LIFE TABLE STUDIES OF *TRILOCHA VIRESCENCE* (BOMBYCIDAE: LEPIDOPTERA) ON *FICUS NITIDA*

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ABSTRACT

The life table of *Trilocha virescence* was constructed in the laboratory which is a serious Lepidopterous pest of *Ficus nitida*. The study declared different impact of larval and adult mortality on the population. Pre reproductive mortality was 30% and 70 percent of the individuals' survived up to the maturity and took part in reproduction. Larval mortality was greater in 1st instar than all other stages. No mortality was observed in 4th and 5th larval instar in subsequent stages. High mortality during 1st instar may exert significant negative effect on the insect population and may be best used for applying control tactics. The net reproductive rate of the insect was 45.44 per individual per generation.
Keywords: *Trilocha virescence*, stage specific, cohort, life table, life expectancy, mortality rate, survivorship

INTRODUCTION

Computing life tables is a fairly current approach used by entomologists to study the insects' population dynamics. With the recent emphasis on population dynamic studies of insects, the usefulness of life table in this area is becoming more recognized. A life table is a tabular device which describes for every particular age of interval.

In ecological study, life table is an important analytical tool, which provides detailed information of population dynamics to generate simple but more informative statistics. It also gives a comprehensive description of the survivorship, development and expectation of life (Ali and Rizvi, 2007; Yzdani and Samih 2012; Gabre et al., 2004). Life tables may be used to study inherent differences in the survivorship and reproductive strategies of populations under different ecological regimes (Afrane et al., 2007). Life table, studies provide an opportunity to assess and evaluate the impact of specific mortality factors acting on insect population (Harcourt, 1969; Bellows *et al*., 1992; Mohapatra, 2007). It can also give information about the changes which occur during the developmental stages and their relationship with different environmental factors (Atwal and Bain, 1974). Life tables constructed using laboratory data collected under controlled conditions and are useful in revealing the maximal growth potential of a population (Gabre et al, 2004). Life tables used can make quantitatively and qualitatively evaluation of various host plants (Ambegaonkar and Bilapate, 1981).

Two kinds of life tables have been developed: (1). ecological life tables for natural populations of animals; and, (2) life tables for laboratory populations of animals. They may be further categorized as horizontal or age-specific life tables and vertical, or time-specific life tables. The horizontal life table usually is made from data obtained by studying all or a portion of a population belonging to a single generation. Vertical life tables involve analysis of the age structure of a population (Southwood, 1966). Age specific life tables provide a concise summary of mortality and reproductive schedules and can help explain why certain species proliferate in particular environment (Afrane *et al.,* 2007). *Trilocha virescence* is a member of family Bombicidae and important pest of *Ficus nitida,* which is an ornamental shurb of medium size. *T. viresence* can be considered as a voracies feeder of *Ficus nitida* leaves. Its larvae in 4th and 5th stages are capable of eating more than one leaf per day and can cause severe defoliation of the plant in case of severe infestation. So the studies were conducted with the aim to find out survivorship, mortality, life expectancy and reproductive rate of *Trilocha virescence* on *Ficus nitida.*

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MATERIALS AND METHODS

***Trilocha virescence* culture:** For conducting life table of *T. virescence* under ambient condition, its egg batches were collected from *Ficus nitida* and reared in Biological Control Laboratory, Department of Entomology, PMAS Arid Agriculture University, Rawalpindi. These eggs were kept in petri dishes provided with slightly moistened filter papers and allowed to hatch. From these batches 100 newly emerged larvae were selected and shifted in petri dishes with the help of camel hair brush. Each petri dish was provided *Ficus nitida* tender leaves as a larval food. All transferred larvae were checked daily and their molting to the next stage or mortality were recorded carefully. Subsequent stages like pupa and adult were also checked. After the emergence of adults, male and female were separated. Pairs were made, and each pair was placed in a separate petri dish. Adults were provided with special diet that includes water, methyl paraben, insect's vitamin and sugar. Small pieces of cotton soaked in the diet were placed in the petri dish until the adults completed their lives. Dead males were replaced with the new ones. Fecundity and survival rate of each female were recorded until their death.

Life table Construction

Stage Specific Life Table: For calculating this life table, stage specific data regarding mortality and survival of different insect stages were taken from the age specific life table. Following parameters were used to compute stage specific life table.

x = Age of the insects in days

l_x = Number surviving at the beginning of each interval, out of 100

d_x = Number dying during the age interval, out of 100

The information from above assumptions was used to compute different life table parameters as follows:

Apparent Mortality ($100q_x$): The information regarding number of insects dying as a percent of number entering a particular stage can be obtained from the apparent mortality, which can be calculated as:

Apparent Mortality = $[d_x / l_x] \times 100$

Survival Fraction (Sx): The information obtained from the apparent mortality can be use d to calculate survival fraction of each stage by applying the formula:

Survival Fraction of a particular stage = [l_x of a particular stage] / [l_x of subsequent stage]

Mortality Survival Ratio (MSR): MSR gives the information regarding increase in the population which can occur in a specific stage if the mortality had not occurred in that stage and was calculated by the using the equation:

Mortality Survival Ratio of a particular stage = [Mortality in a particular stage] / [l_x of subsequent stage]

Indispensable Mortality (IM): It indicates the that type of mortality which can be avoided if the factors responsible for it are not permitted to operate, whereas subsequent mortality factors are operating. Indispensable mortality was calculated by the formula:

Indispensable Mortality = [No. of adults emerged] × [MSR of a particular stage]

K-values: It is a mortality factor which has vital role in determining the increase or decrease in number of individuals from one generation to the next. The difference between 'log l_x' of two successive insect stages reflects k-values, which can be used to obtain the total generation mortality (K) as under:

$K = k_{L1}+k_{L2}+k_{L3}+k_{L4}+k_{L5} +k_P$

Where, k_{L1}, k_{L2}. $k_{L3,}$ k_{L4}, k_{L5} and k_P are the k-values at first instar, second instar, third instar, fourth instar, fifth instar and pupal stage of *Trilocha virescence.*

Age Specific Life Table: The larvae were observed daily to determine the dead and alive ones. Following parameter were used to construct the age specific life table *Trilocha virescence* on *Ficus nitida.*

x = Age of the insects in days

l_x = Number surviving at the beginning of each interval, out of 100

d_x = Number dying during the age interval, out of 100

$100q_x$ = Mortality rate at the age interval x and calculated by using formula

$$100q_x = [d_x / l_x] \times 100$$

To calculate e_x, two other parameters like L_x and T_x were also computed

L_x = Number of individuals alive between age

x and x+1

$$L_x = l_x+1\ (x+1)/2$$

Tx = The total number of individual of x age units beyond the age x

$T_x = l_x + (l_x+1) + (l_x+2)$………..+ l_w
Here, l_w = Last age interval
e_x = Expectation of life or mean life for individuals of age x, which was calculated by using following equation

$$e_x = T_x/l_x$$

Cohort Life Table of *Trilocha virescence*: The larvae were observed daily to determine the dead and alive ones. Following parameter were used to construct the life table of *Trilocha virescence* on *Ficus nitida.*

x = Age of the insects in days
l_x = Number surviving at the beginning of each interval, out of 100
d_x = Number dying during the age interval, out of 100
$100q_x$ = Mortality rate at the age interval x and calculated by using formula

$$100q_x = [d_x / l_x] \times 100$$

To calculate e_x, two other parameters like L_x and T_x were also computed
L_x = Number of individuals alive between age x and x+1

$$L_x = l_x+1\ (x+1)/2$$

Tx = The total number of individual of x age units beyond the age x
$T_x = l_x + (l_x+1) + (l_x+2)$………..+ l_w
Here, l_w = Last age interval
e_x = Expectation of life or mean life for individuals of age x, which was calculated by using following equation

$$e_x = T_x/l_x$$

Average daily mortality = 1/ex
Fx = eggs produced at each stage
mx = eggs produced per surviving individual at each stage
lxmx = eggs produced per original individual at each stage

RESULTS

Age-specific Life Table of *T. virescence*

The data revealed that *T. virescence* larvae required maximum 33 days to complete whole life cycle under ambient environmental condition (). Age-specific survivorship lx, of the cohort showed rapid decrease during early days (up to 3rd day) which gradually slowed down in later days and remained nearly constant from 6th to 26th day. The mortality curve exhibited an irregular pattern with sharp high peaks on 2, 5 and 28 days. However nil mortality (negative low peaks) was recorded on 6 to 11 and 13 to 25 days. The life expectancy, exhibited a slight increase in early days (up to 3rd day), after that it showed a steady declining trend (Fig. 1).

Stage specific life table of *T. virescence*

Maximum apparent mortality was observed in first larval instar which declined slowly in later instars and reached to zero in 4th instar to onward including pupal stage. The survival fraction was lower in earlier instars as compared to the later instars. Minimum survival fraction was observed in 1st instar which started increasing from 2nd instar and reached maximum at 4th instar. Mortality survival ratio, dispensable mortality and K-value showed the same trend as was seen in apparent mortality; their values were highest in 1st larval instar, started decreasing from 2nd instar and reached to zero in the 4th instar (Table 1).

Cohort Life Table of *T. virescence*

The number alive nx, was high at first larval instar, it highly decreased from 100 to 76 at second larval instar, with slight fluctuation it decreased to 72 at third larval instar and 70 at fourth instar which remained constant up to the adult stage. Survivorship lx, decreased from the first larval instar up to third larval stage and then remained constant in the subsequent stages. Mortality rate (qx) was high at early larval instar, i.e. 0.24 then decresed to 0.05 and 0.02 at second and third larval instars respectively. No mortality was noticed at fourth and fifth larval instar, and also in pupal and adult stage. Number of egg produced (Fx,) at adult stage, were 4544, number of off-springs produced per female or individual fecundity mx, was 64.91 and net reproductive rate was 45.44. The last three columns can used to assess the reproductive output. Intrinsic rate of natural increase r, was 0.163 insects per individual per day (Table 2).

DISCUSSION

The life table study of *T. virescence* indicated that age had a profound impact on the suviivorship of larval population. This trend indicates the delicacy of the earlier instars as compared to the later instars (Ali and Rizvi, 2007; Padmalaictha *et al*., 2003). Reduced survivorship in early days indicates high larval mortality which is an important check to counterbalance the effect of reproduction in mature stage. The mortality prior to attain the sexual maturity plays a key role in decreasing the reproduction of insect (Nath and Rai, 2010). In the present study the mortality was zero in pre-reproductive stages (4th instar, 5th instar and pupal stage) which reflect early days of insect development must be focused to get effective control. Cohort life table is suitable to study the dynamics of insect population because it helps to estimate the parameters related to growth potential. The net reproductive rate (Ro) obtained on the current study suggests that this pest has adequate ability to develop and reproduce on *Ficus nitida* plant.

The results in present studies demonstrate the *T. virescence* possesses impressive fitness on *Ficus nitida.* After first three instars the insect was best able to survive and reach to maturity with zero mortality. High net reproductive rate also advocated its ability to use the plant efficiently as a host. Furthermore the more delicate age in the insect life confined to only first three days which can be used as weak link to manage the pest effectively.

Fig 1: Age Specific Suvivorship (lx), Death (dx) and Life Expectancy (ex) of *Trilocha virescence* on *Ficus nitida*

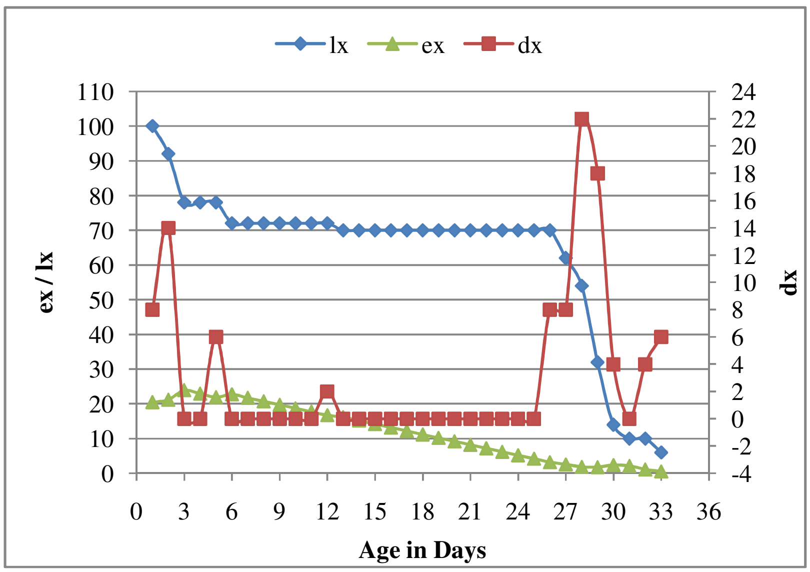

Table 1.Stage specific life table of *T. virescence* on leaves of *Ficus nitida*

Stage x	No surviving at the beginning of the stage, lx	No. dying in each stage, dx	Apparent Mortality, 100qx	Survival Fraction, Sx	Mortality / Survival Ratio, MSR	Indespansible mortality, IM	Log lx	K-values
First Instar	100	24	24.00	0.76	0.32	22.40	2	0.12
Second Instar	76	4	5.26	0.95	0.06	4.20	1.88	0.02
Third Instar	72	2	2.78	0.97	0.03	2.10	1.86	0.01
Fourth Instar	70	0	0.00	1.00	0.00	0.00	1.85	0
Fifth Instar	70	0	0.00	1.00	0.00	0.00	1.85	0
Pupa	70	0	0.00	1.00	0.00	0.00	1.85	0
Adult	70	70	100	0.00	---	---	1.85	---
								K = 0.15

Table 2.Cohort life table of *T. virescence* on *Ficus nitida*

Stage	Number surviving at each stage, ax	Proportion of original cohort surviving to each stage lx	Proportion of original cohort dying during each stage, dx	Mortality Rate qx	Eggs produced at each stage Fx	Eggs produced per surviving individual at each stage mx	Eggs produced per original individual at each stage lxmx
First Instar	100	1	0.24	0.24	0	0	0
Second Instar	76	0.76	0.4	0.05	0	0	0
Third Instar	72	0.72	0.2	0.03	0	0	0
Fourth Instar	70	0.70	0	0.00	0	0	0
Fifth Instar	70	0.70	0	0.00	0	0	0
Pupa	70	0.70	0	0.00	0	0	0
Adult	70	0.70	0.70	-	4544	64.91	45.44

Table 3. Reproductive parameters of *T. virescence* fed on *Ficus nitida*

Parameter name	Notation	Formula	Values
Net reproductive rate	Ro	$\sum$ lx.mx	45.44
Mean length of generation	Tc	$\sum$x(lx.mx)/$\sum$(lx.mx)	29.04
Intrinsic rate of natural increase	r	lnRo/Tc	0.131
Finite rate of increase	λ	e^r	1.21
Gross reproduction rate	GRR	$\sum$mx	64.91

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