

**CLITOSTETHUS ARCUATUS (ROSSI) (COLEOPTERA: COCCINELLIDAE),
A PREDATOR SPECIES, OF THE CITRUS WHITEFLY,
DIALEURODES CITRI (ASHM.) (HOMOPTERA:
ALEYRODIDAE) IN EGYPT**

S.M. Metwally*, A.H. El-Heneidy**, Z. Shenishen*, H.A. Boraie* and A.H. Mesbah**

* Faculty of Agriculture, Kafr El-Sheikh, Tanta University, Egypt

** Plant Protection Research Institute, Agricultural Research Center, Giza, Egypt

(Received, October 10, 1999; Accepted, November, 24, 1999)

ABSTRACT

Seasonal abundance of the predator, *Clitostethus arcuatus* (Rossi) was studied at Kafr El-Sheikh Governorate (northern Egypt) for two successive entire years, 1993 and 1994. Population of the predator accounted 41.9 % of the total number of predators found associated with the citrus whitefly, *Dialeurodes citri* (Ashm.) on citrus trees. Highest mean number of the predator, 15 individual / 80 double net-strokes, was recorded during October in both years. General morphology of the *C. arcuatus* adult and immature stages were described. Duration of immature stages and adult longevity were estimated under laboratory conditions. Total developmental stages averaged 17.4 days. Adult longevity averaged 12 and 17.7 days for males and females, respectively.

Key Words: *Clitostethus arcuatus*, *Dialeurodes citri*, Citrus, Egypt.

INTRODUCTION

Clitostethus arcuatus (Rossi), a predator of aleyrodids and other insects and mites is one of several coccinellids reported to feed on whiteflies (Gerling 1990). It was widely distributed in the Mediterranean and surrounding areas, and France; the Italian peninsula (Priore 1969, Tremblay 1969, Loi 1978); Sicily (Liotta 1981); Greece (Mentzelos 1967); Turkey (Soylu 1980, Ulu 1985); Germany (Bathon and Pietrzik 1986); and in the southern and western of the former USSR (Agekyan 1977). Its distribution in northern Africa was also considered Agekyan (1977).

C. arcuatus has been reported feeding on symmetric aleyrodids native to its Old World distribution (*Siphoninus phillyreae* Haliday) (Mentzelos, 1967; Tremblay 1969), and *Aleyrodes proletella* L. (Bathon and Pietrzik 1986), as well as species introduced to the Mediterranean and mid-east (*Dialeurodes citri* Ashm). [Priore, 1969; Agekyan, 1977; Loi, 1978; Soylu 1980; Liotta 1981; Ulu, 1985], *Trialeurodes vaporariorum* (Westwood) (Agekyan 1977), and *Aleurothrixus floccosus* (Maskell) (Liotta, 1981)). It feeds on whitefly eggs, nymphs and adults (Priore 1969, Bathon and Pietrzik 1986), with predation

apparently primarily on the eggs and nymphs when all stages are present (Priore, 1969). Loi (1978) mentioned that *C. arcuatus* (Rossi) was first described as *Scymnus* by Rossi in 1794 and added that wise describe this genus as *Clitostethus* in 1885.

In the summer 1989, *C. arcuatus* was imported from Israel to California as part of a broader program to introduce natural enemies against *S. phillyreae*.

C. arcuatus was recorded recently for the first time in Egypt, (Mesbah *et al*, 1998). Adults and larvae were found preying on *Dialeurodes citri* immature stages, particularly the eggs on citrus trees at Kafr El-Sheikh Governorate.

In the present study, morphological, ecological and biological studies of *C. arcuatus* were undertaken in order to high light some of the relevant information about seasonal abundance and life history, as a recently recorded predator in Egypt, under field and laboratory conditions.

MATERIALS AND METHODS

A citrus orchard of navel orange, about 5 feddans, at Kafr El-Sheikh Governorate, was chosen to carry out this study throughout the two

successive years 1993 and 1994.

Samples from the predator adults were collected biweekly from the citrus trees using the sweep net, 80 double net-strokes were conducted per sample. Collected samples were transferred to the laboratory for counting the predator. Samples from the predator adults were collected biweekly from the citrus trees using the sweep net, 80 double net-strokes were conducted per sample. Collected samples were transferred to the laboratory for counting the predator. Samples from the predator adults were collected biweekly from the citrus trees using the sweep net, 80 double net-strokes were conducted per sample. Collected samples were transferred to the laboratory for counting the predator.

Specimens from the adults and larvae were preserved in alcohol (70%) and sent for identification. The specimens were identified by the German D. SC. Werner Witsack, Martin-Luther University, Halle, Witternberg, Zoology Institute as *Clitostethus arcuatus* (Rossi), (Coleoptera-Coccinellidae). The reference used in identification was Freude, H., Harde, K.W. and G.A. Lohse (1967), the beetles of middle-Europe, Vol.7).

A citrus sprig having ample amounts of the citrus whitefly, *Dialeurodes citri* eggs was introduced into a glass vial (2 x 4 cm) filled with water to keep the sprig fresh. The vial was placed into a jar (9 x 25 cm). *C. arcuatus* adults were released on the citrus sprig to feed on the host eggs, and to oviposit on the sprig leaves. To avoid the cannibalism, citrus sprigs having the predator's eggs were always been substituted by new ones, having *D. citri* eggs (Tawfik *et al.*, 1962). The sprigs carrying the predatory eggs were put into petri dishes until hatching. *C. arcuatus* larvae were reared individually in vials, each provided with one citrus leaf having *D. citri* eggs to serve as food.

Incubation periods, duration of larval and pupal stages of the coccinellid were recorded. Also, longevity was estimated by keeping pairs of newly emerged adults (0-24 h old) in separate vials provided with citrus leaves having *D. citri* eggs. Different tests were conducted under the laboratory conditions of $27 \pm 2^\circ\text{C}$, 55-60% R.H. and 12:12 (L: D) photoperiod.

Specimens of different stages of *C. arcuatus* were prepared for morphological study using the Stereomicroscope (Agekyan, 1977). Specimens of different stages of *C. arcuatus* were prepared for morphological study using the Stereomicroscope (Agekyan, 1977). Specimens of different stages of *C. arcuatus* were prepared for morphological study using the Stereomicroscope (Agekyan, 1977).

RESULTS AND DISCUSSION

I. Ecological Studies

Population Dynamics of *Clitostethus arcuatus* (Rossi)

Population dynamics of *C. arcuatus* on citrus trees were studied at Kafr El-Sheikh Governorate for the two entire years, 1993 and 1994. Numbers of the predator were counted thoroughly with the other predatory species found associated with *D. citri* immature stages on citrus trees. The population was recorded bi-weekly throughout the study period using the sweep-net. Obtained data are summarized in Table (1). As shown in the table, the predator was almost recorded associated with *D. citri* immature stages all the year round. Generally, numbers of the predator were relatively higher in year 1993 than in year 1994. This may be due to insecticide application (on May 10th, 94) during the active period of the predator (Liotta 1978). Overall means of 8.3 and 5.5 individuals per 80 double sweep-net strokes were calculated in years 1993 and 1994, respectively. Highest monthly mean number of the predator (15 individuals/80 double net-strokes) was recorded in the same month (October) in the two years while the lowest numbers of the predator were counted during the period January-March and December, 1993 and January-April and December, 1994. *C. arcuatus* was the most dominant predatory species found associated with *D. citri* immature stages on citrus trees at Kafr El-Sheikh Governorate during the present study. It represented about 42 % of the total number of recorded predators. Meshah, 1999 mentioned that its number represented 43.4 and 39.8 % of the total number of predators counted in 1993 and 1994 years, respectively.

II. Morphological and Biological Studies on the Predator *C. arcuatus*

Adults of the predator were collected from the

Table (1): Population dynamics of *Dialeurodes citri* immatures, and adults of the predator, *Clitostethus arcuatus* on citrus trees at Kafr El-Sheikh, Governorate during 1993 and 1994.

Month	1993				1994			
	No. of <i>D. citri</i> immature stages/240 cm ²			No. of <i>C. arcuatus</i> /80 strokes	No. of <i>D. citri</i> immature stages/240 cm ²			No. of <i>C. arcuatus</i> /80 strokes
	Eggs	Larvae	Pupae		Eggs	Larvae	Pupae	
Jan.	96.7	325.3	219.3	5.7	187.5	292.5	60.0	1.0
Feb.	11.5	261.5	177.5	0.0	97.5	284.5	5.5	1.0
Mar.	13.5	231.0	250.5	10.5	48.5	236.5	146.0	0.0
Apr.	40.0	7.00	354.5	10.5	3178.0	78.5	112.5	9.5
May	854.5	80.5	6.0	10.0	2640.0	191.5	4.0	8.5
June	95.0	108.5	59.0	7.0	742.0	239.0	35.0	12.0
July	645.0	30.0	24.0	7.0	921.0	156.0	25.0	1.5
Aug.	664.0	184.5	77.0	8.5	582.5	112.0	108.0	5.5
Sept.	936.5	179.5	24.0	13.0	564.5	118.5	68.0	5.5
Oct.	360.0	472.5	8.0	15.0	13.0	234.0	35.5	15.0
Nov.	94.5	298.0	230.0	10.5	12.0	105.5	74.5	7.0
Dec.	135.0	520.0	72.0	2.0	12.5	73.5	117.5	1.5
Mean	319.6	232.9	124.9	8.3	749.0	176.8	66.0	5.5
	±	±	±	±	±	±	±	±
	105.4	48.9	35.1	1.3	320.4	21.9	14.1	4.9

Date of sprays:

7 Jan., 20 Feb. and 20 Nov. (1993)

10 Jan., 10 May. and 25 Nov. (1994)

Table (2): Duration of *Clitostethus arcuatus* (Rossi) immature stages and adult longevity under the laboratory conditions (27±2°C and 55-60% R.H).

Stage	No. of replicates	Duration		
		Minimum	Maximum	Mean
Egg stage	50	3	3	4.4
Larval stage:	46			
1st instar		1	2	1.1
2nd instar		2	3	2.3
3rd instar		2	3	2.3
4th instar		2	4	2.5
Larval period		7	12	8.2
Pupal stage	39	4	5	4.8
Total developmental period	37	14	22	17.4
Adult longevity	32			
Male		10	14	12.0
Female		10	31	17.7



Fig. (1): *Clitostethus arcuatus* (Roosi) adult



Fig. (2): *Clitostethus arcuatus* (Roosi) larva

fields and reared under the laboratory conditions of $27 \pm 2^\circ\text{C}$ and 55-60% R.H. for laboratory studies. General morphological characters of different stages of the predator were described. Also duration of the predator's immature stages and longevity of the adults were estimated.

II.1. General Morphology

Adult's body (Fig. 1) is short oval in shape, densely covered with short hairs. Head whitish. Pronotum yellow-brown in color, with large rounded spots along sides and an irregularly shaped spot in the center. Elytra cinnamon brown-dark brown, with 1-2 yellow-white fasciform spots. Mouth parts, antennae and legs are yellow. Body length measures 1.5-2 mm.

Egg is cream-white in color, elongate-oval in shape, and 0.44-0.46 mm long and 0.22 mm wide in measurements.

Mature larva (before pupation) is dirty white in color (Fig. 2). Tubercles bearing hairs along body margin on thoracic segments. Abdominal segments have 2 rows of these tubercles. Longitudinal row of paired hairs extending along middle of thoracic segments. The body measures 2.76-2.82 mm length and 0.81-0.93 mm width.

Pupa is dirty white in color, with graytinge, with black, erect, fairly long setae, (1.9-2.0 mm long and 1.09-1.19 mm wide).

II.2. Duration of *C. arcuatus* Immature Stages

Duration of different immature stages of the aleyrodids predator *C. arcuatus* when fed on *D. citri* eggs were estimated under the laboratory condition 27 ± 2 and 55-60%, R. H. (Table 2).

Egg Stage

Eggs were laid singly at random on the lower surface of young citrus leaves. The incubation period of the *C. arcuatus* eggs ranged between 3-5 days, with an average of 4.4 days (Table 2). Percentage of egg hatching reached 91.2% under the laboratory conditions.

Larval Stage

Larva moults 3 times. Duration of the four larval instars of *C. arcuatus* when fed on *D. citri* eggs, ranged between 1-2, 2-3, 2-3 and 2-4 days for the 1st, 2nd, 3rd and 4th instars of the predator, respectively. Duration averaged 1.1,

2.3, 2.3 and 2.5 days under the laboratory conditions for the correspondent four larval instars, respectively. Survival of different larval instars of the predator was estimated by 80.8, 61.9, 72.7 and 100% for 1st, 2nd, 3rd 4th larval instars, respectively. An overall mean of 68% was calculated for the survival of all larval instars. The total larval period ranged between 6-9 days, with an average of 7.9 days.

Pupal Stage

The pupal stage of *C. arcuatus* lasted 4-5 days under the mentioned laboratory conditions, with an average of 4.8 days. Survival of the pupae was estimated by 83.3%.

Consequently, the entire developmental period (egg-adult) ranged between 15-19 days, with an average of 16.8 days. Survival of the total developmental immature stages of the predator was estimated by 74%.

II.3. Adult Longevity

Longevity of *C. arcuatus* adults, males and females was estimated under the laboratory conditions of $27 \pm 1^\circ\text{C}$ and 55-60% R.H. Longevity of males ranged between 10-14 days, with an average of 12 days. Longevity of females lasted 10-31 days, with an average of 17 days (Table 2).

Agekyan (1977) reported that egg, larval and pupal duration at $24-27^\circ\text{C}$ reached 5, 13-14 and 4-5 days, respectively, with a total developmental time of 23-25 days. Loi (1978) reported the correspondent developmental periods as 3-8, 8-24, and 3-8 days, respectively. Bellows *et al.* (1992) mentioned that preimaginal developmental time was shortest for all stages except the egg at 28.2°C . Development from egg to adult was fastest at this temperature, with a developmental time of 15.6 days. The three studies were for populations fed on *D. citri* on citrus and the results obtained are relatively in accordance with their findings. Bellows *et al.* (1992) also reported that survival and adult longevity were strongly affected by temperature.

REFERENCES

- Agekyan, N.G. 1977. *Clitostethus arcuatus* (Rossi) (Coleoptera, Coccinellidae), a predator

- of the citrus whitefly in Adzharia. Entomol. Rev., 56(1): 22-23.
- Bathon, V.H. and J. Pietrizik 1986. Zur Nahrungsaufnahme des Begen-Marienkfers, *Clitostethus arcuatus* (Rossi) (Col.: Coccinellidae), einem Vertilger der Kohlmottenlaus, *Aleurodes proletella* linné (Hom.: Aleurodidae). J. Appl. Ent., 102: 321-326.
- Bellows, T.S.; T.D. Paine and D. Gerling 1992. Development, survival, longevity, and fecundity of *Clitostethus arcuatus* (Coleoptera: Coccinellidae) on *Siphoninus phillyreae* (Homoptera: Aleyrodidae) in the laboratory. Environ. Entomol. 21(3): 659-663.
- Gerling, D. 1990. Whiteflies: their bionomics, pest status and management. Intercept Ltd., Andover, UK, 348 pp.
- Liotta, G. 1978. Effetti secondari dei fitofarmaci comunemente adoperati contro *Dialeurodes citri* (Ashm.) (Hom.: Aleyrodidae) su *Clitostethus arcuatus* (Rossi) (Col.: Coccinellidae). Atti XI Congr. Ital. Ent., Portici-Sorrento 10-15 Maggio 1976, 437-444.
- Liotta, G. 1981. Osservazioni bio-etologiche su *Clitostethus arcuatus* (Rossi) (Col.: Coccinellidae) in Sicilia Redia 64: 173-185.
- Loi, G. 1978. Osservazioni eco-etologiche sul coleottero coccinellidae scimmio *Clitostethus arcuatus* (Rossi), predatore di *Dialeurodes citri* (Ashm.) in Toscana. Frust. Entom., 1: 123-145.
- Mentzelos, I.A. 1967. Contribution to the study of the entomophagous insects of *Siphoninus phillyreae* (Halid) Aleyrodidae on pear trees in central Macedonia. Report of the plant protection Agricultural research station, Thessaloniki 3: 92-102.
- Mesbah, A. H. 1999. Studies on certain natural enemies of the whiteflies. Ph.D. Thesis, Dept of Econ. Entomolgy, Faculty of Agriculture, Kafr El-Sheikh Tanta University. 133 pp.
- Mesbah, A. H., A.H. El-Heneidy, S.M. Metwally, Z. Shenishen and H.A. Boraei. (1998). *Clitostethus arcuatus* (Rossi) (Coleoptera: Coccinellidae), A new recorded predator species, of the citrus whitefly, *Dialeurodes citri* (Ashm.) (Homoptera: Aleyrodidae) in Egypt. Egypt. J. Biol. Pest Control, 8 (2): 99-100
- Priore, R. 1969. *Dialeurodes citri* (Ashm.) (Homoptera, Aleyrodidae) in Camania. Notes on morphology and biology. Boll. Lab. Entomol. Agrar. F. Silvestri Portici 27: 287-316.
- Soylu, O.Z. 1980. Investigations on the biology and control of citrus whitefly, *Dialeurodes citri* (Ashm.) injurious in citrus orchard in the Mediterranean region of Turkey. Bitki Koruma Bullen; 20 (1/4): 36-53.
- Tawfik, M.F.S.; M. Hafez and B. Said 1962. Studies on *Scymnus* (Pullus) *syriacus* Mars. (Coleoptera: Coccinellidae). Bull. Ent. Soc. Egypt, XLVI, 485-504.
- Tremblay, E. 1969. Il controllo del *Siphoninus phillyreae* (Haliday) in integrata control inermi animali delle piante: XL. Boll. Lab. Entomol. Agrar. Filippo Silvestri, Portici 27: 317-323.
- Ulu, O. 1985. Investigations of the taxonomic characters, damage, biology, ecology and control of the citrus whitefly *Dialeurodes citri* (Ashm.) (Homoptera: Aleyrodidae), which attacks citrus in the Aegean region. Ege Univ. Ziraat Fakultesi Dergisi., 22 (3): 159-174.