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Preliminary Laboratory Study on Population Growth of *Aedes albopictus*

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Abstract: The "population cage" of 40×40×40 cm in size was constructed for *Aedes albopictus* to study the growth pattern of laboratory populations, and the changes in population density was examined for 15 weeks. Long-term and within-week fluctuatitons were found in the larval population. The density dependent death of young larvae was one of the factors resulting in the within-week fluctuation. The adult female population increased gradually with small fluctuations and the maximum density of 98 was observed. The finite rate of female population increase was calculated as 1.149 per week. It was considered that this "population cage" could be used effectively in the population study of *Ae. albopicuts*.

Key words: Population cage, *Aedes albopictus*, Long term fluctuation, Density dependent mortality

INTRODUCTION

Parameters of vector population, such as mean density, survival rate and longevity of adult and recruitment rate of adults, describe the characteristics of the populations, and the mathematical studies of vector-borne diseases show their importance in determining the stability and the equilibrium prevalence of infection (Bailey, 1982; Dietz, 1988). Population parameters vary in time and their changes depend on biological and environmental conditions. Because the fluctuation of vector population is the result of the change in population parameters, we must measure these parameters in reproducing vector populations under a given set of environmental conditions to know the dynamic aspects of vector populations and vector-borne diseases.

In field situations, many environmental factors affect the reproduction of vector populations and the causal relationships between population parameters and environmental factors are so complex that it is hard to understand the dynamics of vector populations even by very sophisticated field experiments. Comparing with the field populations, the reproducing populations in artificially controlled environments are of simpler ecological system and it is expected that we can analyse and understand their population dynamics more precisely.

As to vector mosquitoes, few ecological studies have been done on growth patterns of

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laboratory populations. The construction of an experimental system for a reproducing population of mosquitoes is not easy for most species of *Anopheles* and *Culex*, but in the case of some aedine mosquitoes like *Aedes albopictus*, adults mate and oviposit successfully in a relatively small cage and larvae develop normally in a small artificial water container. In the present study, we constructed an experimental system of reproducing populations, called "population cage", for *Ae. albopictus* and examined a long-term trend of the population growth.

Materials and Methods

The mosquitoes used in the study were from a population of *Aedes albopictus*, which had been kept for 6 months under laboratory conditions of 27℃ and 60−75% R.H. Newly emerging mosquitoes were collected and reared for a week with a 3% sugar solution. Thereafter, they were allowed to feed on a mouse. Two days after blood feeding, 7 males and 11 engorged females were introduced into the population cage as an initial population.

A population cage was basically composed of a cubic cage for adults and two ovi-cups as breeding sites (Fig. 1). The cage (40×40×40 cm) had a metal frame covered with fine-mesh cloth. A polyethylene bottle (250 ml in volume, 6.5 cm in diameter) was used as an ovi-cup. Each ovi-cup was fixed to the inside corner of the cage and was connected with a vinyl tube (1.6 cm in diameter, 50 cm long) to another polyethylene bottle outside of the cage. Through the vinyl tube and the outside bottle, all the contents of the ovi-cup can be collected without any disturbance in the adult population.

Pupae were collected and kept in a polyethylene bottle with water, "pupal bottle" (250 ml in volume), until they emerge. There was one small window (ca. 1 cm in diameter) near the bottom of the cage through which emerging adults were added to the adult population and dead adults were removed.

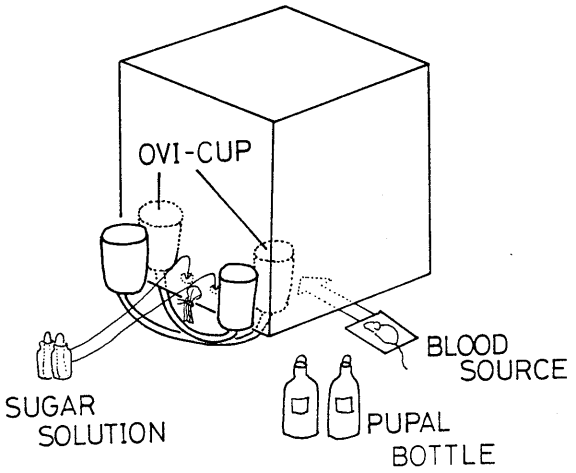

Fig. 1 Schematic explanation of the population cage.

Two glass tubes (15 ml in volume) were inserted into small holes (ca. 2 cm in diameter) in the bottom of the cage. Each glass tube had a cotton wick and was filled with a 3% sugar solution. Adult mosquitoes could take sugar from the cotton wick. To feed mosquitoes on a blood meal, a mouse restrained in a tight fitting hardware-cloth cylinder was placed under th bottom of the cage.

Table 1 summarized the environmental conditions of the present experiment. As the larval food, 50 mg of powdered mouse pellet was supplied and the amount of water in each ovi-cup was 300 ml. The water was renewed every week and larval food was supplied at the same time.

The mosquitoes were allowed to feed on a mouse every week for about 3 hr and engorged females were counted after taking out the mouse. The investigation of larval population started 2 weeks after the introduction of adults to the population cage. From 2 to 10 weeks after the introduction, the larval population was investigated 4 times a week as a rule, and thereafter weekly, and the number of larvae were counted for each instar. Pupae were counted 4 times a week as a rule and kept in the pupal bottle.

Table 1. Environmental conditions of population cage

Amount of water in ovi-cup	300 ml
Food amount for larvae	50 mg
Renewal interval of water	1 week
Interval of blood feeding	1 week
Blood source	1 mouse
Period of blood feeding	3 hr
Temperature	27℃
Humidity	75%

RESULTS

Figure 2 shows the density changes of larvae (pupae inclusive) and females. The total number of larvae counted in each observation was plotted and connected with brocken line in Fig. 2a. Solid line shows weekly changes in the larval density. The larval density decreased gradually in the beginning of the experimental period, and then increased with fluctuation. We can distinguish two types of fluctuation, long-term and within week fluctuation. The within week fluctuation became clear during the 6th to 10th weeks of the experimental period. The rapid increase and decrease in larval density occurred within a week. Because females lay eggs on the wall of ovi-cups near the water surface and the water level in the ovi-cup became the highest just after the renewal of the water, many eggs were immersed and hatched in the beginning of a week. The main reason of the decrease in larval density was the death of larvae, and the density dependent mortality was suggested in the larval stage.

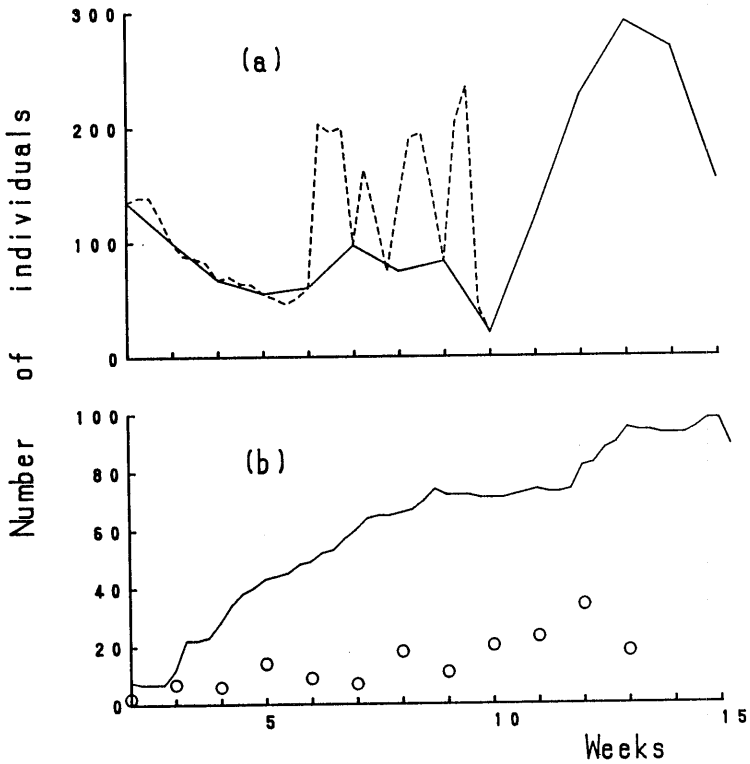

Fig. 2 Changes in the number of larvae (a) and the number of females (b). The solid line and broken line in the upper graph give the results of weekly and 2 day interval observation, respectively. The open circles in the lower graph show the number of engorged females counted.

The number of females increased almost continuousely with small fluctuations and the maximum density of 98 was observed in the last week of the experiment (Fig. 2b). The number of engorged females shown by open circles also increased gradually. At the end of the experiment, there were 88 females, thus the finite rate of population increase during the experiment was 1.149/week.

The weekly changes in age structure of the larval population is depicted in Fig. 3. During the first 6 weeks of the experimental period in which the gradual decrease in larval density was observed, a large proportion of the larval population was composed of the 3rd and the 4th instar. Thereafter, the proportion of the young larvae increased rapidly to a certain level and fluctuated.

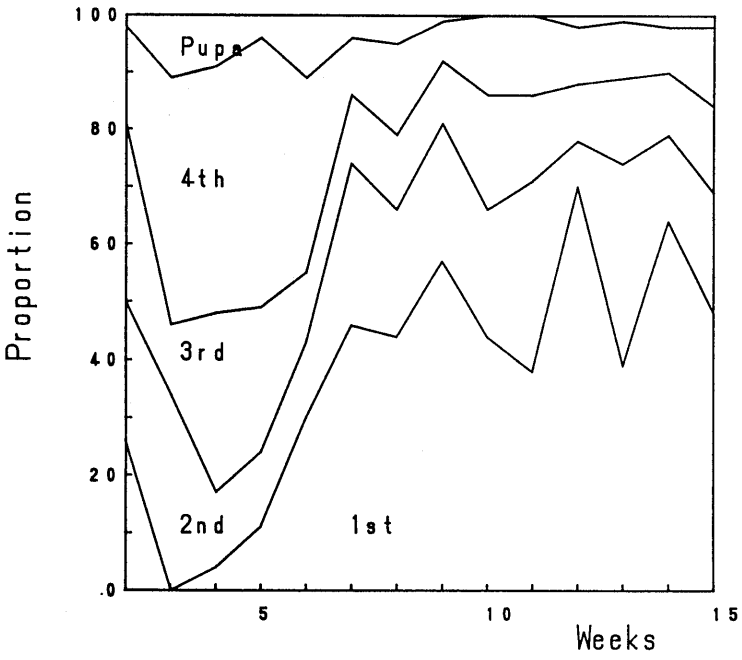

Fig. 3 Changes in the age composition of larval population.

DISCUSSION

Gilpin *et al.* (1976) examined the growth pattern of laboratory population of *Ae. aegypti*. Using three experimental systems they examined the long-term change in adult population density over a period of 40 weeks. Because they introduced spatial heterogeneity into the system, their results are completely different from the present study. The adult population in the present study showed very small fluctuations, while they observed large and irregular fluctuations.

The larval population showed a long-term fluctuation and a within week fluctuation in the present study. The main factors of the within week fluctuation is probably the renewal of water in the ovi-cups and the density dependent mortality of larvae. When water in the ovi-cup was renewed, the water level went up and eggs on the wall were immersed in water and stimulated to hatch. After eggs hatched, the density dependent death occurred and the larval population decreased. As to the mechanism of the density dependent death of larvae, competition for food between larvae seems to be important. Mori (1976) reported the density effects of larvae on their survival and development using a cohort of hatched larvae of *Ae. albopictus*. Although the eggs hatched weekly in the present study, the larval population was rather stable in age structure. Thus the competitive interaction might exist not only within cohort but also between cohorts of hatched larvae. About the between cohort interaction, some studies on aedine mosquitoes demonstrated that the presence of mature larvae prevents the hatching of eggs (Gillett, 1959; Gillett *et al.*, 1977; Livdahl, 1982; Livdahl *et al.*, 1984; Liv-

dahl and Edgerly, 1987). This interaction if existed and the change in age structure of the adult population seem to relate the long-term fluctuation in the larval population.

The changes in the population of *Ae. albopictus* shown in this experiment can be reasonably explained. This implies the usefulness of the "population cage" in the population study of this mosquito. The dynamic aspect of the *Ae. albopictus* population could be pursued further by giving differennt environmental conditions in this "population cage".

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