Field Trapping of the Onion and Seed-Corn Flies with Baits of Fresh and Aged Onion Pulp^{1,2}

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Compounds with a propylthio moiety, such as n-propylthiol (PrSH) and di-n-propyl disulfide (PrSSPr) emanating from onions have been known to attract the onion fly, *Hylemya antiqua* MEIGEN, and stimulate its oviposition in laboratory tests (ISHIKAWA et al., 1978, PIERCE et al., 1978, VERNON et al., 1978). MATSUMOTO (1970) also reported the attractancy of these compounds particularly to the female flies in a field-trapping test conducted in Canada. TOMIOKA (1977), however, reported a much higher attractancy of the decaying onion pulp to the onion fly and the seed-corn fly, *Hylemya platura* MEIGEN, than of the fresh pulp or PrSSPr in a field-trapping test in Hokkaido, Japan.

In the present investigation, we aimed to confirm the increased attractancy of the aged onion pulp in comparison with that of the fresh pulp, and also to determine the attractancy of PrSSPr in field conditions.

The tests were carried out in an onion field at the Hokkaido National Agricultural Experiment Station, Hitsujigaoka, Sapporo from the 16th to 25th of August 1980. Eleven thousand onion seedlings were planted 15-cm apart in each

column and at a 45-cm interval in each row in the field. Each trap was essentially the same as that described by MATSUMOTO (1970); it was composed of a transparent plastic cylinder (15 cm in diam. $\times$ 15 cm in height) covered with a flat top and a cone (15 cm in diam. $\times$ 6.5 cm in depth, ending in a basal hole 6 mm in diam.) fit for the bottom of the cylinder. The trap was supported by a triangular wire frame inserted into the ground so that the base of the trap was ca. 5 cm above the ground and the bait was set under the trap in a petri dish. Flies attracted to the bait entered the cylinder through the basal hole by their positive phototaxis as they left the bait. Nine or 16 traps were placed at 10-m intervals in a 3 $\times$ 3 or 4 $\times$ 4 latin square layout.

The onion pulp was prepared by grinding 450-g sliced onion in a blender for 2 min at full power. One-hundred-and-fifty grams of the onion pulp was provided per petri dish (13 cm in diam. $\times$ 3 cm in depth). PrSSPr (1.2 ml) diluted in 25-ml odorless liquid paraffin was put in a smaller petri dish (9 cm in diam. $\times$ 1 cm in depth), and covered with a sheet of coarse nylon gauze to prevent drowning of the flies. Twenty-five ml of water was used as a control. Two series of trapping tests were carried out. In series I, the effects of the following three samples were examined: the fresh onion pulp prepared daily, the onion pulp left in the field throughout the experimental period, and water. In series II, PrSSPr was tested in addition to the above three samples.

Traps were set at 12:00 noon and then the flies captured were counted every 2 hr. At 10:00 a.m. the following mornings, the flies trapped were killed with an aerosol insecticide and identified according to KATO's key (1951) under a 20 $\times$ binocular microscope. The traps were changed and washed every day with detergent to thoroughly eliminate the remaining insecticide.

The total number of flies captured by the fresh, aged onion pulps and PrSSPr during the two series of experimental periods are shown in Table 1. The insects trapped were almost exclusively the onion flies and the seed-corn flies. Aged onion pulp was the most attractive to both species of flies among the tested samples. The number of

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Table 1. THE NUMBER OF THE FLIES CAPTURED IN TRAPS BAITED WITH ONION PULP AND DIPROPYL DISULFIDE (PrSSPr) DURING FIVE DAYS

Baits	Numbers of flies captured ¹					
	<i>Hylemya antiqua</i>			<i>Hylemya platura</i>		
	Male	Female	Total	Male	Female	Total
Experiment I ²						
Water (control)	5	1	6 a	1	0	1 c
Fresh onion pulp	35	34	69 b	13	15	28 d
Aged onion pulp	56	52	108 b	40	17	57 d
Experiment II ³						
Water (control)	0	5	5 e	0	3	3 h
PrSSPr	3	11	14 ef	1	8	9 h
Fresh onion pulp	16	19	35 fg	10	25	35 i
Aged onion pulp	32	39	71 g	36	32	68 i

¹ Figures in each experimental series followed by the same letter are not statistically different at 5% level.

² Test period: August 16–20, 1980. Temperature: 15–25°C. Weather: Rainy, except August 20.

³ Test period: August 21–25. Temperature: 17–28°C.

Weather: Fine 21–22, cloudy or rainy 23–25.

flies trapped by the aged onion pulp was 1.6 to 2.0 times larger than that trapped by the fresh pulp. The PrSSPr captured a smaller number of flies of both species compared with either fresh or aged onion pulp. The number of onion flies attracted to PrSSPr was about 2/5 of that to the fresh onion pulp and 1/5 of the aged pulp and that of seed-corn flies was about 1/4 and 1/8 of the fresh and aged onion pulps, respectively. Both the fresh and aged onion pulps attracted both sexes of the two fly species, while PrSSPr attracted their females predominantly. These results seem to suggest that the onion pulp, whether it is fresh or aged, functions as a feeding lure, while PrSSPr acts as an oviposition lure to these species.

To determine the increasing attractancy of the aged onion pulp in relation to its age, the change in the number of flies captured was examined every day. It is apparent from Table 2 that the onion pulp gradually increased its attractancy to the onion fly with the passage of time. Onion pulp aged more than 2 days caught 1.5 to 4.3 times more onion flies than the fresh pulp. On the other hand, the intensified attractancy of the onion pulp to the seed-corn fly was exhibited after 4- or 5-days aging. It was noticed that the highest percentages, 63.2% and 48.5%, of the seed-corn flies captured were found on the last (5th) day of the experiments. The difference in response

between the onion flies and the seed-corn flies to the aging onions suggests the difference in the spectrum of attractants effective for the two species. As each experimental series was terminated after 5 days, we could not conclude that 5-day-old onion pulp had maximum attractancy.

The percentages of onion and seed-corn flies caught in each 2-hr interval from 12:00 to 18:00, and during 16 hrs from 18:00 to 10:00 the following morning were recorded (Table 3). As the sunrise and sunset were at 4:50 and 18:30, respectively, the active time of these diurnal flies was estimated as about 5.7 hr between 18:00 and 10:00 the next morning. In the last, longer interval, therefore, the number of flies trapped per hr was calculated on the basis of this value. The cabbage root fly, *Hylemya brassicae* BOUCHE, a species closely related to the onion and seed-corn flies, has been shown to be quite active at dawn and 4 hr prior to light-off under laboratory conditions (ZOHREN, 1968). The onion and seed-corn flies, on the contrary, showed no clear peaks in capture/hr in our field trapping test. Our results do not seem to necessarily reflect the general activity of these species, however, because of the almost constant rainy and unusually cool weather during the experimental period.

In this experiment and in our preliminary trapping tests in 1978 and 1979 in the same field (ISHIKAWA, unpublished data), we could not cap-

Table 2. CHANGES IN THE NUMBER OF *Hylemya antiqua* AND *H. platura* CAPTURED IN TRAPS BAITED WITH FRESH AND AGED ONION PULP

Baits	Days aged 0-1	1-2	2-3	3-4	4-5	Total
Exp. I¹						
<i>Hylemya antiqua</i>						
Water (control)	1	3	2	0	0	6
Fresh onion pulp(F)	7	11	17	17	17	69
Aged onion pulp(A)	10	10	25	25	38	108
Ratio (A/F) ³	1.4	0.9	1.5*	1.5*	2.2*	1.6
<i>Hylemya platura</i>						
Water (control)	1	0	0	0	0	1
Fresh onion pulp(F)	5	3	4	10	6	28
Aged onion pulp(A)	1	5	3	12	36(63%)	57
Ratio (A/F) ³	0.2	1.7	0.8	1.2	6.0*	2.0
Exp. II²						
<i>Hylemya antiqua</i>						
Water (control)	3	1	1	0	0	5
PrSSPr	5	2	1	4	2	14
Fresh on pulp(F)	13	4	5	4	9	35
Aged onion pulp(A)	13	7	11	17	23	71
Ratio (A/F) ³	1.0	1.8	2.2*	4.3*	2.6*	2.0
<i>Hylemya platura</i>						
Water (control)	1	0	0	2	0	3
PrSSPr	2	2	2	2	1	9
Fresh onion pulp(F)	5	3	8	5	14	35
Aged onion pulp(A)	10	3	4	18	33(49%)	68
Ratio (A/F) ³	2.0	1.0	0.5	3.6*	2.4*	1.9

^{1,2} See the footnotes to Table 1.³ Ratios with an asterisk are significantly different from 1.0 at 5% level.Table 3. CAPTURING OF ONION AND SEED-CORN FLIES DURING A DAY¹

Time	Percent of flies captured ²	
	<i>H. antiqua</i>	<i>H. platura</i>
12 : 00-14 : 00	17.7 (8.9)	17.5 (8.8)
14 : 00-16 : 00	13.5 (6.8)	22.0 (11.0)
16 : 00-18 : 00	17.7 (8.9)	11.3 (5.7)
18 : 00-10 : 00 (next day)	52.2 (9.2) ³	49.2 (8.6) ³

¹ Data from Exp. 1 and 2. Trap was set at 12 : 00. Sunrise: 4 : 50, Sunset: 18 : 30.² Figures in parentheses indicate the percents of flies captured per hr.³ See the text for the calculation of these values.

ture a large number of onion flies with PrSSPr. Several trapping tests made in Japan have also failed to show the efficacy of PrSSPr as a synthetic bait for either the onion fly or the seed-corn fly

(NISHIZAWA et al., 1972, TOMIOKA 1977). On the other hand, MATSUMOTO (1970) in Canada, LOOSJES (1976) in the Netherlands, and DINDONIS and MILLER (1980) in the U.S.A. succeeded in capturing a significant number of onion flies in the field with PrSSPr as a bait. This discrepancy in behavioral response to PrSSPr in the field between the onion fly in Japan and that in Europe or North America might suggest a difference in their strains.

This experiment confirmed that onion pulp is superior to PrSSPr as a bait for onion and seed-corn flies in the field. This indicated the presence of some strong attractants besides the propylthio compounds in the onion pulp. As to the intensified attractancy of the decaying onion, we have already clarified that ethyl acetate produced by bacteria synergizes the attractancy of PrSSPr to the onion fly in the laboratory bioassay (IKESHOJI et al., 1980). The enhanced attractancy of the aged onion pulp to both the onion and seed-corn flies, therefore, may be attributed

to the production of ethyl acetate and other yet unidentified compounds by bacterial decomposition. Another possible origin of the enhanced attractancy would be the reduction of repellent pungency in the onion pulp and/or a change in the odor quality by auto-oxidation.

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REFERENCES

- DINDONIS, L. L. and J. R. MILLER (1980) *Environ. Entomol.* **9** : 467-472.
- IKESHOJI, T., Y. ISHIKAWA and Y. MATSUMOTO (1980) *J. Pesticide Sci.* **5** : 343-350.
- ISHIKAWA, Y., T. IKESHOJI and Y. MATSUMOTO (1978) *Appl. Ent. Zool.* **13** : 115-122.
- KATO, S. (1951) *Plant Protection News* (Boeki Jiho) **22** : 28-33. (in Japanese).
- LOOSJES, M. (1976) *Agric. Res. Rep.* (Versl. landbouwk. Onderz.) 857. Pudoc, Wageningen. 179pp.
- MATSUMOTO, Y. (1970) In "Control of Insect Behavior by Natural Products." (eds. Wood, D., R. Silverstein and M. Nakajima) Academic Press. 345pp.
- NISHIZAWA, S., A. ASAH, H. NAKAMURA, S. TAHARA, J. MIZUTANI and Y. OBATA (1972) *Memoirs Fac. Agr. Hokkaido Univ.* **8** : 102-109. (in Japanese with English summary).
- PIERCE, H. D. Jr., R. S. VERNON, J. H. BORDEN and A. C. OEHLISCHLAGER (1978) *J. Chem. Ecol.* **4** : 65-72.
- TOMIOKA, T. (1977) *Plant Protection*. (Shokubutsu Boeki) **31** : 206-209. (in Japanese).
- VERNON, R. S., H. D. PIERCE Jr., J. H. BORDEN and A. C. OEHLISCHLAGER (1978) *Environ. Entomol.* **7** : 728-731.
- ZOHREN, Von E. (1968) *Z. angew. Ent.* **62** : 139-188.

Relationship between Host Plant Ranges of the Three Papilionid Butterflies and Oviposition-Inducing Contact Chemicals in Their Host Plants¹

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It has been elucidated that Papilionid female butterflies select suitable host plants from among many species by touching the surface of sprouts or leaves with their forelegs (NISHIDA, 1977; ICHINOSÉ and HONDA, 1978). This behavior may be triggered in a certain zone and enable dis-

crimination of chemical stimuli in the host plant through contact chemoreception which induces eventual oviposition. It seems, however, not always understood in the sense of successive steps of host-searching-ovipositional behavior, for SAXENA and GOYAL (1978) studied combined effects of several factors on the orientational preference and ovipositional behavior of *Papilio demoleus*, and INAIZUMI (1979) so stressed an erroneous oviposition of *P. protenor* that he lost sight of this inherent ovipositional behavior of the species. The chemicals in the host plants have been studied for two Papilionid species (NISHIDA, 1977) and *P. protenor demetrius* (ICHINOSÉ and HONDA, 1978) and found to be hydrophilic and thermostable substance(s).

Eight species of the Japanese 'Citrus Papilio' exclusively lay eggs and feed on various rutaceous plants. The range of these host plants is broadly overlapped among the butterfly species, whereas each species perceives its specific host plants.

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