

SOME BIOLOGICAL AND POPULATION DENSITY ASPECTS OF PREDATOR ARMORED SCALE LADYBIRD BEETLE, *CHILOCORUS BIPUSTULATUS* AND ORIENTAL YELLOW SCALE, *AONIDIELLA ORIENTALIS* IN CITRUS ORCHARDS OF IRAQ

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Abstract— Laboratory and field studies were conducted to investigate some biological and population densities of predator Armored scale ladybird beetle (ASLB) *Chilocorus bipustulatus* and Oriental yellow Scale (OYS) *Aonidiella orientalis* in Iraqi citrus orchards during 2013- 2014. Study was implemented in citrus orchards of mixed citrus varieties: Bergamot, *Citrus aurantium*; Mandarin, *C. reticulata* and Orange, *C. sinensis*. Population densities of *C. bipustulatus* were measured according to stages (larvae, Pupae and adults) per leaf and fruit; OYS calculated per 1cm² in leaf and fruit. Biological parameters were studied under controlling conditions (27 C⁰ ± 2, 70% ± 5 RH, and 16: 8 h light: dark photo period). Results indicated that the population density of YOS in 1 cm²/ leaf: fruit were 10.6: 11.2, 3.0: 5.6 and 0.2: 0.3 in *C. aurantium*, *C. reticulata* and *C. sinensis*, respectively. While, population densities of ASLB were 22: 27, 4.5: 8 and 0: 0 per 100 leaves: 100 fruit in *C. aurantium*, *C. reticulata* and *C. sinensis*, respectively. The body parameters of width: length of last instar larvae, prepupa, pupa, male and female adult were: 2.32: 4.75, 2.69: 4.77, 3.49: 4.92, 3.13: 3.75, 3.60: 4.24 cm, respectively. The duration of egg, larva, pupa, preoviposition period development were: 10.1, 22.3, 8.1, 7.9 days, respectively. Total period was 40.6 day and survivorship 85.3%, 72.2% and 97.7%, respectively and 55.1% total preimaginal development. The study results demonstrate the dispersal of *C. bipustulatus* as a biological control agent in Iraqi environment for YOS in citrus orchards.

Keywords— Population density, Biology, *Chilocorus bipustulatus*, *Aonidella orientalis*, Citrus.

I. INTRODUCTION

The predator Armored scale ladybird beetle (ASLB) *Chilocorus bipustulatus* (Coleoptera: Coccinellidae) is a natural enemy of many species of scale insects, soft scales and whiteflies (Argyriou and Katsoyannos, 1977; Viggiani, 1985; Yigit *et al.*, 2003; Stathas, *et al.*, 2003, 2009). It was found to be the most common predator and that associated with diverse species of diaspidids in Antalya and other parts of Turkey (Eliopoulos *et al.*, 2010). *C. bipustulatus* is found throughout the Palearctic region preying on a wide variety of coccids, particularly armored scales (Hodek, 1973; Yinon, 1969). Kehat (1968) reported that mature differ from young groves favor *C. bipustulatus*. Khalaf and Sokhansanj, 1993 mentioned that the natural enemies, *Chilocorus bipustulatus*, *Cybocephalus* sp. and *Encarsia aurantii* were thought to be important for biological control in Iran, and pruning lower stalks and water management were also useful in controlling *A. orientalis*.

C. bipustulatus was reared on the oleander scale *Aspidiotus nerii*, in the duration of all developmental stages (egg, larva, pupa) reaching 38.7 day under laboratory conditions (25C⁰, 65% Rh and 16:8 h light: dark photoperiod) (Eliopoulos *et al.*, 2010).

The Oriental yellow Scale (OYS), *Aonidiella orientalis* is an important pest of woody plants, and it has been recorded from hosts in 36 genera and 25 plant families, including *Citrus* species such as *Ficus*, mango, and papaya, bananas *Rosa*, *Ziziphus*, and *Populus*; moreover, it was reported from Tea,

Camellia sinensis, and palm tree, including date palm, coconut and arecanut (Hussain, 1963; Davidson and Miller, 1990; Al-Malo and Abdul Rassoul, 2010). Al-Khaldy (2005) mentioned that OYS present in citrus orchards on the central region of Iraq and caused high infestation in leave and fruits. Population dynamics and host preference of OYS were studied in citrus orchards of Iraq by Khalaf *et al.* 2007.

The main objective of study is to investigate the development stages of *C. bipustulatus* under laboratory conditions and population densities of *C. bipustulatus* and *A. orientalis* in citrus orchards in south Baghdad.

II. MATERIALS AND METHODS

1. Research site

The works were conducted during 2013 – 2014 season at citrus orchards of Almadain /Baghdad and the location was determined according to Global Positioning System GPS: latitude 33.15 north, longitude 44.56 east, and altitude 15.40, 14 Feet, 208 SW. Selected orchards were with medium age trees of most common citrus varieties such as: Bergamot, *Citrus aurantium*; Mandarin, *C. reticulata* and Orange, *C. sinensis*.

2. Field surveys

2-1. Calculation of population density of *Aonidiella orientalis*

Population density of *A. orientalis* was calculated by counting number of insect scale per 1 cm^2 /leaf and fruit under microscope in each 100 leaf and fruit that collected randomly from each varieties Bergamot, *Citrus aurantium*; Mandarin, *C. reticulata* and Orange, *C. sinensis*.

2-2. Hand collection of *Chilocorus bipustulatus*

The predator *C. bipustulatus* was collected from citrus orchards in Al- Madain/ Baghdad during September till the end of November. Mature and immature stages (larvae, pupae and adults) were collected from leaves and fruits of citrus by using glass vials and transferred into plastic container (5 L) that supplied with leave and fruits citrus infested by *A. orientalis* to get the laboratory colony of predator.

2-3. Calculation of population density of *C. bipustulatus*

C. bipustulatus was counted each two weeks depending on the number of larvae, pupa and adults that presented on leaves and fruits of each citrus variety: Bergamot, *Citrus aurantium*; Mandarin, *C. reticulata* and Orange, *C. sinensis*. The counting was done in 100 leaf and fruit directly in the field and the variety was randomly selected.

3. Biological study

C. bipustulatus adults around (50) were placed into plastic containers (5 L) supplied with fresh leave and

fruits of citrus that infested by OYS as a source of predator that were replaced weekly. Containers bottom was covered with organza cloth and stabled by rubber band and incubated under controlling conditions: $27 \pm 2\text{ C}^\circ$, $70\% \pm 5\text{ RH}\%$, and 16: 8 h light: dark photo period. Newly laid eggs were transferred into glass vials (2.5 cm diameter \times 8 cm height) using 10 eggs per vial with 20 replicates. Each vial was observed daily until hatching to record duration of egg duration and hatching percentage.

First instar larvae (one day age) transferred to Petri dishes (16cm diameter \times 2.5cm height) with 10 larvae per dish, and with 10 replicates that supplied with leave and citrus fruits that infested by OYS as larval source of food. Each Petri dish was examined daily till pupation to record duration of development, and body parameters (width, length). Pupae (one day age) were also transferred into glass vials that covered from the top by cotton (one pupa per vial with 30 replicates). Each vial was examined daily till the emerges of adults to record the duration of development, survivorship (adults emergence percentage) and body parameters (figure 1).

III. STATISTICAL ANALYSIS

Statistical analysis was done using Genstat software program and Duncan test.

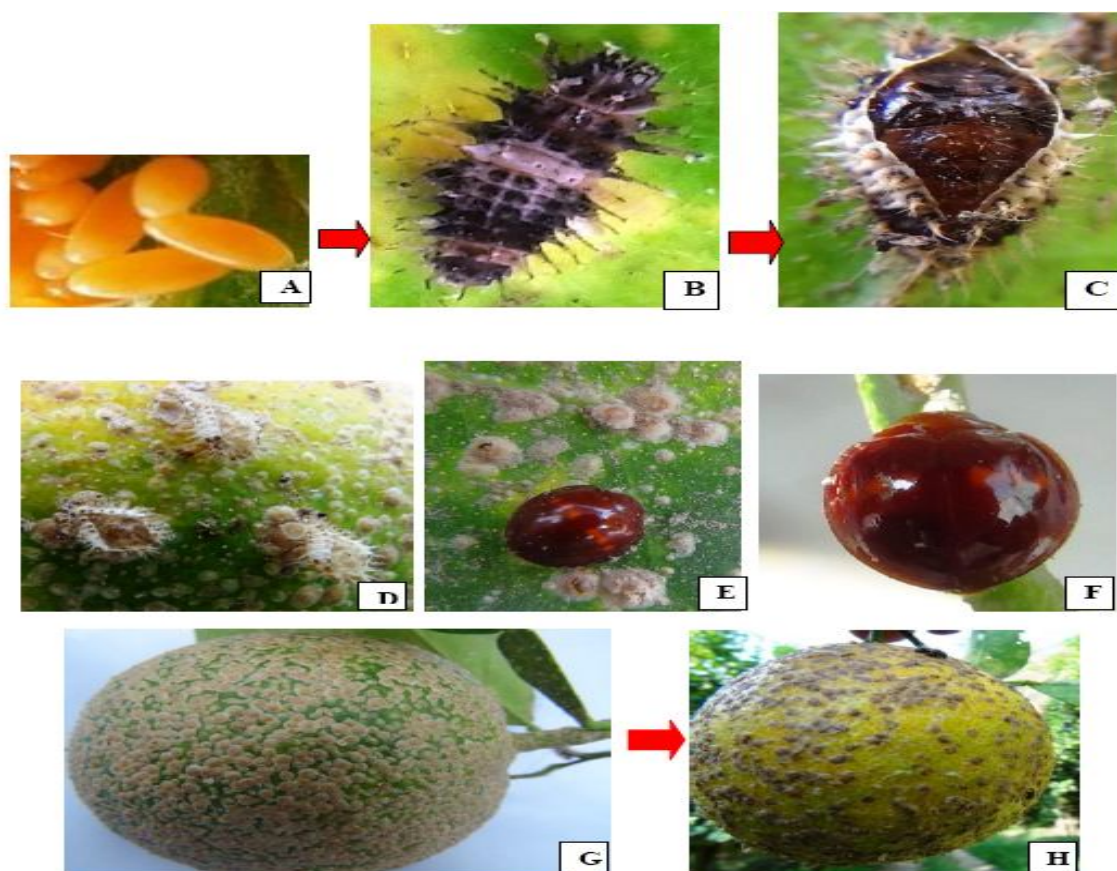


Figure 1: A (Eggs), B (Larva), C (Pupa), D (Emergence of adult), E and F (Adults) of *Chilocorus bipustulatus*, G and H (*Aonidiella orientalis* before and after predation by *C. bipustulatus*).

IV. RESULTS AND DISCUSSION

Population density of Oriental Yellow Scale (OYS) *Aonidella orientalis* that demonstrated in table 1 indicated that the heavy population density of OYS in Bergamot, *Citrus aurantium* in comparison with Mandarin, *C. reticulata* and Orange, *C. Sinensis*. The fruits were more preferable by leave in all citrus varieties. The density reached 10.6: 11.2, 3.1: 5.6 and 0.2: 0.3 insect scales per cm² / leaf: fruit in *C. aurantium*, *C. reticulata* and *C. Sinensis*, respectively especially during mid October 2014.

Population density of the predator Armored scale ladybird beetle (ASLB) *Chilocorus bipustulatus* (Table 1) indicated that the predator density in fruits was much higher than that on leave. The results also revealed that the number of predator was 22: 27, 4.5: 8 and 0: 0 per 100 leaves: fruits in *C. aurantium*, *C. reticulata* and *C. Sinensis*, respectively especially during mid October 2014. The current study showed that the predator ALSB is active during the time of high peak of OYS in Baghdad citrus orchards. It is also able to survive and be active at both high and mid temperatures especially during September (50C°) and November (23C°).

Table 1. Population density of predator *Chilocorus bipustulatus* and Oriental yellow Scale, *Aonidella orientalis* on Citrus in South Baghdad orchards during 2014.

Type of Citrus	Leave parameters		No. of insect scale per cm ²		No. of predators, <i>C. bipustulatus</i>					
	Width cm	Length cm	leaf	Fruit	Per 100 leaf			Per 100 fruit		
					Larva	Pupa	Adult	Larva	Pupa	Adult
Bergamot <i>Citrus aurantium</i>	4.6 a	10.4 a	10.6 c	11.2 c	9 c	7 c	6 c	11 c	10 c	6 c
Local Mandarin <i>C. reticulata</i>	3.0 b	9.0 b	3.1 b	5.6 b	2.5 b	1.5 b	0.5 b	4 b	3 b	1 b
Orange <i>C. sinensis</i>	4.4 a	9.9 a	0.2 a	0.3 a	0 a	0 c	0 a	0 a	0 a	0 a

Values followed by the same letters in each column are not significantly different according to Duncan test (P<0.05)

Biological Studies of *Chilocorus bipustulatus*:

Some morphological and body parameters of *C. bipustulatus*:

The females laid eggs in patch content 10-15 egg that yellow in color, larval body is black and white in color, it has 33 pairs of hairy appendages (5 pairs in first segment, 3 pairs in each of 2-9 segments, 2 pairs in each of 10-11 segments, dorsa- lateral) (figure1-B). The body parameters of *C. bipustulatus* that fed on OYS under laboratory conditions were 2.32 : 4.75, 2.69 : 4.77, 3.49 : 4.92, 3.13 : 3.75 and 3.60 : 4.92 mm width : length of last instar larvae, prepupa, pupa, adult(male) and adult(female), respectively(Table 2).

Table 2: Some parameters body of *Chilocorus bipustulatus* that fed on *Aonidella orientalis* under controlling conditions

Stage of development	Body width mm Mean ± SD	Body length mm Mean ± SD
Last instar larvae	2.32 ± 0.42	4.75 ± 0.71
Prepupa	2.69 ± 0.46	4.77 ± 0.65
Pupa	3.49 ± 0.63	4.92 ± 0.82
Adult(male)	3.13 ± 0.76	3.75 ± 0.78
Adult (female)	3.60 ± 0.64	4.24 ± 0.71

Time development of immature stages:

The development duration of all immature stages of *C. bipustulatus* was 40.6 day under laboratory conditions (27 C° ± 2, 70% ± 5 RH, and 16: 8 h light: dark photo period). However, main development time

of egg, pupa, larva and pupa were 10.1, 22.3 and 8.1 day and the survival of all immature stages was 55.1% (85.3% in eggs, 72.2% in larvae and 97.6% in pupae) (Table 3). Podoler and Hemen (1983) reported that the *Chilocorus* sp. beetle completed life cycle from egg to adult in 27 day at 26 – 28C° and 33.7 day at 26C° that fed on *Aspidiotus nerii* as reported by (Karatay and Karaca, 2013). In our study, the predator completed its development in a longer time that almost matches with Eliopoulos *et al.* (2010) that mentioned that the predator completed immature stages in 38.7 day.

Table 3: Duration of development and survivorship percentage of immature stages of *Chilocorus bipustulatus* fed on *Aonidella orientalis* stage of development under controlling conditions

Stage	Duration of development /Day Mean ± SD	Survivorship %
Egg	10.1 ± 0.7	85.3
Larvae	22.3 ± 0.9	72.2
Pupa	8.1 ± 0.6	97.6
Preoviposition period	7.9 ± 0.5	-----
Total	40.6	-----
Total preimaginal development	-----	55.1

The study results revealed that the predator *C. bipustulatus* is active during the period August – November (Autumn season) synchronizing with the presence of OYS , *A. orientalis* in citrus orchards under Iraqi agro-ecosystem. It is an important

predator of OYS in Iraq. The study found that the predator is able to survive at both mid and high temperatures with development duration of immature stages reaching 40 days and 55% survival.

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