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LIFE CYCLE OF SMALL SALMON ARAB *COLOTIS AMATA* (LEPIDOPTERA: PIERIDAE)

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ABSTRACT

This work highlights the complete life cycle of *Colotis amata* Fabricius (Lepidoptera: Pieridae). It lays eggs singly on tender leafs of *Salvadora persica*. The life cycle from egg to adult emergence is relatively short and spanning over 19-26 days. Observations regarding, egg laying, egg hatcing, larval period, pupal period and adult emergence was recorded along with the stage specific life table. The time required for the egg to develop to the adult was 19 - 26 days (egg 3 - 4; larva 10 - 15; pupa 6 - 7). Maximum indispensable mortality (6.72) was encountered at early larval stage as compared to other stages. Data for K-value exhibited the highest value (0.06) at early larval stage.

INTRODUCTION

Butterflies (Lepidoptera) are very important group of insects because they take part in the key stone ecological process of pollination (Bhuyan *et al*., 1999). Butterflies have evolved in complex feeding relationship with plants since the development of both larvae and adults takes place on green plants (Ehrlich and Raven, 1964). Their larvae are typically host specific (Tiple *et al*., 2011) while adults often show a high degree of generalization. Butterflies have been documented as effective ecological indicators of ecosystem health (Oostermeijer and Van-Swaay, 1998).

The genus *Colotis* comprises of 40 species, 39 of which are primarily or entirely Afrotropical in distribution. The majority have pure white uppersides, with prominent orange, yellow or crimson tips to the forewings. A few however, including *amata, phisadia* and *vesta* have uppersides that are more akin to the *Colias* clouded yellows in appearance, although they are only distantly unrelated, being members of a different subfamily (http://www.learnaboutbutterflies.com, assessed on 9.3.2013). Caterpillars feed on species of *Capparis* (capparaceae) and *Salvadora* (Salvadoraceae) (Ackery, *et al*., 1995).

For the success of a conservation management programme, sound knowledge of the butterfly and ecology of all butterflies in an area is required to be documented. Such knowledge in most cases of Indian butterflies is seriously inadequate (Gay *et al*., 1992; Venkata Ramana, 2010). We are describing here the details of life cycle along with the stage specific life table of *Colotis amata* for better conservation programme.

MATERIALS AND METHODS

Eggs of *Colotis amata* were collected from *Salvadora persica*. The eggs with the leaf material were brought to the laboratory and were reared in plastic containers with proper aeration. Caterpillars were provided with fresh *Salvadora persica* leaves everyday for feeding. Scale was used to measure the length of the caterpillar. Further developmental stages were followed, and the data on egg hatching, larval and pupal development and the time of adult emergence was recorded. The whole life cycle was studied at room temperature.

Life Table Construction (Ali and Rizvi, 2010**)**

Stage Specific Life-Table

Data on stage specific survival and mortality of eggs, larvae, pupae and adults of *Colotis amata* were recorded. Following standard heads were used to complete stage specific life table.

x = Stage of the insect.

l_x = Number surviving at the beginning of the stage x.

d_x = Mortality during the stage indicated in the column x.

The data calculated through above assumptions were used for computing various life parameters as given below:

Apparent Mortality (100 q_x)

It gives the information on number dying as percentage of number entering that stage and was calculated by using the formula:

Apparent Mortality = $(d_x / l_x) \times 100$

Survival Fraction (S_x)

Data obtained on apparent mortality was used for the calculation of the stage specific survival fraction (S_x) of each

Table 1: Stage specific survival and mortality of *Colotis amata* on *Salvadora persica*

Stage x	No. surviving at the beginning of stage l_x	No. dying in each stage d_x	Apparent mortality $100q_x$	Survival fraction s_x	Mortality/ survival ration (MSR)	Indespensible mortality IM	Log l_x	k-values
Egg	100	9	9.00	0.91	0.10	4.80	2.00	0.04
Ist Instar	91	11	12.09	0.88	0.14	6.72	1.96	0.06
IInd instar	80	8	10.00	0.90	1.11	5.28	1.90	0.04
IIIrd instar	72	8	11.11	0.89	1.14	6.24	1.86	0.05
IVrd instar	64	7	10.94	0.89	1.10	5.76	1.81	0.05
Vth instar	57	5	08.77	0.91	0.10	4.80	1.76	0.04
Pupa	52	4	07.69	0.92	0.08	3.84	1.72	0.04
Adult	48	48	100	-	-	-	1.68	-
	K value=0.32							

stage by using the equation:

S_x of particular stage = (l_x of subsequent stage) / (l_x of particular stage).

Mortality Survivor Ratio (MSR)

It is the increase in population that would have occurred if the mortality in the stage, in question had not occurred and was calculated as follows:

MSR of particular stage = (Mortality in particular stage)/ (l_x of subsequent stage)

Indispensable Mortality (IM)

This type of mortality would not be there in case the factor (s) causing it is not allowed to operate. However, the subsequent mortality factors operate. The equation is,

IM = [Number of adults emerged] x [M.S.R. of particular stage]

K-values

It is the key factor, which is primarily responsible for increase or decrease in number from one generation to another and was computed as the difference between the successive values for "log l_x ". However, the total generation mortality was calculated by adding the k values of different development stages of the insect, which is designated/ indicated as "K"(Southwood, 1978; Varley and Gradwell, 1960).

$$K = kE + kL1 + kL2 + kL3 + kL4 + kL5 + kP$$

Where, kE, kL1, kL2, kL3, kL4, kL5 and kP are the k-values at egg, first instar, second instar, third instar, fourth instar, fifth instar and pupal stage.

RESULTS AND DISCUSSION

The breeding female laid eggs on upper surfaces of young and soft leaves of *Salvadora persica*. Female lays eggs singly in a batch of about 16-78, measuring about 0.12±0.01 cm, which are creamish white in colour when just laid and become pale yellow before hatching. The eggs were oval in shape. Hatching took place after 3 - 4 days of incubation. The larvae passed through five distinct instars (Fig. 1).

Larva are cylindrical in shape and pea-green in colour; very slightly rough; lower part lighter green; Ist instar larvae with black head. IInd and IIIrd instar larvae has two black spots on head but in the later instars the black spot on head disappeared and they have green heads; in early instars the first half of the streak down the back is whitish, while in later instars this whitish streak was along its whole length. Larvae feed gregariously on *Salvadora persica* leaves. The larva passes through five instars and attains full growth over a period of 10–15 days.

Instar I: This stage lasted 2 - 3 days. The first instar larvae measured 0.23± 0.015 cm in length. Its head measured 0.11± 0.01 cm in diameter. Its body was pale yellow in color. The head was round and black in colour.

Instar II: This stage also lasted 2 - 3 days. The larva grew to 0.51± 0.018 cm in length. Its body was yellowish green in color. The head was round with two round dots and measured 0.13 ± 0.02 cm in diameter.

Instar III: This stage also lasted 2 - 3 days. It grew to 0.82± 0.01cm in length. Its head measured 0.22 ± 0.013 cm in diameter. The head was round with two black dots.

Instar IV: This stage lasted 2 - 3 days. It attained a length of 1.1± 0.03cm. Its head measured 0.24 ± 0.02 cm in diameter. The head was round and green in colour.

Instar V: This stage also lasted 2 - 3 days. The instar progressed to a length of 1.4± 0.03cm and 0.34±0.02cm head diameter.

The fully grown fifth instar prepared itself for pupation by stopping feeding, and contracting its body. The process took place for a day. The pupal stage lasted 6-7 days. It measured 1.25± 0.02cm in length and 0.25± 0.02cm in width at its broadest region. Anterior end of the pupa was pointed. Its posterior end was broad. Pupa is initially green in colour but near to adult emergence turn into cream colour.

Based on the observed duration of life of eggs, larvae, and pupae, it could be estimated that the time required for the egg to develop into adult was 19 - 26 days (egg 3-4; larva 10-15; pupa 6-7).

Adult

Upperside of the wing has a salmon-pink base colour. The costa on the forewing is black and has a black spot at apex of cell. Hind wing has a band on costal margin covered with dense black specialized scales extending to the upper margin and joined on to a broad black coloured terminal band of ordinary scales enclosing a double series of small spots of the base colour.

Similar type of study was conducted by Appala Naidu and Venkata Ramana, 2010 on the life cycle of the large salmon arab *Colotis fausta* from Eastern ghats of India and data on population index of eggs, larvae and pupae on the host plant


Eggs


Neonate larvae emerging from eggs


Ist Instar Larvae


Nature of damage due to feeding by larvae


IInd Instar larvae


IIIrd Instar Larvae


IVth Instar Larvae


Vth Instar Larvae


Closer view of Larvae


Final Stage larvae preparing itself for pupation


Pupa


Adult

Cadaba fruiticosa was recorded.

Stage Specific Life-Table

At egg stage, the apparent mortality was 9.00. When comparison was made between larval instars, maximum apparent mortality was observed in Ist instar (12.9) whereas minimum in Vth instar (8.77). In present investigations, the early larval instars were much delicate than the later instars and hence, showed higher mortality at first instar stage which was in accordance to the findings of Ali and Rizvi 2007; Dreyer *et al.*, 1997 and Padmalatha *et al.*, 2003. As far as the survival fraction was concerned,variation in the values was of low magnitude at egg, early and late larval stage. Survival fraction (S_x) was found to be 0.91 in egg stage and 0.92 in pupal stage. The mortality survival rate followed the opposite trend as observed in case of survival fraction. Mortality survival ratio (MSR), in egg stage was found to be 0.10, whereas, maximum in IIIrd instar (1.14) and minimum in pupa stage (0.08).

Similar was the case with indispensable mortality where maximum mortality was observed in the early larval instar (6.72) and minimum (3.84) in pupal stage. At egg and pupal stage, the k-value was found to be 0.04 whereas, maximum (0.06) in Ist instar. The total generation mortality 'K' was recorded to be 0.32 (Table 1).

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