Fertility Table Parameters of Predatory Bug *Orius bifilarus* Ghauri (Hemiptera: Anthocoridae) Preying upon *Thrips palmi* and Eggs of *Corcyra cepholinica*

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**Abstract**

The study was carried out to construct the life table and to study the age dependent reproduction of the predatory bug *Orius bifilarus* feeding on fictitious host, eggs of rice meal moth, *Corcyra cephalonica* (Stainton) (Lepidoptera: Galleriidae) and on its natural host, *Thrips palmi* Karny (Thysanoptera: Thripidae) (collected from cucumber) under controlled conditions (25 ± 1°C, 65 ± 5% RH). The mean durations of the pre, post and oviposition periods were 4.3, 1.4 and 14.2 days on *C. cephalonica* eggs and 4.1, 2.1 and 16.4 days on thrips, the difference being non-significant. The fecundity of *O. bifilarus* reared on *Corcyra* eggs and thrips did not differ significantly and was 40.8 (20-65) eggs/female and 42.1 (7-67) eggs/female, respectively, though the female survival was slightly longer (22.7 days) on thrips as compared to *Corcyra* eggs (19.8 days). The intrinsic rate of natural increase (r_m) on respective host was 0.088 and 0.085 and hence *Corcyra* eggs can effectively be used for mass rearing of *O. bifilarus*.

**Keywords**

*Orius bifilarus*, *Thrips palmi*, *Corcyra cephalonica*, Life table, Age dependent reproduction

**Introduction**

Flower bugs in the genus *Orius* are efficient predators of a wide range of arthropod pests such as thrips, aphids, mites and eggs of lepidopteron pests (Wang et al., 2014). Although *Orius* spp. are polyphagous, these predators show a preference for attacking larval and adult thrips (Kakimoto et al., 2006; Xu and Enkegaard, 2009). Thrips (Thysanoptera) are cosmopolitan pests of manyimportant agricultural plants (Stuart et al., 2011). They cause damages directly by feeding and indirectly by transmitting viruses (Sakimura, 1963). Flower bugs have proven efficacious biological control agents against many thrips species, including *Frankliniella occidentalis* (Pergande) (Blaeser et al., 2004; Osekre et al., 2008; Chow et al., 2010), *Frankliniella bispinosa* (Morgan) (Shirk et al., 2012), *Thrips palmi* Karny (Kawai, 1995; Carvalho et al., 2011; Hemerik and Yano, 2011) and *Scirtothrips dorsalis* Hood (Dogramaci et al., 2011). In India *Orius indicus* (Reuter), *Orius insidiosus* (Say), *Orius tristicolor* (White), *Orius laevigatus* (Fieber) and *Orius albidipennis* (Reuter), have been reported to be an effective predator of *F. occidentalis*, *Therioaphis maculata* (Buckton), *Gynaikothrips ficorum* (Marchal),
Megalourothrips nigricornis, Sericothrips variabilis (Beach), eggs and newly hatched larvae of cotton bollworm, Helicoverpa armigera (Hübner) and Helicoverpa zea (Boddie), whiteflies, aphids, leaf hopper nymphs, mites and nymphs of cotton flea hopper, Psal/us seriatus (Reut.) (Rajsekhara and Chatterji, 1970; Awadallah et al., 1977; Ananthakrishnan and Sureshkumar, 1985; Nasser and Abdurahiman, 2004).

Life table parameters, especially the intrinsic rate of increase ($r_m$), are very important biological features for describing the population growth rate and are used to assess the potential effectiveness of natural enemies. These tables can describe duration and survival at each life stage. Daily fecundity data generated by these tables allow prediction of the population size and age structure of a natural enemy at any time (Southwood 1976; Southwood and Henderson, 2000).

Tommasini et al., (2004) carried out laboratory trials in order to determine biological traits and predation activity of four Orius species, viz. the palearctic Orius majusculus (Reuter), O. laevigatus and Oriusniger Wolff and the Nearctic O. insidiosus, using Ehestia kuehniella (Zeller) eggs and F. occidentalis adults as prey. Baniameri et al., (2005) too studied life table and age-dependent reproduction of O. niger on E. kuehniella eggs. Kemasa et al., (2008) study on biological life table of Orius minutus (L.) fed with Thrips palmi and eggs of Corcyra cephalonica.

Tiwari et al., (2017) conducted studies on the biology and predation efficiency of Eocanthecona furcellata (Wolff.) on different hosts viz., Maruca vitrata, Spodoptera littura, Spilarctia obliqua, Corcyra cephalonica under laboratory condition to find out its preferred host, with the intention that the same could be utilized for the mass rearing.

However, no information or published data on reproductive biology or life table is available for O. bifilarus. Therefore, the objective of the present study was to determine the life table parameters of the flower bug, O. bifilarus, when fed on its natural prey, Thrips palmi and fictitious host i.e. eggs of C. cephalonica at constant temperature as the temperature plays an important role in determining the growth rate of insects as insects are poikilothermic animals whose metabolism, rate and magnitude of growth, development and overall behavioral activities respond significantly to temperature change (Saxena and Murty, 2014).

Materials and Methods

Rearing

O. bifilarus used in the experiments were collected on flowers and apical bud of cucumber, Cucumis sativus (L.) in Himachal Pradesh (31.1033° N, 77.1722° E), India. O. bifilarus was identified by using the key and single rearing method (Ghauri, 1972; Yasonaga, 1997a, 1997b, 1997c). The adults were paired up and released in plastic container (10.5 x 10.5 x 10.5cm$^3$) with a moistened filter paper placed at its bottom and covered with a muslin cloth. Bean pods were provided as egg laying substrate. Adult rearing was divided into two experimental units. In one experimental unit adult predators were provide with its natural host i.e. T. palmi (collected from cucumber) as its prey and in another rearing unit they were provided with its fictitious host i.e. eggs of C. cephalonica as prey. Adult predators were provided with fresh prey after every 1-2 days. Pods containing eggs of the anthocorid bugs were collected daily or on alternate days depending on egg laying rhythm of the female and placed in separate container for hatching and emergence of nymphs. Subsequently, nymphs were shifted to vials and provided with
Emerged adults were sexed, paired and further utilized to multiply their numbers. Observations on reproductive biology were recorded by maintaining male and female in pairs from the raised culture in rearing chamber containing sufficient prey as food source and oviposition substrate. Each pair of bugs was transferred to a test tube of diameter 3cm and length 15cm. Opening was covered by a muslin cloth to provide ventilation. 20 such pairs were kept for these studies in each experimental unit. The dead male was replaced by another male. Observations on attaining reproductive maturity, duration of pre-oviposition, oviposition, and post-oviposition periods were recorded. Total number of eggs oviposited during survival of the female and hatchability was recorded. The bugs were daily provided with respective prey and bean pod as food and oviposition sites. Bean pods were checked daily for Orius eggs and were kept in test tubes of diameter 1.5cm and length 9cm until hatching. After hatching II instars were sifted individually to another test tube provides with moistened filter paper and respective prey to avoid cannibalism. Survival of eggs was recorded after the hatching of all of the eggs. To prevent disturbance of nymphs, their survival and sex were recorded at the emerging of the adults.

**Fertility analysis**

Fertility table was developed by using developmental biology statistics as per Birch (1948) and elaborated by Howe (1953) and Carey (1993). Data recorded on mortality in immature stages, number of adults formed and proportion of females among them, female progeny laid by each female at specific pivotal age and percentage of alive females of specific age group were utilized for construction of life-tables. The main parameters in a life table are x (pivotal age), lx (proportion of females surviving to start of age interval x) and mx (average number of female eggs laid by a female of age x). The most basic measure of reproduction is the average number of eggs laid by a female in the cohort in the interval x to x+1 and is denoted by Mx. The fraction of these eggs that hatch represents the hatch schedule, hx (0). We followed the methods of Birch (1948), Howe (1953) and Carey (1993) for calculating life table parameters and reproductive parameters. Southwood (1976) gave a graphical method for the calculation of precise value of \( r_m \). The arbitrary values of \( r_c \) up to two decimal places were substituted in the formula \( \Sigma_l x_m e^{-r_m(x+0.5)} \) until the two values were found one of which lie immediately above 1 and the other below 1. These values were then plotted on the horizontal axis against their respective arbitrary values of \( r_m \) on vertical axis. The points were joined to give a line which intersected a vertical line drawn from the desired value of \( \Sigma_l x_m e^{-r_m(x+0.5)} = 1 \). The point of intersection gave the value of \( r_m \) accurate to three decimal places. The intrinsic rate of increase can also be used to estimate the effect of mortality of each stage on the population growth rate, and this can subsequently be used to optimize mass rearing. Antilog of \( r_m \) is known as finite rate of increase, which depicts the number of times the population increases per unit time in a generation.

\[ \text{Net reproductive rate (} R_0) = \frac{\lambda}{\delta}, \text{intrinsic rate of increase (} r_m), \text{finite rate of increase (} \lambda), \text{intrinsic birth rate (} b), \text{intrinsic death rate (} d), \text{doubling time (} DT) \text{ and mean generation time (} T) \text{ were calculated using the formulae shown in Table 2.} \]

**Results and Discussion**

The survival and fecundity rate are two important parameters which contribute towards population increase. Keeping this in view fertility tables of *O. bifilarus* were prepared after feeding their progeny on *Corcyra* eggs and *T. palmi*. 
In experimentally maintained pairs of *O. bifilarus* on *Corcyra* eggs and *T. palmi*, mating was often observed one day after adult emergence. When fed on *Corcyra* eggs, the pre-oviposition, oviposition and post-oviposition periods were 4.3 + 0.78, 14.2 + 4.56 and 1.4 + 1.56 days, while on thrips as prey, these were 4.3 + 0.70, 16.4 + 7.12 and 2.0 + 2.00 days, respectively (Table 3). There was a non-significant difference on these attributes of reproduction between two tested prey.

The eggs were often laid singly by inserting ovipositor into the bean pod tissue. The number of egg laid per female per day ranged from 0-6 on both hosts. The total eggs laid per female during its life span ranged from 20-65 (40.8) and 7-67 (42.1) and their survival was for 10-27 (19.8) and 13-35 (22.7) days on *Corcyra* eggs and *T. palmi*, respectively. The sex ratio was (female: male) 1: 1.3 (57% female).

The survival from egg stage till attaining the adult stage on eggs of *C. cephalonica* was 78 per cent and the bug started egg laying at the pivotal age of 24 days (Table 1). The last reproducing female survived up to 31 days. The female progeny deposited by a female (*m*) during its survival ranged from 0.06 to 2.22 and the maximum number of female progeny was produced on pivotal age of 32nd day (Fig. 1a). The mean female progeny per female over the entire reproduction period (gross reproductive rate) was 23.26. The net reproductive rate was 15.97 female eggs/female. This bug had an approximate generation time (*T*<sub>c</sub>) of 32.5 and the innate capacity of natural increase (*r*<sub>c</sub>) was 0.083. This arbitrary value of *r*<sub>m</sub> was used to determine the true intrinsic rate of increase (*r*<sub>m</sub>) graphically as 0.085. The finite rate of increase (*λ*) was 1.09, while the true generation time (*T*) and the time taken to double the population (DT) were 31.48 and 8.14 days, respectively. The gross fecundity of the bug was 42.1 eggs with gross fertility rate of 32.72 eggs and egg hatch of 78 per cent with net fertility of 26.85 eggs/female. The female on an average laid 1.48 eggs/day and amongst these fertile eggs were 1.15 (Table 3).

Average duration of three reproductive phases of *O. bifilarus*, viz. pre-oviposition, oviposition and post-oviposition period was 4.3, 14.2 and 1.4 days on *C. cephalonica* eggs.
and 4.1, 16.4 and 2.1 days on T. palmi, the difference being non-significant. However, for O. insidiosus, a much worked out species, lepidopteran eggs (E. kuehniella) increased longevity (individuals fed on the eggs of Heliothis virescens lived 3 times longer than on thrips, Sericothrips variabilis: Kiman and Yeargan, 1985) 44 days (Richards and Schmidt, 1996) and only 9 days on A. gossypii (Bush et al., 1993), 5 times more than that on nymphs of A. gossypii and 4 times more than that on thrips Caliothrips phaseoli (Mendes et al., 2002), reduced the pre-oviposition period (half than that on thrips: Mendes et al., 2002) and increased the oviposition period (5 times longer than that on nymphs of A. gossypii (Mendes et al., 2002).

The fecundity of O. bifilarus reared on Corcyra eggs and T. palmi did not differ significantly and was 41 (20-65) and 42.3 eggs/female, respectively, though the female survival was slightly longer (22.7 days) on thrips as compared to Corcyra eggs (19.8 days) and hence Corcyra eggs can effectively be used for mass rearing of O. bifilarus. However, the fecundity of O. insidiosus was directly affected by the quality of their diet. According to Mendes et al., (2002) females fed on the eggs of E. kuehniella laid about nine times more eggs (195.3 ± 22.77 eggs) than those fed on A. gossypii (20.0 ± 5.50 eggs/female) and three times more eggs than those fed on Caliothrips phaseoli (70.0 ± 7.48 eggs/female).

High rates of egg laying by females fed on Lepidoptera eggs was also observed by Tommasini & Nicoli (1993), who reported that females fed on the eggs of E. kuehniella laid about 2.5 times more eggs than females that preyed on thrips Frankliniella occidentalis. Similarly Bush et al., (1993) found that females fed on the eggs of Heliothis virescens laid five times more eggs than those that consumed A. gossypii. The results obtained in this study with regard to the different types of prey pointed out the nutritional superiority of Lepidoptera eggs as the prey of choice for development and reproduction of O. insidiosus; similar conclusion was drawn by Eubanks and Denno (2000), who stated that lepidopteran eggs were prey of high quality for many generalist predators, while aphids were relatively of low nutritional quality. Ferkovich and Shapiro (2004) found improved rearing and oviposition rate of O. insidiosus on an artificial diet supplemented with cells from an embryonic line, IPLB-(Pie) of Plodia interpunctella (Hubner) with increase in concentration of cells added to the diet and later in 2005, recorded that eggs production significantly increased only in a fraction of protein separated from the cell line having isoelectric point of pH 5 and this fraction contained several Commassie blue-stained bands, but the exact nature of this fecundity factor was not known (Ferkovich and Shapiro, 2005).

Mean number of eggs laid per oviposition day by O. bifilarus reared on C. cephalonica eggs and thrips was 2.9 and 2.6, respectively. Blaeser et al., (2004) showed that mean number of eggs laid was significantly different among the three species of Orius; O. majuscles laid 0.8 eggs/day, while O. albidipennis and O. sauteri laid 1.1 and 2.2 eggs/day, respectively, when fed on F. occidentalis.

Fertility table summarizes the information on biological performance of a species. It takes into cognizance the survival value and fecundity rate for determining net reproductive rate ($R_o$) and innate capacity to increase ($r_c$). The latter is exploited to determine the intrinsic rate of the natural increase of the species ($r_m$) and true generation time ($T$). Intrinsic rate of natural increase ($r_m$) is a measure of biotic potential of the species.
Table 1 Life table and age-dependent reproduction of *Orius bifilarus* on *Corcyra cephalonica* eggs and on thrips \( x \)=age of female in days; \( lx \)=survival of female until \( x \); \( mx \)=number of female offspring produced at age \( x \); \( Mx \)=total number of offspring (=number of eggs) produced at age \( x \), \( hx \)=hatch rate of eggs

| (x) | (lx) | (mx) | (Mx) | (hx) | (lx) | (mx) | (Mx) | (hx) |
|-----|------|------|------|------|------|------|------|------|
| 0-5 | 0.90 | 0.00 | 0.00 | 0.00 | 0-5  | 0.87 | 0.00 | 0.00 |
| 6-23| 0.78 | 0.00 | 0.00 | 0.00 | 6-23 | 0.76 | 0.00 | 0.00 |
| 24  | 0.78 | 0.19 | 0.25 | 0.31 | 0.76 | 0.23 | 1.25 | 2.24 |
| 25  | 0.78 | 0.74 | 1.34 | 0.92 | 0.78 | 0.75 | 0.51 | 0.97 |
| 26  | 0.78 | 1.08 | 1.97 | 0.94 | 0.78 | 0.76 | 0.51 | 0.97 |
| 27  | 0.78 | 1.25 | 2.26 | 0.95 | 0.78 | 0.76 | 1.26 | 2.24 |
| 28  | 0.78 | 1.54 | 2.72 | 0.85 | 0.78 | 0.76 | 1.99 | 3.50 |
| 29  | 0.78 | 1.77 | 3.09 | 0.78 | 0.78 | 0.76 | 1.99 | 3.50 |
| 30  | 0.78 | 1.94 | 3.45 | 0.80 | 0.78 | 0.76 | 2.22 | 3.90 |
| 31  | 0.78 | 1.88 | 3.30 | 0.74 | 0.78 | 0.68 | 1.82 | 3.20 |
| 32  | 0.78 | 2.22 | 3.90 | 0.72 | 0.78 | 0.68 | 1.71 | 3.07 |
| 33  | 0.78 | 1.82 | 3.20 | 0.80 | 0.78 | 0.61 | 1.48 | 2.60 |
| 34  | 0.78 | 1.71 | 3.06 | 0.86 | 0.78 | 0.54 | 1.42 | 2.50 |
| 35  | 0.78 | 1.31 | 2.30 | 0.82 | 0.78 | 0.55 | 1.19 | 2.10 |
| 36  | 0.55 | 1.08 | 1.90 | 0.83 | 0.55 | 0.49 | 1.08 | 1.90 |
| 37  | 0.39 | 0.91 | 1.60 | 0.83 | 0.39 | 0.44 | 0.91 | 1.60 |
| 38  | 0.39 | 0.97 | 1.80 | 0.85 | 0.39 | 0.44 | 0.97 | 1.70 |
| 39  | 0.39 | 0.80 | 1.40 | 0.80 | 0.39 | 0.53 | 0.68 | 1.20 |
| 40  | 0.39 | 0.74 | 1.30 | 0.72 | 0.39 | 0.53 | 0.74 | 1.30 |
| 41  | 0.39 | 0.46 | 0.80 | 0.77 | 0.39 | 0.46 | 0.63 | 1.10 |
| 42  | 0.39 | 0.23 | 0.40 | 0.93 | 0.39 | 0.46 | 0.57 | 1.00 |
| 43  | 0.23 | 0.11 | 0.20 | 1.00 | 0.23 | 0.30 | 0.29 | 0.50 |
| 44  | 0.23 | 0.17 | 0.30 | 0.83 | 0.23 | 0.30 | 0.39 | 0.70 |
| 45  | 0.23 | 0.17 | 0.30 | 0.55 | 0.23 | 0.30 | 0.23 | 0.40 |
| 46  | 0.23 | 0.06 | 0.10 | 0.58 | 0.23 | 0.23 | 0.17 | 0.30 |
| 47  | 0.16 | 0.00 | 0.10 | 0.10 | 0.16 | 0.15 | 0.29 | 0.50 |
| 48  | 0.16 | 0.06 | 0.10 | 0.00 | 0.16 | 0.15 | 0.23 | 0.40 |
| 49  | 0.08 | 0.00 | 0.10 | 0.00 | 0.08 | 0.15 | 0.06 | 0.10 |
| 50  | 0.08 | 0.00 | 0.00 | 0.00 | 0.08 | 0.15 | 0.11 | 0.20 |
| 51  | 0.08 | 0.00 | 0.00 | 0.00 | 0.08 | 0.15 | 0.06 | 0.10 |
| 52  | 0.08 | 0.00 | 0.00 | 0.00 | 0.08 | 0.15 | 0.00 | 0.00 |
| 53  | 0.08 | 0.00 | 0.00 | 0.00 | 0.08 | 0.08 | 0.00 | 0.00 |
| 54  | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.00 | 0.00 |

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Table.2 Description, formula, symbol, values and units for population parameters of Orius bifilarus on two different hosts

| Parameter: Formula | Corcyra cephalonica eggs | Thrips spp. |
|--------------------|--------------------------|-------------|
| Gross reproductive rate: ($\sum (m_x)$) | = 23.26 | 24.0 |
| Net Reproductive rate (female egg/female) ($R_o$):($\sum (l_xm_x)$) | = 15.97 | 14.62 |
| Approximate Generation Time ($T_c$): ($\sum (x_lx_m)$)/$R_o$ | = 32.09 | 32.50 |
| The Innate Capacity for increase ($r_c$): ($\log R_o/T_c$) | = 0.086 | 0.083 |
| Intrinsic rate of natural increase (daughter/female/day) ($r_m$) | = 0.088 | 0.085 |
| True Generation Time ($T$): ($\log R_o/r_m$) | = 31.38 | 31.48 |
| Finite rate of increase ($\lambda$): (Antilog $r_m$) | = 1.09 | 1.09 |
| Doubling Time (DT): ($\log 2/r_m$) | = 7.85 | 8.14 |
| Weekly multiplication rate: ($e^{7r_m}$) | = 1.85 | 1.82 |
| Intrinsic Birth rate ($b$): ($\sum e^{-r_tx+0.5}$Lx) | = 0.81 | 0.84 |
| Intrinsic Death Rate ($d$): ($b-r_m$) | = 0.72 | 0.75 |
| Gross fecundity: ($\sum (M_x)$) | = 40.80 | 42.1 |
| Gross fertility rate: ($h_xM_x$) | = 33.25 | 32.72 |
| Gross hatch rate: ($\sum h_xM_x/\sum M_x$) | = 0.815 | 0.78 |
| Net fertility rate: ($\sum L_xh_xM_x$) | = 29.79 | 26.85 |
| Eggs /female /day: ($\sum L_xh_xM_x/\sum L_xh_x$) | = 1.65 | 1.48 |
| Fertile eggs/ female/day: ($\sum L_xh_xM_x/\sum L_xh_x$) | = 1.35 | 1.15 |
| Mean age gross fecundity (days): ($\sum M_x/\sum L_xh_x$) | = 32.52 | 33.40 |
| Mean age gross fertility (days): ($\sum xh_xM_x/\sum h_xM_x$) | = 32.32 | 33.40 |
| Mean age net fecundity: ($\sum xL_xh_xM_x/\sum L_xh_xM_x$) | = 31.65 | 32.12 |
| Mean age net fertility: ($\sum xL_xh_xM_x/\sum L_xh_xM_x$) | = 31.50 | 32.16 |
| Mean age hatch: ($\sum xh_x/\sum h_x$) | = 35.86 | 37.00 |

Table.3 Reproductive phases of Orius bifilarus on two hosts

| Reproductive phases | Corecyra eggs | Thrips |
|---------------------|--------------|--------|
|                     | Mean ± SD    | Range  | Mean ± SD    | Range  |
| Pre oviposition period (days) | 4.3 ± 0.78  | 3-6    | 4.1 ± 0.70  | 3-5    |
| Oviposition period (days)       | 14.2 ± 4.56 | 7-24   | 16.4 ± 7.12 | 4-28   |
| Post oviposition period (days)  | 1.4 ± 1.56  | 0-5    | 2.0 ± 2.00  | 0-7    |
| Adult survival (days)           | 19.8 ± 6.34 | 10-27  | 22.7 ± 6.56 | 13-35  |
Fig. 1. Reproduction and survival curves of *Orius bifilarus* on eggs of *C. cephalonica* (a) and *Thrips* spp. (b) lx=survival of females until age x; mx=number of female offspring produced at age x; and Mx total number of offspring (number of eggs) produced at age x (days).
Its calculation is based on innate capacity to increase ($r_c$) and the later is determined by dividing net reproductive rate on natural log scale with the approximate generation time. The intrinsic rate of increase is a basic parameter which an ecologist may wish to establish for an insect population. Birch (1948) defined the intrinsic rate of increase as the rate of increase per head under specified physical conditions, in an unlimited environment where the effect of increases in density do not need to be considered. Lewontin (1965) indicated that studies on the effect of changing various aspects of the life cycle on the intrinsic rate of increase of a species were important. He considered even the effect of small changes in such life cycle phenomena as fecundity, longevity, length of developmental period etc., on the rate of increase. Jervis and Copland (1996) reviewed the use of life table analysis both by ecologists and by biological control workers. They indicated that, in a biological control programme, when faced with a choice of candidate parasitoid species, in the absence of other criteria the selection would be for the species with the greatest value for the intrinsic rate of natural increase. The advantage of using the intrinsic rate of increase is that it integrates the effects of mortality and fertility factors into a single value. Species having high $r_m$ values usually have high net reproductive rate and $\lambda$ or lesser generation time. Thus, instead of comparing several life history characteristics (i.e. development rate, longevity, fertility, mortality, sex ratio) among the population, a single comparison can be applied (Havelka and Zemek, 1999). The intrinsic rate of increase can also be used to estimate the effect of mortality of each stage on the population growth rate, and this can subsequently be used to optimize mass rearing. Antilog of $r_m$ is known as finite rate of increase, which depicts the number of times the population increases per unit time in a generation.

The net reproductive rate which is the measure of number of females produced per female in each generation, was almost same on thrips (collected from beans and cucurbits) and C. cephalonica eggs (14.62 and 15.97 female progeny/female, respectively) for O. bifilarus

On the basis of literature, Sabelis and Van Rijn (1997) stated that the $r_m$ value for O. niger was the lowest among all Orius species studied using E. kuehniella as food source, while Tommasini et al., (2004) even found a negative value (-0.003). However, Baniameri et al., (2005) obtained high $r_m$ for this species reared at 26, 29 and 32 °C (0.113, 0.127 and 0.157 daughters/female/day, respectively) on E. kuehniella eggs. The value of $r_m$ for O. bifilarus was 0.0883 and 0.0875 female progeny/female/day on Corcyra eggs and thrips, respectively, and the finite rate of increase ($\lambda$) as 1.092 and1.089. The $r_m$ value for A. dividens and B. pallescens was 0.069 and 0.0787 female progeny/female/day on Corcyra eggs.

The value of fertility parameters may vary from species to species and within species when fed upon different hosts and even when reared in different environmental conditions. Tommasini et al., (2004) worked out the life table of four Orius species, viz. O. insidiousus, O. laevigatus, O. majuscles and O. niger on eggs of E. kuehniella and thrips F. occidentalis at 26°C and found $r_m$ value to be 0.101, 0.068, 0.080 and -0.003 on E. kuehniella and 0.116, 0.94, 0.097 and 0.035 on F. occidentalis, respectively, for these species and concluded that F. occidentalis was the best for multiplication of first three species. Kakimoto et al., (2004) found that on the eggs of E. kuehniella at 17, 20, 23 and 26°C, the mean generation time of three species was nearly the same at all the temperatures but the net reproductive rate of
O. minutus was higher than that of other two species, i.e. O. strigicollis and O. sauterii, and that of O. strigicollis was the highest among the three species at 29°C. Although the intrinsic rate of natural increase did not differ among the three species, the rate for O. strigicollis was far higher than that for other two species at 29°C, thus interspecific differences in the reproductive potential of 3 species tend to become larger as the temperature increases, and O. strigicollis was advantageous over a wider temperature range than the other two species. According to Cocuzza et al., (1997), the rm value increased with temperature (0.121 at 25° and 0.202 at 35°C), whereas for O. laevigatus it peaked at 25°C (0.0105) but decreased at 35°C. Kemasa et al., (2008) made biological study on Orius minutus (L.) on Thrips spp., egg of C. cephalonica and Tetranychus spp. and concluded that egg of C. cephalonica followed by Thrips spp. suited for mass-rearing process of Orius sp. as the capacity for increase (r_c and 0.365 and 0.086 and the finite rate of increase (λ) = 1.44 and 1.0898 and the cohort generation time (T_c)= 13.4386 and 16.7598 days when fed with Thrips spp. and C. cephalonica eggs, respectively. From these statistics, it can be concluded that performance of different Orius spp. is affected by environmental conditions.

In conclusion, results of the present study suggest that the predatory bug O. bifilarus can easily be reared on fictitious diet of C. cephalonica eggs. There is no significant difference between life table parameters when reared on fictitious host and natural host and is therefore a possible candidate for mass releases for biological control of various thrips species. Because of its adaptation to varying climates in its area of origin, it is hoped that the present study can elucidate some of the factors responsible for efficacy of O. bifilarus to control different soft bodied insect pests on greenhouse plants in India.

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