

## Biological studies on coccinellid predator, *Cryptolaemus montrouzieri* Muls. of grapevine mealy bug, *Maconellicoccus hirsutus* Green

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The coccinellid predator, *Cryptolaemus montrouzieri* Muls. of grapevine mealy bug, *Maconellicoccus hirsutus* Green was studied in the present investigation in the laboratory conditions (temp. 25°C to 31°C with 65% to 72% R.H.) at Department of Agricultural Entomology, MAU, Parbhani (MS). The Australian coccinellid, *Cryptolaemus montrouzieri* Muls. has been established very well because of its role in biological suppression of mealy bugs (Mani and Krishnamurthy, 1997). but very little work was carried out on this predator in Maharashtra. Hence, an attempt has been made in the present investigation to study the life history of the *Cryptolaemus* on grapevine mealy bug, *Maconellicoccus hirsutus* Green and to know its feeding potentiality. The incubation period of *C. montrouzieri* was 3 to 7 days. The duration of the first, second, third and fourth instars grub were 4 to 7, 3 to 5, 5 to 10 and 7 to 11 days. Prepupal and pupal periods ranged from 2 to 3 and 6 to 10 days. The males lived for 69.7 days and females for 74.7 days. The oviposition period lasted for 54 to 83 days. The females laid 476.2 eggs. While sex ratio was 1:1 The predation rate of *C. montrouzieri* on the biostages of *M. hirsutus* were in the order of eggs > nymphs > adults. It can also be concluded that female consumed more biostages during their life span than the males in the present studies.

Key words : Coccinellid predator, Grapevine mealy bug, *Maconellicoccus hirsutus* Green

### INTRODUCTION

The pink mealy bug, *Maconellicoccus hirsutus* Green is very serious problem in the grape orchards through out the India. It is very hard to kill by chemicals because of its protective waxy coating. Hence the biological control through its natural enemies like predators are of great importance, since they have proved their value in checking so many homopteran pests. (PDBC Rep., 1995) The Australian lady bird beetle, *Cryptolaemus montrouzieri* Muls. is a important mealy bug destroyer. Though this predator is now well established in South India and available information on successful multiplication and establishment of this predator under agroclimatic conditions of Marathwada region of Maharashtra is scanty. Hence, the exploitation of this coccinellid as biocontrol agent of grape mealy bug, *M. hirsutus* is contemplated to generate information that will be useful in the mass multiplication and augmentation program.

### MATERIALS AND METHODS

The technique of propagating mealy bug culture as well as its predator on ripe red pumpkin fruits was utilized for present study as standardized method by Chacko *et al.* (1978). The egg, larval, pupal period and adult emergence and its survival were recorded. Also their

mating period, pre oviposition and oviposition periods of female beetles with fecundity recorded periodically.

In order to determine the feeding preference and feeding potential of the grub and adult stages of the predator, known number of eggs, nymphs and adults of mealy bug, *M. hirsutus* were supplied separately as well as in combinations. For these studies newly hatched grubs and emerged adults of *C. montrouzieri* were used. Petri plates (10 x 2 cm) were used for grubs while the adults were confined to transparent plastic container (9 x 11 cm) with muslin cloth and rubber bands for confining. As soon as the cast skin was observed the number of eggs left uneaten were counted and deducted from the total number of eggs to be supplied. The total number of bio-stages consumed by the each instars grub was assessed as per the procedure suggested by Murthy (1982). The total development period of grub and longevity of adults were recorded.

### RESULTS AND DISCUSSION

*Biology of the predator, C. Montrouzieri :*

The results obtained in the biological studies and morphometric characters on *C. montrouzieri* are presented in Table 1 and Table 2 respectively

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a. Mass culture of *M. hirsutus*

b. Rearing Cage



c. Mealy bug infected pumpkin use for mass culture of predator

**Egg stage :**

The females of *C. montrouzieri* laid their eggs mostly in the ovisacs of the mealy bug, *M. hirsutus* either singly or in groups.



Freshly laid egg was pale yellowish white, smooth and cylindrical (capsule shaped), both ends being smooth and rounded. The egg measured 0.71 mm

in length and 0.38 mm in breadth. At the time of hatching, the shining of egg disappeared and a longitudinal depression was seen. The grub hatched by breaking egg shell at the depression. The incubation period varied from 3 to 7 days with an average of 4.73 days.

Similar range of incubation period was reported by Mani (1986); Baskaran *et al.* (1999) and Naik *et al.* (2003). However, these findings slightly differ from the findings of Murthy (1982); Babu and Azam (1988) and Shirke and Salunke (1996). Babu and Azam (1988) concluded that duration of life stages was shorter during

Table 1: Biology of the predator, *C. montrouzieri* on grape mealy bug, *M. hirsutus*

Life stages	Duration (days) mean $\pm$ SE	Range
Eggs Period	4.73 $\pm$ 0.69	3 – 7
Grub period		
I instar	4.87 $\pm$ 0.47	4 – 7
II instar	4.01 $\pm$ 0.38	3 – 5
III instar	7.12 $\pm$ 0.69	5 – 10
IV instar	8.03 $\pm$ 0.86	7 – 11
Total development	24.03 $\pm$ 1.29	21 – 28
Pre-pupal period	2.20 $\pm$ 0.23	2 – 3
Pupal period	8.30 $\pm$ 0.64	6 – 10
Total life span	39.26 $\pm$ 1.57	34 – 53

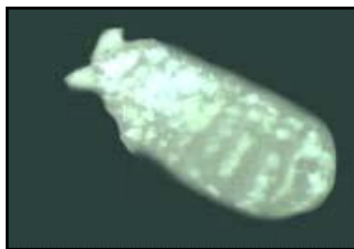
Table 2 : Morphometric measurement of *C. montrouzieri*.

Stage	Length (mm) (mean)	Breadth (mm) (mean)
Egg	0.71	0.38
I instar grub	1.69	1.10
II instar grub	3.96	1.46
III instar grub	5.29	2.38
IV instar grub	8.20	4.55
Pupa	6.95	5.19
Male adult	4.15	2.98
Female adult	4.48	3.03

summer and longer during winter and also varied with the temperature.

**Grub stage :****First instar grub :**

The first instar grub soon after emergence was a light yellow in colour. Within few hours the body was covered with a white bloom. After that, the body was gradually covered with waxy filaments on the dorsum of thorax and abdomen.

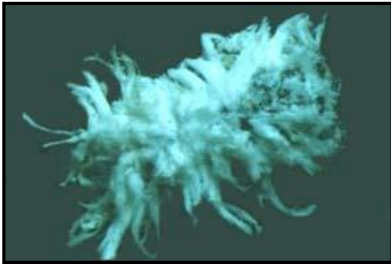


The larvae were found to hide in the egg mass of mealy bug. They clung to the egg masses of the *M. hirsutus* very closely. The grub measured 1.69 mm in length and 1.10 in breadth. The mean duration of first instar grub was 4.87 days.

**Second instar grub :**

The body of second instar grub was also covered with waxy coating within few hours

after moulting. The grub measured 3.96 mm in length and 1.46 mm in breadth. The duration of grub ranged from 3-5 days.

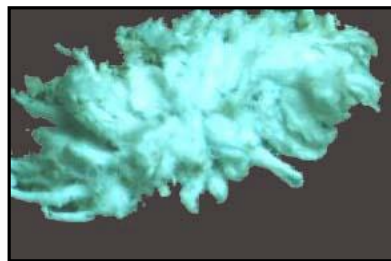


**Third instar grub :**  
Immediately after the moulting of the larva, the body was found to be smooth lemon yellow in colour.

Within few hours, white waxy filaments developed on the dorsum of thorax and abdomen. It measured 5.29 in length and 2.38 mm in breadth. The duration of third instar grub was 5 – 10 days.

#### *Fourth instar grub :*

The fourth instar grub was fully covered with waxy



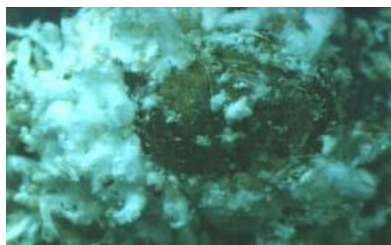
coating within few hours after moulting. The length of fourth instar grub was 8.20 mm and breadth was 4.55 mm. The fourth

instar lasted for 7 – 11 days.

#### *Cannibalism :*

Larvae of *C. montrouzieri* were found to feed on other larvae in the mass rearing cages when enough food was not available.

The above findings are supported by Mani (1986). However, the present findings differ from the observations of Murthy (1982); Babu and Azam (1988); Shirke and Salunke (1996); Baskaran *et al.* (1999) and Naik *et al.* (2003). The variation in the developmental period of grub might be due to quality and quantity of prey available and



variation in the environmental conditions in rearing room i.e. temperature and relative humidity.

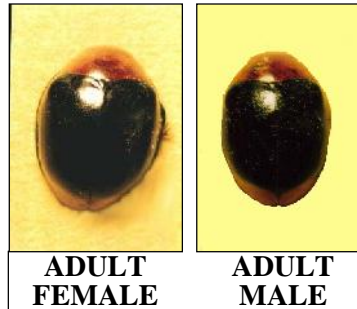
#### *Pupal stage:*

It was observed that the grub underwent a prepupal stage which lasted for two to three days. During this period the grub was inactive, remained isolated, stopped feeding and some body fluid oozing out and finally larva entered in pupal stage. The pupa was reddish brown in colour. Pupa measured 6.95 mm in length and 5.19 mm in breadth. The duration of pupal stage was 6-10

days. The pupa was fully covered dorsally with the white waxy filaments and the larval exuvium.

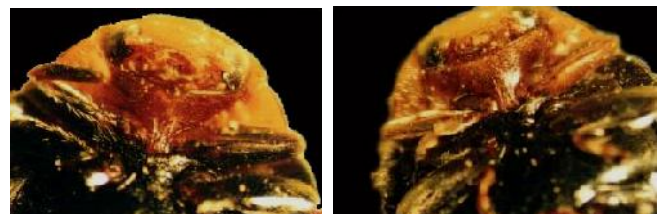
The total development period (from egg to adult formation) of *C. montrouzieri* was 39.26 days.

More or less similar range of pupal and total developmental period (from egg to adult formation) were also reported by Baskaran *et al.* (1999) and Naik *et al.* (2003). However, Murthy (1982) and Babu and Azam (1988) reported slightly higher range of



pupal period than the present findings. colour hardened, i.e. the light black tinge on the anterior parts of the elytra become jet black.

Adults were long, ellipsoid and have the typical form of ladybird beetles. The abdomen was pointed posteriorly



as compared to other species. Head, pronotum, the end of elytra (except black narrow margin) and abdomen are cinnamon red to orange coloured. Elytra are covered with pubescent hair, body and legs were black

#### *Sexual dimorphism in C. montrouzieri.*

The phenomenon of sexual dimorphism was observed in the adults of *C. montrouzieri*. The male and female could be distinguished from each other with the help of the colour difference in the first pair of legs. They were orange coloured in males and black coloured in females.

#### *Adult longevity and fecundity :*

The adult male beetle measured 4.15 mm in length and 2.98 mm in breadth. While female beetle measured 4.48 mm in length and 3.03 mm in breadth. It was clear from the figures that a females lived longer than males (Table-3).

The adult longevity in case of female beetle was 59-85 days with mean longevity of 69.70 days. The fecundity varied from 337-612 eggs with an average of

416.20 eggs per female. In case of male beetle longevity was 58-89 days with mean of 74.70 days.

These findings are in close agreement with the earlier reporters like Shirke and Salunke (1996) and Naik *et al.* (2003). The findings on fecundity of *C. montrouzieri* are supported by Shirke and Salunke (1996). However, the results obtained are quite deviating from the earlier records of Murthy (1982); Mani (1986) and Babu and Azam (1988) who recorded some what more or less adult longevity and less fecundity.

#### *Premating, mating, pre - oviposition and oviposition periods :*

Males and females emerging on same day required a pre mating period of 4 – 9 days. Repeated mating was observed in most of the cases in their life period. Mating time varied from 5 minutes to 36 minutes with repeated mounting and dismounting of the males. The beetles copulate 4 to 9 days after emergence and egg laying was observed within 6 to 12 days after emergence of the beetles with an average of 7.9 days. (Table-4)

The predaceous female preferred egg sacs of mealy bugs for oviposition. Capsule shaped eggs were found inserted inside the egg sac either singly or in groups during night hours. The egg laying period ranged 54 to 83 days. These findings matches with the reports of Murthy (1982), Mani (1986) and Shirke and Salunke (1996) and Naik *et al.* (2003).

#### *Sex ratio :*

Adult beetles emerged from the mother culture maintained on *M. hirsutus* were sexed by observing their fore pair of legs and sex ratio was worked out. In the present investigations 1:1 (male to female) sex ratio was

Table 3 : Longevity and fecundity of *C. montrouzieri*

Pair No.	Longevity(Days)		Fecundity
	Male	Female	
1	59	69	337
2	64	88	674
3	63	58	403
4	68	65	409
5	77	71	418
6	85	78	467
7	66	89	612
8	73	66	381
9	79	82	568
10	63	81	493
Range	59 –85	58 – 89	337 – 612
Average	69.70	74.70	476.20

Table:4 Premating, mating, preovipositional and oviposition periods of *C. montrouzieri*

Obs. No.	Premating period (days)	Mating period (minutes)	Preovi- positional period (days)	Oviposition period (days)
1	5	5, 15, 28	9	54
2	4	10 , 21, 17	12	74
3	4	9, 12, 29	8	83
4	5	5, 20, 32	7	58
5	8	10, 12, 36	11	79
6	9	9, 27, 33	7	56
7	6	7, 8, 29	6	74
8	4	18, 21, 30	7	54
9	7	6, 15, 22	6	56
10	5	12, 19, 30	6	83
Range	4 – 9	5 – 36	6 – 12	54 -83
Mean	5.7	18.23	7.9	67.1

observed. This ratio is similar with that of Mani (1986); Babu and Azam (1988) and Shirke and Salunke (1996). While, present sex ratio varied from the ratio found by Murthy (1982) and Baskaran *et al.* (1999).

#### *Feeding potential of C. montrouzieri :*

##### *General observations on the feeding habit and host stage preference of C. montrouzieri :*

All the grub stages and adult beetles could feed on all the stages *viz.*, eggs, nymphs and adults of *M. hirsutus*. However, the eggs and first and second instar nymphs could be devoured by all the predatory stages of *C. montrouzieri*. Whereas, first and second instar grub could not devour the nymphs and adults of *M. hirsutus* totally, but they could maul the body. Subsequently the adult prey died, shriveled and turned black. Similar feeding habit was observed in case of third and fourth instar grubs, However, both male and female adults could feed on the all the stages of *M. hirsutus* and female beetles were voracious feeder than males beetles on all the stages of *M. hirsutus*. Generally it was also observed that when combination of stages of *M. hirsutus* were provided (*viz.*, eggs + nymphs, nymphs + adults, eggs + adults, eggs + nymphs+ adults) to the predatory stages of *C. montrouzieri*, it was found that grubs and adults mostly preferred the egg stage of *M. hirsutus*. But when there was no egg stage then the predator preferred nymphal stage and then at last adults of *M. hirsutus*.

Observations in the present investigations are in conformity with the findings of Murthy (1982). Mani and

Thontadarya (1987); Jayaraman *et al.* (1988) Babu and Azam (1988), Pralhad *et al.* (2000) and Naik *et al.* (2003) also reported that the predatory stages of *C. montrouzieri* preferred most the egg stage followed by nymph and adult stages.

*Feeding on egg stage alone :*

On an average I, II, III and IV instars grub consumed 944.5 total number of eggs in her life period of 27.35 days when provided eggs stage alone. However, male and female beetles consumed 4039.9 and 5341.6 eggs in their total life span of 69.7 and 72.4 days, respectively.(Table 5a) Hence, the result show that the

Table: 5a Feeding on egg stage alone

Stage of predator	No. of nymphs Consumed (mean $\pm$ SE)	Developmental period (mean $\pm$ SE)
1. Grub		
I instar	91.55 $\pm$ 5.33	5.55 $\pm$ 0.20
II instar	113.30 $\pm$ 5.01	3.95 $\pm$ 0.17
III instar	192.00 $\pm$ 9.79	7.30 $\pm$ 0.26
IV instar	547.20 $\pm$ 25.34	10.55 $\pm$ 0.32
Total	944.05 $\pm$ 26.82	27.35 $\pm$ 0.54
2. Adult		
Male	4039.9 $\pm$ 223.30	69.7 $\pm$ 2.66
Female	5341.6 $\pm$ 303.11	72.4 $\pm$ 6.66

female adults consumed more eggs than male adults.

*Feeding on nymphal stage alone :*

The single larva consumed 310.7 nymphs in a total period of 19.45 days. The adult female consumed 200.7 more nymphs than male adult (166.2) with in period of 59.50 and 56.35 days, respectively.(Table 5b) Hence, the results revealed that the average life period of predatory stages of *C. montrouzieri* decreased when grubs and adults feed

Table: 5b Feeding on nymph stage alone

Stage of predator	No. of nymphs consumed (mean $\pm$ SE)	Developmental period (mean $\pm$ SE)
1. Grub		
I instar	5.95 $\pm$ 0.93	3.9 $\pm$ 0.14
II instar	28.25 $\pm$ 3.71	3.45 $\pm$ 0.20
III instar	91.35 $\pm$ 5.51	5.20 $\pm$ 0.51
IV instar	185.15 $\pm$ 3.53	6.90 $\pm$ 0.63
Total	310.7 $\pm$ 7.53	19.45 $\pm$ 0.91
2. Adult		
Male	166.2 $\pm$ 13.70	56.35 $\pm$ 5.52
Female	200.7 $\pm$ 14.85	59.50 $\pm$ 5.72

*Feeding on adult stage alone :*

When larva of *C. montrouzieri* preyed upon adults of *M. hirsutus*, the total larval period was 17.15 days during which it consumed 35.4 adults. Male completed, its life period in 36.6 days and consumed 30.4 adults while female completed, its life period in 52 days and consumed 39.2 adults of *M. hirsutus*. Hence, the host stage also affected the developmental period of predatory stages of *C.*

Table:5c Feeding on adult stage alone

Stage of predator	No. of adult consumed (mean $\pm$ SE)	Developmental period (mean $\pm$ SE)
1. Grub		
I instar	2.75 $\pm$ 0.17	3.95 $\pm$ 0.39
II instar	5.30 $\pm$ 0.58	3.45 $\pm$ 0.35
III instar	9.05 $\pm$ 1.02	4.50 $\pm$ 0.18
IV instar	18.3 $\pm$ 1.59	5.25 $\pm$ 0.40
Total	35.4 $\pm$ 2.54	17.15 $\pm$ 0.71
2. Adult		
Male	30.4 $\pm$ 4.37	36.6 $\pm$ 7.76
Female	39.2 $\pm$ 4.18	52.00 $\pm$ 5.19

*montrouzieri* (Table 5c)

*Feeding on egg + nymph stages :*

The feeding rate of *C. montrouzieri* was recorded on egg and nymph stages of *M. hirsutus* when provided

Table 5d : Feeding on eggs + nymph stage alone

Stage of predator	No. of eggs + nymphs consumed (mean $\pm$ SE)	Developmental period (mean $\pm$ SE)
1. Grub		
I instar	73.45 $\pm$ 8.15 + 2.6 $\pm$ 0.20	5.25 $\pm$ 0.42
II instar	91.1 $\pm$ 5.93 + 9.85 $\pm$ 1.23	3.8 $\pm$ 0.15
III instar	168.65 $\pm$ 17.70 + 81.2 $\pm$ 11.71	5.55 $\pm$ 0.40
IV instar	419.25 $\pm$ 38.07 143.3 $\pm$ 11.09	8.15 $\pm$ 0.65
Total	752.45 $\pm$ 51.27 + 236.95 $\pm$ 16.37	22.75 $\pm$ 1.07
2. Adult		
Male	3548.10 $\pm$ 297.39 + 150.4 $\pm$ 21.43	46.3 $\pm$ 6.24
Female	4337.70 $\pm$ 178.40 + 239.27 $\pm$ 22.83	52.6 $\pm$ 6.41

combinely, the results showed that (Table 5d). The larva (from I to IV instars) consumed on an average 752.45 eggs + 236.45 nymphs in a period of 22.75 days. However, male and female beetles devoured 3548.10 eggs + 150 nymphs and 4337.70 + 239.27 nymphs, respectively. Hence, it can be concluded that when choice was there the grubs and adults of *C. montrouzieri* preferred the egg stage than nymphal stage of *M. hirsutus*.

#### Feeding on egg + adult stages

The grubs and adults of *C. montrouzieri* were provided with the combination of eggs + adults of *M. hirsutus* as a food.. The total consumption was 791.35 eggs and 7.15 adults within duration of 23.05 days. While male and female adults consumed 3173.00 eggs, 16.3 adults and 3373.90 eggs + 25.00 adults of *M. hirsutus* with in total life period of 42.10 and 51.5 days, respectively.(Table 5e)

Table:5e Feeding on egg + adult stages

Stage of predator	No. of eggs + adults consumed (mean $\pm$ SE)	Developmental period (mean $\pm$ SE)
1. Grub		
I instar	88.75 $\pm$ 6.57 + 1.45 $\pm$ 0.19	5.45 $\pm$ 0.21
II instar	74.00 $\pm$ 4.29 + 1.25 $\pm$ 0.23	3.50 $\pm$ 0.21
III instar	174.90 $\pm$ 9.58 + 2.05 $\pm$ 0.22	6.35 $\pm$ 0.52
IV instar	453.7 $\pm$ 54.90 + 2.40 $\pm$ 0.39	7.75 $\pm$ 0.62
Total	791.35 $\pm$ 59.44 + 7.15 $\pm$ 0.53	23.05 $\pm$ 0.89
2. Adult		
Male	3173.00 $\pm$ 230.53 + 16.3 $\pm$ 3.44	42.10 $\pm$ 7.46
Female	3373.90 $\pm$ 240.79 + 25.00 $\pm$ 4.42	51.5 $\pm$ 12.18

#### Feeding on nymph + adult stages :

Duration of grub was decreased, it completed life span in 17.9 days with consumption of 52.35 nymphs and 7.65 adults. The male beetle consumed 133.1 nymphs and 15 adults within period of 3.2 days while female took 46.6 days and consumed 161.0 nymphs and 33.3 adults of *M. hirsutus*.(Table 5f) The feeding potential of *C. montrouzieri* was found to be considerably reduced when grubs and adults were provided with combination of nymphs and adult stages of *M. hirsutus* as food and the female, male beetles and grubs preferred more

Table 5f : Feeding on nymph + adult stages

Stage of predator	No. of Nymphs + adults consumed (mean $\pm$ SE)	Developmental period (mean $\pm$ SE)
1. Grub		
I instar	2.75 $\pm$ 0.38 + 1.50 $\pm$ 0.18	3.45 $\pm$ 0.15
II instar	2.40 $\pm$ 0.30 + 1.05 $\pm$ 0.15	2.90 $\pm$ 0.15
III instar	14.15 $\pm$ 1.18 + 1.85 $\pm$ 0.14	5.45 $\pm$ 0.18
IV instar	33.05 $\pm$ 2.09 + 3.25 $\pm$ 0.22	6.1 $\pm$ 0.19
Total	52.35 $\pm$ 2.48 + 7.65 $\pm$ 0.38	17.9 $\pm$ 0.31
2. Adult		
Male	133.1 $\pm$ 13.32 + 15.0 $\pm$ 3.51	34.2 $\pm$ 5.20
Female	161.0 $\pm$ 10.09 33.3 $\pm$ 4.79	46.6 $\pm$ 4.95

nymphs than adults in declining order.

#### Feeding on egg + nymph + adult stages

Considering the fact that the field population of *M. hirsutus*, exists in all the biostages viz., eggs, nymphs and adults. These were provided together for the multiple choice of feeding of *C. montrouzieri* (Table 5g). The predatory stages preferred eggs followed by nymphs and adults.. The first instar grub consumed 73.15 eggs + 11.35 nymphs + 2.00 adults and lived for 4 days. The second instar grub consumed 69.05 eggs + 10.65 nymphs and 2.35 adults with in a period of 3.35 days. The third instar grub ate 115.2 eggs + nymphs and 21.9 adults within period of 6-4 days and lived for 5.6 days and fourth instar consumed 133.00 eggs + 30.8 nymphs + 9.1 adults of *M. hirsutus*. However, the female and male adults consumed 3435.90 eggs + 126.6 nymphs + 18.9 adults and 2899.10 eggs + 114.3 nymphs + 11.2 adults of *M. hirsutus*, within life span of 50.90 and 47.7 days, respectively.

The extent of developmental period was directly proportionate to the quantity of food consumed by larvae and beetles of the predator. The information in the context of combined feeding on eggs and nymphs of mealy bugs is meager. However, Murthy (1982); Mani and Thontadarya (1987), Babu and Azam (1988) and Pralhad *et al.* (2000) support the present observations when predation potential of grub and adults of *C. montrouzieri* recorded separately.114.3 nymphs +11.2 adults of *M. hirsutus*, within life span of 50.90 and 47.7 days, respectively. Further, Oncuer and Bayham (1982) gave

Table 5g : Feeding on egg +nymph + adult stages

Stage of predator	No. of eggs +Nymphs + adults consumed (mean $\pm$ SE)	Developmental period (mean $\pm$ SE)
1. Grub		
I instar	73.15 $\pm$ 7.36 + 11.35 $\pm$ 1.95 + 2.00 $\pm$ 0.36	4.00 $\pm$ 0.20
II instar	69.05 $\pm$ 4.27 + 10.65 $\pm$ 1.12 + 1.9 $\pm$ 0.23	3.35 $\pm$ 0.16
III instar	115.2 $\pm$ 6.84 + 19.95 $\pm$ 2.69 + 1.9 $\pm$ 0.23	5.60 $\pm$ 0.23
IV instar	133.00 $\pm$ 13.34 + 30.8 $\pm$ 3.99 + 9.1 $\pm$ 1.10	6.4 $\pm$ 0.20
Total	390.4 $\pm$ 20.0 + 72.75 $\pm$ 5.64 + 15.35 $\pm$ 1.28	19.35 $\pm$ 0.38
2. Adult		
Male	2899.1 $\pm$ 246.76 + 114.3 $\pm$ 19.19 + 11.2 $\pm$ 2.33	47.7 $\pm$ 4.26
Female	3435.90 $\pm$ 243.05 + 126.6 $\pm$ 18.05 + 18.9 $\pm$ 3.16	50.90 $\pm$ 4.20

opinion that eggs as well as other stages of *M. hirsutus* are essential in the diet for successful development of *C. montrouzieri*.

Hence, it can be concluded that *C. montrouzieri* is an effective predator of *M. hirsutus* because of its higher feeding potential and all the predatory stages completed whole life cycle on all the bio stages of *M. hirsutus*. Thus *C. montrouzieri* can be utilized for control of mealy bug, *M. hirsutus* on grapevine.

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