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Life Table and Population Parameters of Bihar Hairy Caterpillar, *Spilarctia obliqua* Walker on Jute

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Abstract: Life tables and population parameters of the Bihar hairy caterpillar (BHC), *Spilarctia obliqua* Walker were constructed in an environment with unlimited food supply. The highest mortality occurred in the immature stage, especially in the first, second and third instars. The life table analysis showed that the population density of *S. obliqua* decreased gradually. The females lived for a maximum of 6.0 days. Two braconid larval parasitoids, *Meteorusspilosomae* and *Protapantelesobliquae* were the key mortality factors during early stage whereas in late instars, mortality due to virus was more. The population of *S. obliqua* has been predicted to be much higher in the ensuing generation as trend index was positive. This indicates the need of insecticidal intervention to manage this pest as the natural mortality factors were inadequate to suppress the increasing population of the pest in the jute ecosystem. The net reproductive rate (Ro) and intrinsic rate of natural increase (r_m) have been determined to be 533.56 females offspring's/female/generation and 1.15 female's offsprings/female/day, respectively. The mean generation time was 46 days and it is predicted that the population would double within a span of 6.0 days with the existing daily finite rate (ë)of increase of 3.16.

Key Words: Bihar hairy caterpillar, Fertility table, Jute, Life table, Net reproductive rate, *Spilarctia obliqua*

Life table provides an important tool in understanding the changes in population of insect pests during different developmental stages throughout their life cycle. Further, it help to analyze the mortality of insect population to determine key factors responsible for the highest mortality within population from one life stage to another (Kakde *et al.*, 2014). It generates simple summary statistics including life expectancy, key mortality factors and natality rate (Ali and Rizvi, 2007). Fertility life tables are appropriate to study the dynamics of arthropods as an intermediate process for estimating parameters related to the population growth potential also called demographic parameters (Southwood and Henderson, 2000). Bihar hairy caterpillar, *Spilarctia obliqua* Walker (Lepidoptera: Arctiidae) is a highly polyphagous nature and it attacks cultivated crops including bastfibre crops such as jute,mesta, ramie and sunnhempand causes severe economic damage (Gupta and Bhattacharya, 2008). The pest infestation besides having direct adverse effect on yield also affect the quality of the fibres. In recent years, outbreaks of this pest noticed during 2011 in jute and 2012 in sunnhemp crop and causing substantial loss to the fibre yield (Satpathy *et al.*, 2014). Timely management of this pest is very important as delay may even lead to complete defoliation of crop if remains unchecked in the field. Thorough understanding of the key mortality factors, population parameters and fecundity rate, can serve as important tools for *S. obliqua* management through more exact predicting and forecasting of its population. Studies of its host plant spectrum, natural enemies, life cycle and breeding potential on various hosts, including jute have been carried out by many workers. However, the life table statistics of this pest has not been studied very elaborately in jute ecosystem. Therefore, the role of natural enemies for management of this pest needs to be explored. Information on spectrum and type of native natural enemies is a pre-requisite for large scale inoculative releases of biocontrol agents. Thus, the objective of the current study was to evaluate fecundity, life expectancy variables, and fertility tables for *S. obliqua* in jute plants in the field.

MATERIAL AND METHODS

Nucleus culture of *S. obliqua* was collected from unsprayed crop at Central Research Institute for Jute and Allied Fibres (CRIJAF) Research farm. Further, the nucleus culture was maintained on jute plant (*Corchorusolitorius* L) in the rearing container (13cm height x13cm dia) with temperature 27±2°C and RH 85±5% in BOD. Ten pairs of freshly emerged moths were allowed to oviposit on 45 days jute plants (*C. olitorius*) which was grown in earthen pot (37.5 upper radiusx15.5 cm lower radius x 27 cm height) and caged in mylar film sheet with 10cm wide base provided with 10% honey solution (soaked on cotton swab) as a food for adults. After 48 h of moth's release, eggs were found in clusters on the lower sides of the leaves were used in the experiments with ?ve replication.

A cohort comprising 100 eggs was taken and kept in an incubator. After hatching, the larvae were reared individually in a plastic vials (13cm height x13cm dia) on jute plants (*C. olitorius*). The centre of the screw was cut open and fine brass mesh of 80 gauge fixed for ventilation. The inner side of top half of each vial was lined with a moist filter paper to prevent desiccation of the leaves. For the final instar larvae moist sterilized sand in each vial was provided for pupation. Observation on hatching, larval and pupal development, adult emergence and daily mortality in eggs, larvae, pupae

and adults were recorded at 24 hrs interval. The female obtained were paired and released in separate plastic jar containing seedling of test plant. The females kept in an incubator at temperature 27±2°C and RH 85±5% with 12:12 hrs photoperiod. Observations on adult mortality, fecundity were recorded.

When larval density of *S. obliqua* was highest, the field populations were examined by sampling randomly selected plant from each corner and the centre of the field to assess the parasitoids present. Each site consisted of 100 jute plants. Observations were taken at 15-day interval for four months (May to August) during 2012 and 2013. Parasitized larvae were collected from the colony after counting total colony size then reared individually in jars until parasitoid emergence. From the above data, simple percentage parasitism was calculated separately for each species of parasitoid.

The age-specific life tables were constructed as per the standard methodology described by Harcourt (1969). The 'k' value indicating the effectiveness of a mortality factor was worked out as per Varley and Gradwell's (1960) method. Age-specific fecundity tables were constructed as per the standard methodology described by Birch (1948). Several population growth indices *viz.*, intrinsic rate of increase, finite rate of increase, net reproductive rate, weekly multiplication rate, mean generation time and doubling time were estimated.

RESULTS AND DISCUSSION

Biology of *S. obliqua*: The incubation period was 4.10±0.42 days and the caterpillar pupated after six instars, an average larval duration of 29.84±2.11 days. The pupal stage lasted about 8.62±0.46 days. The fecundity/femalewas 566.76±24.12. The adult population was predominantly female, with a mean sex ratio (M: F) of 1:2.4. Male longevity was 4.06±0.195 days, whereas females survived for 7.34±0.24 days. These results were in close agreement with Varatharajan*et al.* (1998); Das and Chaudhuri (2005). They found that, egg incubation period, larval, pupal period, adult female moth survival, fecundity andsex ratio (M: F) as 4.0-5.0 days, 28.8-33.0 days, 8.0-11.2 days, 8.0-10 days, 530-618 female and 1:3.6 respectively on sunflower and jute crops. However, Taleb *et al.* (1998) reported that 6.18, 22.37, 7.26, 4.36, 6.10 and 887.60 days of incubation period, total larval period, pupal period, longevity of adult male and female and fecundity, respectively on jute.

Age-specific survival life table of jute hairy caterpillar, *S. obliqua*: The survival rate (lx) of the *S. obliqua*in two different cohortsduring 2012 and 2013 (Fig.1 a, b) showed a similar pattern including high mortality occurred during larval stage, particularly at the early instar growth.The observed survival pattern indicated that the immature *S. obliqua* are more susceptible to the density dependent mortality factors and later stages susceptible unknown virus. The *S. obliqua* survival curve indicated a modest increased rate of mortality during early life stages but a relatively gradual decrease as they reach adult wood. The *S. obliqua* population assumed a type-III survivorship curve according to the classification of Speight *et al.* (1999). Two braconid larval parasitoids, *Meteorusspilosomae*Narendran& Rama and *Protapantelesobliquae* (Wilkinson) were the key mortality factors with the 'k' value of 0.18 whereas in late instars, mortality due to virus was more with 0.21 'k'value. The generation survival was 0.39. The population of *S. obliqua* has been predicted to be much higher in the ensuing generation as trend index was positive. This indicates the need of insecticidal intervention to manage this pest as the natural mortality factors were inadequate to suppress the increasing population of the pest in the jute ecosystem. Higher trend index of *S. obliqua* instead of considerable mortality due to parasitisation and viral infection necessitates the insecticidal management intervention. These results were in close agreement with Varatharajan*et al.* (1998) who have found that *S. obliqua* caterpillars were parasitized by two braconids, *Apantelesobliquae* Wilkinson and *Glyptapantelescreatonoti*Viereck, and a tachnid, *Carcelia* sp. The average parasitism rates in the field were 12.0, 6.0 and 4.0% respectively for the three parasitoids.

Parasitoids: *S. obliqua* caterpillars were parasitized by two braconidslarval parasitoids, *M.spilosomae* and *P.obliquae*. The average parasitism rates in the field were 30.0and 48.0% respectively for the two parasitoids. *M.spilosomae*was found throughout the period of observation with a maximum of 57.0% in June. The parasitization potential of *Meteorus*spp. on *S. obliqua* feeding on cultivated *Vignamungo* and wild weeds, *Xanthium strumarium* and *Partheniumhysterophorus* was to the extent of 77.0% (Gupta and Narendran, 2007). The parasitization of *P. obliquae* was recorded on from Mid-June to Mid-July during the cropping season.

Age-specific fecundity life table of *S. obliqua*: The survivorship (l_x) and fecundity (m_x) of*S. obliqa* are shown in Fig. 2 based on data of Table 1. The first female emerged on day 43.0 and the first first female died on day 49.0.The last females died on day 53.0. The females remained alive for maximum of 6.0 days. Females started laying eggs from 45.0 or within 2.0 days of emerging as adults. The number of eggs deposited was gradually increased in the early stages and decreased during later stages of life span. The population and reproductive parameters of *S. obliqua* are summarized in table 2. The net reproductive rate (Ro) and intrinsic rate of natural increase (r_m) have been determined to be 533.56 females offspring's/female/generation and 1.15 female'soffsprings/female/day, respectively. The mean generation time was 46 days and it is predicted that the population would double within a span of 6.0 days with the existing daily finite rate (ë) of increase of 3.16.Other growth indices including mean generation time (days) (T_c), capacity for increase (r_c)and weekly multiplication rate (WMR) were 47.87, 0.10 and 2.12, respectively (Table 2). The results were close in agreement with Varatharajan*et al.* (1998); Das and Chaudhuri (2005).There reported that the net reproductive rate (Ro) and intrinsic rate of natural increase (rm) as 264.43-

Table 1. Age-specific fecundity of *S. obliqua* on jute

Pivotal age in days (x)	Survival of females at age (lx)	Age-specific fecundity (mx)	No. of progeny per female (lxmx)
0-42* immature stages			
43	0.10	0.00	0.00
44	0.10	0.00	0.00
45	0.10	61.17	61.17
46	0.10	67.91	67.91
47	0.10	70.40	70.40
48	0.10	75.38	75.38
49	0.09	78.33	78.33
50	0.09	71.23	68.47
51	0.07	66.88	50.82
52	0.05	75.47	61.08
53	0.00	0.00	0.00
		566.77	533.56

*4.10, 29.84 and 8.62 days for egg hatching, larval and pupaldurations respectively, i.e. 0-42 days immature stages, 43rd day adult emergence

Table 2. Population and reproductive parameters of *S. obliqua* on jute

Parameter	Formula	Value
Approximate generation time (Tc) (days)	$\dot{O} l_x m_x x / \dot{O} l_x m_x$	47.87
Corrected generation time (T) (days)	$\ln R_o / r_m$	46.00
Innate capacity for increase (rc)	log e R0) /Tc	0.10
Intrinsic rate of natural increase (rm)	$\dot{O} e^{-r} m^x l_x m_x = 1$	1.15
Finite rate of increase (ë)	e^rm	3.16
Doubling time (DT) (days)	ln 2/r	6.0
weekly multiplication rate (WMR)	t= 0.69315/rm	2.12
Net reproduction rate (Ro)	$\dot{O} l_x m_x$	533.56

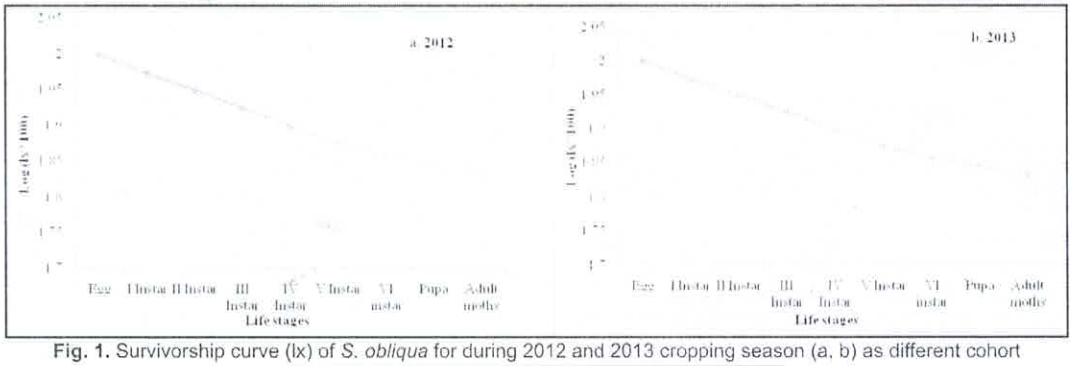

Fig. 1. Survivorship curve (lx) of *S. obliqua* for during 2012 and 2013 cropping season (a, b) as different cohort

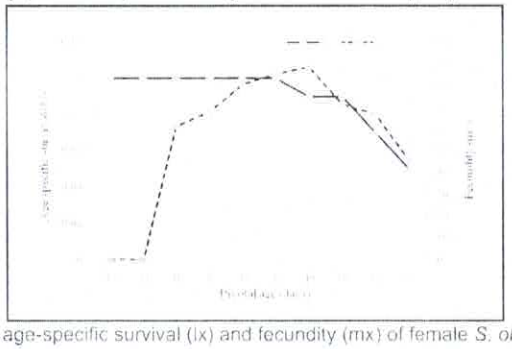

Fig. 2. Daily age-specific survival (lx) and fecundity (mx) of female *S. obliqua*on jute

513 females offspring's/female/generation and 0.129-0.157 female's offsprings/female/day, respectively. Similarly, finite rate of increase, generation time and doubling time as 1.14-1.17, 35.51-48.19 days, 4.41-5.35 days, respectively on sunflower and jute crops. The rm, Tc and DT are useful indices of population growth under a given set of growth conditions. It is generally presumed that short developmental time and high reproduction rate on a host reflect suitability of the plant tested. Life tables with data on the rm of a particular species provide insight into the characteristic life patterns of different species (Satpute *et al.* 2005). There is a range of innate capacity for individual of a population. Insect growth, longevity and reproduction can be influenced by the available food sources (host plants or host prey) and also by environmental factors such as temperature (Ellers-Kirk and Fleischer, 2006).

For present studies it can be concluded that the pattern of survivorship of *S. obliqua* during present study indicated that the immature stage was more susceptible to density dependent factors. The survivorship curve indicated a modest rate of mortality during the early life stages and a gradual decrease as it approached adulthood. The net reproductive rate (Ro) and intrinsic rate of natural increase (r_m) have been determined to be 533.56 females offspring's/female/generation and 1.15 female's off springs/female/day, respectively. The mean generation time was 46 days and it is predicted that the population would double within a span of 6.0 days with the existing daily finite rate (ë) of increase of 3.16.

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