Emergence and mating behavior of the pink borer, *Sesamia inferens* (Walker) (Lepidoptera: Noctuidae)

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Abstract

Emergence pattern and mating behavior of the pink borer, *Sesamia inferens* (Walker) (Lepidoptera: Noctuidae) were studied in the laboratory at 25°C under 14L10D photoregime. Both sexes emerged most frequently at 1.5 h after lights off, but males emerged significantly earlier than females. 0-day-old females started calling at an average of 4.9 h after lights off, while 1- to 4-day-old females did so at around 3.8 h after lights off. For mating among different ages, the highest copulation rate for females was observed at 0-day-old (83.3%) and the lowest at 4-day-old (56.7%). The mating time of 4-day-old females was irregular, and some unmated females conducted oviposition behavior. Therefore, *S. inferens* females appear to mature early. Mean mating duration of *S. inferens* was 1.29±0.71 h (mean±SD).

Key words: Mating behavior; calling behavior; emergence pattern; *Sesamia inferens*; pink borer

INTRODUCTION

The pink borer, *Sesamia inferens* (Walker), is an important pest of graminaceous crops. It is widely distributed in India, Ceylon, Pakistan, Myanmar, Thailand, Vietnam, Indonesia, Philippines, Taiwan, China and Japan (Azuma, 1977; Mia and Iwahashi, 1999). In Okinawa and Kagoshima, this species is a serious pest of sugar cane. Adult females lay egg masses beneath the tightly folded leaf sheaths. Hatched larvae feed on the inner side of the sheath during the first instar, and then disperse by boring into the cane stems. Larvae prefer the heart of the shoot, where they burrow up and down by destroying the basal part of the youngest leaves and the stem tissues at the growing point. This causes the characteristic “dead heart”. During growth, the larvae migrate from shoot to shoot, creating small patches of dead hearts.

It is difficult to control this borer with contact insecticides because the immature larvae live inside the plants. Application of a synthetic sex pheromone has potential for monitoring and control. Three pheromone components of *S. inferens* were identified as Z-11-hexadecenyl acetate, Z-11-hexadecenol and Z-11-hexadecenal (Nesbitt et al., 1976; Wu and Cui, 1986; Zhu et al., 1987) but current knowledge of *S. inferens* mating behavior is limited. In this study, therefore, we investigated the emergence pattern and mating behavior of *S. inferens*.

MATERIALS AND METHODS

Insects. Larvae of *S. inferens* used in the experiments were collected from sugar cane fields in Ikei Island, Okinawa, Japan in April and December 2002. Younger instar larvae were reared on an artificial diet for *Spodoptera litura* (Vitasilk Co. Ltd.). Older larvae were fed sugar cane stems or an artificial diet (Insecta LF; Nihon Nosan Kogyo Co. Ltd., Kanagawa, Japan). They were reared at 25°C under a natural photoregime for two or four generations to obtain enough individuals for the experiments. Insects used in this study were sexed at the pupal stage and kept individually in transparent plastic cups (6.5 cm diam.×3.5 cm ht.). For acclimation to experimental conditions, pupae were kept at 25°C under a reversed 14L10D photoregime (scotophase: 9:30 to 19:30) for at least one week before adult emergence. Moths were designated as 0-day-old on the day of emergence (until the end of first scotophase).

Emergence pattern. All observations of emer-
gence pattern and mating behavior were done at 25°C and under reversed 14L10D photoperiod. A dimmed red light was used for visual observation during the dark period.

The total numbers of females and males used in this experiment were 114 and 127, respectively. Emergence pattern was observed for 11.5 h from 1 h before lights off to 0.5 h after lights on. The numbers of emerged females and males were recorded at 30 min intervals.

**Calling behavior.** Thirty 0-day-old virgin females were individually confined in transparent plastic cups (6.5 cm diam. × 3.5 cm ht.) and provided with diluted honey solution impregnated in a piece of cotton wool. For 0-day-old females, the observations started at ca. 1 h after emergence. The number of females that adopted the calling posture was recorded every 30 min during the dark period for five successive days.

**Mating behavior.** Ten virgin females and twelve males of the same age (0- to 4-day-old) were confined in a mesh cage (49×49×49 cm) with a single transparent acrylic side that allowed observation. They were provided with a diluted honey solution impregnated in a piece of cotton. 0-day-old adults that emerged until 3 h after the start of the scotophase were used in this experiment. Mating behavior was observed every 30 min during the dark period. Mated pairs were transferred from the cage to a plastic cup (13 cm diam. × 6 cm ht.) to facilitate measurement of copulation duration. Since many adults emerged exclusively at 2 h after lights off, the observation of 0-day-old individuals started at 4 h after lights off. The observations were replicated three times.

**RESULTS AND DISCUSSION**

Figure 1 shows the emergence patterns of *S. inferens* females and males. Both sexes showed clear large and distinct peaks of emergence (ca. 45%) at 1.5 h after lights off. In the congeneric species *S. nonagrioides*, adults emerged at 5–6 h after lights off (Babilis and Mazomenos, 1992). Males emerged significantly earlier than females (Mann-Whitney's U-test p<0.001). Mean emergence times of males and females were 9:30 and 10:53, respectively. Oshiro and Azuma (1978) surveyed the emergence pattern of *S. inferens* at room temperature under natural photoperiod in summer and winter. Adult emergence peaked at 20:00–21:00 in summer (ca. 1.5 h after sunset) and at 19:00–20:00 in winter (ca. 1.5 h after sunset). These peaks are similar to the results in this study.

Females were observed to take calling postures (Fig. 2A) from 2 to 4 h after emergence. Immediately before calling, they extended their antennae forward and engaged in slight wing vibration. They then rhythmically protruded and retracted the ovipositor. Frequency of calling in 0-day-old females increased sharply and attained a peak at ca. 7 h after lights off (Fig. 3). Most 1- to 4-day-old females started calling from 2 h (mean: 3.8 h) after lights off (Fig. 3). The frequency gradually increased thereafter and attained almost 100% at 5–6 h after lights off. 0-day-old females repeated short calling bouts with many interruptions for variable periods during the dark period. Once 1- to 4-day-old females initiated calling, they often continued without interruption until 1–2 h before the scotophase terminated.

Within the first 2 h of the scotophase, females and males extended their antennae forward and generally stayed quiescent. Short flights were occasionally observed. Males became active 2 h after lights off, flying throughout the entire cage when females started calling. The male landed on or near
calling females, curved the abdomen toward her and copulated. After the claspers were successfully joined, the male rotated 180° and the pair directed their heads in opposite directions (Fig. 2B). Mating lasted for 1.29 ± 0.71 h (mean ± SD), and there was no significant difference among age groups (Kruskal-Wallis test, p > 0.05).

Mating rates were highest in 0-day-old females (83.3%) and decreased markedly to 56.7% in 4-day-old females (Fig. 4). It is of interest that S. inferens females mated immediately after emergence. In S. nonagrioides, most mating occurred on the first and second nights but none on the night of emergence (Babilis and Mazomenos, 1992). In the other noctuid moths, mating rate is low on the first night of emergence. Most females of the three spotted plusias, *Plusia agnata* (Kitamura and Koyama, 1984), the beet armyworm moth, *S. exigua* (Wakamura, 1989), and the spotted cutworm moth, *Amathes c.-nigrum* (Fujimura, 1976) mate from the second night after emergence. Females of the Oriental armyworm moth, *Leucania separata* (Kanda and Naito, 1979) and cabbage armyworm *Mamestra brassica* (Hirai, 1977) mate from the third night.

Mating rate of 4-day-old females was the lowest (56.7%), and the mating time become irregular (Fig. 4). Oviposition was observed in some unmated 4-day-old females. This suggests that aging might cause a rapid reduction in the reproductive activity of females.

Communication disruption with synthetic sex
pheromone is principally aimed at reducing daily mating opportunity, or delaying the timing of mating, and consequently could reduce density of fertilized eggs in the field. In Spodoptera exigua, mating delay for more than 4 d after emergence resulted in fewer eggs and lower hatchability (Wakamura, 1990). In the present investigations, we found that S. inferens females should mature early (Figs. 3 and 4). This implies that mating delay would seriously impede fecundity of females. Although further detailed investigation is necessary to understand the mating and reproduction of S. inferens, our present findings on the relationships of age and time of day of mating activity will be useful to establish techniques for isolating and monitoring the sex pheromone.

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