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Fertility table of an exotic parasitoid, *Telenomus remus* Nixon (Hymenoptera: Scelionidae) on *Spodoptera litura* (Fabricius)

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ABSTRACT: Fecundity studies on *Telenomus remus*, an exotic parasitoid of *Spodoptera litura* (Fabricius) indicated that in individual rearing, net reproductive rate was higher (120.53) and the population increased with an infinitesimal rate of 0.399 and a finite rate of 1.491. In group rearing, the corresponding figures were lower, being 65.03, 0.348 and 1.416, respectively. There was a preponderance of females in the individual rearing method, while a balanced sex ratio was obtained in group rearing.

KEY WORDS: Fertility table, rearing, *Spodoptera litura, Telenomus remus*

Spodoptera litura (Fabricius) (Lepidoptera: Noctuidae) is an important polyphagous pest infesting 120 host plants and is a serious pest on cole crops, tobacco, groundnut, taro and castor (Singh and Jalali, 1997). *Telenomus remus* Nixon (Hymenoptera: Scelionidae) was recorded as an important parasitoid of *S. litura* in colocasia plantations in Western Samoa (Braune, 1982). This exotic parasitoid was introduced into India as one of the candidates for the biological control of *Spodoptera litura* (Fabricius). Field cage studies in Karnataka revealed that *T. remus* is effective in parasitising *S. litura* infesting cabbage (Krishnamoorthy and Mani, 1985). The release of *T. remus* in the field has enhanced the biological control of *Spodoptera* species in Barbados (Alam, 1974), India (Patel *et al.*, 1979) and Venezuela (Hernandez *et al.*, 1989).

The construction of fertility tables to calculate certain vital statistics is an important component in the basic understanding of the population dynamics of a species (Southwood, 1978). The objective of our present study was to investigate variations in the fertility table of *T. remus* on *S. litura* when reared individually or in groups.

MATERIALS AND METHODS

Telenomus remus adults and *S. litura* eggs were obtained from the cultures maintained at the Mass Production Laboratory of Project Directorate of Biological Control, Bangalore, India. Adults of *T. remus* were allowed to mate and after a pre-oviposition period of 24 hours, ten pairs were kept individually in 15 x 2.5 cm glass vials with one pair in each vial (individual rearing or IR). Ten more sets were set up with ten pairs in each vial (group rearing or GR). Two cotton swabs (one saturated with 50 % honey solution and another with water) were stuck to the inner wall of each vial. *Spodoptera litura* eggs (0-24 h old) at the rate of 100 eggs per day per female were exposed to the parasitoids in both IR and GR methods. The exposed eggs were removed after every 24-hour period and a set of fresh eggs was exposed. The exposures were continued till female mortality and longevity was noted. The adults emerging from each exposure were allowed to die, sexed and counted, and thus the fecundity (in terms of progeny produced) was recorded. The experiment was conducted at 26 ± 2°C and per cent relative humidity of 65 ± 2. The fertility table statistics was calculated using the methods followed by Andrewartha and Birch (1954) and was based on the production of female progeny only.

The age specific survival (l_x) and age specific fecundity (m_x) at each pivotal age x was worked out for entire reproductive period. The number of individuals alive at age x as the fraction of 1 was recorded as l_x and the number of female offspring produced per female at age interval x as m_x. Utilising these, the following fertility table parameters were calculated.

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

Approximate duration of a generation (T_c) = $\frac{\Sigma x l_x m_x}{R_o}$

Approximate intrinsic rate of increase (r_c) = $\frac{\log_e R_o}{T_c}$

Precise intrinsic rate of increase (r_m) = $e^{-r_m} x l_x m_x = 1$

Net generation time (T) = $\frac{\log_e R_o}{r_m}$

Finite rate of increase (λ) = anti $\log_e r_m$

Weekly multiplication of the population (r_w) = $(_e r_m)^7$

Hypothetical F_2 females = $(R_o)^2$

RESULTS AND DISCUSSION

Figures 1 and 2 depict the age specific survival and fecundity of *T. remus* in the two methods of rearing. In IR, female progeny production was observed to be intensive for the first two days after the pre-oviposition period, beyond which it reduced drastically (Fig. 1). Hernandez and Diaz (1995) also reported that oviposition by *T. remus* on *Spodoptera frugiperda* (Smith) was greatest on the first and second days of the oviposition period. In the case of GR, female progeny production was high only in the first exposure (Fig. 2), after which there was a sudden decline in progeny production.

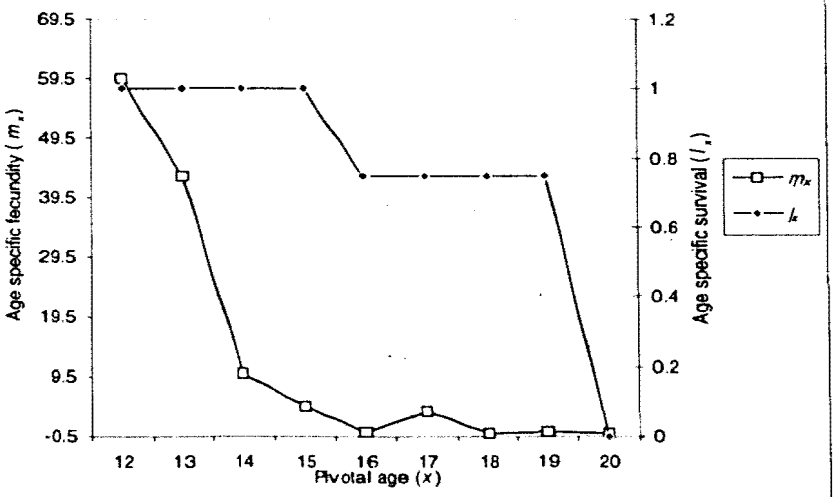

Fig. 1 Age specific survival and fecundity of *Telenomus remus* in individual rearing

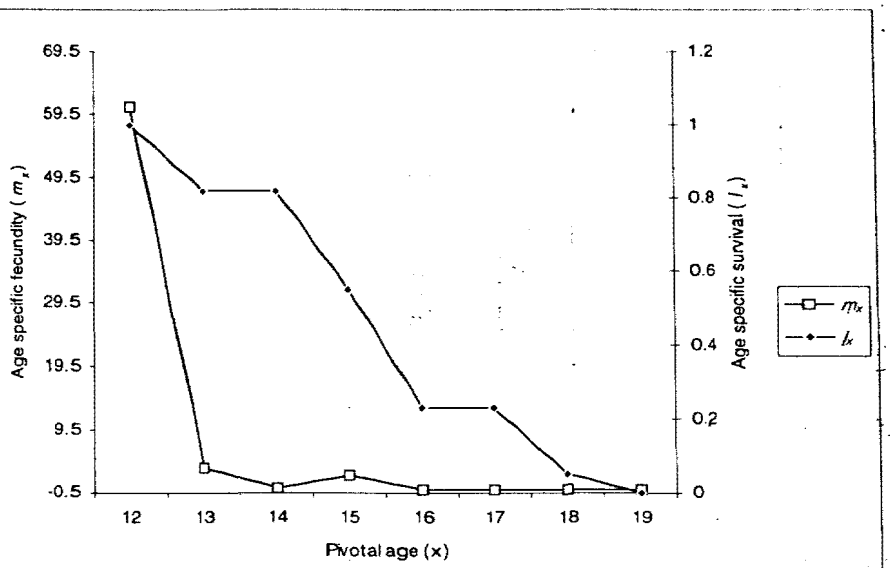

Fig. 2 Age specific survival and fecundity of *Telenomus remus* in group rearing

Table 1. Comparison between fertility table parameters of *T. remus* in individual rearing (IR) and group rearing (GR)

Method of rearing	Mean longevity (days) (♂)	(♀)	R_o	T_c	r_c	r_m	T	λ	Sex Ratio (♂: ♀)	Weekly multiplication rate	Hypothetical F_2 famales
IR	7.25	8.0	120.53	12.78	0.375	0.399	12.0	1.491	1:2.9	16.31	14527.48
GR	5.20	6.5	65.03	12.12	0.344	0.348	12.0	1.416	1:1.7	11.64	4228.90

The first mortality in the cohort occurred on the fifth day from emergence in IR and on the third day in GR. In IR, the number of female progeny per female ranged from 0 to 59.5 in the different exposures. The mean total progeny production was 168.2 and sex ratio (♂:♀) was 1:2.9. The corresponding figures recorded in GR were 0 to 60.77, 143.1 and 1:1.7, respectively.

The longevity of *T. remus* adult females was slightly more in the case of IR (8 days) in comparison to the adult females in GR (6.5 days) (Table1). Similarly, male longevity was also higher in the case of IR (7.25 days) in comparison to GR (5.2 days). Schwartz and Gerling (1974) observed that *T. remus* could live longer when mass reared in comparison to solitary individuals. This is contrary to the observations recorded in the present study. This may be because the adults in the experiment conducted by Schwartz and Gerling (1974) were not provided with host eggs for parasitisation, while in the present study host eggs were continuously provided.

The intrinsic rate of increase (r_m) has been useful as predictive and comparative measures of population growth potential. Fecundity of scelionid parasitoids generally vary from 30-85 eggs (Singh *et al.*, 1995). The actual number of eggs laid depend upon factors like temperature, stage of host, functional and numerical response and nutrition during larval development. Studies have indicated that the fertility of parasitoids could vary based on the type of host eggs provided. In *Psix striaticeps* Dodd (a scelionid parasitoid of the pentatomid silkworm predator, *Canthecona furcellata* Wolff.), r_m was recorded to be 0.275 (Singh *et al.*, 1995) and in the case of *Trissolcus* sp., it varied from 0.1665 to 0.2775 depending on the host species parasitised (Senrayan *et al.*, 1988). The fertility of *T. podisi* also varied from 76.1 to 211 depending on the host species provided. (Pacheco and Ferreira, 1998).

R_o and r_m are generally lower in less fecund species, thus providing an index to parasitoid fitness. In this experiment, the same parasitoid showed different R_o and r_m values, in the two different types of exposure (R_o being 120.53 and 65.03 and r_m 0.375 and 0.348, in IR and GR, respectively). This indicates that the method of rearing causes variation in the reproductive rates.

Table 1 shows that T_c, r_c, r_m and λ were all slightly more in the case of IR. The mean length of generation (T_c) was 12.8 days and 12.12 days in IR and GR, respectively, which approximated the true generation time of 12 days in both. During this time, the parasitoid could multiply 120.53 times in IR and 65.03 times in GR.

Earlier studies have indicated that the age of the parasitoid and that of the host insect determined the oviposition capacity and sex ratio of the progeny of *T. remus* (Hernandez and Diaz, 1995; 1996). In the present investigation, it was observed that the method of rearing could influence the sex ratio and the reproductive rate. The sex ratio was more female biased in the case of IR, with the number of female progeny

being twice the number of male progeny. The higher proportion of females generally led to an accelerated growth rate. In the case of GR, the sex ratio was more balanced. The hypothetical F_2 female number was also higher in IR, being 14527.48 in comparison to 4228.9 in GR. Gerling (1972) has observed superparasitism in *T. remus*. Singh *et al.* (1995) also observed that more females were produced by *P. striaticeps* when the host eggs were parasitised solitarily and superparasitism resulted in a more balanced sex ratio. They opined that superparasitism and higher female progeny production could be reproductive adaptations of the parasitoids to utilise less suitable hosts for production of females.

The present experiment indicated that a higher reproductive rate and a female biased sex ratio could be obtained through individual rearing. In a mass multiplication unit it is not practical to follow individual rearing method, however, it is necessary to know the reproductive potential of a parasitoid when optimum conditions are provided. With this knowledge it is possible to formulate or improve multiplication methods to obtain maximum output, in terms of reproductive rate and female progeny production.

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