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BIOLOGY OF *CRYPTOLAEMUS MONTROUZIERI* MULSANT [*COCCINELLIDAE : COLEOPTERA*] IN RELATION WITH TEMPERATURE

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The effect of temperature on the developmental duration of *Cryptolaemus montrouzieri* Mulsant was quantified by deriving a regression equation for each developmental stage as well as the total life cycle. While the duration of life stages was shorter during summer and longer during winter, the optimum constant temperature for maximal development was found to be 30°C.

The adult longevity was extended when reared at 20°C than at 30°C and ambient temperature. The longevity of adults was longer when maintained on grape mealybug *Maconellicoccus hirsutus* (Green) than on honey and when maintained at 20°C. The fecundity of the predator was higher at 30°C than at 20°C. Eventhough the adults could survive at 10°C, the productive capacity was impaired.

KEY-WORDS : Predator, *Cryptolaemus montrouzieri*, prey, *Maconellicoccus hirsutus*, mealybug.

Cryptolaemus montrouzieri Mulsant, a general predator of a wide range of mealybugs, at all stages of the development is native to Australia. The larvae consume huge number of eggs and crawlers. The grape mealybug, *Maconellicoccus hirsutus* (Green) has become a serious threat to vineyards in Hyderabad (India). Control of the mealybug by releasing the natural predator is preferable to the use of insecticides. Hence, the temperature contributing to optimal reproductive efficiency of the predator, maintained on grape mealybug, was contemplated for study in this experiment. Further the possibility of alteration of duration of developmental stages, through modification of incubating temperature to suit the timely release of predator to control grape mealybug infestation was also investigated.

MATERIALS AND METHODS

Rearing cages (30 × 30 × 30 cm) covered on all sides with 40 mesh/inch mesh and a glass pane on top were used for the propagation of *C. montrouzieri*. Infested pumpkin with mealybug egg masses were periodically provided for oviposition and development of the predator.

The effect of ambient temperature (25-31°C) and controlled temperatures of 10°, 20°, 30° and 40°C was studied on the life history, fecundity, longevity and morphometric characters of the predator. Coccinellid eggs laid during the earlier 24 h were each transferred to a speci-

men tube along with egg masses of grape mealybug. Separate sets of 20 tubes each were maintained at controlled and ambient temperatures to record the duration of incubation period, larval, pupal and adult stages.

Development of a prediction equation was attempted, by correlating the mean monthly ambient temperatures with the duration of developmental stages over a period of 10 generations (July-April). The effect of 3 temperatures (ambient, 20° and 30°C) on pre-oviposition period, total number of eggs laid during life time and sex ratio was investigated using 10 pairs of beetles that emerged on the same day. Longevity in 10 ♂ and 10 ♀ maintained on 3 feeds (grape mealybug, honey and without feed) at 3 temperatures was studied. The sex of the dead adult insect during the experimental period was recorded. The above mentioned data was treated using approved statistical methods.

The morphometry, using a calibrated ocular, was undertaken for each of the developmental stages. Similarly, the weights were recorded. Hundred eggs of the predator laid at different temperatures were used in this study.

RESULTS AND DISCUSSION

The life cycle and morphology of the developmental stages is found to confirm the descriptions of earlier authors (**Chacko** *et al.*, 1978 ; **Murthy**, 1982).

When subjected to 40°C, the adult predator perished within 2 days. The repression on the egg laying capacity was found to be absolute, even though the adult could survive temperature of 10°C.

Higher temperature shortened the incubation period. The incubation period was 52 % longer at 20°C than at 30°C. The temperature effect on the period of incubation reported in this experiment is in agreement with the earlier reports of **Bourne** (1936) and **Bodenheimer** (1951). Similar effect of temperature was also recorded in respect to the duration of other developmental stages during the life history of the predator (table 1).

The total life cycle of 19 days duration recorded during April (mean temperature 31°C) was extended to 47 days during November (mean temperature 25°C).

A depression of 5°C in the mean ambient temperature induced extension of the life cycle by two and half times. A similar effect was also noticed when the predator was subjected to controlled conditions at lower temperature. The above mentioned results are in agreement with the findings of **Chacko** *et al.* (1978) and **Murthy** (1982). It is concluded that the alteration in the duration of developmental stages through modification of incubating temperature is possible to facilitate the timely release of the predator.

The length of time required to complete various stages and total life cycle (Y) of *C.montrouzieri* at a given temperature (X) can be calculated by using the prediction formulae presented in table 1.

The adult longevity in both the sexes of *C.montrouzieri* fed on grape mealybug was observed to be maximal when compared to maintenance on honey and at starvation indicating the grape mealybug to be the natural feed of the predator (table 2). It can be concluded from the data presented in table 2, that the adult longevity of the predator to be maximal when maintained at 20°C on any of the 3 feeding schedules mentioned above. The longevity appears to have been drastically reduced at both the extreme temperatures of 10° and 40°C, however the higher temperature being more detrimental. In general the longevity of the ♀ appears to be slightly more than that of ♂ maintained on any of the temperature and feed regimes. Generally these findings are found to be in agreement with the observations of **Murthy** (1982).

TABLE 1

Effect of ambient and constant temperatures (°C) on mean duration of developmental stages of C. montrouzieri *in days**

Developmental stage	July 27.4°C	August 27.2°C	September 28.9°C	October 28.0°C	November 25.0°C	December 25.2°C	January 25.2°C	February 27.5°C	March 29.5°C	April 30.9°C	Constant temperature 30.0°C	Constant temperature 20.0°C	Regression equation/prediction formula	Correlation coefficient
Egg	3.2	3.5	3.0	3.0	6.1	6.0	5.9	3.3	2.4	1.8	3.0	6.2	Y = 24.88 − 0.77 X	0.95
Larval Instars														
I	3.2	3.3	2.9	3.0	4.9	5.3	5.2	2.9	2.0	2.5	2.7	6.4	Y = 18.52 − 0.55 X	0.91
II	4.0	3.5	3.0	3.7	5.5	5.5	5.2	3.7	3.2	2.4	3.5	7.0	Y = 18.54 − 0.53 X	0.96
III	4.9	5.1	4.6	4.8	8.4	8.3	7.3	5.0	4.9	4.5	4.1	13.5	Y = 24.65 − 0.69 X	0.86
IV	7.0	7.2	6.8	7.0	11.1	9.6	10.4	7.1	6.4	4.4	5.5	17.7	Y = 34.83 − 0.99 X	0.95
Pupa	5.5	6.0	5.9	6.2	10.7	8.4	8.7	6.1	6.6	3.5	6.2	14.3	Y = 30.99 − 0.88 X	0.86
Total Life cycle	27.8	28.6	26.2	27.9	46.7	43.1	42.7	28.1	25.5	19.1	25.2	65.1	Y = 152.34 − 4.40 X	0.94

* Values are means of 10 observations

TABLE 2

Effect of temperature and feed on mean longevity and fecundity of C. montrouzieri

Temperature °C	*Longevity (days)						*Fecundity			
	Feed						Feed			
	Grape mealybug		Honey		Starvation		Grape mealybug			
	♂	♀	♂	♀	♂	♀	Longevity of female adult	Eggs laid in		Pre-oviposition period (days)
								First fort-night	Life time	
Ambient (25-28)	97.8	99.0	83.6	79.5	4.1	5.2	102.7	120.8	237.1	2.4
10	11.0	15.5	7.9	7.8	1.9	2.5	—	—	—	—
20	109.0	122.4	93.8	95.0	7.4	6.8	95.4	30.6	126.1	9.6
30	81.7	94.8	65.0	67.5	3.6	4.4	95.2	89.8	302.9	3.6
40	1.9	2.2	1.2	1.1	0.2	0.4	—	—	—	—

* Values are means of 10 observations
The difference in longevity and fecundity in between treatments is significant at P = 0.05.

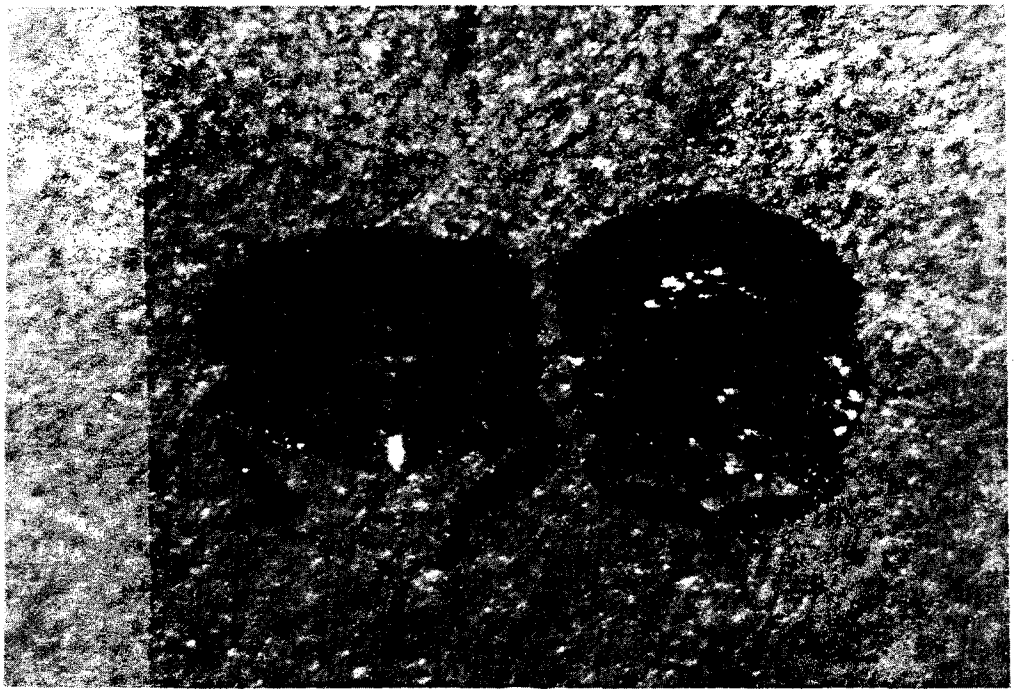

Fig. 1. Sex differentiation in first pair of legs.
Female : Black, Male : Orange.

The seggregation of ♀ from the predator population for the study of fecundity was rendered easy because of the difference in the colour of the 1rst pair of legs. While the colour of 1rst pair legs of ♀ is black, the colour of that of ♂ is orange (fig. 1).

The pre-oviposition period got extended when the predator was maintained at a constant temperature of 20°C, compared to maintenance at ambient and at 30°C. The mean oviposition rate of 3.2 (eggs/ ♀ /day) was highest at 30°C in comparison with the rate of 2.3 at ambient temperature and 1.3 at 20°C. The fecundity of 302.9 (eggs/ ♀) recorded at 30°C was found to be higher in comparison to fecundity recorded at ambient temperature and at 20°C (table 2). The mean number of eggs laid by the predator during the 1rst fortnight was higher than the mean number of eggs laid during any of the subsequent fortnights. The above observations suggest that most efficacious grape mealybug pest control activity could be achieved by releasing the adult predators during the pre-oviposition period, taking advantage of the maximal egg laying capacity.

Mineo (1967) reported ♂ : ♀ ratio as 1 : 3 and **Charansri & Nishida** (1975) as 1 : 1. The sex ratio of ♂ to ♀ observed to be 1 : 1.13 when maintained at 20°C was found to be significantly wider than the sex ratios recorded at ambient temperature (1 : 0.88) and at 30°C (1 : 0.77) in the present studies. The advantage of obtaining higher ♀ insect population when reared at 20°C is offset because of less fecundity, and extended developmental duration.

The morphometric characters of the predator reared at 30°C is found to be higher for any of the developmental stages than when reared at 20°C.

The short life cycle associated with high fecundity and superior morphometric characters were observed in the predator raised at 30°C. Hence the adoption of above mentioned optimal temperature for mass multiplication to facilitate the augmentative field release to control the grape mealybug pest is recommended.

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RÉSUMÉ

Biologie de *Cryptolaemus montrouzieri* Mulsant
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Les effets de la température sur la durée de développement de *Cryptolaemus montrouzieri* Mulsant, ont été quantifiés en dérivant l'équation de régression de chaque stade ainsi que celle du cycle biologique complet. Tandis que la durée des stades était plus courte durant l'été et plus longue durant l'hiver, la température constante optimale pour le développement maximal était de 30°C.

La longévité de l'adulte augmentait quand il était élevé à 20°C plutôt qu'à 30°C ou qu'à la température ambiante. La longévité des adultes s'accroissait lorsqu'ils étaient maintenus sur *Maconellicoccus hirsutus* (Green) plutôt que sur miel ainsi qu'à 20°C. Mais la fécondité du prédateur était plus grande à 30°C qu'à 20°C. Bien que les adultes puissent survivre à 10°C leur capacité de reproduction était diminuée.

MOTS CLEFS : prédateur, *Cryptoloemus montrouzieri*, proie, *Maconellicoccus hirsutus*, cochenille farineuse.

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