The Rate of Catch of the Male of *Spodoptera litura* F. (Lepidoptera: Noctuidae) by Virgin Female Traps

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In order to examine the effectiveness of virgin female traps, marked male moths of *Spodoptera litura* F. were released in a field. When 4 traps baited with 1, 5, 10, and 20 virgin females respectively were operated at the same time within a square field of 100 m $\times$ 100 m, the rate of catch per trap per night was not increased in parallel to the increase in the number of virgin females attached to the trap. The rate of catch in the traps baited with 20 females was not so high as compared with the traps baited with 10 females. The percentage of marked males caught by the 4 traps in the summer season was, in the average, 7.4% to the number of the males released, but that in the autumn was 30.8%. There was no relationship between the daily fluctuation in the rate of catch and weather conditions.

INTRODUCTION

It has frequently been reported during the last several years that the trap baited with virgin females exerts strong attraction to males of many species of insects. In *Spodoptera litura* F., the strong attractiveness of virgin female traps was also confirmed by YUSHIMA *et al.* (1969). However, there has been few quantitative studies on the nature of attractiveness exerted by virgin female traps.

In this paper the results of studies on the attractiveness of the virgin female trap in relation to the number of females attached to it is reported. The relationship between the rate of catch and weather conditions has also been analyzed.

MATERIALS AND METHODS

The insects used were those reared on beet leaves in an insectary where temperature, humidity, and light conditions were not controlled.

On the first day after the night of adult emergence, the males were anesthetized by carbon dioxide gas for marking. The marking was made by a quick drying ink (Pentel pen) on their hind wings. The marked males were kept in the insectary up to the next day and were provided with a 10% honey solution. The keeping of males for one day is because the mating activity of the moth becomes highest at the third night from the day of emergence (YUSHIMA *et al.* 1969). They were then randomly distributed within 4 plots arranged in a field where red clover and orchard grass grew with weeds (field A in Fig. 1). Each plot was a square of 50 m $\times$ 50 m. The marked males were released 4 times in each of the periods from August 9 to 12 (summer season) and from September 17 to 20 (autumn season), 1971. The number of males released in each plot in both seasons are shown in Fig. 1.

Fig. 1. The upper chart shows the arrangement of traps in the respective plots of field A (circles) and the numbers of males released in the summer and autumn seasons (the lefthand and righthand figures, respectively, in each square). The figures in circles indicate the number of females attached to a trap. The lower chart shows the map of the field (the campus of Chiba Pref. Agric. Exp. Sta.).

Fig. 2. Virgin female trap of *Spodoptera litura*. In this photograph, a trap with 5 females is shown. The females were confined in the upper right can and the other 3 cans were kept empty (when baited with 20 females, all the cans contained 5 females, respectively).

The females were also kept in the insectary for one day after their emergence and then used as the source of attractant for the males released into the field. In the field, they were kept in a round can (8.5 cm in diameter and 5.5 cm in length), both sides of which were covered with a wire gauze. This can was hung on a tub (41 cm in diameter)

filled with water. The height of the can from the water surface of the tub was about 5–10 cm (see Fig. 2). Traps baited with 1, 5, 10, or 20 females were set at the centers of the respective plots as shown in Fig. 1.

The females in the cans were replaced by fresh ones every day.

RESULTS AND DISCUSSION

The rate of catch in relation to the number of females attached to a trap

Table 1 shows the numbers of males released into each plot and the number of males caught by the traps baited with 1, 5, 10, and 20 females at the first night of release. According to this table, the number of catches per trap was very small in the summer season as compared with that in the autumn. In the summer season, the number of catches per trap increased slightly as the number of released males increased. However, such a tendency was not observed in the autumn season.

The marked males which were released within a certain plot were caught not only by the trap located in that plot, but also by other traps located in the neighbouring plots. The traps baited with many virgin females often attracted a relatively large number of males which had been released in the neighbouring plots.

In the autumn season, another release experiment was carried out at the same time (on Sept. 18) in a field (field B in Fig. 1) which was about 600 m apart from field A,

Table 1. NUMBERS OF MALES RELEASED AND TRAPPED WITHIN RESPECTIVE PLOTS

Release	No. of females per trap	No. of males			
		Released (Summer season)	Trapped	Released (Autumn season)	Trapped
1st	1	35	1 (0)	87	5 (3)
	5	29	2 (1)	86	17 (10)
	10	36	1 (2)	86	12 (24)
	20	35	0 (0)	91	12 (12)
	Total	135	4 (3)	350	46 (49)
2nd	1	70	3 (0)	81	12 (10)
	5	74	1 (6)	74	17 (11)
	10	71	2 (2)	77	12 (25)
	20	65	2 (5)	80	27 (22)
	Total	280	8 (13)	312	68 (68)
3rd	1	48	0 (0)	53	2 (0)
	5	50	0 (0)	57	1 (0)
	10	48	4 (1)	59	2 (1)
	20	54	2 (10)	58	1 (7)
	Total	200	6 (11)	227	6 (8)
4th	1	40	0 (0)	39	1 (1)
	5	45	0 (2)	39	3 (8)
	10	43	0 (7)	37	4 (3)
	20	43	0 (5)	47	6 (4)
	Total	171	0 (14)	162	14 (16)

The figures in parenthesis indicate the males released in neighbouring plots.

Fig. 3. Relationship between the number of virgin females attached to a trap and the rate of catch per trap during the first night of release. Small circles indicate observed values (hollow and solid circles show the summer and autumn seasons, respectively) and the large ones the average.

Fig. 4. Relationship between the number of virgin females attached to a trap and the number of native males caught per trap per night. Circle indicates the average for 5 or 6 nights.

Fig. 5. Daily fluctuation in catch of marked and native males, and weather conditions. Vertical bar indicates the rate of catch in marked males (black or dotted bar different for the dates of release) and the number of catch of native males (hollow). Figures in the graph show the number of males released on the respective days. Solid line represents temperature and dotted one wind class and direction at 6 p. m.

and the males released in either of fields A and B were caught by traps located in the other field. At the night of release, the trap in field B caught 9 males which had come from field A, and the traps in field A also caught 14 males which had come from field B. Therefore, it is clear that the range over which the male actively moves about is consid-

erably large. According to our unpublished data¹ on the rate of catch in the males released at different distances from a trap baited with 20 virgin females, it is estimated that males come to the trap 1,000 m or more distant from the release point.

Fig. 3 shows the relationship between the number of females attached to a trap and the percentage of males caught. The small circles in the graph indicate the percentages calculated from the number of catches at the first night and the number of the males released at that time. The percentage of catch by the trap greatly fluctuated day by day and from season to season, but a clear tendency was recognized when the average was taken. That is, the tendency seems to be represented by an upward curve with an asymptote. This, of course, means that the rate of catch per trap per night did not increase in parallel with the increase in the number of females attached to the trap. According to HENNEBERRY *et al.* (1967), the number of catches in the light trap baited with virgin females of *Trichoplusia ni* showed an increase parallel to the increase in the number of females attached.

The fact described above was also reconfirmed clearly by data on native males which were caught by the traps together with the marked males (Fig. 4). According to the records of moth catches by a light trap (100 w high pressure mercury lamp) standing on a place near the main building of the station (Chiba Prefectural Agricultural Experiment Station), the occurrence of native moths in the summer and autumn seasons differed considerably from each other, but the relationship between the number of females attached to a trap and the average number of catches per trap per night was quite similar in both seasons. In this case, the number of males caught by the trap baited with 20 virgin females was smaller than that caught by the trap baited with 10 virgin females.

The reason why such a result was obtained is unknown, but an explanation as follows may be possible. It is natural to consider that under field conditions, the females are generally distributed rather sporadically, and crowding of many females on a spot is rather rare even at the time of outbreak. Therefore, it is suspected that the crowded existence of females on a spot may produce an abnormal condition to the male. If so, such a state will bring about some kind of confusion or modification in the normal mating behaviour of the male, and these events may reflect directly on the rate of catch in the trap with an excess number of females.

The rate of catch and weather conditions

Fig. 5 shows the relationship between weather conditions and the rate of catch during successive 4 days in each of the summer and autumn seasons. In this graph, the rate of catch was calculated from the total number of males released and that of males caught at each of the nights of release and afterwards. Data on catch of native males were also included for reference.

In the summer season, marked males were caught only at the first night of release, and the rate of catch was 5–8% (7.4% in the average). In the autumn season, on the contrary, the catch was observed continuously up to the fourth night, and the rate of catch was 12–41% (30.8% in the average), although the catch at the first night occupied 50–90% of the total catch. According to WONG *et al.* (1971), it was estimated that in *Argyrotaenia velutinana* the virgin female trap caught 37% of the males released.

The cause which brought about such a difference between the results obtained in

¹ This will be published elsewhere in the near future.

the two seasons was not clear, but it was suspected that the high temperature in the summer season had an important effect upon the rate of catch. It is certain that under high temperature conditions the survival period of the moth is greatly shortened, and its activity such as dispersal by flight may also become high.

Small amounts of rainfall were recorded during the day of August 13 (0.1 mm), September 18 (8.0 mm), and 22 (1.7 mm), but it is considered that its effect on the catch of males was negligible.

In the autumn season, the rate of catch in marked males and the number of native males caught greatly fluctuated day by day. However, it was very difficult to find out any relationship between weather conditions and such fluctuations. SAARIO *et al.* (1970) also reported that in an experiment on the catch of males of *Trichoplusia ni* with pheromone-baited traps, no correlations existed between daily fluctuation in catch and temperature and relative humidity.

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