Mating Receptivity of Wild Type Females
for Wild Type Males and Mass-Reared
Males in the Melon Fly, *Dacus cucurbitae*
COQUILLET (Diptera: Tephritidae)^{1,2}

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One of the obstacles in the eradication program of the melon fly, *Dacus cucurbitae*, by the sterile insect release method is a decreased sexual competitiveness in released flies (IWAHASHI et al., 1983). Besides the lowered flight activity in mass-reared males (NAKAMORI and SOEMORI, 1981), a change in their mating behavior *per se* may be responsible for this decrease in sexual competitiveness (IWAHASHI, 1987).

IWAHASHI and MAJIMA (1986) studied the mating behavior of the wild melon fly under field conditions, and found that males congregated at dusk on non-host plants such as *Bidense pilosa* and *Amaranthus lividus* which bordered cucurbit fields, and competed for exclusive possession of suitable calling sites (lighter leaves) for females. Furthermore, they suggested that females may exert "mate choice" since an extremely low percentage (1/61, 1.6%) of females which responded to the wing vibration of males resulted in copulations. If female choice of a mate really occurs, mass-reared males are also subjected to the choice of wild females in the field, and such female choice may be responsible for the decrease in their sexual competitiveness. There are, however, no detailed studies in the melon fly on whether wild type females do discriminate between mass-reared males and wild type males.

In this study, we caged wild type females with both wild type males and mass-reared males and compared the mating sequence after encounters of the females with wild type males and after their encounters with mass-reared males (WW- and WR-encounters, respectively). We also examined

whether or not the mass-reared males could successfully mate with the wild type females.

We used three kinds of flies in this experiment: Wild type (abbreviated "W" hereafter) males, W-females and mass-reared ("R" hereafter) males. W-males and W-females were the progeny (F1) of flies collected as larvae from naturally infested fruit of the bitter cucumber, *Momordica charantia* L., in the southern part of Okinawa Is., and R-males were those that had been reared in the mass production facilities of the Fruit-fly Eradication Project Office, Okinawa Prefecture, for about 20 generations.

Both types of flies were sexed within 3 days after emergence and about 15 each of W-males, W-females and R-males were marked individually on the day prior to the day of experiments. The experiments were conducted in the following manner. Five age groups (8–12 day-old flies) were observed for their mating behavior. For example, W-males, W-females and R-males 8-days old (each individually marked on day 7) were released in a field screen cage (2.7×2.7×2.0 m) containing one mulberry tree, *Morus australis* POIR. (ca. 100 cm tall) and one taro plant, *Alocasia odora* SPACR. (ca. 50 cm tall) in planters, and their mating behavior was recorded. The next day, the flies which had been observed were removed and 9 day-old flies were observed in the same manner and so on up through 12 day-old flies.

We recorded the mating behaviors shown in Fig. 1 using a portable tape recorder (Sony Recording Walkman WM-R2®); the recordings started about 18:00 just before the encounters between males and females began. Observations ceased at about 19:30 when identification of individual code became impossible due to darkness. Experiments were conducted from July 16 to September 24, 1987.

The mating sequence of the melon fly can be separated into two types (Fig. 1). When females arrived at the underside of the leaves where males had been vibrating their wings ("calling" vibration as described by KANMIYA et al., 1987) and males approached and the sexes encountered each other, males either A) continued to vibrate their wings in

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Fig. 1. Sequence of mating behavior of the melon fly. Arrows indicate the directions in which behavioral sequences proceed. Upper numerals indicate frequencies of the transitions when wild type females encountered wild type males, and lower ones show frequencies of the transitions when they encountered mass-reared males.

Fig. 2. Relationship between the relative frequency of non-courtship type sequence and age of flies. Solid circles indicate the trend in combination of wild type males and wild type females, and open ones that of mass-reared males and wild type females. The solid triangle illustrates the frequency of non-courtship type sequence when 8 day-old wild type females encountered 11 day-old wild type males, and the open one shows that when 8 day-old wild type females encountered 11 day-old mass-reared males.

a somewhat different manner than before (“courtship” vibration as described by KANMIYA et al., 1987) for at least a few sec and then tried to mount the females, or B) tried to mount the females within a few sec after their arrival without courtship wing vibrations. We refer to the former sequence as “courtship type” and the latter as “non-courtship type”. If the female flew away from the male while he was engaged in wing vibration, we designated it as “escape” and if the female fell from the

leaf when the male attempted to mount, we referred to it as “rejection”. Otherwise, the sequence progressed successfully and resulted in “mounting” and “copulation”. Thus, while males have an active courtship behavior, females apparently make a decision whether to accept them or not.

There was no significant difference in frequencies of the courtship type between WW- and WR-encounters (37/51, 72.5% and 46/66, 69.7%, respectively; Chi-square test, $p > 0.05$). In the courtship type, females escaped from both types of males in rather high proportions (32/37=86.5% for WW- and 39/46=84.8% for WR-encounters) while males were engaged in wing vibration. The duration of the period when females arrived at vibrating males to the time they escaped from them was significantly longer in WW-encounters (60 ± 116 sec, $N=32$) than in WR-encounters (35 ± 78 sec, $N=39$) (MANN-WHITNEY’s U test, $p < 0.05$). That is, W-females escaped from R-males within a shorter time than from W-males when they did not want to accept the male courtship. When males tried to mount females in the courtship type, copulation attempts were accepted only from W-males (4/5) and none from R-males (0/7); the difference between the two types was significant (FISHER’s exact probability test, $p < 0.05$).

In the non-courtship type, females readily ‘accepted’ both types of males (10/14=71.4% for W-males and 10/20=50% for R-males), and the difference was not significant between the two types (Chi-square test, $p > 0.05$); R-males are thus successful only in a non-courtship type sequence.

Under what conditions is the non-courtship type sequence which is favorable to R-males likely to occur?

Figure 2 shows the relationship between the relative frequency of the non-courtship type and the age of flies. The frequency increased with age in a similar manner in WW- and WR-encounters (Chi-square test for contingency, $p < 0.05$). In this experiment, since the age of the two sexes was the same, it was not clear whether the increase in frequency of non-courtship type was due to the age of the males or to that of the females. Thus, we undertook another experiment in which flies of different ages (11 day-old males and 8 day-old females) were used. The result is shown in Fig. 2 by a solid triangle for W-males and an open triangle for R-males. The frequency level of non-courtship type in these cases was the same as those in the experiments in which 8 day-old males and females were used (Chi-square test, $p > 0.05$). So, it is considered that increasing frequency of the non-courtship type was not due to the aging of males but to that of females.

From this study, two points were clarified. First, as females of the melon fly got older, the frequency of non-courtship type began to increase, suggesting that females became more receptive with age. Such a phenomenon was reported in some other insects (e.g. fireflies, *Photinus macdermotti*; SOUCEK and CARLSON, 1975), and its adaptive significance can be easily understood because females may suffer a serious disadvantage if they remain unfertilized for a long time. For example, delay of copulation lowers the fecundity of females in the oriental tea tortrix, *Homona magnanima* (KIRITANI and KANO, 1984).

Second, since sexually immature females of the melon fly never respond to the calling wing vibration of males (IWAHASHI, unpubl.), sexually mature younger females (i.e., 8 or 9 days-old) which came to the males but did not accept them may indeed be discriminating against the males. The females never accepted R-males in the courtship type sequence. If most females of the melon fly mate before they become very old, non-courtship type

sequence may rarely occur under field conditions. And if so, such a female mate intolerance for R-males exerted in the courtship type sequence may be responsible for the decrease in sexual competitiveness of the mass-reared males.

Recently, existence of a female mate preference was suggested in other tephritid flies. For example, females of Caribbean fruit flies, *Anastrepha suspensa*, tended to discriminate among males based on their wing vibration (BURK and WEBB, 1983). Females of the melon fly are also considered to use male wing vibration as information on male characters. Thus, comparison of the characteristics of wing vibration sound produced during courtship between W-males and R-males may be beneficial for further understanding.

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