الدراسة.

اما بالنسبة للاعداء الحيوية فقد تم تسجيل عدد اربع طفيليات و خمسة مفترسات . اما الطفيايات فهى

Coccophagus scutellaris (Dalman), *Metaphycus helvolus* (Compere), *Metaphycus zebratus* (Mercet) and *Diversinervus elegans* Silvestri

اما المفترسات التى تم تسجيلها فكانت:

(*Chilocorus bipustulatus* L. , *Exochomus flavipes* Thunb and *Scymnus syriacus* Marseul و *Orius laevigatus* Fieb. و *Chrysoperlla carnae* Steph (Neuroptera : Chrysopidae

وقد اتضح أيضا من خلال هذا العمل أن الطفيل   *Coccophagus scutellaris* متواجد طوال العام. وأن أعلى نسبة تطفل سجلت فى اول اكتوبر و اول سبتمبر خلال عامى الدراسة على الترتيب.