PREY STAGE PREFERENCE OF THE PREDATOR, TOXORRHYNCHITES RUTILUS RUTILUS ON AEDES AEGYPTI

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ABSTRACT. To determine if 4th-instar Toxorhynchites rutilus rutilus (Coquillett) preferentially consumes one stage of Aedes aegypti (L.), equal numbers of 1st-instar, 4th-instar, and pupae prey were placed in 3.78-liter con-
tainers with one 4th-instar predator. Predators ate significantly more 4th-instar prey than pupae or 1st instars; but they killed, without eating, significantly more pupae than 4th instars, with no 1st-instar killing observed.

Toxorhynchites rutilus rutilus (Coquillett) is a large nonbiting mosquito indigenous to Florida, Georgia, and coastal South Carolina (Carpenter and LaCasse 1955). It is predaceous during the larval stage, breeding in artificial and natural containers, and preying upon other container inhabitants. One such inhabitant is the yellow fever mosquito, Aedes aegypti (L.). Consequently, Tx. r. rutilus is being investigated as a possible biological control agent for this and other container-breeding mosquitoes. The purposes of the present experiment were (1) to determine if Tx. r. rutilus larvae prefer one stage of A. aegypti prey and (2) to obtain estimates of the number of prey each stage consumed. Also, concurrent observations were made on the killing behavior exhibited by the last larval instar of Tx. r. rutilus. The killing of prey without consumption is characteristic of Toxorhynchites spp., and although this behavior is poorly understood, it may be a way of protecting the predator during the defenseless pupal stage (Trpis 1972, Corbet 1963, Corbet and Griffiths 1963). These data are being used to help predict and understand the effects of Tx. r. rutilus on A. aegypti populations through the use of mathematical models.

MATERIALS AND METHODS
Predator and prey immatures used in this experiment were reared according to the procedure described in detail by Focks and Boston (1979). Briefly, pred-

RESULTS AND DISCUSSION
Table 1 presents a summary of the data on the predatory activity of the 4th-stage
<table>
<thead>
<tr>
<th>Stage of prey</th>
<th>S. no. offered</th>
<th>Avg. total development time</th>
<th>Total mean prey consumed</th>
<th>Daily mean prey consumed</th>
<th>Daily mean killed</th>
<th>Exp. mean 10 replicates</th>
</tr>
</thead>
<tbody>
<tr>
<td>4th instar</td>
<td>50</td>
<td>18.2 ± 2.2</td>
<td>234 ± 5.0</td>
<td>12.2 ± 0.9</td>
<td>11.1</td>
<td>40.8</td>
</tr>
<tr>
<td>Pupae</td>
<td>50</td>
<td>12.2 ± 0.9</td>
<td>234 ± 5.0</td>
<td>11.2 ± 3.9</td>
<td>11.1</td>
<td>40.8</td>
</tr>
<tr>
<td>Total</td>
<td>150</td>
<td>15.1</td>
<td>234 ± 5.0</td>
<td>11.1 ± 3.5</td>
<td>11.1</td>
<td>40.8</td>
</tr>
</tbody>
</table>

All means are significantly different at the α = 0.05 level. The values in Table 1 were all significantly different. Previous work has shown that 4th-stage larvae of *Tx. r. rutulus* when offered a single stage of prey in identical containers consumed 93.3 1st instars, 9.8 4th instars, and 7.0 pupae of *Ae. aegypti* per day. The estimates of prey consumption presented here are derived from regression equations developed by Faggett and Focks (1980).

It may be helpful in understanding the differences in rates of killing and consuming among the 3 stages of prey offered to consider differences in the behavior of the prey and predator. At the densities of prey offered in these experiments, it appears that the predator does not actively search out prey but relies on collisions between the 2 species to provide opportunities for prey capture. Because 4th-instar prey are more active than the sessile pupa and because 4th-instar prey habitually “graze” on the bodies of predators, more 4th instars than pupae are eaten. The low consumption of 1st-stage prey can be understood in terms of the adaptive significance of the predator “keying in” on the size of prey offering the highest “energy return per capture” to “energy required to capture” ratio. If the energy required to capture the larger stages is comparable to that required for 1st instars, the predator would be expected to exhibit a strategy which preferentially consumes more large prey. Once a predator has “keyed” onto the 1st instar, enormous numbers can be captured and eaten; laboratory tests involving high
densities of only 1st instar prey demonstrated that T. r. rubitus 4th-instar could consume ca. 100 prey/day (Padgett and Focks 1980).

Current thinking suggests that the intraspecific killing behavior exhibited by the nearly grown 4th-instar predator serves subsequently to protect the defenseless pupa. Larger prey are also attacked, perhaps because they are approximately the same size as 3rd-instar predators which would develop into threatening size during the long pupal stadia of the predator and consume or kill the pupae. Higher rates of killing are observed for the pupae because of their greater effective concentration due to their habit of remaining suspended for indefinite periods of time at the surface of the water. (The killing of early instar prey does not occur because they pose no threat to the predator pupa.) This hypothesis does not suggest that the different rates at which late-instar prey and pupae are killed or eaten are due to a preference of the predator for one stage or the other for food, they may be simply a function of the frequency with which the predator and prey encounter one another.

Figure 1 presents the mean daily consumption of each stage of prey by the 4th-instar predator. This figure indicates that rates of 1st and 4th instar consumption tend to oscillate with decreasing amplitude over time; the rate of pupal consumption was not so well defined over time. The decline in consumption following each peak may reflect the time required to digest the previous day's capture. First instar and pupa consumption rates were significantly correlated with 4th-instar rates with Pearson correlation coefficients of 0.70 and 0.76, respectively.

Figure 2 presents the daily mean killing without consumption of Aedes aegypti 4th instar and pupa. The killing activity increases

![Graph](image_url)

Figure 1. Daily mean consumption of Aedes aegypti prey of various stages by 4th-instar *T. r. rubitus* in 3.79-liter containers.
over time as pupation approaches. The killing rates were not significantly correlated among the 3 stages of prey offered.

From a control perspective, these results are encouraging. The total number destroyed daily either by consumption or killing alone was 49.8 immatures with a total destruction of 326.3 immatures per 4th stadium. In the context of control, it is fortunate that the predator destroys more pupae than 4th instars and more later than earlier stages—fortunate because density dependent natural mortality will reduce recruitment into the later larval stages, and pupal production is most highly correlated with subsequent adult densities.

References Cited


