SHORT COMMUNICATIONS

A Simple Method to Estimate Sterile: Normal Ratios Based on Hatchability on Eggs¹

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During the course of a large-scale field experiment to eradicate the melon fly, *Dacus cucurbitae* COQUILLET, from Kume Zima (Kume Is.), Okinawa, sterile flies to be released were marked with a fluorescent dye, Whitex SKC®, at the ptilinum of adults. Flies were recaptured bi-monthly with 50 monitor traps baited with cue-lure and naled. Detection of marked flies was made under an ultra-violet tube. This operation, however, became difficult due to the occurrence of a green natural fluorescence which was confusable with the blue

fluorescence of Whitex SKC. The flies which showed this green fluorescence appeared since June 1975, possibly due to the decomposition of dead insects in the warm and humid climate. To overcome this difficulty, a simple method was devised to estimate the ratio of sterile flies to normal ones using data on hatchability of eggs sampled from field-infested fruits or laid by field-collected females.

IWAHASHI (1976) reported the results of a pilot release experiment of sterile flies into Kudaka Zima, a small islet near Okinawa Hontô (the Island of Okinawa). Detection of sterile flies with an ultra-violet tube could be made with a high level of precision because there was no confusable natural fluorescence during the experimental period and the rate of hatch of eggs collected from loofahs was obtained in the laboratory. Table 1 presents the results of these studies. As shown in this table the rate of egg hatch in the released area decreased remarkably as compared with those in the control area (Okinawa Hontô).

FRIED (1971) presented an equation to calculate 'sexual competitiveness' of sterile males, that is,

Table 1. RATIO OF MARKED *D. cucurbitae* MALES TO UNMARKED ONES IN 15 PLASTIC TRAPS, RATE OF EGG HATCH, AND RATIO OF STERILE TO NORMAL MALES CALCULATED FROM DATA ON EGG HATCH (ORIGINAL DATA WERE TAKEN FROM IWAHASHI, 1976)

Date	No. males released	Ratio of marked males to unmarked ones ^a	Rate of egg hatch	Calculated ratio of sterile to fertile males
1974				
Nov. 14	50,000			
Nov. 28	50,000	1.41 (632)		
Dec. 5	50,000	1.85 (368)		
Dec. 11	50,000	5.25 (1108)	0.556 (90)	0.380
Dec. 21	50,000	3.17 (492)		
Dec. 27	50,000	6.20 (314)	0.527 (205)	0.480
1975				
Jan. 1	50,000	3.80 (379)	0.245 (49)	2.676
Jan. 8	50,000	5.47 (233)		
Jan. 14	50,000	8.23 (120)	0.070 (113)	12.939
Jan. 29		6.97 (303)	0.111 (18)	7.632
Feb. 5		7.64 (311)	0.092 (98)	9.503
Feb. 13		6.78 (61)	0.395 (152)	1.118
Feb. 20		1.75 (33)		
Feb. 27		2.00 (21)	0.0 (274)	^b
Mar. 6		1.15 (15)	0.870 (23)	

^a Figures in parentheses indicate the number of flies or eggs examined.

^b Infinitive.

¹ Appl. Ent. Zool. **11** (2): 139-140 (1976).

$$c = \frac{Ha - E}{E - Hs} \cdot \frac{N}{S} \quad (1)$$

where:

- N : Number of normal males.
- S : Number of sterile males.
- Ha : Rate of egg hatch in matings of $N \delta \times N \varphi$.
- Hs : Rate of egg hatch in mating of $S \delta \times N \varphi$.
- E : Rate of egg hatch at a given ratio of sterile vs. normal males in the presence of normal females.

Hs is zero in our experiment where a dose of 7 KR γ -radiation was applied to pupae 2 days before adult eclosion.

If we know Ha , E and c , we can estimate the ratio of sterile to normal flies by the equation:

$$\frac{S}{N} = \frac{Ha - E}{E} \cdot \frac{1}{c} \quad (2)^1$$

An overall mean of the rate of hatch of eggs collected from loofahs in the control area during Dec. 27 and March 6 is 0.704 ± 0.160 (This value is lower than those obtained in the warmer seasons, possibly due to low winter temperatures), and this value is used as Ha . For c , 0.7 was tentatively used based on the results of our laboratory experiments on the sexual competitiveness of *D. cucurbitae* (TERUYA and ZUKEYAMA, 1975).

Substituting rates of egg hatch shown in Table 1 for E in Eq. 2, expected values of S/N were obtained (the last column of Table 1) and compared with 'actual' values, that is ratios of marked flies to unmarked ones, both of which were caught by 15 plastic traps.

The calculated values are, as seen in the table, considerably lower than 'actual' values at the initial stage (Dec. 11 and 27). This is natural because the increase of sterile males should precede that of eggs laid by females mated with sterile males. The difference between the calculated and 'actual' ratios decreased on January 1, and there is no large inconsistency between the two from January 14 to February 5. The calculated ratio is far lower than the 'actual' ratio on February 13, the reason for which is not known. We suppose this discrepancy is due to sampling error.

We used here the ratio of the number of hatched eggs to the number of eggs laid as E in FRIED's equation. But, in the case of multiple mating, this method can be used only when sterile sperms

can compete well with fertile sperms. Laboratory experiments on the mating behaviour (IKENAGA, in preparation) and informations on the survival rate of adults under field conditions (ITÔ et al, 1974) suggest that many females can mate several times. Examination of data from Kume Zima (IWAHASHI, in preparation) showed that some females in the experimental area oviposit eggs of which hatchability is considerably low, suggesting that the assumption mentioned above holds. Further studies are needed on this problem, however.

Meanwhile, we can estimate c with Eq. 1 by substituting values for the 'actual' sterile : normal ratio and observed Ha and E . The mean value of c thus estimated for January 14, 29 and February 5 is 0.912 ± 0.172 which is larger than the initially supposed value, 0.7, apparently indicating greater sexual competitiveness as compared with the results of laboratory experiments. As the sample size is small, however, we don't discuss this problem here further.

When we attempt to estimate population parameters based on field sampling, the variances of estimated values are inevitably large. One of the methods to overcome this difficulty is to use several methods of estimation based on different principles. When there should be no remarkable difference between estimates, we would safely adopt these values. The method presented here can be used, even in the case where the ultraviolet detection of sterile males was considered to be made precisely, as a reference value of the sterile : normal ratio estimated from the ratio of fluorescence-marked to unmarked individuals.

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¹ In contrast with many laboratory experiments on the sexual competitiveness where normal females are caged with sterile and normal males, we release sterile females as well as males. But this does not affect the use of FRIED's equation. Although FRIED (1971) did not mention the influence of sex ratio, it is better to maintain a constant sex ratio for comparing Ha and E .