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STUDY OF SEASONAL LIFE TABLES FOR *EXORISTA BOMBYCIS* (LOUIS) (DIPTERA : TACHINIDAE), A PARASITOID OF THE MULBERRY SILKWORM, *BOMBYX MORI*

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Seasonal life tables of uzifly, Exorista bombycis (Louis) (Diptera : Tachinidae) were constructed for spring, summer, rainy and winter seasons under prevailing rearing house conditions revealed that the maximum mortality was in egg stage. The mortality per cent renged from 22.02 to 47.63, 15.54 to 22.89, 2.58 to 7.84, 14.04 to 25.06 and 12.96 to 23.49 in egg, larval (paprasitic stage), maggot, pupal and adult stages, respectively. The abiotic factors, temperature and relative humidity (both minimum and maximum) were found to be the key mortality factors at all stages of Uzifly life table. The infertility on egg, the failure of emergence of maggots from superparasitised host, diseased host, putrification of host pupa and hard cocoon were also the causing factors of mortality. The adults with deformed wings and legs and also heavily sclerotised body were found to be unable to reproduce, which caused reduction of uzifly population.

INTRODUCTION

The uzifly, *Exorista bombycis* (Louis) is a parasitoid of the silkworm, *Bombyx mori* (Mukherjee, 1899; Jameson, 1922; Ghosh, 1949; Dasgupta, 1962), causing menace to the silk industry in West Bengal and the southern states of India (Jolly, 1981). Although infestation *(E. bombycis)* has been reported on the muga and eri silkworm (Mukherjee, 1919; Chowdhury, 1981 & 1982), it is chiefly a pest of mulberry silkworm.

Perusal of literature revealed that Datta & Mukherjee (1978) studied the life history of *E. bombycis*. Patil & Govindan (1984 & 1986) investigated the development of *E. bombycis* in relation to temperature and relative humidity and Veeranna & Nirmala (1989) reported the courtship and mating behaviour of *E. bombycis*. Life table of the uzifly, *Exorista sorbillans*, on the mulberry silkworm was constructed by Bhattacharya *et al.* (1993). But seasonal life table on uzifly under West Bengal climatic conditions has not studied so far. The present investigation deals with the construction of life tables of *E. bombycis* in different seasons correlating with the biotic parameters and the prevailing abiotic conditions to find mortality at different stages as well as total mortality of the parasitoid over generations. In the present contribution the age specific distribution of mortality, its causes and their proportionate effects are expressed in the form of life tables as advocated by Varley (1970) and Varley & Gradwell (1970 & 1971). These tables were developed over a period of three years for 24 generations and were pooled to study the like tables for spring (Mar - Apr.) summer (May - June), rainy (July - Aug.) and winter (Jan - Feb.) seasons. The data were also used to identify stages and factors that were likely to cause variability in population density, either between or within generations through key - factor analysis (Morris, 1959). The determination of key - factors responsible for mortality in a given population of biocontrol agent is not merely of theoritical interest but will eventually provide basis for its success in the field. This information will help in making prognosis of the effects of changes in the next or subsequent generations from information already in hand.

MATERIALS AND METHODS

Mass culture of uzifly was maintained in the laboratory (Bhattacharya *et al.*, 1993). The emerging flies were fed with 10% glucose solution soaked in cotton swab (Sriharan *et al.*, 1980).

Life tables for the Spring, Summer, Rainy and Winter generations of *E. bomycis* were compiled for three years to determine timing, intensity and factors of mortality within generation. For studying a generation of uzifly, *E. bombycis*, three replications each having 200, 5th age larvae of *B. mori* and one pair of mated male and female flies were kept in a cage for oviposition. Daily observation in respect of the ovipositional period of a fertile fly, fecundity, number of eggs oviposited per larva and hatching period was made till emergence of the files. Rearing of the silkworms was maintained inside the cage

with proper care to prevent any pathological occurrence. After the oviposition period (3 to 6 days) the infested larvae were taken out of the cage and reared in a tray having a wire netted covering.

The maggots as emerged in the rearing trays were taken into a sterilised beaker for pupation followed by emergence of the flies. Adult flies were sexed by examining genitalia. They were used as a parental stock for the next generation. Each of the developmental stages of the fly was recorded on the basis of 10 observations (n = 10) for every generation. A stock culture of the uzifly was maintained in the rearing room keeping in the records of meteorological data like temperature and relative humidity (both maximum and minimum) throughout the year.

The data were fitted for construction of life tables developed by Harcourt (1969). The mortality factors operating at each life stage were tabulated and survivorship curves were drawn as per Slobodkin (1962). To recognise the key mortality stage, k values were calculated for each stage of loss based on the method by Varley & Grandwell (1970) and the total killimg power 'K' was equal to the sum of mortalities *i.e.* k, s = K', which gave the estimate of overall generation mortality.

Twenty four life tables prepared for a period of three consecutive years were pooled to construct the life tables for the spring, summer, rainy and winter seasons. The columns of the life table are as given below.

X = The age interval at which the samples were taken.
lx = The number surviving at the begining of the stage noted in the X column.
dx = The number dying within the age interval in the X column.
dxf = The mortality factors observed or presumed responsible for dx.
100 qx = Per cent apparent mortality, dx / lx * 100
Sx = survival rate within period X, (lx - dx) / lx * 100

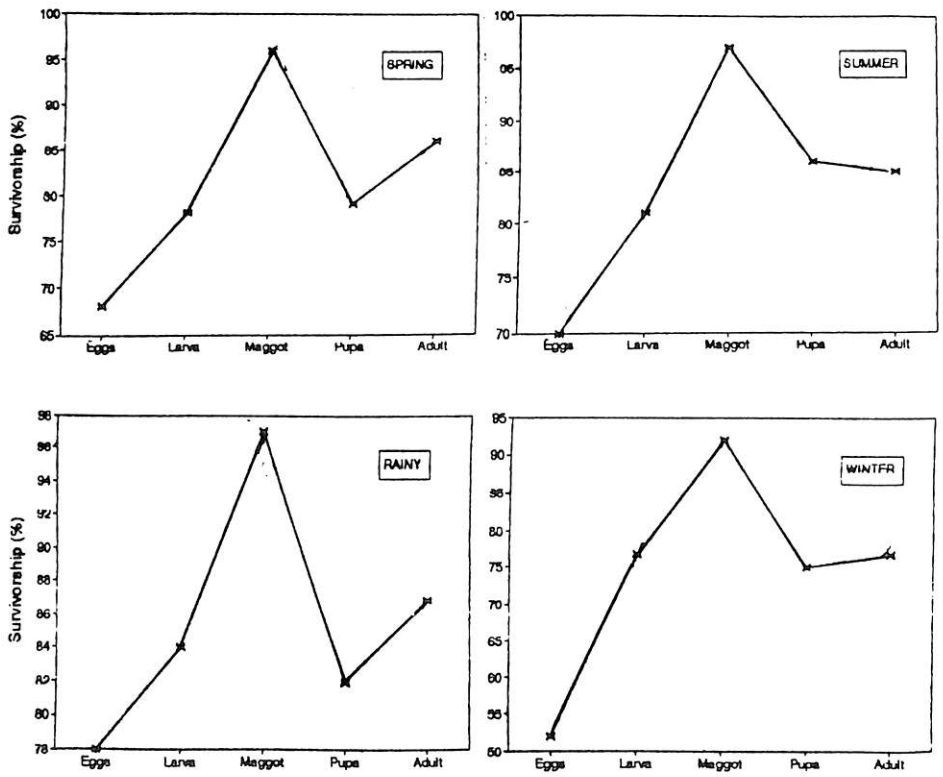

Fig. 1 : Survivorship graphs of life table of Uzifly for four seasons.

The total number of eggs laid by a female was counted and considered as initial cohort (lx). The inital population at maggot stage was based on the total number of maggots that successfully hatched out from the eggs and penetrated the host, as evidenced from the black scar. The sampling of this parasitoid in its three larval instars was not possible as it completed all instars inside the host (Datta & Mukherjee, 1978). Therefore, the proportion of maggots that failed to emerge out from the host was determined and the mortality factors were recorded accordingly.

The initial population at pupal stage was determined by direct population sampling *i. e.* by number of maggots pupated. The pupal mortality was obtained based on the number of pupae failed to transform into adults and the mortality factors responsible were recorded. The adults were counted immediately after emergence and sexed to arrive at the initial population.

RESULTS AND DISCUSSION

The life tables obtained from four seasons are given in Tables I to IV and the survivorship graphs are illustrated in Fig. 1. The percentage of eggs failed to hatch mainly due to abiotic factors, temperature and relative humidity (both minimum and maximum) and also due to infertility ranged from 22.02 to 47.63 among all seasons.

Table I : Life table of uzifly for spring (March - April) season

Temperature : Minimum 24.74 Humidity : Minimum 53.69
(°C) (%)
Maximum 28.17 Maximum 71.05

Stages x	1x	dxf	dx	100 qx	Sx
Eggs	253.75	Infertility Abiotic factors Unknown causes	81.25	32.02	0.68
Larvae	172.50	Abiotic factors Unknown causes	37.75	21.88	0.78
Maggot	134.75	Failure of maggot emergence from host cocoon Parasitized host died due to grasserie and muscardine Abiotic factors Unknown causes	5.25	3.90	0.96
Pupa	129.50	Putrification Abiotic factors Unknown causes	27.50	21.24	0.79
Adult	104.00	Deformed wings Deformed legs Sclerotization Abiotic factors	14.76	14.19	0.86

The larval mortality of 21.88, 19.36, 15.54 and 22.89 per cent was noticed during spring, summer, rainy and winter seasons, respectively.

In maggot stage, mortality of 5.25, 4.25, 6.25 and 9.50 per cent was recorded during spring, summer, rainy and winter seasons, respectively. The key mortality factors operated at this stage were failure of emergence of maggots from superparasitised and diseased worms and also from host cocoons.

Pupal mortality of 21.88, 14.04, 18.25 and 25.06 per cent was encountered during spring, summer, rainy and winter seasons, respectively. Mortality at this stage was due to putrification and abiotic factors.

The adult mortality was 14.19, 14.79. 12.96 and 23.49 per cent during spring, summer, rainy and winter seasons, respectively. Flies with deformed wings and legs and heavily sclerotised flies that were unable to reproduce were considered as the key mortality factors.

Table II : Life table of uzifly for summer (May - June) season.

Temperature : (°C) Minimum 27.08 Maximum 31.16 Humidity : (%) Minimum 70.6 Maximum 83.9

Stages x	1x	dxf	dx	100 qx	Sx
Eggs	290.25	Infertility Abiotic factors Unknown causes	86.25	29.72	0.70
Larvae	204.00	Abiotic factors Unknown causes	39.50	19.36	0.81
Maggot	164.50	Failure of maggot emergence from host cocoon Parasitized host died due to grasserie and muscardine Abiotic factors Unknown causes	4.25	2.58	0.97
Pupa	160.25	Putrification Abiotic factors Unknown causes	22.50	14.04	0.86
Adult	138.25	Deformed wings Deformed legs Sclerotization Abiotic factors	20.45	14.79	0.85

A comparison of the key mortality factors given in Table V shown that the generation survival in four seasons spring (March - April), Summer (May - June), Rainy (July - August) and Winter (Jan - Feb) was affected to the maximum in the egg stage which varied from 0.108 to 0.281 mainly due to abiotic factors and certain unknown causes.

Table III : Life table of uzifly for rainy (July - August) season.

Temperature : (°C) Minimum 27.29 Maximum 29.29 Humidity : (%) Minimum 83.49 Maximum 89.43

Stages x	1x	dxf	dx	100 qx	Sx
Eggs	361.00	Infertility Abiotic factors Unknown causes	79.50	22.02	0.78
Larvae	281.50	Abiotic factors Unknown causes	43.75	15.54	0.84
Maggot	237.75	Failure of maggot emergence from host cocoon Parasitized host died due to grasserie and muscardine Abiotic factors Unknown causes	6.25	2.63	0.97
Pupa	231.50	Putrification Abiotic factors Unknown causes	42.25	18.25	0.82
Adult	190.25	Deformed wings Deformed legs Sclerotization Abiotic factors	24.65	12.96	0.87

Table IV : Life table of uzifly for winter (Jan - Feb) season.

Temperature : (°C) Minimum 21.10 Maximum 23.60 Humidity : (%) Minimum 62.2 Maximum 71.10

Stages x	1x	dxf	dx	100 qx	Sx
Eggs	300.25	Infertility Abiotic factors Unknown causes	143.00	47.63	0.52
Larvae	157.25	Abiotic factors Unknown causes	36.00	22.89	0.77
Maggot	121.25	Failure of maggot emergence from host cocoon Parasitized host died due to grasserie and muscardine Abiotic factors Unknown causes	9.50	7.84	0.92
Pupa	111.75	Putrification Abiotic factors Unknown causes	28 00	25.06	0.75
Adult	83.75	Deformed wings Deformed legs Sclerotization Abiotic factors	19.67	23.49	0.77

The correlation analysis between k values of various stages and total K values revealed that there was significant positive correlation between total mortality factors (K values) and egg and maggot stages (Table II). However, the age interval reveals that mortality rate was highest in egg stage followed by larval, pupal, adult and maggot stages. The maggot stage being the shortest period (5 to 8 hrs) of its life cycle exposed to minimum duration under natural conditions, the chances of mortality were minimum as evidenced by the present observation. The seasonal comparison of survivorship curves (Fig. 1) indicates that the mortality was highest in winter followed by spring, summer and rainy seasons, respectively.

Table V : Population budget of Uzifly for four seasons

Age interval	Seasons (k - values)			
	Spring	Summer	Rainy	Winter
Egg - Larvae	0.1676	0.1531	0.1080	0.2809
Larva - Maggot	0.1073	0.0935	0.0734	0.1129
Maggot - Pupa	0.0173	0.0114	0.0116	0.0354
Pupa - Adult	0.0952	0.0641	0.0852	0.1253
Total	0.3874	0.3221	0.2782	0.5545

Table VI : Relationship between mortality (k,s) stagewise and total mortality (K)

Mortality stage	Correlation coefficient
Eggs - larvae	0.990*
Larva - Maggot	0.854*
Maggot - pupa	0.982*
Pupa - Adult	0.879*

* = Significant at 5%

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