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FERTILITY LIFE TABLES OF *PLASTANOXUS WESTWOODI* (KIEFFER) (HYMENOPTERA: BETHYLIDAE) ON *CRYPTOLESTES PUSILLUS* (SCHON.) (COLEOPTERA: CUCUJIDAE)

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Abstract

Plastanoxus westwoodi is an efficient ectoparasitoid of larvae and pupae of the red flat grain beetle *Cryptolestes pusillus*. Fertility life tables and effects of host instar on life table parameters of *P. westwoodi* on *C. pusillus* were studied in the laboratory. Generally adult females lived for 13-16 days. Oviposition commenced on the 1st day of adult emergence and continued till death or 1-2 days before the death of a parasitoid. The intrinsic rate of natural increase (r_m) was found to be 0.2291 per female per day. The net reproductive rate (R_0) was 64.07; the innate capacity for increase (r_c) was 0.2096. The finite rate of increase (λ) was calculated as 1.4735 per female per day, while corrected generation time (T) was computed as 18.16 days.

Key words: *Plastanoxus westwoodi*, *Cryptolestes pusillus*, Oviposition, Life table, Biological control

Introduction

Stored product insects cause many kinds of hazards in cereal warehouses, especially in countries where high temperature and the lack of appropriate technologies allow the increase of pest population densities resulting in considerable losses of the products. The increasing importance of organic production has led to undertake research on biological control agent, because these could represent an interesting component of IPM strategies (Russo *et al.* 2004). Life table studies of parasitoids and predators give us more information on the extent of control they can exercise on the pest population as well as the rate at which they build up their population (Muthukrishnan *et al*. 1995).

Cryptolestes pusillus (Schon.) is a serious cosmopolitan pest of stored product commodities and may subsequently build up huge population. **:** *Plastanoxus westwoodi* (Kieffer) parasitize the larvae, pre-pupae and pupae of *C. pusillus*. *P. westwoodi* may play vital roles in the control of *C. pusillus*. No information is available on the suppressive effect of *P. westwoodi* on the population of *C. pusillus* either in natural conditions in the granaries or in laboratory conditions. The present investigation provides life table data and intrinsic rate of natural increase (r_m) of *P. westwoodi* together with other population growth parameters that have been studied in the laboratory.

Materials and Methods

The test insect of *C. pusillus* and the parasitoid *P. westwoodi* were collected from the stock cultures maintain in the Control Temperature (CT) room, Integrated Pest Management (IPM) Laboratory, Institute of Biological Sciences, Rajshahi University, Bangladesh. The newly emerged (12h old) and mated female parasitoids of *P. westwoodi* were collected from the stock cultures and released in small glass vials (size 4.5cm ×1.1cm)

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with small amount of food medium and 25 *C. pusillus* matured larvae (16-18-days-old). After every 24h, the parasitized host larvae were removed and the parasitoids were reintroduced into new glass vials. This procedure was continued until each female died out. A series of parasitized host larvae were collected daily from individual parasitoid and kept separately in small glass vials (size 4.5cm ×1.1cm) with a small amount of food medium in each. The openings of the vials were covered by cotton wads. All the experiments were conducted in an incubator at (27±1)°C and (70±5) % RH.

On emergence, the progeny were counted daily (and the sex ratio was recorded) to provide an index for parasitoid fecundity used in the (m_x) column. Life tables were prepared from observed survival and "fecundity" (progeny production) rates. The intrinsic rate of natural increase was calculated employing the formula (Birch 1948): $\sum_{x-1}^{\omega} e^{rm\lambda} l_x m_x = 1$. Where ω is the oldest age class, l_x and m_x are the proportion of surviving females at age x and the number of females produced per female in the age interval x, respectively and e is the base of natural logarithm. The sum of products ($l_x m_x$) is the net reproductive rate (R_0).

The approximate generation time (Mean length of generation) (T_c) was calculated as: $T_c = \sum l_x m_x X / l_x m_x$. The capacity for increase (r_c) was calculated as: r_c = log eR_0 / T_c. The mean generation time (T) was computed from the formula: T = log eR_0 / r_m, and the finite rate of increase λ was computed from the formula: λ = antilog $_e$ r_m. This (λ) represents the number of individuals added to the population per female per day.

Results

Development of immature stages of *P. westwoodi* on *C. pusillus* from oviposition to adult emergence took 12-15 days at 27±1°C and 70± 5 % RH. Adult female lived for 13-16 days and produced 147.53 female progeny per female (Table 1). Oviposition commenced on the 1st day of adult emergence and continued till death or 1-2 days before the death of a parasitoid.

The intrinsic rate of natural increase (r_m) was found to be 0.2291 per female per day. The net reproductive rate (R_0) was 64.07; the innate capacity for increase (r_c) was 0.2096. The finite rate of increase (λ) was calculated as 1.4735 per female per day, while corrected generation time (T) was computed as 18.16 days (Table 3).

Discussion

Under these experimental conditions, development from oviposition to adult emergence of *P. westwoodi* on *C. pusillus* took 12-15 days at (27±1)°C and (70±5) % rh as compared to 276-312 hours at a temperature of 30±1°C reported by Islam (1995) of a pteromalid parasitoid *Dinarmus basalis* (Rond.) on its host *Callosobruchus chinensis* and Islam (2002) reported that the developmental time of *D. basalis* on *C. maculatus* was 12-13 days at a constant temperature of 30±1°C. The present result is similar to that finding.

Campbel and Sinha (1978) have demonstrated a significant positive correlation between net conversion efficiency and intrinsic rate of population increase of stored product insect pests. Therefore, the high intrinsic rate of population increase of the parasitoids may be related to the high net conversion efficiency of the parasitoids. In this investigation intrinsic rate of natural increase was 0.2291. Oloo (1992) recorded the life table data and intrinsic rate of natural increase (r_m) of the eulophid pupal parasitoid, *Pediobius furvus* (Hymenoptera: Eulophidae) on *Chilo partellus* (Lepidoptera: Pyralidae) in the laboratory. He reported that the intrinsic rate of natural increase (r_m) was 0.2558; net reproductive rate (R_0) was 237.25; the capacity for increase (r_c) was of 0.252; and the finite rate of increase (λ) was 1.29/female/day. Thus, each female contributed 231.42 individuals to the population in a mean generation time of 21.38 days. These results are in close agreement with the present findings.

Table 1. Life table and age specific fecundity of *P. westwoodi* on *C. pusillus*

Pivotal age in days (*X*)	Proportion of survival of female at different stages (l_x)	Numbers of females produced per female at different ages (m_x)	l_xm_x	l_xm_xX
0-13	0.67			
14	0.67			
15	0.67	9.13	6.12	91.80
16	0.66	10.29	6.79	108.64
17	0.65	10.83	7.04	119.68
18	0.67	11.25	7.54	135.72
19	0.62	11.37	7.05	133.95
20	0.61	10.51	6.41	128.20
21	0.56	8.36	4.68	98.28
22	0.53	7.12	3.77	82.94
23	0.49	6.69	3.28	75.44
24	0.48	6.19	2.97	71.28
25	0.46	6.00	2.76	69.00
26	0.39	5.35	2.08	54.08
27	0.34	3.29	1.12	30.24
28	0.31	3.14	0.97	27.16
29	0.25	2.67	0.67	19.43
30	0.21	1.86	0.39	11.70
31	0.19	1.47	0.28	8.68
32	0.15	1.03	0.15	4.80
33	00	00	00	00
34	00	00	00	00
Total		**$\sum m_x$=116.55**	**$\sum l_xm_x$= 64.07**	**$\sum l_xm_xX$=1271 .02**

Table 2. Duration and survival (%) of different stages of *P. westwoodi* on *C. pusillus*

Stage	Duration (Hours/Days)	Survival (%)
Egg	18-48 h	92.45±3.22
1st instar larva	3-4 d	87.17±2.56
2nd instar larva	5-6 d	80.68±2.72
3rd instar larva	6-7 d	75.35±3.69
4th instar larva	8-9 d	72.81±2.77
Pre-pupa	9-10 d	69.43±1.83
Pupa	10-12 d	67.19±1.02
Adult	12-15 d	65.72±2.67

Table 3. Life table statistics of *P. westwoodi*

Net reproductive rate (R_0)	64.07
Mean length of generation (T_c)	19.84
Innate capacity for increase (r_c)	0.2096
Intrinsic rate of natural increase (r_m)	0.2291
Corrected generation time (T)	18.16
Finite rate of increase (λ)	1.4735

Matadha *et al*. (2004) observed the life table parameters of *Encarsia citrina* at different temperatures (15, 17.5, 20, 25, 27.5 and 30°C) and opined that the intrinsic rate of increase (r_m) values ranged from 0.074 at 17.5°C to 0.176 at 27.5°C. The highest net reproductive rate (R_0) was 93.7 at 20°C. These results are agree with the present findings. Eliopoulos (2006) observed the life table of the parasitoid *Venturia canescens* at different temperatures (15, 20, 25 and 30°C) and reported that temperature increase resulted in higher values of the intrinsic rate of natural increase (r_m), the net reproductive rate (R_0), the finite capacity of increase (λ) and the gross reproductive rates (GRR), whereas it was followed by decrease of the mean generation time (G) and the doubling time (DT) values. These results comply with the outcome of present investigation.

There is no question that life tables give a more accurate precision of the importance of natural enemies than pointing out samples of predator abundance or parasitism (Crawley 1992). Considering the intrinsic rate of population increase and shorter population doubling time as well as high female based sex ratio of the progeny, it may be concluded that this bethylid parasitoid can produce significant contribution toward successful biological control.

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