J. Biol. Control, 15(2): 113-117, 2001

Life table studies on the natural enemies of *Chilo partellus* (Swinhoe) (Lepidoptera: Pyralidae)*

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ABSTRACT: **Life table studies were carried out on egg, larval and pupal parasitoids of *Chilo partellus* (Swinhoe) in the laboratory. Egg parasitoid *Trichogramma chilonis* Ishii (maize strain) had the highest finite rate of increase of 1.41 per female per day and doubling time was less than 2 days, the shortest amongst trichogrammatids studied. The larval parasitoid, *Cotesia flavipes* Cameron lived for 7.79 days and the first two days after pre-oviposition period accounted for 88.7 per cent of its total fecundity. The finite rate of increase was 1.147 per female per day, whereas finite rate of increase of the pupal parasitoid, *Xanthopimpla stemmator* (Thunberg) and *Tetrastichus howardi* (Olliff) were 1.178 and 1.274 per female per day, respectively.**

KEY WORDS: *Chilo partellus*, life table, natural enemies

The stem borer, *Chilo partellus* (Swinhoe) is a very important and destructive pest of maize and sorghum in many countries in Asia and Africa (Chatterji *et al.*, 1969; Seshu Reddy, 1989). The use of life tables showing changes in population during different developmental stages of an insect species has been considered as one of the most important approaches in understanding the population dynamics. Life tables also enable planing the production of natural enemies (Harcourt, 1969). The relevance of some hymenopteran parasitoids in the population dynamics of tissue borers in terms of intrinsic rates of natural increase have been assessed (Chundurwar, 1977; Nikam and Sathe, 1983; Nikam and Basarkar, 1981; Jalali and Singh, 1993). This paper attempts to study the age specific fecundity and collect life table statistics of some important parasitoids of *C. partellus* to enable selection of promising ones for field evaluation.

MATERIALS AND METHODS

Life table studies were conducted on four species of trichogrammatids *viz. T. chilonis* Ishii (maize strain), *T. dendrolimi* Matsumara, *T. evanescens* Westwood and *T. japonicum* Ashmead in the laboratory on the eggs and *Cotesia flavipes* Cameron on the larvae and *Xanthopimpla stemmator* (Thunberg) and *Tetrastichus howardi* (Olliff) on the pupae of *C. partellus*.

Experiment on parasitoids was started with

* Part of the Ph.D. thesis submitted to Mysore University, Mysore

25pairs of newly emerged adults. After one day, mated females were separated out. Egg parasitoids were kept in glass vials measuring 15x2.5cm and fine streaks of concentrated honey was provided as adult food. Female of each species was provided with fifty *C. partellus* eggs per day and this was repeated till all females died. Larval parasitoid, *C. flavipes* was kept in transparent plastic container measuring 16 x 8 cm and cotton swab with 50 per cent honey was provided daily as adult food. Each female parasitoid was provided with 25 fourth instar larvae per day and this was repeated till all females died. Pupal parasitoids were also exposed in a similar pattern except that *T. howardi* and *X. stemmator* females were provided with *C. partellus* pupae in paper drinking straws. The parasitised individuals of each exposure were maintained separately for observation on parasitism and subsequently for number of female progenies produced per day.

Observation was also recorded on number of females dead per day.

The following parameters were worked based on Andrewartha and Birch (1954) and Southwood (1966).

x = pivotal age in days

l_x = age specific longevity

m_x = age specific fecundity

$l_x m_x$ = age specific longevity x age specific fecundity

Life table was constructed with the following parameters.

R_o = net reproductive rate ($\Sigma l_x m_x$)

T_c = approximate duration of generation ($\Sigma x l_x m_x / \Sigma l_x m_x$)

r_c = approximate intrinsic rate of the increase ($\log_e R_o / Tc^{-rm}$)

r_m = the innate capacity for increase in numbers ($e^{-rm} x l_x m_x = 1$)

T = net generation time ($\log_e R_o / r_m$)

l = the finite rate of the increase (anti $\log_e r_m$)

Generation doubling time = $\log 2 / \log \lambda$

During the experiment the ambient laboratory temperature was 25±0.5°C and relative humidity 65±5 per cent.

RESULTS AND DISCUSSION

Trichogramma spp.

The adults *T. chilonis* lived for 11 days and

Table 1. Life table statistics of *Trichogramma* spp. on *Chilo partellus* eggs

Life table Parameter	*T. chilonis* (ms)	*T. dendrolimi*	*T. evanescens*	*T. japonicum*
Net reproductive rate (R_o)	42.660	21.250	28.000	38.550
Generation duration of (T_c)	12.540	12.850	12.610	14.810
Intrinsic rate of increase (r_c)	0.299	0.238	0.264	0.246
Innate capacity for increase (r_m)	0.341	0.255	0.278	0.304
Net generation time (T)	11.00	12.00	12.00	12.00
Finite rate of increase (λ)	1.41	1.29	1.32	1.35

laid maximum number of eggs for first three days compared to 8–9 days for other three species *viz. T. dendrolimi*, *T. evanescens* and *T. japonicum* when *C. partellus* eggs were used. The per cent eggs laid for first three days occupied 78.2, 61.1, 96.3 and 82.0 per cent of the total egg laying, respectively. The total female progeny produced during life span was highest (42.66) in *T. chilonis* followed by *T. japonicum* (38.5), *T. evanescens* (28.0) and *T. dendrolimi* (21.3). In order to guard against super-parasitism, the ratio of host and parasitoid in laboratory multiplication should be 35:1 for first three days and 10:1 for subsequent days for all four species. Sex ratio obtained was 1male : 1female in all days. Intrinsic rate of increase (r_m) was 0.341, 0.255, 0.278 and 0.304, respectively. The finite rate of increase (λ) of 1.40 female / female / day was highest for *T. chilonis* compared to 1.29 to 1.35 for other species (Table 1) and generation doubling time of 2.01 days was shortest compared to 2.31 to 2.72 for other species.

In the present investigations when *C. partellus* eggs were used as host, net reproductive rate (R_o), intrinsic rate of increase (r_m) and finite rate of increase (λ) was highest for *T. chilonis* than other three species used. Nagarkatti and Nagaraja (1978) obtained r_m value of 0.382 for λ *T. chilonis* and Jalali and Singh (1993) recorded λ values of various ecotypes ranging from 1.140-1.364 female/female/day on *C. cephalonica* eggs, which were less than the 1.41 recorded for the maize strain of *T. chilonis* during this study. *Trichogramma chilonis* (ms) is thus more adapted to *C. partellus*, hence considered more suitable for evaluation in the maize ecosystem.

***Cotesia flavipes* Cameron**

The results of the age specific fecundity and longevity of *C. flavipes* revealed that immature stages (egg laying to adult emergence) lasted 25 days and adults lived for 7.79 days (range 3-10 days). First two days after pre-oviposition period accounted for 88.7 per cent of its fecundity and maximum egg laying of 21.3 occurred on third day after emergence. Each female parasitoid produced 46.24 female progeny and $\Sigma x l_x m_x$ obtained was 1284.5. Net reproductive rate (R_o) was 46.24 times in a generation time of 28 days. The intrinsic rate of increase (r_m) and finite rate of increase (λ) obtained was 0.137 and 1.147 female/ female/day (Table 2).

The mean longevity of *C. flavipes* obtained is in agreement with Nikam and Sathe (1983) who reported mean longevity of 7.9 days. The net

Table 2. Life table statistics of larval and pupal parasitoids of *Chilo partellus*

Life table Parameter	*C. flavipes*	*X. stemmator*	*T. howardi*
Net reproductive rate (R_o)	46.240	36.820	99.950
Generation duration of (T_c)	27.710	22.930	20.680
Intrinsic rate of increase (r_c)	0.138	0.152	0.223
Innate capacity for increase (r_m)	0.137	0.164	0.242
Net generation time (T)	28.00	22.00	19.00
Finite rate of increase (λ)	1.147	1.178	1.274

reproductive rate (R_o) obtained in the present investigation, however, is much higher than that reported by Nikam and Sathe (1983). This discrepancy could be due to 7 - 8 days old larvae, which they considered as the most appropriate age, while during the present study 5th instar larvae were used giving significantly more progeny.

***Xanthopimpla stemmator* (Thunberg)**

Xanthopimpla stemmator lives longer comparing to all other parasitoids of *C. partellus*. The longevity of the females ranged from 11-31 days with a mean of 20.8 days. Parasitoids took 17 days to emerge from the parasitised host pupae. After a pre-oviposition period of two days, egg laying continued for a period of 18 days after which the females lived for another 12 days. The female progeny produced was 36.82 and $\Sigma x l_x m_x$ obtained was 840.6. The net reproductive rate (R_o) per generation was 36.82 per female progeny in a generation time of 22 days (λ). The calculated finite rate of increase (λ) showed that population of *X. stemmator* increased by 1.178 female/female/ day and intrinsic rate of increase (r_m) was 0.164 (Table 2). The longevity of *X. stemmator* females was much higher than any other parasitoid of *C. partellus*. In the present study, fecundity of female staggered for 18days after pre-oviposition period. Similar observation of staggered egg laying for 21days was recorded by Nikam and Basarkar (1981). The intrinsic rate of increase (r_m) 0.164 and finite rate of increase (λ) as 1.178 times/female/day obtained in the present investigation were slightly higher than values of 0.131 and 1.14 reported in their study.

***Tetrastichus howardi* (Olliff)**

Immature stages (egg laying to adult emergence) of *T. howardi* was 17 days and females laid 88.2 per cent of its progeny in first 5 days after emergence. The female progeny produced during the life span was 99.95 and $\Sigma x l_x m_x$ obtained was 2067.2. The mean adult longevity was 12.3 days (range 10.0 - 19.5) days. The net reproductive rate (R_o) was 99.95 females / generation in a generation time of 19.00 days. The intrinsic rate of increase (r_m) was 0.242 and finite rate on increase (λ) 1.274 female/ female/day (Table 2). The adults lived for a fairly long time but the maximum progeny produced per day was on the first day itself though egg laying occurred for another ten days after the pre-oviposition period. Ganesh Kumar *et al.* (1995) observed maximum progeny production in *T. israeli* Mani and Kurian on the first day itself and net reproductive rate (R_o) varied significantly on different hosts. The values finite rate of increase (λ) obtained ranged from 1.33-1.48. The finite rate of increase was highest on *Opisina arenosella* Walker than other hosts like *Spodoptera litura* (Fabricius), *Helicoverpa armigera* (Hübner) and *Ariadane merione* (Cramer) as reported by them.

The studies showed that the population of egg, larval and pupal parasitoids is capable of multiplying under favourable conditions. Amongst different trichogrammatids tried, *Trichogramma chilonis* (maize strain) suitable to parasitise *C. partellus* eggs because it is more adapted to maize ecosystem, hence should be considered for field evaluation. The production of larval parasitoid *C. flavipes* can be planned on 4th or 5th instar larvae as these give significant higher progeny production. The rate of multiplication of *X. stemmator* was much less than that of *T. howardi* – the other pupal parasitoid. However, field evaluation is necessary to determine their efficacy. Based on finite rate of multiplication, laboratory production of these parasitoids can be planned according to field requirement.

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