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EFFECT OF PREY DENSITY ON REPRODUCTION, PREY CONSUMPTION AND SEX-RATIO OF AMBLYSEIUS BARKERI (ACARI: PHYTOSEIIDAE)

BY F. M. MOMEN *

ABSTRACT: The oviposition and prey consumption rates of Amblyseius barkeri (Hughes) depend on the number of prey available. The number of eggs laid by the predator female, and the consumption of Tetranychus urticae Koch as prey, increased with increasing prey density to maximum of 1.96 eggs deposited and 20.96 devoured protonymphs per day at a prey density of 40 protonymphs. The total number of reproductive days also increased, but then declined at the highest level of prey density. As the level of prey density was increased, there was a shift in sex ratio towards an increased proportion of females.

INTRODUCTION

Phytoseiid mites have been studied in considerable detail because of their importance as predators of phytophagous mite pests (cf. Helle and Sabelis 1985). The predatory mite Amblyseius barkeri (Hughes) is an important control agent for thrips, Thrips tabaci Lindeman, tetranychid and eriophyid mites, Tetranychus urticae Koch and Eriophyes dioscoridies Soliman and Abou-Awad (Hansen 1988; Bonde 1989; Hoy and Glenister 1991; Momen 1995). The change in the number of prey eaten by each predator in response to a change in prey density is the functional response (Solomon, 1949). The numerical response of phytoseiid mites to prey density has not been studied extensively. A number of authors (Chant 1961, McMurtry and Scriven 1966; Sandness and McMurtry 1970; Laing and Osborn 1974; Takafuji and Chant 1976; Fries and Gilstrap 1982; Badi and McMurtry 1988; Reda and Momen 1993) reported an increase in the rate of oviposition, up to a maximum level, as prey density increased. Chant (1961) stated that the fecundity of predacious phytoseiid mites is considerably influenced by their very recent nutritional history at the time of oviposition. Momen (1993, 1994) reported some factors affecting reproduction and sex ratio of Amblyseius barkeri. This report is the third to deal with the influence of prey density on reproduction, prey consumption and sex ratio during the adult stage of A. barkeri in the laboratory.

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MATERIALS AND METHODS

Laboratory stock cultures: Stock cultures of *Tetranychus urticae* were collected from infested potato leaves in the laboratory at N. R. C. Cairo. Phytoseiid stock cultures were initiated from a supply provided in July of 1992 by Lundqvist of the University of Lund, Sweden.

Experimental procedures:

Leaf discs of mulberry (*Morus alba*), 2 cm in diameter were used as rearing arenas. The discs were placed in petri dishes, upper surface downwards on water-saturated cotton. Newly moulted, unfed and mated adult females of the same age were transferred singly to the rearing discs and exposed to six different prey densities ranging from 1 to 40 protonymphs of *T. urticae*. The number of individual prey killed/female and the daily fecundity of the female predator were recorded every 24 hours. All the dead prey were removed and replaced with one of 6 levels of prey availability: 1, 3, 5, 10, 20, 40 protonymphs of *T. urticae*, and were restocked daily for the completed ovipositional period. The experiments were conducted under laboratory conditions at 27 ± 1°C and 70-80% R. H.

RESULTS AND DISCUSSION

As the density of the protonymphs increased (up to 40/disc) there was an increase in total fecundity, daily fecundity, and number of prey killed during the ovipositional period (Tables 1, 2). The data indicate that, in this experiment, the number of prey eaten by the predator was a function of the number of prey provided; and that the number of eggs laid per day was a function of the number of prey eaten, up to the maximum prey density.

Sabelis and Van de Vrie (1979) found almost no numerical response of *Amblyseius potentillae* (Garman) to increasing densities of *T. urticae* on roses. They attributed this to the prey web which interfered with searching success of the predator and resulted in their avoiding the webbed parts on the plant. McMurry et al. (1970) state that the mean number of eggs laid per day was a function of the number of prey provided; and that the number of eggs per day of ovipositional period for *A. barkeri* at standard laboratory conditions.

### Table 1: Influence of several levels of prey *Tetranychus urticae* (Protonymphs) availability on: sex ratio; number of eggs oviposited per ovipositional period; number of reproductive days; and number of eggs per day of ovipositional period for *A. barkeri* at standard laboratory conditions.

<table>
<thead>
<tr>
<th>Number prey provided daily</th>
<th>Female proportion (%)</th>
<th>Number of eggs oviposited (± S.E.)</th>
<th>Number of reproductive days (± S.E.)</th>
<th>Eggs per day ± S.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2 Sex ratio</td>
<td>10 day Total</td>
<td>5 day Total</td>
</tr>
<tr>
<td>1</td>
<td>4.82 ± 0.47</td>
<td>17.14 ± 0.96</td>
<td>0.25 ± 0.02</td>
<td>0.71 ± 1</td>
</tr>
<tr>
<td>3</td>
<td>13.00 ± 0.98</td>
<td>21.15 ± 1.14</td>
<td>0.63 ± 0.05</td>
<td>0.62 ± 1</td>
</tr>
<tr>
<td>5</td>
<td>17.92 ± 0.54</td>
<td>23.54 ± 1.72</td>
<td>0.82 ± 0.07</td>
<td>0.90 ± 1</td>
</tr>
<tr>
<td>10</td>
<td>31.46 ± 1.50</td>
<td>27.46 ± 1.69</td>
<td>1.18 ± 0.06</td>
<td>1.22 ± 1</td>
</tr>
<tr>
<td>20</td>
<td>40.38 ± 0.59</td>
<td>27.00 ± 1.28</td>
<td>1.53 ± 0.06</td>
<td>1.62 ± 1</td>
</tr>
<tr>
<td>40</td>
<td>50.67 ± 0.54</td>
<td>25.83 ± 0.27</td>
<td>1.96 ± 0.03</td>
<td>1.92 ± 1</td>
</tr>
</tbody>
</table>

### Table 2: Influence of several levels of prey *Tetranychus urticae* protonymphs) availability on the total and daily number of prey killed by females of *A. barkeri* at standard laboratory conditions.

<table>
<thead>
<tr>
<th>Number prey provided daily</th>
<th>Daily Total</th>
<th>Per predator egg produced</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Daily</td>
<td>Total</td>
</tr>
<tr>
<td>1</td>
<td>0.97 ± 0.00</td>
<td>16.71 ± 0.96</td>
</tr>
<tr>
<td>3</td>
<td>2.59 ± 0.04</td>
<td>55.08 ± 3.17</td>
</tr>
<tr>
<td>5</td>
<td>3.67 ± 0.09</td>
<td>85.92 ± 6.03</td>
</tr>
<tr>
<td>10</td>
<td>6.04 ± 0.29</td>
<td>164.31 ± 11.40</td>
</tr>
<tr>
<td>20</td>
<td>10.65 ± 0.43</td>
<td>284.61 ± 12.91</td>
</tr>
<tr>
<td>40</td>
<td>20.96 ± 0.43</td>
<td>541.00 ± 10.60</td>
</tr>
</tbody>
</table>

14 females tested at 1, 3, 5, 10, 20 and 40 prey provision levels.

**Summary:**

- As the density of the protonymphs increased, the total and daily number of eggs oviposited increased.
- The number of reproductive days also increased as the density of prey increased.
- The number of eggs per day of ovipositional period decreased at the highest densities.
- The sex ratio of the females tended to vary with the level of prey availability.
- The number of eggs per female per day varied considerably, depending on the species and testing conditions.

The number of reproductive days increased as the level of prey density increased, but at the highest density of prey the trend apparently reversed and the ovipositional period decreased (Table 1). Momen (1993) reported a significantly longer ovipositional period in *A. barkeri* in the case of multiple mating. Furthermore, a significantly shorter ovipositional period was recorded for females of *A. barkeri* at standard laboratory conditions.
A. barkeri when exposed to different food deprivation programmes (Mommen 1994).

The number of prey killed per predator egg produced increased as the prey density was increased (Table 2). Ball (1980) reported ratios of 3.2 to 40.2 prey eggs eaten per predator egg laid in a study of four phytoseiid predators at two constant temperatures, while Frise and Gilstrap (1982) reported 1.5 to 12.1 prey eggs eaten per predator egg laid in a study of three phytoseiid predators. Sabelis (1981) reported that model estimations of biomass conversion suggest that 60-70% of the ingested prey is utilized in predator egg production.

The sex ratio of the progeny of females increased in favor of females as the level of prey density (and predator fecundity) increased (Table 1). Frise and Gilstrap (1982) stated that a shift to a high ratio of females at higher prey density would cause an increased numerical response, and thus enhance a predator's capacity for prey population regulation.

Much more information is needed on the effects of higher densities in all categories tested above in A. barkeri. The results of this and other studies on A. barkeri suggest that it has excellent potential as a bio-control agent for tetranychid mites in agricultural systems.

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