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# Polymorphic adaptation in biology and life-table studies of *Rhynocoris marginatus* (Fabricius) on *Earias vittella* (Fabricius)

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**ABSTRACT:** Life tables of three morphs of *Rhynocoris marginatus* (Fabricius) (*niger*, *nigrosanguineous* and *sanguineous*) on the spotted bollworm *Earias vittella* (Fabricius) were constructed in the laboratory. Maximum fecundity and longevity were observed in *niger* morph followed by *nigrosanguineous* and *sanguineous* morphs. The intrinsic rates of natural increase were 0.034, 0.028 and 0.026 per female per day for *niger*, *nigrosanguineous* and *sanguineous* morphs, respectively. The population multiplication of the *niger* morph was comparatively higher than that of *nigrosanguineous* and *sanguineous* morphs in the cohort generation time. The life expectancy ($e_x$) of newly laid eggs decreased with increasing age in all the morphs.

**KEY WORDS:** Development, life tables, morphs, *Rhynocoris marginatus*

Reduviidae is the largest family of predaceous land Heteroptera with considerable potential to act as biological control agents. *Rhynocoris marginatus* (Fabricius) is a reduviid predominantly found in agroecosystems, scrub jungles and semiarid zones bordering agroecosystems and voraciously predates on various economically important insect pests such as *Helicoverpa armigera* (Hübner), *Pectinophora gossypiella* (Saunders), *Achaea janata* (Linnaeus), *Spodoptera litura* (Fabricius), and *Corcyra cephalonica* Stainton (Ambrose, 1996,1999). It exists in three different morphs *viz*., i. with black connexivum (*niger*), ii. with red connexivum (*sanguineous*) and iii. with black and red-banded connexivum (*nigrosanguineous*) (Ambrose and Livingstone, 1988). Much progress has been made to understand the action of natural enemies through life-table analysis (Bellows *et al*., 1992). However, life-table studies on predatory insects are scanty except the works of Jones *et al*. (1988), Singh and Singh (1994), Kumar and Velusamy (1995), Sharma and Bhalla (1995), Gupta and Singh (1996), Venkatesan *et al*. (1997), and George *et al*. (1998). There was no account on the adaptation gained by polymorphism on biology and reproductive potential. Hence, the present study was undertaken to find out whether there is any variation among these three morphs of *R. marginatus* in the biology through life-table studies on *Earias vittella*, which is essential to conserve and augment the better-adapted morph for subsequent utilization in the Insect Pest Management Programme.

## MATERIALS AND METHODS

Adult and nymphal instars of all the three morphs of *R. marginatus* were collected from Sivanthipatti agroecosystem in Tirunelveli district, Tamil Nadu (altitude 125.33 ± 2.87m; latitude 77° 21E and 8° 31N). They were reared in the laboratory (temperature 30±2°C, humidity 80-85 %; photoperiod 11-13h) separately in plastic containers (8 x 6 x 4cm) on the larvae of *Earias vittella* and thus different morphic stocks were maintained. A cohort consisting of 100 eggs from each morph was used to construct life tables. Eggs were collected and allowed to hatch in small plastic containers with moistened cotton swabs for maintaining optimum humidity (85%). The cotton swabs were changed periodically to prevent fungal attack. After hatching, all the nymphs were reared individually in plastic containers and larvae of *E. vittella* were provided as prey. Observations were made on hatching, completion of nymphal development, successful adult emergence, fecundity and age specific mortality in respective stages. After adult emergence life-table was constructed separately for the different morphs. The life-tables were constructed by determining and recording the each age interval, the survival rate ($l_x$) and the mean number of female progeny per female ($m_x$) still alive at such age interval. The intrinsic rates of increase of population in different morphs were calculated. The studies were made using Birch's (1948) formula elaborated by Watson (1964), Laughlin (1965) and Southwood (1978).

In life table statistics the intrinsic rate of increase was determined by using the equation $\Sigma e^{r_m x} l_x m_x = 1$

Where 'e' is the base of natural logarithm, 'x' is the age of the individual in days, $l_x$ is the number of individuals alive at age 'x' as the proportion of 1, and '$m_x$' is the number of female offspring produced per female in the age interval 'x'. The sum of products '$l_x m_x$' is the net reproductive rate ($R_0$). The rate of multiplication of population for each generation was measured in terms of females produced per generation. The precise value of cohort generation was calculated as follows.

$$T_c = \frac{\Sigma l_x m_x}{R_0}$$

The arbitrary value of innate capacity for increase '$r_c$' was calculated from the equation

$$r_c = \frac{\log_e R_0}{T_c}$$

This is an appropriate '$r_m$' value. The values of negative exponent of $e^{-r_m x}$ ascertained from this experiment often lay outside the range. For this reason both sides of the equation were multiplied by a factor of $\Sigma e^{7-r_m x} l_x m_x = 1096.6$ (Birch, 1948; Watson, 1964). The two values of $\Sigma e^{7-r_m x} l_x m_x$ were then plotted on the horizontal axis against their respective arbitrary '$r_m$' on the vertical axis. Two points were then joined to give a line, which was intersected by a vertical line drawn from the desired value of $\Sigma e^{7-r_m x} l_x m_x$ (1096.6).

The point of intersection gives the value of '$r_m$' accurate to three decimal places. The precise generation time (T) was then calculated from equation

$$T = \frac{\log_e R_0}{r_m}$$

The finite rate of increase ($\lambda$) was calculated as $e^{r_m}$. This $\lambda$ represents the number of individuals added to the population per female per day (Siddiqui, 1973). The weekly multiplication of predator population was calculated as $(e^{r_m})^7$. The doubling time was calculated as $\log_2/\log \lambda$. Age (x) and age specific survival ($l_x$) values were further used to develop the life expectancy tables by using the method of Deevy (1947).

## RESULTS AND DISCUSSION

The egg incubation period of *R. marginatus* lasted for 8.35 ± 0.49 to 10.05 ± 0.53 days. The shortest nymphal period of the predator was recorded in *niger* morph (99.94 ± 2.62 days) followed by *nigrosanguineous* (102.13±1.77 days) and *sanguineous* morphs (105.14 ± 1.75 days). Similarly the pre-oviposition period was also minimum in *niger* morph (25.95±3.76 days) followed by *nigrosanguineous* (29.43 ± 3.89 days) and *sanguineous* morphs (32.43 ± 3.32 days). But

Table 1. Biology of the three morphs of *R. marginatus* on *E. vittella*

| Parameter | Morph | | |
|---|---|---|---|
| | *Niger* | *Nigrosanguineous* | *Sanguineous* |
| Incubation period | 10.05 ± 0.53[b] | 8.35 ± 0.49[a] | 9.60 ± 0.82[ab] |
| Total developmental period | 99.94 ± 2.62[b] | 102.10 ± 1.77[a] | 105.14 ± 1.75[b] |
| Longevity | 70.25 ± 13.44[a] | 61.73 ± 15.06[b] | 52.07 ± 9.14[c] |
| Pre-oviposition period | 25.95 ± 3.76[a] | 29.43 ± 3.89[b] | 32.43 ± 9.14[c] |
| Fecundity | 142.20 ± 20.81[a] | 141.50 ± 17.09[a] | 122.13 ± 16.68[b] |

Values followed by similar superscripts "across a row" are not statistically different at $p<0.05$.

on the contrary the longevity and fecundity of *niger* morph were maximum followed by *nigrosanguineous* and *sanguineous* morphs (Table 1)

The life table characteristics of each morph are given in Table 2. Perusal of the results indicated that the multiplication per generation (net reproductive rate) was higher in the case of the *niger* morph (46.50) when compared with that of *nigrosanguineous* (41.50) and *sanguineous* morphs (37.55), which indicated that niger morph had the capacity to multiply faster in a generation. The values of innate capacity for increase ($r_m$) of the three morphs also revealed that the *niger* morph would multiply at a faster rate (0.039) than the *nigrosanguineous* (0.034) and *sanguineous* morphs (0.031). The intrinsic rate of natural increase ($r_c$) and the finite rate of increase ($\lambda$) were determined as 0.034 and 1.040, 0.028 and 1.035 and 0.026 and 1.030 females/ female/day, respectively in niger, *nigrosanguineous* and *sanguineous* morphs. However, these rates of increase were attainable only under favourable conditions and also by the sufficient supply of prey larvae *E. vittella*. At this rate, the population of *R. marginatus* are capable of multiplying 1.314, 1.269 and 1.242 times per week and 1.5 x $10^6$, 2.4 x $10^5$ and 8.2 x $10^4$ times per annum, respectively, under specified environmental conditions provided to the insect. Time required to double the population was calculated as 17.71, 20.20 and 23.52 days, respectively for *niger*, *nigrosanguineous* and *sanguineous* morphs (Table 2). The life expectancy of newly laid eggs was calculated as 7.1, 6.7 and 5.8 days for *niger*, *nigrosanguineous* and *sanguineous* morphs, respectively which gradually decreased with increase in the age. Similar, decreased life expectancy with increase of age was observed by Kumar and Goel (1996).

The variation in the life table statistics exhibited by the morphs of *R. marginatus* revealed the intraspecific variations of an ecotype. Mayr (1963) briefly defined polymorphism as variability within a population. Ford (1937) explained polymorphism as the " occurrence together in the same habitat in the same species in such a proportion that the rare of them can't be maintained by recurrent mutation". Breeding experiments between morphs of a particular ecotype by Ambrose and Livingstone (1988) revealed that such intraspecific variations were not strictly genetic. They further reported that the level of population of different morphs both in the field and in laboratory suggested that the segregation phenomenon did not occur in the Mendelian fashion. However, the adaptive significance of a particular morph in a given ecosystem cannot be ruled out as evidenced by niger with its higher insecticide resistance (George and Ambrose, 1996). The present study established the variation in the life table characteristics of different morphs of *R. marginatus* and suggested that the effective niger morph could be selected for the biocontrol

Table 2. Life table statistics of three morphs of *R. marginatus* on *E. vittella*

| Parameter | Morph | | |
|---|---|---|---|
| | *Niger* | *Nigrosanguineous* | *Sanguineous* |
| Gross reproductive rate | 71.000 | 70.000 | 60.000 |
| Net reproductive rate ($R_0$) | 46.500 | 41.500 | 37.550 |
| Mean length of generation ($T_c$) | 107.520 | 126.930 | 134.100 |
| Estimated value of intrinsic rate Of increase in numbers ($r_c$) | 0.034 | 0.028 | 0.026 |
| Corrected $r_m$ | 0.039 | 0.034 | 0.031 |
| True generation time (T) | 95.530 | 106.640 | 112.930 |
| Finite rate of increase ($\lambda$) | 1.040 | 1.035 | 1.030 |
| Doubling time | 17.710 | 20.200 | 23.520 |
| Rate of weekly multiplication of the population | 1.314 | 1.269 | 1.240 |
| Annual rate of increase | $1.5 \times 10^6$ | $2.4 \times 10^5$ | $8.2 \times 10^4$ |
| Hypothetical female in $F_2$ Generation $(R_0)^2$ | 2162.25 | 1722.25 | 1410.00 |

programme. Anyhow, further investigations are required to understand this phenomenon of polymorphism better.

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