Laboratory study of predation by *Curinus coeruleus* (Coleoptera: Coccinellidae) on eggs of *Aedes albopictus* (Diptera: Culicidae)

Pingjun Yang
Hawaii Department of Health, Vector Control Branch, 99-945 Halawa Valley St., Aiea, HI 96701
E-mail: pingjun.yang@doh.hawaii.gov

**Abstract.** The lady beetle, *Curinus coeruleus* (Mulsant), a biological control agent of the coconut mealybug, *Nipaecoccus nipa* (Maskell) and the psyllid, *Heteropsylla cubana* Crawford, was examined for its ability to consume *Aedes albopictus* (Skuse) eggs in the laboratory. Most *C. coeruleus* larvae in this test preyed on *A. albopictus* eggs (75% for the 2nd and 3rd instar and 71% for the 4th instar). The 2nd and 3rd instar larvae consumed an average of 51.8 eggs compared to an average of 57.7 eggs consumed by the 4th instar larvae. The 2nd and 3rd instar larvae survived for an average of 5.3 days, while the 4th instar larvae survived for an average of 5.6 days. *Curinus coeruleus* could not complete its life cycle by feeding only on *A. albopictus* eggs. *Aedes albopictus* eggs, which are available year round in Hawaii, may be a supplemental food source for *C. coeruleus* larvae when there is a shortage of psyllids.

**Key words:** *Curinus coeruleus, Aedes albopictus, egg predation*

The lady beetle, *Curinus coeruleus* (Mulsant) was introduced into Hawaii from Mexico in 1922 to control the coconut mealybug, *Nipaecoccus nipa* (Maskell) (Lai et al. 1986). It also has become an important predator of the psyllid, *Heteropsylla cubana* Crawford, a serious pest of koa-haole tree, *Leucaena leucocephala* de. Wit, and monkeypod tree, *Samanea saman* (Jacq.) Merr. (Takara et al. 1990, Anonymous 1990). In the past two years, I observed several occasions that some lady beetle larvae were on the paddles (hardboard ca. 2 cm wide and 12.8 cm long) in the “ovitraps” that were used for collecting *Aedes albopictus* (Skuse) eggs at the Port Allen harbor, Hanapepe, on the island of Kauai, Hawaii. I also observed many times that either some *A. albopictus* eggs on the paddles were chewed open, or some eggs were missing but the layer of dried glue, which female mosquitoes used to glue the eggs, were still on the paddles. In April 2005, I found one lady beetle larva (2 mm long, perhaps a second instar larva) on a paddle, feeding on *A. albopictus* eggs. The larva was brought to the laboratory and observed with a dissecting microscope. It was found that the larva chewed the mosquito eggs from the two sites near the two ends or in the middle, then ate the contents. It took ca. 7 to 8 minutes to consume one egg. Later, this larva was transferred to a cubical screen cage (30 cm x 30 cm x 30 cm) and supplied with *A. albopictus* eggs on paddles and a cotton ball soaked with water. This single larva consumed about one hundred eggs within three days.

Little is known about egg predators of *A. albopictus* except for a species of ant, *Solenopsis invicta* Buren (Hymenoptera: Formicidae) known to feed on the eggs of these mosquitoes (Burnham et al. 1994). The objective of this study was to further examine the ability of *C. coeruleus* larvae to consume *A. albopictus* eggs.
During July and August 2005, *Curinus coeruleus* larvae were collected from koa-haole trees in the Hanapepe valley and the Nawiliwili Harbor area of Kauai, Hawaii. The larvae on koa-haole leaves were stored in a plastic Presto® bag (26.8 X 27.9 cm, Presto Products Company, Appleton, WI), and brought back to the laboratory. The larvae were then immediately transferred into individual mosquito breeders (BioQuip Products Co. Garden, CA) from which the plastic cone-shaped part in the middle of the breeder had been removed. Thirty-eight *C. coeruleus* larvae (2nd instar: 8, 3rd instar: 16, and 4th instar: 14) were randomly chosen for the tests. Mosquito eggs on the paddles (the numbers of eggs were recorded) and a cotton ball soaked with water were provided. The numbers of eggs consumed daily were recorded and new eggs were added when necessary. Mortalities and molting of *C. coeruleus* larvae were also recorded. The tests were conducted in a room maintained at 25—28°C, 50—60 % RH, and a photoperiod of ca. 12L:12D. Information about predation and survival of *C. coeruleus* larvae was only obtained from those individuals consuming *Aedes albopictus* eggs. Larvae were categorized into two groups: the 2nd and 3rd instar larvae, and the 4th instar larvae (the 3rd instar larvae which molted to the 4th instar were considered in the 3rd instar group). All comparisons of mean values in egg predation and survival of the lady beetle larvae were done using Student’s t test and the data were square-root transformed before analysis (Analytical Software 1996).

Most *C. coeruleus* larvae that were tested preyed on *A. albopictus* eggs (75% for the 2nd and 3rd instar and 71% for the 4th instar) (Table 1). The 2nd and 3rd instar larvae consumed an average of 51.8 eggs compared to an average of 57.7 eggs consumed by the 4th instar larvae (Table 1). No statistical significance was found between these two averages (t = 0.3, df = 26, p = 0.77). The larvae survived an average of 5.3 days for the 2nd and 3rd instar, and an average of 5.6 days for the 4th instar (Table 1). Also, there was no significant difference between these two values (t = 0.29, df = 26, p = 0.79). This result indicates that the lady beetle larvae can survive at least several days by feeding only on *A. albopictus* eggs. Although some 4th instar larvae pupated during the test period, all the 2nd and 3rd instar larvae with a molting rate of 0.46 eventually died before reaching the pupal stage (Table 1). Thus, it seems that *C. coeruleus* cannot complete its life cycle by feeding only on *A. albopictus* eggs.

In Hawaii, koa-haole trees grow widely on roadside, pastures, empty lots, hills, etc., and monkeypod trees are planted near buildings and in many public places. Seasonal flushes of these trees cause the psyllid populations to build up rapidly, and large populations of *C.

### Table 1. Percent predation, average number of eggs consumed, survival, and molting for *Curinus coeruleus* larvae feeding on *Aedes albopictus* eggs.

<table>
<thead>
<tr>
<th>Larval stage</th>
<th>N</th>
<th>% Predation</th>
<th>Eggs consumed</th>
<th>Survival (days)</th>
<th>% Molting or pupating</th>
</tr>
</thead>
<tbody>
<tr>
<td>2, 3</td>
<td>24</td>
<td>75</td>
<td>51.8 ± 13.4a</td>
<td>5.3 ± 0.6a</td>
<td>0.46</td>
</tr>
<tr>
<td>4</td>
<td>14</td>
<td>71</td>
<td>57.7 ± 19.1a</td>
<td>5.6 ± 0.9a</td>
<td>0.40</td>
</tr>
</tbody>
</table>

*Values were calculated only from the larvae that preyed on mosquito eggs, mean ± SE for eggs consumed and beetle larva survival, and means within same columns followed by the same letter are not significantly different (Student’s t test, p > 0.05).*
Predation by Curinus Coeruleus on Aedes Albopictus Eggs

Curinus coeruleus are subsequently produced (Takara et al. 1990, Anonymous 1990), but there may be seasonal scarcity of these insects. Aedes albopictus, which breeds in artificial containers, leaf axils, and tree holes, occurs year round in Hawaii. The female mosquitoes lay their eggs on the inside walls of containers at or above the waterline. Therefore, A. albopictus eggs are available year round and are easily accessible to lady beetle larvae, and may be a supplemental food source for C. coeruleus larvae when there is a shortage of psyllids.

Acknowledgments

I thank Bernarr R. Kumashiro (Hawaii Department of Agriculture), Linda B. Larish, Roy T. Furumizo, Clyde Takekuma, Greg Olmsted (Hawaii Department of Health), and Xingeng Wang (University of Hawaii) for their helpful comments on an early draft of the manuscript. I also thank Bernarr R. Kumashiro for taxonomic assistance and providing some references.

Literature Cited
