FACTORs INFLUENCING DEVELOPMENT AND SURVIVAL OF
CULEX PIPiens PALLENS LARVAE (DIPTERA: CULICIDAE)
IN POLLUTED URBAN CREEKS

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INTRODUCTION

Species of the Culex pipiens complex are some of the best studied mosquitoes due to their worldwide distribution, close association with man, ecological and morphological variation, and importance as nuisances or vectors of human and animal diseases. However, factors influencing development and survival of the immatures have been little studied in the field except for Culex quinquefasciatus Say in India (Rajagopalan et al., 1975, 1976a, b, 1977; Menon and Rajagopalan, 1981). This lack of knowledge is due partly to the absence of analytical methods applicable to the immature population generally consisting of incompletely overlapping generations. Assuming the stable age structure, Rajagopalan et al. (1976a) and Menon and Rajagopalan (1981) estimated survival rates of C. quinquefasciatus in polluted urban drainages. However, no attempts have been made to specify mortality factors for the natural population in polluted urban creeks, despite the importance of this habitat for the larvae of the complex at various localities of the world.

The urban area of Saga City includes networks of creeks. Formerly, these creeks were indispensable sources of water for irrigation, fishing and bathing. In the rainy season, they still protect the urban area lying at the sea level from inundation. Recently, however, excess waste from urban expansion has polluted the creek water. Many fouled creeks have now turned into favorable habitats for Culex pipiens pallens Coquillett larvae. Adult females of this species actively bite man and are a main vector of canine filariasis in western Japan (Suenaga and Itoh, 1973).

This report is part of a basic study undertaken to solve urban mosquito problems in Saga City. To establish ecologically sound and effective strategies for the pest control, an understanding of processes underlying population fluctuations is essential. The aim of this report is to evaluate factors influencing development and survival of C. pipiens pallens larvae in polluted urban creeks.
MATERIALS AND METHODS

Study Sites

The study was performed at 4 sites for ca. 1 month in the peak breeding season of *C. pipiens pallens* in 1984. Table 1 describes conditions of each site. All sites were a part of longer creeks usually with slow currents. There were no obstructions to influx and efflux of immature mosquitoes. A larvicide (not specified) was applied to Site D by residents on the day before the study, but all sites were free from larvicide application during the study. Weather records were obtained from Saga Meteorological Station locating within 2.5 km from the study sites. Daily mean air temperatures remained rather constant within each period before or after the relatively steep rise in early July (Fig. 1). Precipitation was heaviest during the last 10 days in June and low during most of July.

Sampling of Natural Populations

Larvae and pupae were collected daily with a dipper (15 cm diameter and 3 cm deep) at 1-m intervals along one margin of each creek. Numbers of dips were 50, 15, 30 and 30 for Site A through D, respectively. Daily samples from each site were combined, concentrated and preserved in 10% formalin solution for later sorting, identification, age-grading and counting. The most (Site A and C) or some (Site D) material was dispersed evenly in a circular vat (20 cm diameter) partitioned by lines into 10 sectors of equal size. The specimens falling into a set of two opposite sectors were taken up and processed. The total number was then obtained as a fivefold multiple of the numbers in these two sectors. Other material, including all from Site B, was processed totally.

Development and Survival in Predator-free Cages

The Saga strain of *C. pipiens pallens* had been maintained for ca. 5 generations in an insectary (28°C/15.5 hr photophase) prior to the study. One small (10 x 10 x 10 cm) and one or two large (30 x 30 x 10 cm) 100-mesh cloth cages were floated on the creek at each site and tied to stakes with strings. All cages were completely covered with 100-mesh cloth to prevent entry of predators. Daily maximal and minimal water

<table>
<thead>
<tr>
<th>Site</th>
<th>Length (m)</th>
<th>Width (m)</th>
<th>Water depth (cm)</th>
<th>Water pollution*</th>
<th>Emergent vegetation</th>
<th>Topminnowb</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>50</td>
<td>0.6</td>
<td>10–25</td>
<td>+</td>
<td>–</td>
<td>+</td>
</tr>
<tr>
<td>B</td>
<td>15</td>
<td>3.5</td>
<td>25–50</td>
<td>+</td>
<td>–</td>
<td>+</td>
</tr>
<tr>
<td>C</td>
<td>30</td>
<td>2.5</td>
<td>30–50</td>
<td>+</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>D</td>
<td>30</td>
<td>1.0</td>
<td>3–20</td>
<td>+</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

* + = Less polluted;  # = Polluted.

b + = *Gambusia affinis* (Beard & Girard) were released in early May; – = Not released.