PREDATOR-PREY INTERACTIONS
BETWEEN TYPHLODROMALUS PEREGRINUS
AND POLYPHAGOTARSONEMUS LATUS: EFFECTS
OF ALTERNATIVE PREY AND OTHER FOOD RESOURCES

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ABSTRACT

Studies on predation and feeding habits of Typhlodromalus peregrinus (Muma) were
conducted in the laboratory and greenhouse. Throughout the study, the broad mite,
Polyphagotarsonemus latus (Banks), the citrus rust mite, Phyllocoptura oleivora
(Ashmead), commercial bee pollen and pollen from Schinus terebinthifolius, Parthenium
hysterophorus and Bidens bipinata were used as predator food.
Typhlodromalus peregrinus consumed P. latus eggs, immatures and adults. T. peregrinus
consumed 23-75% of the prey population in 6 days. T. peregrinus did not reject
P. oleivora as prey, but favored P. latus when the latter was present. T. peregrinus
developed on bee pollen, bee pollen and P. latus, and on S. terebinthifolius pollen.

RESUMEN

Se realizaron estudios de los habitos alimenticios y predacion de Typhlodromalus
peregrinus (Muma) en el laboratorio y en el invernadero. Se suministro como alimentos
e el acaro blanco Polyphagotarsonemus latus Banks, el acaro tostador de los citricos
Phyllocoptura oleivora (Ashmead), polen de abejas, polen de Schinus terebinthifolius,
de Parthenium hysterophorus, y de Bidens bipinata. El acaro predador T. peregrinus
consumio huevos, estados larvarios, y adultos de P. latus. T. peregrinus consumio el
23-75% de la presa en 6 dias. T. peregrinus prefirio P. latus como presa y no rechazo
P. oleivora como presa, pero cuando P. latus se encontro presente prefirio a este ultimo.
T. peregrinus se desarrolló en pollen de abejas, en una mezcla de pollen de abejas y P. latus, y en pollen de Schinus terebinthifolius.

The broad mite, Polyphagotarsonemus latus (Banks) is one of the major pests of limes in southern Florida (Wolfenbarger 1974, Campbell 1979). Broad mite (BM) is also a pest of ornamentals, row and fruit crops in tropical, subtropical and temperate areas (Jeppson et al. 1975). Several predaceous mites have been observed feeding on this pest in California (McMurtry et al. 1984, Badii & McMurtry 1984) and in Florida (Peña et al. 1988).

Typhlodromalus peregrinus (Muma) is the most common species of phytoseiid mites in lime groves in southern Florida (Peña et al. 1989). The effectiveness of this predator against different prey species was investigated by Muma (1971). He observed that T. peregrinus is a facultative predator able to feed on purple scale, Lepidosaphes beckii (Newman), Florida red scale, Chrysomphalus aonidum, (L.) sooty mold, and mites but had little impact on mite populations. Little is known about the food preferences of T. peregrinus in the lime ecosystem. The objectives of this study were to investigate the potential of T. peregrinus as a predator of P. latus; to determine if T. peregrinus fed on an alternative eriophyid prey species, Phytophthora oleivora (Ashmead); and finally, to determine if it utilizes pollen of three common plant species found near most lime groves, Schinus terebinthifolius, Spanish needles, Bidens bipinata and Parthenium hysterophorus.

MATERIALS AND METHODS

Experiment 1.

All experiments were performed in the laboratory at a temperature of 26±1°C and RH of 55%-65%. The T. peregrinus used in the test were reared in the insectary on bee pollen and broad mites following a similar procedure reported by McMurtry and Scriven (1975) for Amblyseius hihiisi (Chant).

In tests where broad mites or citrus rust mites (P. oleivora) were offered as prey, the predaceous mites were placed on young lime fruits ca. 3.5 cm in diameter. To confine the predator and prey to the stylar area (less than 19 cm²) the basal half of each fruit was ringed with a Tanglefoot barrier. The fruit was supported by a water-saturated plastic foam pad in an 80 ml plastic cup filled with distilled water. Adult and larval stages of broad mites were transferred by brushing them from infested fruits to the fruit arenas. To provide eggs as prey, female adults were confined to the fruit arenas and removed after oviposition 24 h later. After 2-4 days, when eggs, larvae or adults were present, one adult female T. peregrinus mite was placed on each of the fruits. Each treatment was replicated 10 times.

In tests where pollen was offered as food, the sources were ground commercial bee pollen, and locally collected pollen from S. terebinthifolius, P. hysterophorus and B. bipinata. Four to 10 predaceous female mites were placed in each of 10 experimental arenas as described by McMurtry and Scriven (1975). Pollen grains were spread with a fine camel’s hair brush over the arena. Fresh pollen was added daily. The number of predators was counted daily for 24 days.

Experiment 2.

To determine the efficacy of T. peregrinus as a predator of broad mites under greenhouse conditions, different predator-prey ratios were tested. First, pinto beans,
<table>
<thead>
<tr>
<th>Stage</th>
<th>N</th>
<th>1</th>
<th>17</th>
<th>24</th>
<th>48</th>
<th>72</th>
<th>96</th>
<th>hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egg</td>
<td>16</td>
<td>2.50 ± 1.23</td>
<td>10.80 ± 3.22</td>
<td>11.50 ± 3.22</td>
<td>13.80 ± 2.91</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Immatures</td>
<td>15</td>
<td>—</td>
<td>—</td>
<td>9.17 ± 2.62</td>
<td>11.50 ± 4.40</td>
<td>12.56 ± 3.21</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Adults</td>
<td>17</td>
<td>—</td>
<td>—</td>
<td>7.90 ± 1.07</td>
<td>11.96 ± 1.69</td>
<td>14.78 ± 2.56</td>
<td>15.05 ± 2.83</td>
<td>—</td>
</tr>
</tbody>
</table>
Phaseolus vulgaris L. were planted 1.5-2 cm deep and were infested with bean stock leaves containing only P. latus. The mites moved to plants in 2 days and the dried stock leaves were removed after 2-3 days. Plants were rated as having a low broad mite density (lower than 24 mites/trifoliate leaf) or high broad mite density (greater than 240 mites/trifoliate leaf).

RESULTS AND DISCUSSION

Experiment 1.

Typhlodromalus peregrinus attacked all stages of broad mites. There was no difference (P = 0.05) among the mean number of different stages eaten by T. peregrinus at 24, 48, and 72 h (Table 1). Only 14% of the initial egg population was eaten during the first hour. Feeding increased in the next 24 h. Sixty-one percent of the larval prey was eaten during the first 24 h and consumption increased up to 83% at 72 h. A similar feeding rate was observed when P. latus adults were exposed to T. peregrinus females. Forty-six percent of the adult prey was consumed during the first 24 h and feeding

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**Fig. 1.** Number of broad mites (RM) and rust mites (CRM) with and without T. peregrinus. 1A: broad mites (cross hatch) and rust mites (diagonal hatch) after exposure to T. peregrinus. 1B: Rust mites with (cross hatch) and without (open bar) T. peregrinus. 1C: control, broad mites (solid bar), rust mites (diagonal hatch).
<table>
<thead>
<tr>
<th>Source of Food</th>
<th>Females/Arena</th>
<th>Adults/day</th>
<th>% Survival</th>
<th>Juvenile/day</th>
<th>Eggs/day</th>
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<tbody>
<tr>
<td>Bee pollen</td>
<td>5-10</td>
<td>7.86 ± 2.13</td>
<td>100</td>
<td>4.98 ± 3.25</td>
<td>1.93 ± 1.31</td>
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<tr>
<td>Bee pollen + BM</td>
<td>10</td>
<td>13.0 ± 3.75</td>
<td>100</td>
<td>4.88 ± 2.97</td>
<td>1.33 ± 1.68</td>
</tr>
<tr>
<td>Schinus</td>
<td>4</td>
<td>3.1 ± 0.2</td>
<td>50</td>
<td>1.4 ± 0.03</td>
<td>—</td>
</tr>
<tr>
<td>Portulaca</td>
<td>4</td>
<td>1.9 ± 0.5</td>
<td>25</td>
<td>0.5 ± 0.01</td>
<td>—</td>
</tr>
<tr>
<td>Bidens</td>
<td>4</td>
<td>2.2 ± 0.75</td>
<td>25</td>
<td>0.0 ± 0.0</td>
<td>—</td>
</tr>
<tr>
<td>Broad mite density</td>
<td>Predator density</td>
<td>Number of broad mite surviving after</td>
<td></td>
<td>% Mortality</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>------------------</td>
<td>--------------------------------------</td>
<td>---</td>
<td>------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>1</td>
<td>2 days</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>1</td>
<td>23.5 a*</td>
<td>22.0 ab</td>
<td>16.25 abc</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>17.75 a</td>
<td>18.5 a</td>
<td>17.0 a</td>
<td>6.6</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>22.75 a</td>
<td>6.25 b</td>
<td>15.75 ab</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>25.5 a</td>
<td>14.5 a</td>
<td>8.75 b</td>
<td>8.0</td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td>28.5 a</td>
<td>26.5 a</td>
<td>26.25 a</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>1</td>
<td>311.37 a</td>
<td>209.25 b</td>
<td>82.37 c</td>
<td>73.0</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>252.37 a</td>
<td>196.62 a</td>
<td>104.25 b</td>
<td>58.0</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>204.37 a</td>
<td>137.25 g</td>
<td>73.13 c</td>
<td>64.0</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>272.62 a</td>
<td>136.75 b</td>
<td>78.62 bc</td>
<td>71.0</td>
</tr>
</tbody>
</table>

*Numbers in the same row followed by the same letter are not statistically significant (P < 0.05) by Duncan's Multiple Range Test.

**Percent mortality (Martignoni & Steinhaus), \( \gamma = \frac{P}{1 - c} \)

where \( \gamma \) = \# died treatment \( \div \) total, \( c \) = \# died control \( \div \) total
continued 96 h after initiation of the experiment. There was a significant linear relationship between predation and time during the first seven hours ($r^2 = 0.90$) (Predation rate = 18.77 /-$\overline{5}.47$ hours). In the absence of prey, most *T. peregrinus* females died in 1-6 days.

*Polyphagotarsonemus latus* appeared to be more suitable as prey than *P. oleivora* (Fig. 1A). When both species were present in an arena, the number of *P. latus* was maintained at a relatively lower level (5% level by Student's t-test). *T. peregrinus* only reduced *P. oleivora* density when *P. latus* was not present in the arena. When *P. oleivora* was the only prey species offered (Fig. 1C) there was a significant reduction (P < 0.05) 5% level by Student's t-test in its density 2 days after exposure. This may indicate that *T. peregrinus* may consume *P. oleivora* only when other preferred prey is scarce.

The number of *T. peregrinus* immatures and eggs produced/day increased over 24 days when 1 mg of bee pollen was supplied daily (Table 2). When broad mites were offered as prey and pollen was supplied, the number of eggs and immatures did not increase significantly 7-15 days after exposure (Table 2).

Pollen from *S. terebinthifolius* was the best for the predator allowing a better survival and a higher rate of egg laying than the other types of pollen (Table 2). The capability of *T. peregrinus* females to prolong their survival to 24 days on pollen would enable such predators to exist in the field when prey is lacking at unfavorable conditions. The present data confirms Muma's (1971) observations and suggest that the survival of *T. peregrinus* depends on the availability of both prey and alternative food.

**Experiment 2.**

Number of *P. latus* were significantly higher on the control plants than on *T. peregrinus* treated plants. Further, at highest host densities, *P. latus* were reduced in higher numbers (58-73%) than at lower host densities (6.6-8%) (Table 3). At lower host densities (n = 17 - 25) more *P. latus* were destroyed when the number of predators per plant was 8. At higher host densities (n = 204 - 311) numbers were destroyed whether at low or high predator densities. These differences between lowest and highest host densities could be the result of different factors. First, the availability of low prey density may force the predator to increase its searching activity, resulting in a reduction for the predator to capture more prey in a given period of time. Predators were not forced to stay on the leaf substrates, thus, their rates of dispersal may increase than when they are confined in fruit arenas. Whether high host density also increased more chances for the predators to capture broad mites is an open question. This data suggests that *T. peregrinus* is a general predator limited in its ability to regulate broad mite population.

**ACKNOWLEDGMENTS**

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**REFERENCES CITED**

FREQUENCY AND DISTRIBUTION OF POLGYNE FIRE ANTS (HYMENOPTERA: FORMICIDAE) IN FLORIDA

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ABSTRACT

In order to determine the frequency and distribution of polygyne and monogyne fire ants (Solenopsis invicta) in Florida, preselected sites were surveyed from Key West to Tallahassee. Polygyne colonies were found at 15% of infested sites—a frequency similar to other states in the southeastern United States, but much less than in Texas. Polygyne was most common in the region around Marion county, but smaller populations were also scattered across the state. The density of mounds at polygyne sites was more than twice that at monogyne sites (262 versus 115 mounds/ha), although mound diameters were about 20% smaller. Polygyne and monogyne queens averaged the same size (1.42 mm, head width), but monogyne queens were much heavier (24.3 mg versus 14.4 mg) due to their physogastric. As expected, workers in polygyne colonies were considerably smaller than those in monogyne colonies (0.28 mg versus 0.19 mg, dry fat-free).

RESUMEN

Para determinar la frecuencia y distribución de “hormigas bravas” (Solenopsis invicta) políginas y monóginas en Florida, se muestrearon sitios preseleccionados desde Key West hasta Tallahassee. Se encontraron colonias políginas en 15% de los lugares infestados, una frecuencia similar a la de otros estados en el sureste de los EE.UU., pero mucho menor que la frecuencia de Texas. Las hormigas políginas resultaron más comunes en el condado Marion pero también se encontraron pequeñas poblaciones espaciadas a lo largo del Estado. La densidad de los túmulos en lugares con polígina fue más del doble que en lugares con monógina (262 versus 115, túmulos/ha), a pesar de que el diámetro medio de los túmulos fue 20% menor. Las reinas políginas y monóginas fueron del mismo tamaño (1.42 mm, ancho de cabeza) pero debido a su fisogastria, las reinas