

ニカメイチュウ次世代の生物学的特性におよぼす雌成虫の 日令の影響

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Effects of Maternal Age on the Biological Characteristics of the Offspring of the Rice Stem Borer, *Chilo suppressalis* WALKER (Lepidoptera : Pyralidae)

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In the rice stem borer, *Chilo suppressalis* WALKER, the influence of maternal age on several biological characteristics of the offspring was investigated. The size of egg masses was the largest on the first day of oviposition, whereupon it decreased with increasing maternal age. The duration of the egg period was not affected by maternal age. Concerning the fertility and hatchability of eggs, a decreasing tendency with progress of maternal age was observed. The survival rate of newly hatched larvae decreased with an increase in maternal age. These results suggest that the eggs deposited in the late period due to their low viability contribute least to the population of the next generation as compared with earlier deposited ones.

INTRODUCTION

The effects of parental age on several biological characteristics of the offspring have been studied in some insect species. HOWE (1967) reviewed the effects on the size and viability of eggs, the developmental rate of immature stages, the longevity and fecundity of adults, and other offspring characteristics in 16 different species. He concluded that, in general, the influences of parental age are real though varied. RICHARDS and KOLDERIE (1957) recorded that the first batches of eggs laid by freshly emerged females of the milkweed bug, *Oncopeltus fasciatus*, were relatively light in weight, the last eggs were even lighter, and the heaviest eggs were laid at the peak of oviposition. Furthermore, the eggs laid by middle-aged parents showed better hatching than those of young and old parents. KIRITANI and KIMURA (1967) observed that the hatchability of eggs of the southern green stink bug, *Nezara viridula*, decreased with progressive aging of the female adults. In the mealworm, *Tenebrio molitor*, LUDWIG (1956) noted that the duration of the larval stage was shorter in offspring produced by old in comparison to young beetles.

However, studies of the influence of parental age in Lepidoptera, of which adults are characterized by short longevity in contrast to other orders, are few. RAROS and CHIANG (1967) briefly reported that the biological attributes of offspring on the European corn borer, *Ostrinia nubilalis*, were affected by maternal age.

The present paper deals with the effects of maternal age on developmental aspects such as egg fertility, hatchability and larval survival, in the rice stem borer, *Chilo suppressalis* WALKER (Lepidoptera : Pyralidae), which is one of the most serious pests

of rice plants in Japan.

MATERIALS AND METHODS

The insects used in this study were collected from the field and reared successively in bottles (450 cm³ in volume) at 25°C, 16 hr illumination. Rice seeds of the variety, Yamahoshi, were germinated in the bottles and served as food. All of the experiments were conducted at 25°C, 16 hr illumination.

The influence of maternal age on egg fertility and hatchability was determined for eggs laid by 30 females. Pupae were collected from the rearing bottles. Upon emergence, females were paired with males. Mated females were transferred individually to cylindrical cages (9 cm in diameter and 30 cm in height) constructed of transparent plastic for oviposition. The cages were set upon rice plants (5–6 leaf-stage) which were used as the ovipositional site. Egg masses deposited by females were collected daily until the females died, and the duration of the egg stage was investigated. The rates of hatching and fertilization for each egg mass were determined after hatching.

The influence of maternal age on larval survival was observed by placing the eggs on the rice plants of the Yamahoshi variety. In this test, the egg masses from another 30 females were examined. Oviposition of the females was checked every day similar to the previous test. When eggs reached the black-head stage, they were placed on rice plants (5–6 leaf-stage). After the rice plants were infested by newly hatched larvae, the previously described cylindrical cages were positioned in order to prevent larvae from escaping. The infested rice plants were dissected 7 days after infestation, and the rate of larval survival was determined.

RESULTS

Longevity and ovipositional pattern of parental females

The longevity and preovipositional period of adult females averaged 6.9 and 1.9 days, respectively. Since most of the females continued oviposition immediately before death, the mean ovipositional period was 4.5 days. Fig. 1 illustrates daily changes in the mean number of eggs laid per female after the initiation of oviposition. The average number of eggs deposited was the greatest on the first day of oviposition, after which it decreased with increasing maternal age.

The size of egg masses and duration of the egg period

The size of egg masses also decreased with aging of females and the largest egg masses were laid on the first day of oviposition. The duration of the egg period was about 6 days on the average. It was not affected by aging of the mother.

Fertility and hatchability of eggs

Table 1 shows that the percentages of fertile eggs decreased with progress of maternal age. Moreover, the percentage of fertile eggs that successfully completed embryonic development showed a fairly consistent decrease with an increase in maternal age. It was observed that development of embryos stopped at a late stage of their development when the head capsules were clearly visible. The hatching

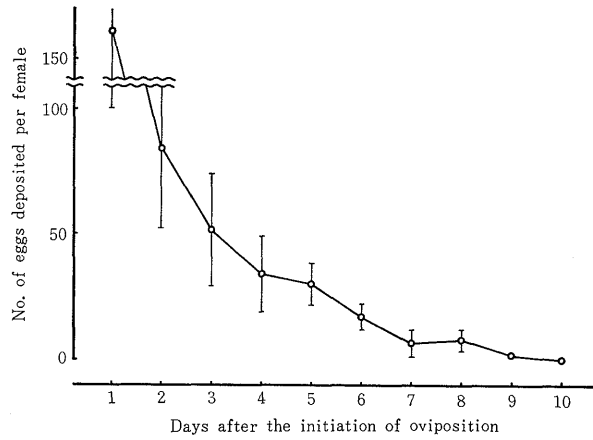


Fig. 1. Change in the mean daily number of eggs laid per female in relation to number of days elapsed after the initiation of oviposition. Vertical lines indicate the range of 95 percent confidence limit.

Table 1. EFFECT OF MATERNAL AGE ON VIABILITY OF EGGS DEPOSITED BY FEMALE MOTHS AGED FROM 1 TO 8 OR MORE DAYS

Maternal age in days	1	2	3	4	5	6	7	8+
Total live females involved	30	30	28	26	22	16	13	12-0
Total egg masses laid	86	75	65	52	52	36	27	24
Total eggs laid	4570	2264	1388	856	608	268	84	60
Size of egg mass (No. of eggs per mass)	53.1	30.2	21.4	16.5	11.7	7.4	3.1	2.5
Rate of infertile eggs (%)	4.6	3.2	4.0	4.8	6.8	4.3	9.4	8.2
Rate of fertile eggs not hatched (%)	8.0	14.6	7.1	12.3	19.9	28.3	28.5	28.3
Rate of eggs hatched (%)	87.4	82.2	88.9	82.9	73.3	67.2	61.9	62.9
Duration of egg period in days	6.1	6.1	6.1	6.3	6.6	6.0	6.3	6.3

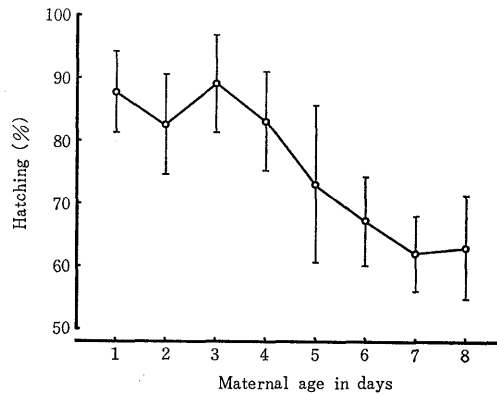


Fig. 2. Effect of maternal age on hatchability of eggs. Each percentage shows the mean value with 95 percent confidence limit.

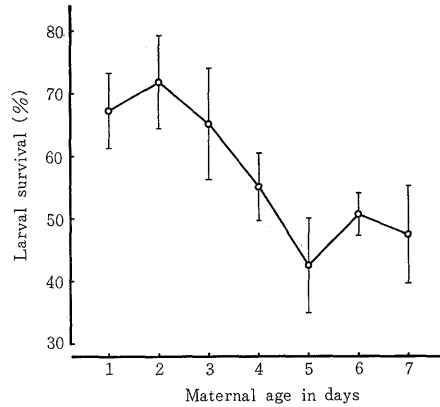


Fig. 3. Effect of maternal age on the survival rate of newly hatched larvae at 7 days after infestation. Each percentage shows the mean value with 95 percent confidence limit.

rate of eggs, therefore, decreased with increasing maternal age as shown in Fig. 2.

Survival rate of larvae

The survival rate of newly hatched larvae was more than 60 percent for progeny from females of 1–4 days old and it decreased with progress of maternal age as shown in Fig. 3. Significant differences were shown for survival among the progeny originated from different ages of mothers.

DISCUSSION

KIRITANI (1963) reported that the size of egg masses of *Nezara viridula* from two days old females after oviposition was the smallest and resumed an increasing trend as a function of maternal age. Furthermore, he observed that the duration of the egg period was reduced from 7.6 to 5.5 days with progress of maternal age. SANG (1956) found that the eggs of middle-aged parent of *Drosophila melanogaster* required the longest incubation period. In *Chilo suppressalis*, however, the authors recognized the phenomenon that differed from the above mentioned species. Namely, the size of egg masses was the largest on the first day of oviposition and it decreased with an increase in maternal age. Also, duration of the egg period did not entirely change through the ovipositional period.

In *Ostrinia nubilalis*, RAROS and CHIANG (1969) described that maternal age had no effect on egg fertility, but the failure of fully developed embryos to hatch increased with an increase in the female's age. ICHIKAWA and KIRITANI (1973) reported that the hatchability of eggs in the green rice leafhopper, *Nephotettix cincticeps*, demonstrated a higher tendency at the beginning of oviposition. In our experiments, the percentage and hatchability of fertile eggs decreased with progress of the ovipositional period. Thus, in the egg stage, the influence of maternal age on fertility and ability of fully developed embryos to hatch was manifested.

On the other hand, KIRITANI and KIMURA (1967) noted that the survival of larvae of *Nezara viridula* remained unchanged until the second period (1 period : 10

days) from the initiation of oviposition and these reached the maximum for the larval offspring of the third period, then decreased with an increase in maternal age. In *Ostrinia nubilalis*, RAROS and CHIANG (1969) observed that the number of surviving larvae hatched from eggs laid by 2-day-old moths was higher than those eggs laid by 6-day-old moths during early larval life. A similar result was obtained in *Chilo suppressalis*. Namely, the survival rate of newly hatched larvae gradually decreased with increasing age of mothers.

In the present study, it was confirmed that many biological characteristics of offspring in *Chilo suppressalis* were influenced by the difference of maternal age. These results suggest that the eggs deposited during a late period due to low viability contribute least to the population of the next generation as compared with earlier deposition. These results further suggest that for studies involving small numbers of eggs, the factor of maternal age should definitely be controlled.

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