July - December, 1974
Laboratory Report
Gypsy Moth Methods Development Laboratory
Plant Protection and Quarantine Programs
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Project Number: GM 5.1.1
Project Title: Laboratory Screening of Candidate Pesticides
Report Period: July - December, 1974
Report Type: Interim
Project Leader: Winfred H. McLane

The main objective of this laboratory screening project is to collect mortality data on experimental compounds potentially useful against the gypsy moth, evaluating the data and selecting suitable materials for field testing.

Circular tin dishes 3.75 X 0.5" were sprayed at 1 lb. AI/gal/ac in replicates of 5 with 2nd instar gypsy moth larvae used as test insects. Five larvae were allowed to crawl over the treated surface of each dish for given periods of time. Larvae were then removed and held on artificial diet with mortality readings being taken at various times. Results are tabulated below.

Material	Exposure	Hours After Treatment Larvae Exposed	Hours	Mortality %
DDT 50 W/P	5 min	1	23	4
"	"	4	27	16
"	"	7	20	40
"	"	24	2.5	28
Sevin 80S	5 min	1	30	44
"	"	4	27	88
"	"	7	20	68
Resmethrin EC	5 min	1	23	84
"	"	4	27	92
"	"	7	20	100
Check	5 min	1	30	0
DDT 50 W/P	1 hour	1	24	32
"	2 "	2.5	25	84
"	3 "	4.5	42	96
"	17.5 "	8	25	76
"	7 "	0.5	16	44
Sevin 80S	1 hour	1	24	96
"	2 "	2.5	21	100
"	3 "	4.5	42	92
"	17.5 "	8	25	100
"	7 "	0.5	16	96
Resmethrin EC	1 hour	1	24	100
"	2 "	2.5	21	96
"	3 "	4.5	42	100
"	17.5 "	8	25	76
"	7 "	0.5	16	100
Check	17.5 "	1	42	0

CGA-18809, Imidan and TH-6040 wettable powders were mixed with H_2O and allowed to age for 5 days at 80° and 60% humidity. After this period tender oak seedlings were sprayed and 2nd instar larvae were then introduced onto plants.

Material	Dosage	Days Aged	Mortality % 24 H	48 H	72 H	96 H
CGA-18809	0.25 lb/gal/ac	0	32	70	99	
"	0.125 lb/gal/ac	0	25	95	100	
"	0.25 lb/gal/ac	5	15	73	100	
"	0.125 lb/gal/ac	5	18	76	100	
Imidan	1.0 lb/gal/ac	0	94	100		
"	0.5 lb/gal/ac	0	44	100		
"	1.0 lb/gal/ac	5	16	82	99	100
"	0.5 lb/gal/ac	5	13	71	99	99
TH-6040	0.03 lb/gal/ac	0	0	0	4	9
"	0.015 lb/gal/ac	0	0	0	2	4
"	0.03 lb/gal/ac	5	0	3	64	85
"	0.015 lb/gal/ac	5	0	4	52	90
Check	-	-	0	0	0	0

Little if any effectiveness was lost with CGA-18809 or Imidan. TH-6040 appeared to gain strength, however, this in part may have been due to the age of 2nd instar test insects.

A field sample of encapsulated Diazinon was tested in the laboratory and gave good mortality for 3 weeks. This same material performed poorly in the field.

Encapsulated Dibrom was tested at various dosages with results being poor.

SAN I 197 and SAN I 201, organo phosphates from Sandoz Inc., gave excellent control of 2nd instar gypsy moth larvae when tested on oak seedlings at 0.0625 lb AI/gal/ac. When exposed to 3" of rainfall materials continued to give good kill. The acute oral LD 50 of SAN I 197 and SAN 201 to male rats is 1800 and 3120 mg/kg respectively.

Material	Dosage	Rain	Mortality % 24 H	48 H	72 H	96 H
SAN I 197	2 lb AI/gal/ac	-	87	99	100	
"	1 "	-	86	100		
"	0.5 "	-	70	97	100	
"	0.25 "	-	50	94	100	
"	0.125 "	-	41	93	100	

Material	Dosage	Rain	Mortality % 24 H	48 H	72 H	96 H
SAN I 197	0.062 lb AI/gal/ac	-	14	38	63	
"	0.031 "	-	6	15	18	
"	0.0156 "	-	8	22	41	
"	0.0078 "	-	4	19	25	
Check	-	-	0	0	0	
SAN I 197	1 lb AI/gal/ac	1"	87	98	100	
"	0.5 "	"	74	97	100	
"	0.25 "	"	64	78	97	
"	0.125 "	"	42	57	85	
"	0.062 "	"	36	54	71	
Check	-	-	0	0	0	
SAN I 197	1 lb AI/gal/ac	3"	57	80	86	89
"	0.5 "	"	51	84	97	99
"	0.25 "	"	23	29	42	60
"	0.125 "	"	42	52	81	92
"	0.062 "	"	26	45	64	80
Check	-	-	0	0	0	0
SAN I 201	2 lb AI/gal/ac	-	83	100		
"	1 "	-	79	100		
"	0.5 "	-	66	99	100	
"	0.25 "	-	57	97	100	
"	0.125 "	-	40	97	100	
"	0.062 "	-	46	83	100	
"	0.031 "	-	15	41	86	
"	0.015 "	-	3	4	9	
"	0.007 "	-	2	2	13	
Check	-	-	0	0	0	
SAN I 201	1 lb AI/gal/ac	1"	64	92	99	
"	0.5 "	"	60	87	97	
"	0.25 "	"	52	75	98	
"	0.12 "	"	39	69	91	
"	0.06 "	"	29	43	54	
Check	-	-	0	0	0	
SAN I 201	1 lb AI/gal/ac	3"	49	94		
"	0.5 "	"	46	96		
"	0.25 "	"	37	83		
"	0.12 "	"	19	64		
"	0.06 "	"	22	56		
Control	-	-	0	0		

The following materials were tested against 2nd instar larvae on treated tender oak seedlings.

Material	Dosage lb/gal/ac	Percent Mortality
DS-24465 (Diamond Shamrock)	1.0	100 (4 days)
	0.5	95
	0.25	92
	0.125	86
	0.062	85
	0.031	25
	0.015	3
	0.007	0
	0.003	1
	Check	0
ACD-7029 (Allied Chemical)	1.0	44 (3 days)
	0.5	67
	0.25	51
	0.125	18
	0.062	11
	Check	2
GC-9160 (Allied Chemical)	1.0	38 (3 days)
	0.5	4
	0.25	6
	0.125	1
	0.062	0
	Check	0
GC-S-10200 (Allied Chemical)	1.0	3 (3 days)
	0.5	1
	0.25	0
	0.12	3
	0.06	0
	Check	0
Gulf 15126	1.0	96 (3 days)
	0.5	97
	0.25	98
	0.125	99
	0.062	95
	0.031	83
	0.015	61
	0.007	23
	0.003	17
	Check	0

Material	Dosage lb/gal/ac	Percent Mortality
Buson 30 (Buckman Laboratory)	1.0	8 (4 days)
	0.5	3
	0.25	4
	0.125	5
	0.06	4
	Check	0
Vineland B	1.0	1 (4 days)
	0.5	3
	0.25	0
	Check	0
GC-10101	1.0	9 (4 days)
	0.5	5
	0.25	0
	Check	0
GC-10284	1.0	94 (3 days)
	0.5	85
	0.25	75
	0.12	34
	0.06	21
	Check	0
SAN-197 (In Water)	1.0	100 (2 days)
	0.5	100 (4 days)
	0.25	100 (4 days)
	0.125	100 (4 days)
	0.062	63 (4 days)
SAN-197 (In Kerosene)	1.0	100 (2 days)
	0.5	99 (4 days)
	0.25	97 (4 days)
	0.125	95 (4 days)
	0.062	89 (4 days)
	Check	0 (4 days)

Material - SAN I-197

Dosage lb/gal/ac	Rain	Sticker	Percent Mortality
1	1"	-	100 (72 hrs)
"	3"	-	86 (72 hrs)
"	1"	3% Chevron	100 (96 hrs)
"	1"	3% Pinolene 1902	100 (96 hrs)
0.5	1"	-	100 (72 hrs)
"	3"	-	97 (72 hrs)
"	1"	3% Chevron	100 (96 hrs)
"	1"	3% Pinolene 1902	100 (96 hrs)
0.25	1"	-	97 (72 hrs)
"	3"	-	42 (72 hrs)
0.125	1"	-	85 (72 hrs)
"	3"	-	81 (72 hrs)
"	1"	3% Chevron	93 (96 hrs)
"	1"	3% Pinolene Nufilm	99 (96 hrs)
"	1"	6% Chevron	87 (96 hrs)
"	1"	6% Pinolene Nufilm	100 (96 hrs)

Material - Gulf 51526 E 15, Aged 23 days

lb/gal/ac	Percent Mortality After 5 Days
0.25	100
0.125	100
0.062	100
0.031	96
0.015	6

Based on prior field tests and laboratory data, the following materials will be field tested during 1975 using aerial application.

TH-6040	0.065 lb/gal/ac	150 acres
TH-6040	0.015 lb/gal/ac	150 acres
CGA-18809	0.5 lb/gal/ac	150 acres
CGA-18809	0.125 lb/gal/ac	150 acres
S-15126	0.5 lb/gal/ac	150 acres
S-15126	0.125 lb/gal/ac	150 acres
SAN I-197	0.20 lb/gal/ac	150 acres
SAN I-197	0.06 lb/gal/ac	150 acres
Sevin 4 Oil (Standard)	1.0 lb/40 oz/ac	150 acres

Ground applications will be made with the following materials.

ABG-6010	SAN I-197
CGA-18809	SBP-1513
Dipel	Sevin 805
FMC-33297	S-1S126
NTN-8629	TH-6040

Project Number: GM 5.1.2
Project Title: Field Evaluations of Insecticides Against the Gypsy Moth
Report Period: January - December, 1974
Report Type: Interim
Project Leader: Larry L. Herbaugh, W. H. McLane, and C. R. Stacy

Appendix 1 is a special report detailing procedures, data and conclusions resulting from this project.

Project Number: GM 5.1.3
Project Title: Laboratory Testing of Larval Repellents
Report Period: January - December, 1974
Report Type: Interim
Project Leader: A. P. Morris

A search for repellents of late instar gypsy moth larvae, 6th instar female and 5th instar males, was begun in 1973, with the objective of developing chemical compounds to keep larvae from pupating on recreational vehicles and equipment, common vectors for the spread of the species to uninfested areas of the United States.

Two valid techniques of screening candidate compounds have been used during the last year. The first was by treating 6" X 72" strips of plasticized grocery wrap paper with test compounds. The inside of aluminum boxes 23" X 14" X 9" in size were lined with these strips, exposing the treated side of the paper. Larvae were released in the open boxes and those counted on the bottom, untreated surface, at certain time intervals were considered repelled. The second technique involved treating 8.3" X 13.3" strips of chromatography paper with compounds and lining the inside of 2 qt. ice cream cartons with this paper. Larvae were released into the cartons and those observed on the screen wire bottom of the bio-assay chamber were considered repelled.

The results of tests using the aluminum box technique are shown in Table 1, "Results of Screening for Gypsy Moth Larval Repellents Using Aluminum Boxes". The results of tests using the ice cream carton technique are shown in Table 2, "Results of Screening for Gypsy Moth Larval Repellents Using Paper Cartons". The names or numbers of compounds screened, dosages used, results, and other pertinent information are given in both tables. Adequate untreated controls were run during all tests by both techniques.

Approximately 167 ARS Ent numbered compounds and 39 other chemicals or formulations suspected of repellent properties were screened, along with one insecticide synergist and one insecticide.

An analysis of the results in Tables 1 and 2 was made and the following compounds selected for further testing prior to field testing.

ARS Ent Numbers:

1016	35522	35659	35771-a
4203	35614-a	35697	35898
18486	35645	35700	
34288-b	36151	35768	

Other Compounds:
Chlordimeform
Paradichlorobenzene
Citrol (oil of lemon grass)

Table 1. Results of Screening for Gypsy Moth Larval Repellents Using Aluminum Boxes

Compound	Dosage mg/ft	Maximum Repellency %	Time to Maximum Repellency Hours	Total No. Larvae Used	Number of Replicates	Substrate Composition	Substrate Size in ft^2	Solvent
337 (4-26-73)	11	24	0.5	100	5	Plastic Paper[1/]	3.0	Acetone
	111	32	0.5	100	5	"	3.0	"
	222	74	3.5	25	1	"	1.5	"
4203 (4-26-73)	11	27	0.5	100	5	"	3.0	"
	111	29	0.5	100	5	"	3.0	"
	222	94	4.5	25	1	"	1.5	"
8118 (2-12-73)	11	20	6.0	100	5	"	3.0	"
	111	42	0.5	100	5	"	3.0	"
	222	68	3.5	25	1	"	1.5	"
18486 (2-17-72)	11	25	0.5	100	5	"	3.0	"
	111	35	0.5	100	5	"	3.0	"
	222	76	4.5	25	1	"	1.5	"
32849 (2-17-72)	11	34	0.5	100	5	"	3.0	"
	222	80	5.0	25	1	"	1.5	"
32848 (2-17-72)	11	32	0.5	100	5	"	3.0	"
	222	66	2.0	25	1	"	1.5	"
34288-b	11	25	0.5	100	5	"	3.0	"
	222	88	3.0	25	1	"	1.5	"
35616	11	16	0.5	100	5	"	3.0	"
	222	76	3.0	25	1	"	1.5	"

[1/] Plastic Paper = grocery wrap paper with plastic on one side.

Table 1 continued

Compound	Dosage mg/ft	Maximum Repellency %	Time to Maximum Repellency Hours	Total No. Larvae Used	Number of Replicates	Substrate Composition	Substrate Size in ft^2	Solvent
35768	11	16	0.5	100	5	Plastic Paper[1/]	3.0	Acetone
	222	98	4.5	25	1	"	1.5	"
35651	11	13	0.5	100	5	"	3.0	"
	222	90	3.0	25	1	"	1.5	"
34289-b	11	14	0.5	100	5	"	3.0	"
	222	88	4.5	25	1	"	1.5	"
34698	11	17	0.5	100	5	"	3.0	"
	222	58	2.0	25	1	"	1.5	"
35770	11	10	+20	100	5	"	3.0	"
	222	82	5.0	25	1	"	1.5	"
35898	11	20	+20	100	5	"	3.0	"
	222	90	1.5	25	1	"	1.5	"
35899	11	18	5.0	100	5	"	3.0	"
	222	70	2.0	25	1	"	1.5	"
35658	11	24	0.5	100	5	"	3.0	"
	222	86	2.5	25	1	"	1.5	"
396 (5-11-73)	11	16	0.5	100	5	"	3.0	"
	222	66	4.0	25	1	"	1.5	"
35458	11	15	6.0	100	5	"	3.0	"
	222	46	+20	25	1	"	1.5	"

[1/] Plastic Paper = grocery wrap paper with plastic on one side.

Table 1 continued

Compound	Dosage mg/ft	Maximum Repellency %	Time to Maximum Repellency Hours	Total No. Larvae Used	Number of Replicates	Substrate Composition	Substrate Size in ft^2	Solvent
35659	11	19	+20	100	5	Plastic Paper[1/]	3.0	Acetone
	222	72	+20	25	1	"	1.5	"
35645	11	28	0.5	100	5	"	3.0	"
	222	94	+20	25	1	"	1.5	"
35511	11	24	0.5	100	5	"	3.0	"
	222	76	3.0	25	1	"	1.5	"
35635	11	10	+20	100	5	"	3.0	"
	222	68	5.0	25	1	"	1.5	"
35769	11	19	+20	100	5	"	3.0	"
	222	92	4.5	25	1	"	1.5	"
20573-b	11	18	+20	100	5	"	3.0	"
	222	62	3.0	25	1	"	1.5	"
1016 (9-5-73)	11	18	+20	100	5	"	3.0	"
	111	90	4.0	50	2	"	1.5	"
35697	11	18	0.5	100	5	"	3.0	"
	111	86	4.5	50	2	"	1.5	"
35698	11	27	0.5	100	5	"	3.0	"
	111	32	+20	25	1	"	3.0	"
35460	11	13	2.0	100	5	"	3.0	"
	111	24	0.5	25	1	"	3.0	"

[1/] Plastic Paper = grocery wrap paper with plastic on one side.

Table 1 continued

Compound	Dosage mg/ft	Maximum Repellency %	Time to Maximum Repellency Hours	Total No. Larvae Used	Number of Replicates	Substrate Composition	Substrate Size in ft^2	Solvent
35692	11	24	0.5	100	5	Plastic Paper[1/]	3.0	Acetone
	111	32	0.5	25	1	"	3.0	"
18274 (6-26-72)	11	15	+20	100	5	"	3.0	"
	111	24	+20	25	1	"	3.0	"
35459	11	23	5.0	100	5	"	3.0	"
	111	16	+20	25	1	"	3.0	"
35693	11	23	+20	100	5	"	3.0	"
	111	56	0.5	25	1	"	3.0	"
2065 (5-11-73)	11	17	0.5	100	5	"	3.0	"
	111	24	1.5	25	1	"	3.0	"
35671-a	11	22	0.5	100	5	"	3.0	"
	111	24	0.5	25	1	"	3.0	"
20829 (4-17-73)	11	15	0.5	100	5	"	3.0	"
	111	16	0.5	25	1	"	3.0	"
32852 (2-17-72)	11	20	0.5	100	5	"	3.0	"
	111	12	2.0	25	1	"	3.0	"
35617	11	26	0.5	100	5	"	3.0	"
	111	12	4.0	25	1	"	3.0	"
35240	11	23	+20	100	5	"	3.0	"
	111	28	3.5	25	1	"	3.0	"

[1/] Plastic Paper = grocery wrap paper with plastic on one side.

Table 1 continued

Compound	Dosage mg/ft	Maximum Repellency %	Time to Maximum Repellency Hours	Total No. Larvae Used	Number of Replicates	Substrate Composition	Substrate Size in ft^2	Solvent
35652	11	10	0.5	100	5	Plastic paper 1/	3.0	Acetone
	111	24	+20	25	1	"	3.0	"
34697-a	11	19	0.5	100	5	"	3.0	"
	111	28	+20	25	1	"	3.0	"
35525	11	18	0.5	100	5	"	3.0	"
	111	8	0.5	25	1	"	3.0	"
35662	11	16	+20	100	5	"	3.0	"
	111	16	+20	25	1	"	3.0	"
33510	11	14	+20	100	5	"	3.0	"
	111	12	4.0	25	1	"	3.0	"
35672-a	11	15	0.5	100	5	"	3.0	"
	111	16	+20	25	1	"	3.0	"
20831	11	13	0.5	100	5	"	3.0	"
	111	12	1.5	25	1	"	3.0	"
35663	11	10	0.5	100	5	"	3.0	"
	111	12	5.0	25	1	"	3.0	"
35509	11	17	0.5	100	5	"	3.0	"
	111	20	1.0	25	1	"	3.0	"

1/Plastic Paper = grocery wrap paper with plastic on one side.

Table 1 continued

Compound	Dosage mg/ft	Maximum Repellency %	Time to Maximum Repellency Hours	Total No. Larvae Used	Number of Replicates	Substrate Composition	Substrate Size in ft^2	Solvent
34293-a	11	23	0.5	100	5	Plastic Paper[1/]	3.0	Acetone
	111	24	0.5	25	1	"	3.0	"
20127(2-21-73)	11	14	0.5	100	5	"	3.0	"
	111	16	0.5	25	1	"	3.0	"
31056(2-17-72)	11	19	0.5	100	5	"	3.0	"
	111	16	0.5	25	1	"	3.0	"
32853(2-17-72)	11	13	+20	100	5	"	3.0	"
	111	20	0.5	25	1	"	3.0	"
35669	11	15	0.5	100	5	"	3.0	"
	111	24	0.5	25	1	"	3.0	"
658	156	16	0.5	100	5	"	3.0	"
5096	156	29	6.0	100	5	"	3.0	"
2940	156	37	0.5	100	5	"	3.0	"
5998	156	12	0.5	100	5	"	3.0	"
6147	156	28	+20	100	5	"	3.0	"
20571	156	17	+20	100	5	"	3.0	"

[1/] Plastic Paper = grocery wrap paper with plastic on one side.

Table 1 continued

Compound	Dosage mg/ft	Maximum Repellency %	Time to Maximum Repellency Hours	Total No. Larvae Used	Number of Replicates	Substrate Composition	Substrate Size in ft^2	Solvent
3425	156	15	0.5	100	5	Plastic Paper[1/]	3.0	Acetone
6420	156	13	0.5	100	5	"	3.0	"
6555	156	14	+20	100	5	"	3.0	"
5974	156	21	0.5	100	5	"	3.0	"
6418	156	23	0.5	100	5	"	3.0	"
6575	156	17	0.5	100	5	"	3.0	"
6582	156	23	0.5	100	5	"	3.0	"
7198	156	34	0.5	100	5	"	3.0	"
16053	156	19	0.5	100	5	"	3.0	"
18278	156	30	0.5	100	5	"	3.0	"
18420	156	21	0.5	100	5	"	3.0	"
18493	156	36	0.5	100	5	"	3.0	"
18059	156	30	0.5	100	5	"	3.0	"
18489	156	36	0.5	100	5	"	3.0	"

1/ Plastic Paper = grocery wrap paper with plastic on one side.

Table 1 continued

Compound	Dosage mg/ft	Maximum Repellency %	Time to Maximum Repellency Hours	Total No. Larvae Used	Number of Replicates	Substrate Composition	Substrate Size in ft^2	Solvent
20188	156	35	0.5	100	5	Plastic Paper[1/]	3.0	Acetone
20828	156	35	0.5	100	5	"	3.0	"
22131	156	30	6.0	100	5	"	3.0	"
22851	156	26	+20	100	5	"	3.0	"
23585	156	36	0.5	100	5	"	3.0	"
23773	156	30	0.5	100	5	"	3.0	"
24090	156	34	0.5	100	5	"	3.0	"
24232	156	36	0.5	100	5	"	3.0	"
34292	156	31	4.0	100	5	"	3.0	"
35464	156	32	+20	100	5	"	3.0	"
35510	156	49	+20	100	5	"	3.0	"
35521	156	39	+20	100	5	"	3.0	"
35613	156	64	6.0	100	5	"	3.0	"
35631	156	50	6.0	100	5	"	3.0	"
36071	156	48	+20	100	5	"	3.0	"

[1/] Plastic paper = grocery wrap paper with plastic on one side.

Table 1 continued

Compound	Dosage mg/ft	Maximum Repellency %	Time to Maximum Repellency Hours	Total No. Larvae Used	Number of Replicates	Substrate Composition	Substrate Size in ft^2	Solvent
36073	156	29	+20	100	5	Plastic Paper 1/	3.0	Acetone
36110	156	30	+20	100	5	"	3.0	"
36168	156	40	+20	100	5	"	3.0	"
36174	156	43	+20	100	5	"	3.0	"
36187	156	39	+20	100	5	"	3.0	"
Chlordimeform	10 2/	41	6.0	100	5	"	3.0	"
	100 2/	50	5.0	100	5	"	3.0	"
	156	73	6.0	100	5	"	3.0	"
	250	62	4.5	100	5	"	3.0	"
	500	60	5.0	100	5	"	3.0	"
	1000 2/	79	+20	100	5	"	3.0	"
	1000 2/	73	+20	100	5	"	3.0	"
	10000	99	6.0	100	5	"	3.0	"
Chlordimeform or Fundal EC	250	24	3.0	100	5	Tar Paper	3.0	H_2O
	500	39	+20	80 3/	5	"	3.0	"
	1000	36	+20	100	5	"	3.0	"

1/ Plastic Paper = grocery wrap paper with plastic on one side.
2/ Part of a geometric dosage test.
3/ One reading missed.

Table 1 continued

Compound	Dosage mg/ft	Maximum Repellency %	Time to Maximum Repellency Hours	Total No. Larvae Used	Number of Replicates	Substrate Composition	Substrate Size in ft^2	Solvent
Chlordimeform or Fundal EC	250	40	+20	100	5	Tarpaulin	3.0	H_2O
	500	43	4.0	80 3/	5	"	3.0	"
	1000	41	1.5	100	5	"	3.0	"
Chlordimeform	125	32	5.0	100	5	Tar Paper	3.0	Isopar H
	250	31	4.0	100	5	"	3.0	"
	500	43	+20	80 3/	5	"	3.0	"
	1000	46	+20	100	5	"	3.0	"
	2000	56	+20	100	5	"	3.0	"
Chlordimeform	125	49	5.0	100	5	Tarpaulin	3.0	"
	250	48	5.0	80 3/	5	"	3.0	"
	500	41	3.0	100	5	"	3.0	"
	1000	40	6.0	100	5	"	3.0	"
	2000	48	6.0	100	5	"	3.0	"
Chlordimeform	1000	94	+20	80 3/	5	Plastic Paper 1/	3.0	Isopar H
N,N-Diethyl Tolnamide	156	65	+20	100	5	Plastic Paper 1/	3.0	Acetone
	500 4/	38	0.5	100	5	"	3.0	"
	1000	63	6.0	100	5	"	3.0	"
	1000 4/	66	+20	100	5	"	3.0	"

1/ Plastic Paper = grocery wrap paper with plastic on one side.
3/ One reading missed.
4/ Trade name Metadelphene(Hercules Chemical Co.)

Table 2. Results of Screening for Gypsy Moth Larval Repellents Using Paper Cartons

Compound	Dosage[1/] mg/ft^2	Maximum Repellency %	Time to Maximum Repellency Hours	Total No. Larvae Used	Number of Replicates	Substrate Composition	Substrate Size in ft^2	Solvent
35632	500	46	5.5	50	5	Ch. Paper[2/]	0.75	Acetone
31837	"	16	1.0	"	"	"	0.75	"
35614	"	98	4.5	"	"	"	0.75	"
35638	"	44	4.5	"	"	"	0.75	"
35648	"	10	0.5	"	"	"	0.75	"
35760	"	6	0.5	"	"	"	0.75	"
35976	"	6	0.5	"	"	"	0.75	"
35695	"	4	1.5	"	"	"	0.75	"
35701	"	14	5.5	"	"	"	0.75	"
23985	"	22	0.5	"	"	"	0.75	"
35771	"	80	6.0	"	"	"	0.75	"
35640	"	6	3.5	"	"	"	0.75	"
35641	"	8	1.0	"	"	"	0.75	"
35667	"	4	4.5	"	"	"	0.75	"

1/ Results of tests at 50 mg/ft^2 are not shown for brevity reasons.
2/ Chromatography Paper.

Table 2 continued

Compound	Dosage[1] mg/ft^2	Maximum Repellency %	Time to Maximum Repellency Hours	Total No. Larvae Used	Number of Replicates	Substrate Composition	Substrate Size in ft^2	Solvent
36025	500	30	6.0	50	5	Ch. Paper[2]	0.75	Acetone
33270	"	2	1.0	"	"	"	0.75	"
35900	"	4	1.5	"	"	"	0.75	"
36191	"	34	5.5	"	"	"	0.75	"
35761	"	4	3.5	"	"	"	0.75	"
36190	"	20	1.5	"	"	"	0.75	"
35649	"	8	6.0	"	"	"	0.75	"
35763	"	6	6.0	"	"	"	0.75	"
35975	"	4	3.0	"	"	"	0.75	"
35702	"	4	6.0	"	"	"	0.75	"
35657	"	2	3.5	"	"	"	0.75	"
35758	"	0	-	"	"	"	0.75	"
35762	"	2	1.0	"	"	"	0.75	"
35639	"	4	0.5	"	"	"	0.75	"

1/ Results of tests at 50 mg/ft^2 are not shown for brevity reasons.
2/ Chromatography Paper.

Table 2 continued

Compound	Dosage[1/] mg/ft^2	Maximum Repellency %	Time to Maximum Repellency Hours	Total No. Larvae Used	Number of Replicates	Composition	Size in ft^2	Solvent
35700	500	100	3.5	50	5	Ch. Paper[2/]	0.75	Acetone
44561	"	2	1.0	"	"	"	0.75	"
35767	"	8	1.5	"	"	"	0.75	"
36179	"	2	2.0	"	"	"	0.75	"
35974	"	4	3.0	"	"	"	0.75	"
33268	"	2	1.5	"	"	"	0.75	"
36016	"	4	3.0	"	"	"	0.75	"
35668	"	4	3.0	"	"	"	0.75	"
25071	"	2	1.5	"	"	"	0.75	"
25084	"	8	1.5	"	"	"	0.75	"
32849	"	16	4.0	"	"	"	0.75	"
32848	"	22	5.5	"	"	"	0.75	"
35511	"	38	6.0	"	"	"	0.75	"
33267	"	4	1.0	"	"	"	0.75	"

1/ Results of tests at 50 mg/ft^2 are not shown for brevity reasons.
2/ Chromatography Paper.

Table 2 continued

Compound	Dosage[1] mg/ft^2	Maximum Repellency %	Time to Maximum Repellency Hours	Total No. Larvae Used	Number of Replicates	Substrate Composition	Substrate Size in ft^2	Solvent
35522	500	92	6.0	50	5	Ch. Paper[2]	0.75	Acetone
36176	"	78	6.0	"	"	"	0.75	"
35523	"	62	6.0	"	"	"	0.75	"
36175	"	18	3.0	"	"	"	0.75	"
36178	"	6	0.5	"	"	"	0.75	"
36173	"	20	5.0	"	"	"	0.75	"
35759	"	26	4.0	"	"	"	0.75	"
36167	"	24	4.5	"	"	"	0.75	"
36118	"	44	0.5	"	"	"	0.75	"
36121	"	22	0.5	"	"	"	0.75	"
36111	"	12	1.0	"	"	"	0.75	"
35960	"	4	1.0	"	"	"	0.75	"
36165	"	10	4.0	"	"	"	0.75	"
36162	"	10	0.5	"	"	"	0.75	"

1/ Results of tests at 50 mg/ft^2 are not shown for brevity reasons.
2/ Chromatography Paper.

Table 2 continued

Compound	Dosage[1/] mg/ft^2	Maximum Repellency %	Time to Maximum Repellency Hours	Total No. Larvae Used	Number of Replicates	Substrate Composition	Substrate Size in ft^2	Solvent
36171	500	8	1.5	50	5	Ch. Paper[2/]	0.75	Acetone
36172	"	6	1.5	"	"	"	0.75	"
35710	"	12	0.5	"	"	"	0.75	"
36158	"	12	2.0	"	"	"	0.75	"
36170	"	6	1.5	"	"	"	0.75	"
36159	"	14	0.5	"	"	"	0.75	"
36164	"	4	1.0	"	"	"	0.75	"
35973	"	10	4.0	"	"	"	0.75	"
36127	"	76	4.5	"	"	"	0.75	"
36161	"	42	5.5	"	"	"	0.75	"
36156	"	36	0.5	"	"	"	0.75	"
35707	"	6	0.5	"	"	"	0.75	"
35764	"	20	0.5	"	"	"	0.75	"
36157	"	34	6.0	"	"	"	0.75	"

1/ Results of tests at 50 mg/ft^2 are not shown for brevity reasons.
2/ Chromatography Paper.

Table 2 continued

Compound	Dosage[1/] mg/ft^2	Maximum Repellency %	Time to Maximum Repellency Hours	Total No. Larvae Used	Number of Replicates	Substrate Composition	Substrate Size in ft^2	Solvent
35971	500	66	0.5	50	5	Ch. Paper[2/]	0.75	Acetone
35972	"	60	0.5	"	"	"	0.75	"
35705	"	70	6.0	"	"	"	0.75	"
35765	"	22	5.5	"	"	"	0.75	"
36160	"	42	6.0	"	"	"	0.75	"
35958	"	22	1.0	"	"	"	0.75	"
35656	"	34	6.0	"	"	"	0.75	"
35766	"	16	5.5	"	"	"	0.75	"
35642	"	64	6.0	"	"	"	0.75	"
2 Ethyl-1,3-Hexanediol	"	4	1.0	"	"	"	0.75	"
Citral	"	88	5.5	"	"	"	0.75	"
	"	54	6.0	"	"	"	0.75	"
Citronellal	"	8	1.0	"	"	"	0.75	"

1/ Results of tests at 50 mg/ft^2 are not shown for brevity reasons.
2/ Chromatography Paper.

Table 2 continued

Compound	Dosage[1] mg/ft^2	Maximum Repellency %	Time to Maximum Repellency Hours	Total No. Larvae Used	Number of Replicates	Substrate Composition	Substrate Size in ft^2	Solvent
Cineole	500	6	4.0	50	5	Ch. Paper[2]	0.75	Acetone
Heavy Aromatic Naptha	"	4	1.0	"	"	"	0.75	"
Triple Mix	"	4	5.5	"	"	"	0.75	"
MGK 264	"	2	4.0	"	"	"	0.75	"
MGK 874	"	8	4.5	"	"	"	0.75	"
MGK 326	"	4	2.5	"	"	"	0.75	"
MGK GD 880	"	24	5.5	"	"	"	0.75	"
MGK 11	"	22	1.0	"	"	"	0.75	"
MGK 933	"	48	3.5	"	"	"	0.75	"
N, N-Diethyl Toluamide[3]	"	34	5.5	"	"	"	0.75	"
	"	10	0.5	"	"	"	0.75	"
Stabelene	"	16	1.5	"	"	"	0.75	"

1/ Results of tests at 50 mg/ft^2 are not shown for brevity reasons.
2/ Chromatography Paper.
3/ Trade name Metadelphene for Hercules Chemical Co.

Table 2 continued

Compound	Dosage[1] mg/ft^2	Maximum Repellency %	Time to Maximum Repellency Hours	Total No. Larvae Used	Number of Replicates	Substrate Composition	Substrate Size in ft^2	Solvent
Di Methyl Phtholate	500	12	0.5	50	5	Ch. Paper[2]	0.75	Acetone
Di Butyl Phtholate	"	12	0.5	"	"	"	0.75	"
Benzyl Benzoate	"	8	0.5	"	"	"	0.75	"
Isosafrole	"	22	0.5	"	"	"	0.75	"
Para Dichloro-benzene, Grade 1	"	92	1.0	"	"	"	0.75	"
	"	14	0.5	"	"	"	0.75	"
Para Dichloro-benzene, Grade 3	"	62	0.5	"	"	"	0.75	"
Mitin FF	"	18	0.5	"	"	"	0.75	"
Ortho Dichloro-benzene	"	50	2.0	"	"	"	0.75	"

1/ Results of tests at 50 mg/ft^2 are not shown for brevity reasons.
2/ Chromatography Paper.

Table 2 continued

Compound	Dosage[1] mg/ft^2	Maximum Repellency %	Time to Maximum Repellency Hours	Total No. Larvae Used	Number of Replicates	Substrate Composition	Substrate Size in ft^2	Solvent
Cedar Wood Oil	500	8	0.5	50	5	Ch. Paper[2]	0.75	Acetone
Indalone	"	4	1.0	"	"	"	0.75	"
Benzaldehyde	"	12	2.0	"	"	"	0.75	"
Carbolineum	"	54	4.0	"	"	"	0.75	"
Tar Acid Oil(35%)	"	16	4.5	"	"	"	0.75	"
Saf-T-Sol (coal) aromatic naptha	"	48	6.0	"	"	"	0.75	"
Vanguard Repel	"	12	0.5	"	"	"	0.75	"
"Ole Time" Woodsman	"	12	1.0	"	"	"	0.75	"
ZIP Deer and Rabbit Taste Repellent	"	10	0.5	"	"	"	0.75	"
Ortho Chloro-benzenealdehyde	"	4	0.5	"	"	"	0.75	"

1/ Results of tests at 50 mg/ft^2 are not shown for brevity reasons.
2/ Chromatography Paper.

Table 2 continued

Compound	Dosage[1] mg/ft^2	Maximum Repellency %	Time to Maximum Repellency Hours	Total No. Larvae Used	Number of Replicates	Substrate Composition	Substrate Size in ft^2	Solvent
Para-Chloro-benzenealdehyde	500	30	3.5	50	5	Ch. Paper[2]	0.75	Acetone
2,4-Dichloro-benzenealdehyde	"	24	5.0	"	"	"	0.75	"
3,4-Dichloro-benzenealdehyde	"	40	6.0	"	"	"	0.75	"
dl-camphor	"	8	0.5	"	"	"	0.75	"
d-camphor	"	6	3.5	"	"	"	0.75	"
Piperonyl Butoxide[4]	"	22	0.5	"	"	"	0.75	"
Pyrethrins[5]	50	100	3.0	"	"	"	0.75	"
	500	100	1.5	"	"	"	0.75	"

1/ Results of tests at 50 mg/ft^2 are not shown for brevity reasons.
2/ Chromatography Paper.
4/ Synergist for some insecticides.
5/ Fast knockdown insecticide.

Project Number: GM 5.1.4
Project Title: Devices Used in Fumigation of Gypsy Moth Eggs
Report Period: July - December, 1974
Report Type: Final
Project Leaders: Larry L. Herbaugh, C. R. Stacy, and J. G. R. Tardif

Attached Appendix II is a special report detailing specialized equipment and techniques developed for fumigation tests.

Project Number: GM 5.1.5
Project Title: Fumigation of Gypsy Moth Eggs with Methyl Bromide
Report Period: July - December, 1974
Report Type: Interim
Project Leader: Larry L. Herbaugh, C. R. Stacy

The objective of this project is to determine the optimum dosage of methyl bromide and exposure time required to kill gypsy moth eggs at varying temperatures.

These studies are being conducted with both field-collected and laboratory-reared eggs. The egg masses are longitudinally divided, using one half for treatment and the corresponding half for an untreated check. The eggs to be treated are then placed in a paper bag and put into the fumigation chambers.

The following results have been accumulated to date.

	Avg. Temp(°F)	No. Tests	Dosage (lbs)	Time (Hours)	Avg. C/T	No. Eggs Treated[1/]	No. Eggs Hatched	No. Eggs Check	No. Eggs Hatched
80°F and above	80	6	2	2	70	2,677	0	3,053	721
70 - 79°F	76	10	2	1	26	4,580	0	4,720	817
	74	2	1.5	1	25	1,931	2	1,307	1,022
	72	6	1.5	1	26	5,317	0	4,996	3,626
	71	8	1	1	20	4,622	11	4,882	1,312
60 - 69°F	67	4	2	1	35	2,101	1	1,976	537
	66	2	1.5	1	22	1,875	241	1,625	815
	65	2	1.75	2	57	2,268	0	1,959	1,096
	62	4	1.5	2	43	3,499	0	3,469	2,424
50 - 59°F	59	2	2	2	61	2,065	0	1,678	1,204
	59	2	1	2	30	1,907	1	1,604	323
	55	2	1.5	2	45	1,961	0	2,192	1,856
	54	2	1.5	2	58	2,076	0	1,754	374
	52	2	1	2	41	2,051	2	2,000	743
	50	2	2	2	51	1,502	0	1,154	793

1/ Fumiscope thermal conductivity reading multiplied by duration of experiment in hours

Data from above table indicates gypsy moth eggs treated with 2 lbs. of methyl bromide for 2 hours will give 100% mortality. This project will be continued to determine if this mortality trend will be consistent in all situations.

Project Number: GM 5.1.6
Project Title: Tarpaulin Fumigation of Nursery Stock
Report Period: October - December, 1974
Report Type: Final
Project Leaders: Larry L. Herbaugh, C. R. Stacy, J. G. R. Tardif

The purpose of this project is to develop a fumigation schedule, using methyl bromide as a fumigant, for cut and balled and burlapped Christmas trees. This schedule will ultimately give the dosages required for 100% gypsy moth egg mortality with no noticeable phytotoxicity to the treated material.

The following is a brief description of special procedures developed and utilized in this study.

A quonset frame chamber containing 1000 cubic feet was constructed from wooden 2" X 4"'s, 1" X 2" supporting strips and 3/8" metal rods. The frame was covered with 4 mil clear polyethelene tarpaulin and sealed along the base with sand bags. Electric cords, fumiscope tubes, and the methyl bromide discharge hose entered the chamber at appropriate places. The fumigatorium was equipped with a 110 volt baseboard heater for temperature control and two axil-type (blade) fans (1250 CFM capacity). These fans were tilted upward at a 45° angle to give complete gas distribution during fumigation. A thermometer was mounted on the inside 2" X 4" frame and was visible from the outside to monitor temperature readings. The methyl bromide adaptor discharge hose was secured to the frame with the opening approximately 3 feet from the floor to facilitate dissemination and to eliminate the possibility of methyl bromide liquid coming into direct contact with materials being fumigated. Two fumiscopes were used at opposite ends of the chamber. One intake hose took air samples about 6 inches from the floor and the other at approximately 5 feet from the floor. In both cases the return line laid on the floor.

Methyl bromide was introduced into the chamber as follows. Cans of methyl bromide stored at room temperature (72°F) were placed into a container of warm water (100°F) and delivered to the fumigation site. The cans were connected to the adaptor discharge line and immediately placed into boiling water behind a plexiglass shield. This caused the methyl bromide to volatize very rapidly and a 1 1/2 lb. can could be emptied within 2 - 3 minutes.

This technique was used with several groups of B and B and cut Christmas trees and found to be very safe and practical. It also eliminated the need for extra volatizing equipment and scales, and reduced the chance of error in disseminating the fumigant.

The following data has been accumulated to date.

Tree Species	No. of Trees Treated B+B	No. of Trees Treated Cut	Dosage (lbs)	Time (hrs)	Avg. Chamber Temp(°F)	Avg.[1] C/T	No. Days Observed	Degree of Phyto-toxicity	No. Eggs Hatched/ Treated	No. Eggs Hatched/ Untreated
Colorado Blue Spruce	5	5	3	3	49	96	11	None[2]	0/1810	403/1571
	5	5	3	4	49	132	11	None	0/2730	444/1575
	5	5	3	5	51	160	14	None[3]	0/2628	400/1614
Black Hill Spruce	5		3	5	49	185	10	None	0/3078	2008/2701
	5		3	4	52	152	10	None	0/1861	1754/2411
	5		3	3	49	102	10	None	1/2292	777/2087
Norway Spruce		5	3	3	49	102	10	None	1/2292	777/2087
		5	3	4	52	152	10	None	0/1861	1754/2411
		5	3	5	49	185	10	None	0/3078	2008/2701
Douglas Fir		10	3	4	49	156	15	None	0/4400	1629/2487
		5	3	3	48	99	11	None	0/1762	824/1689
Scotch Pine		5	3	3	48	99	11	None	0/1762	824/1689
		5	3	4	49	156	15	None	0/4400	1629/2487

1/ Fumiscope thermal conductivity reading multiplied by duration of experiment in hours.
2/ None noticeable per visual examination.
3/ Needle drop observed at 22 days on 2 trees (possibly caused by desiccation).

Data from above table indicate that 3 lbs. of methyl bromide for 4 hours will give the desired mortality. This project will be continued to determine if similar results can be expected with other species of B and B nursery stock.

Project Number: GM 5.1.7
Project Title: Spotting of Automobile Paint with Microencapsulated Disparlure
Report Period: October - December, 1974
Report Type: Preliminary
Project Leader: C. R. Stacy

The objective of this project is to determine the discoloring and spotting effects of Penwalt microencapsulated disparlure on automobile paint.

Six inch square pieces of metal cut from different types of painted automobile parts were sprayed with a Penwalt microencapsulated formulation of disparlure containing 2% UCAR latex as sticker, Triton X and an anti-foaming agent.

The dried disparlure slurry could not be easily removed from unwaxed and waxed automobile finishes by washing with water and detergents. However, automobile waxes and polishing compounds containing petroleum distillate removed all traces of the slurry. No discoloration or spotting was noted.

Project Number: GM 5.1.8
Project Title: Evaluation of Pesticides for Brown-tail Moth
Report Period: April - December, 1974
Report Type: Interim
Project Leader: Winfred H. McLane

The primary objective of this project is to screen candidate materials for potential use against the brown-tail moth.

Laboratory tests are conducted with field-collected brown-tail larvae that are reared on artificial gypsy moth diet and tender oak seedling foliage. Results of laboratory tests are tabulated below.

Material	Dosage	Rain	% Mortality	
			72 Hrs.	96 Hrs.
Dipel	8 BIU	-	71	90
	8 BIU	-	93	100
	8 BIU	0.5"	71	99
	4 BIU	-	69	79
	2 BIU	-	63	91
	1 BIU	-	23	52
Thuricide	8 BIU	-	68	100
	8 BIU	0.5"	32	92
	2 BIU	-	44	87
	1 BIU	-	22	43
Check	-	-	0	0

Material	Dosage ai/gal/A	Instar	% Mortality
Sevin 80S	1.0 lbs	3rd	100(6 days)
	0.5 "	"	100
	0.25 "	"	100
	0.12 "	"	99
	0.06 "	"	87
Check	-	"	2
Sevin 80S	1.0 lbs	5th	96(5 days)
	0.5 "	"	96
	0.25 "	"	89
	0.12 "	"	72
	0.06 "	"	49
	0.03 "	"	28
	0.01 "	"	8
Check	-	"	1
Dylox 1.5 oil	1.5 lbs	5th	100(4 days)
	0.75 "	"	90
	0.37 "	"	42
	0.18 "	"	34
	0.093"	"	38
Check	-	"	0
SBP-1382	1.0 lbs	5th	97(4 days)
	0.5 "	"	100
	0.25	"	98
	0.12	"	78
	0.06	"	73
Check	-	"	1

General observation and terminal counts were used for evaluation of the May treatments. At each sub-plot, 3 terminals were selected and marked prior to treatment. Pre-spray terminal larvae counts were conducted along with post-spray counts at 48 hour intervals. All counts were made on the original terminals.

Sandy Neck - May

				Terminal Counts			
					After Treatment		
Plot	Material	BIU/gal/A	Sub-Plot	Pre-Spray	48 H	96 H	144 H
1	Dipel	8	1	17	17	27	15
1	"	"	2	0	0	0	13
3	"	"	1	21	11	17	23
3	"	"	2	0	1	3	5
5	"	"	1	11	26	23	9
5	"	"	2	4	15	12	11
			Total:	53	70	82	76
						% Change	
					+32	+55	+43
2	Thuricide	8	1	33	17	34	13
2	"	"	2	0	1	2	0
4	"	"	1	17	20	26	30
4	"	"	2	26	38	35	18
6	"	"	1	22	9	4	8
6	"	"	2	22	11	6	9
			Total:	120	96	107	78
						% Change	
					-20	-1	-35
Check	-	-	1	9	6	14	17
"	-	-	2	5	18	6	20
"	-	-	1	3	8	11	10
"	-	-	2	5	9	9	11
			Total:	22	41	40	58
						% Change	
					+86	+82	+163

Truro - May

Plot	Material	BIU/gal/A	Sub-Plot	Terminal Counts Pre-Spray	After Treatment 96 H	After Treatment 144 H
1	Dipel	8	1	14	21	20
"	"	"	2	9	12	5
"	"	"	3	39	34	22
"	"	"	4	39	11	14
"	"	"	5	14	20	11
"	"	"	6	33	23	10
				Total:148	121	82
					% Change	
					-18	-45
2	Thuricide	8	1	100	47	85
"	"	"	2	23	23	63
"	"	"	3	10	4	17
"	"	"	4	43	2	34
"	"	"	5	12	1	19
"	"	"	6	5	1	8
				Total:193	78	226
					% Change	
					-60	+17
Check	-	-	1	43	16	28
"	-	-	2	14	36	14
"	-	-	1	10	50	31
"	-	-	2	11	20	13
				Total: 78	122	86
					% Change	
					+56	+10

Overwintering larvae were treated with various formulations of Bacillus thuringiensis at Truro on August 21, 1974. It was anticipated that newly hatched larvae would feed for a sufficient length of time to ingest lethal amounts of Bacillus thuringiensis. Although complete hatch had occurred only 3 - 4 days prior to treatment, most larvae had constructed a protective over-wintering web at time of treatment. Twelve overwintering webs were marked as check points in each treated and control plot. Webs were checked for activity prior to treatment and again at 2 days, 7 days, and 14 days following treatment. Although foliage was completely extended the treatment was not effective as larvae continued to be active within each web 2 weeks following treatment. There was no appreciable difference noticed between Dipel and Thuricide treated plots and the checks.

Poor mortality after the May treatments was due in part to the lack of suitable foliage at treatment time. Also, the insect directed most of its

feeding activity to a small area near where it hatched. Even where Rosa rugosa foliage was extended 60% and good spray coverage was achieved mortality was very limited.

Although foliage was extended completely at the time of the August treatment, results were similar to spring treatments. Degree of control was greatly affected by the short feeding time and subsequent winter web construction.

The tests would indicate that brown-tail moth larvae can not be effectively controlled by aerially applied applications of Bacillus thuringiensis.

Project Number: GM 5.1.9
Project Title: Field Testing of Ground Applied Insecticides
Report Period: April - December, 1974
Report Type: Interim
Project Leaders: Larry L. Herbaugh, W. H. McLane, C. R. Stacy

A roto mist blower mounted on a 1 1/2 ton truck was used to apply chemical insecticides to "simulated campground" areas. In most cases this was a densely wooded country lane, heavily infested with gypsy moth.

The following chemicals were applied when the majority of the insects were in the 3rd instar and the oak foliage completely expanded.

Material	Application Rate	
Bioethanomethrin	2 qts/50 gal	applied 25 gal/ac
Dipel Flowable	1 lb/1 gal	applied 1 gal/ac
Dipel Flowable	1 lb/1 gal	applied to drip off/ac
Thuricide 16 B	1 lb/1 gal	applied 1 gal/ac
Thuricide 16 B	1 lb/1 gal	applied to drip off/ac
Resmethrin(SBP-1382)	.06 lb/50 gal	applied 1 gal/ac
Resmethrin(SBP-1382)	.06 lb/50 gal	applied 25 gal/ac

These chemicals gave some control based on general observations of larval mortality and foliage protection. However, mortality was not judged adequate for regulatory treatment purposes.

In addition to the above chemicals, carbaryl was tested at the following dosages.

50 lbs ai/50 gal/+3% Chevron sticker
35 lbs ai/50 gal/ " " "
20 lbs ai/50 gal/ " " "
10 lbs ai/50 gal/ " " "

The above were applied at rates normally employed for treatment of campsites. Visual estimates of mortality and foliage protection indicated that all dosages gave excellent results and in the 10 lbs ai/50 gal treatment a very definite degree of protection was afforded. Those observations justify the recommendation that lesser amounts of chemical than presently used will provide adequate control for regulatory treatment of campsites.

Project Number: 5.2.1
Project Title: Field Testing of Disparlure in Remote Infestations-Michigan
Report Period: July - December, 1974
Report Type: Interim
Project Leaders: C. P. Schwalbe, C. Stephens, B. Kesler

Field studies performed in central Michigan in 1974 were directed toward development of treatment systems effective against very low-level, remote infestations. Treatments were mass distribution of pheromone-baited traps, broadcast application of microencapsulated disparlure and insecticide (Sevin-4-oil) treatment in various combinations with each other. Since population levels in such areas are so low that egg mass survey data are difficult to accurately obtain, evaluation of disparlure treatments cannot be completed until the following season when more sensitive methods such as placement of pheromone-baited traps and sterilized females can be employed. In addition to reevaluation of 1974 study sites, several new areas delimited by 1974 survey and detection programs will be utilized for similar tests.

The objectives of the 1975 program in Michigan are:

1. To compare effectiveness of treatments with Sevin-4-oil, microencapsulated disparlure, both singly and in combination.
2. To mass-trap the area that in 1974 was mass trapped. Male recoveries from the 1974 traps presumably reflect insect distribution and density. Similar treatment and evaluation in 1975 would provide valuable assessment of 1974 treatment effectiveness.
3. To perform intensive second year evaluation of several 1974 test sites without supplemental 1975 treatments.

Details of treatment methods are:

Mass trap - Pheromone-baited Delta traps will be hand placed at the rate of 10 traps/acre prior to adult emergence.
Insecticide - Sevin-4-oil will be applied aerially at the rate of 1 lb ai/A when most larvae are in second instar.
Disparlure - Microencapsulated disparlure will be applied at the rate of 8 g disparlure/A in a single application at the time of adult emergence.

Below are indicated treatments under study. The 1975 Sevin-Disparlure treatment will be funded through Michigan Department of Agriculture and APHIS, PPQ, Michigan.

Treatment		Acres
1974	1975	
Sevin-Traps	No Treatment	3,500
Traps	Traps	3,100
Sevin-Disparlure	Disparlure	1,750
Sevin-Disparlure	No Treatment	1,750
Disparlure	Disparlure	1,600
Disparlure	No Treatment	1,600
No Treatment	Disparlure	3,500
No Treatment	Sevin-Disparlure	7,200
No Treatment	No Treatment	3,500
Treatment Totals		35,800

Project Number: GM 5.2.2
Project Title: Field Testing of Disparlure in Fringe Infestations-Maryland
Report Period: October - December, 1974
Report Type: Preliminary
Project Leader: C. P. Schwalbe

This is a newly developed research project originated by USDA, Agricultural Research Service. APHIS involvement has been in early joint planning sessions and cooperation through commitment of funds to provide microencapsulated disparlure. Intensive egg mass surveys have been completed in cooperation with State Agencies. The study site has been mapped out in Cecil County, MD and is located south of Highway 95 in the vicinity of Elk Neck State Forest. Preliminary plans call for broadcast application of microencapsulated disparlure at 8 gal/A over ca 35,000 acres. A "buffer zone" of high density Delta traps will separate the treatment area from peripheral infestations. Final plans for evaluation will be prepared by ARS.

Project Number: GM 5.2.3
Project Title: Field Testing of Disparlure in Remote Infestations-Virginia
Report Period: October - December, 1974
Report Type: Preliminary
Project Leaders: C. P. Schwalbe and A. P. Morris

Gypsy moth survey and detection programs at Dayton, Virginia have, since 1972, demonstrated the presence of adult male moths. Captures totaled 11 moths in 1974. However, intensive egg mass surveys have been predictably negative. This study has been recently initiated to attempt spot eradication of the insect from the urban area through the use of saturation trapping. Preliminary meetings with VA Department of Agriculture and APHIS, PPQ cooperators have resulted in the following treatment plan. In approximately 2 mi^2 over and around the town of Dayton, gypsy moth Delta traps will be hand placed at 9-10 traps/acre. A peripheral area (ca 10-15 mi^2) surrounding this "core" will be trapped on a grid system at 3 traps/acre. Only forested plots in the peripheral area will be trapped. Effectiveness of this treatment will be judged on the basis of data obtained in succeeding years from similar trap placement patterns.

Project Number: 5.2.4
Project Title: Recovery of Moths Released at Various Distances from Single Survey Traps
Report Period: June, 1972 - July, 1974
Report Type: Final
Project Leader: E. C. Paszek

The effective range of attracting male moths with gypsy moth survey traps baited with disparlure is not known. Limited tests conducted with caged virgin females, natural attractant, gyplure and synthetic natural lure, indicate that survey traps are more efficient in capturing moths at shorter distances of 1/16 to 1/4 mi than the 1/4 to 1 mi range.

The 3 objectives of this study were:

1. Test the efficiency of single traps in attracting moths released in small numbers.
2. Comparison of the recovery of moths in traps placed 1/32, 1/16, 1/8, 1/4, 1/2, 3/4, and 1 mile from the release site.
3. Comparison of laboratory-reared moths with native moths that emerged from field collected pupae.

In the 1972 study, the trap tested was a 2" dia X 4" long paper cylinder fitted with funnel shaped plastic ends with 1" openings. The cotton wick dispenser impregnated with 100 mg of disparlure was attached to the Tack Trap® adhesive in the upper section of the trap. Trap sites were separated by a minimum distance of 2 miles and small numbers of marked male moths were released from each of the 4 cardinal directions, N, S, E, and W.

In the 1973 study the Johnson trap (8 oz Dixie® cup) was baited with a 300 ug disparlure impregnated cotton wick dispenser suspended on a metal Klippie® within the trap. Marked moths were released only upwind from each of the trap sites.

The 1974 study tested a 9.5" long triangular trap with 3.5" X 3.5" X 3.5" open ends. This trap was baited with a plastic Hercon® dispenser (3 cm X 3 cm) stapled by one corner to the trap. Marked moths were released upwind from these trap sites.

In 1972, a total of 1640 ♂♂ were released at each of the 6 trap sites, 410 ♂♂ from each cardinal direction. Results are shown in Table 1.

Table 1. (1972) Efficiency of single gypsy moth survey traps[1] (2" dia X 4" long paper cylinders with 1" openings) in capturing marked laboratory-reared moths released in small numbers at distances of 1/16, 1/8, 1/4, 1/2, 3/4, and 1 mile from the trap locations.

	Number Moths Released		Number and Release Origin of Recovered Moths							
Date	Number per Direction	Total Number per Site	1/16	1/8	1/4	1/2	3/4	1 mi	Temp[2]	Wind
6/2	10	40	0	0	0	0	0	0	66-76	SW
6/5	10	40	2	0	0	0	0	0	69-71	NE
6/12	10	40	0	0	0	0	0	0	67-68	NW
6/16	20	80	1- N	2- E	0	0	0	0	75-65	SW
6/19	40	160	1- W	2-1N 1E	0	0	0	0	62-77	NE
6/21	40	160	0	2-1N 1W	0	0	0	0	77-74	SE
6/27	100	400	14-2N 3S 6E 3W	15-7N 3S 1E 4W	0	0	0	0	74-80	SW
7/7	20	80	0	1- N	0	0	0	0	68-77	SE
7/10	40	160	8-1S 4E 3W	3-1N 2W	0	0	0	0	76-86	SW
7/14	40	160	4-1S 1E 2W	7-3N 1S 2E 1W	3-2E 1W	0	0	0	77-80	SW
7/17[3]	40	160	5-1S 2E 2W	4-1S 1E 2W	0	1- E	0	0	84-81	SW
7/20	40	160	2-1N 1W	1- E	1- E	0	0	0	72-82	NE
Total	410	1640	37 (2.2%)	34 (2%)	4 (0.2%)	1 (0.06%)	0	0		

1/ Cotton wick impregnated with 100 ug of disparlure and 2 mg trioctanoin keeper and attached to upper surface of Tack Trap® adhesive.

2/ High temperature on day of release and 48 hours after release

3/ Moths released on 7/17 were native moths that emerged from field collected pupae.

In 1973 a total of 3500 ♂♂ were released upwind of each of the 6 trap sites. The Johnson survey trap, baited with 300 ug of disparlure captured the number of moths shown in Table 2.

Table 2. (1973) Efficiency of single Johnson survey traps[1] in capturing marked, laboratory-reared gypsy moths released 1/16, 1/8, 1/4, 1/2, 3/4, and 1 mile upwind from each separate trap site (Plymouth County, Mass.).

Date	Number Released per Site	Number of Moths Captured					
		1/16	1/8	1/4	1/2	3/4	1 mi
7/9	300	6(2.0%)	8(2.6%)	2(0.6%)	0	0	0
7/11	300[2]	1(0.3%)	2(0.6%)	0	0	0	0
7/16	300[2]	4(1.3%)	0	0	0	0	0
7/18	300	4(1.3%)	0	0	0	0	0
7/20	300	3(1.0%)	13(4.3%)	0	0	0	0
7/24	300	10(3.3%)	15(5.0%)	1(0.3%)	0	0	1(0.3%)
7/26	200	4(2.0%)	6(3.0%)	2(1.0%)	0	0	0
7/31	200	2(1.0%)	2(1.0%)	0	0	0	0
8/3	200	0	10(5.0%)	0	0	0	1(0.2%)
8/7	300	6(2.0%)	10(3.3%)	0	0	0	0
8/10	200	5(2.5%)	7(3.5%)	0	0	0	0
8/13	100	6(6.0%)	0	0	0	0	0
8/17	200	6(3.0%)	8(4.0%)	0	0	0	0
8/31	300	15(5.0%)	0	1(0.3%)	0	1(0.3%)	1(0.3%)
Total	3500	72(2.0%)	81(2.3%)	6(0.1%)	0	1(0.02%)	3(0.08%)

1/ Cotton wick impregnated with 300 ug of disparlure and 2 mg trioctanoin keeper and suspended on Klippie® 1 1/2" below top surface of Tack Trap® adhesive.

2/ Moth releases for 7/11 and 7/16/73 were native moths that emerged from field collected pupae

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A much larger trap (9.5" long with 3.5" triangular open ends) was used in the 1974 study. It was similar to the traps used in the integrated control studies conducted in Michigan and Massachusetts in 1974. These traps were baited with 3 cm X 3 cm Hercon® wicks (ca 0.58 g, 2.87% disparlure). A total of 915 ♂♂ (laboratory-reared and native) were released upwind from each of the 7 sites. These traps recovered the following number of moths (Tables 3 and 3A).

Table 3. (1974) Efficiency of single 9.5" long triangular control traps[1/] with 3.5 X 3.5 X 3.5" openings in capturing laboratory-reared gypsy moths released 1/32, 1/16, 1/8, 1/4, 1/2, 3/4, and 1 mile upwind from each trap site. (Plymouth County, Mass.).

Date	Number Released per Site	Number of Moths Captured 1/32	1/16	1/8	1/4	1/2	3/4	1 mi
6/19	50	6(12.0%)	0	1(2.0%)	0	0	0	0
6/21	50	0	1(2.0%)	0	0	0	0	0
6/24	50	0	0	0	0	0	0	0
7/9	100	1(1.0%)	0	2(2.0%)	2(2.0%)	3(3.0%)	1(3.0%)	0
7/16	60	0	0	4(6.6%)	1(1.6%)	0	0	1(1.6%)
7/18	100	1(1.0%)	2(2.0%)	7(7.0%)	2(2.0%)	1(1.0%)	2(2.0%)	1(1.0%)
7/19	100	3(3.0%)	1(1.0%)	4(4.0%)	2(2.0%)	6(6.0%)	0	0
7/26	100	0	1(1.0%)	2(2.0%)	3(3.0%)	1(1.0%)	0	0
Total	610	11(1.8%)	5(0.8%)	20(3.2%)	10(1.6%)	11(1.8%)	3(0.4%)	2(0.3%)

1/ Traps baited with Hercon® wicks 3 cm X 3 cm with average disparlure weight of 8 mg per wick.

Table 3A. (1974) Efficiency of single triangular control traps in capturing released native moths which emerged from field collected pupae. Moths were released 1/32, 1/16, 1/8, 1/4, 1/2, 3/4, and 1 mile upwind from each separate trap site (Plymouth County, Mass.).

Date	Number Released per Site	1/32	1/16	1/8	1/4	1/2	3/4	1 mi
7/12	40	1	0	0	0	0	0	0
7/15	120	1	2	1	0	0	0	0
7/18	30	0	1	3	1	1	0	1
7/19	40	0	1	2	0	0	0	0
7/23	75	0	0	0	0	1	0	0
Total	305	2(0.6%)	4(1.3%)	6(1.9%)	1(0.3%)	2(0.6%)	0	1(0.3%)
Combined Total (Tables 3 + 3A)	915	13(1.4%)	9(1.0%)	26(2.8%)	11(1.2%)	13(1.4%)	3(0.3%)	3(0.3%)

In the 1974 study 1/3 (305) of the 915 ♂♂ released at each site were native moths. A slightly higher percentage of laboratory-reared males released were recovered from 6 out of the 7 trap distances studied. (Tables 3 and 3A).

The efficiency of a modified Graham trap baited with 300 ug of disparlure was tested twice in 1973 by releasing a total of 1100 marked, laboratory-reared moths and 1100 marked, native moths from a distance of 1/10 mi. Again, a higher percentage of the laboratory-reared moths were recovered in both tests. Results are shown below in Table 4.

Table 4. (1973) Efficiency of a Graham trap (300 ug disparlure) in capturing dyed moths (laboratory-reared and native) released 1/10 mi upwind in an area free of trees and other obstructions.

	Number Released		Number Caught		Temperature (°F)		Wind (mph)	
Date	Laboratory	Native	Laboratory	Native	Max	Min	Dir.	Veloc.
7/6	500	500	16(3.2%)	11(2.2%)	82	64	SW	18
7/12	600	600	7(1.4%)	2(0.4%)	71	61	SW	26

In 1973, fifty laboratory-reared virgin females (4-48 hr old) were caged 2' above the ground and 600 laboratory-reared males were released 1/10 mi upwind from this cage. As the male moths alighted upon the cage and performed precopulatory behavior, they were killed by the observer. A total of 45 (7.5%) of the males were recovered within 48 hours. A number of males flew around the cage but did not alight upon it. Two were devoured by a preying mantis in tall grass nearby. Results are shown in Table 5.

Table 5. (1973) Efficiency of 50 caged[1/] laboratory-reared females (4-48 hr old) in attracting 600 laboratory-reared males released 1/10 mi upwind in an area free of trees and other obstructions

Date	Time	Number Caught	Temperature (°F) Max	Min	Wind Dir.	(mph) Veloc.
7/19	1100-1200	12	83	62	SW	15
	1200-1300	13	"	"	"	"
	1300-1400	11	"	"	"	"
	1400-1500	0	"	"	"	"
	1500-1600	4	"	"	"	"
Total		40				
7/20	1600-0800	4	"	"	"	"
	0800-1600	1	"	"	"	"
Total		5				
Grand Total		45 (7.5%)				

1/ Females held inside hardware cloth cylinder 15" X 15" dia enclosed within a screen cage 17 1/2" X 12" X 10". From 1100-1600, male moths were killed as they alighted on the cage and performed precopulatory behavior.

These studies primarily indicate that long-range orientation to pheromone sources is not a major element in gypsy moth mate-finding behavior. Extremely low percentages of released moths are captured and this does not appreciably improve with increased pheromone concentration within the trap. Additionally, laboratory-reared moths were consistently more responsive to pheromone sources than were those field-collected. It is interesting to note, however, that in comparing captures in Tables 4 and 5, caged, virgin females were more attractive than cotton wick pheromone sources. This is possibly due to:

1. Failure of attracted moths to enter baited traps (Table 4). In the Table 5 experiments males were killed and counted as they alighted on the cage containing females.
2. The caged females were likely emitting more pheromone than the cotton wicks, resulting in greater captures.
3. Other stimuli (chemical or physical) may be produced by the females and not present in baited traps.

Studies directed toward this phenomenon will be conducted in the future.

Project Number: GM 5.2.5
Project Title: Multiple Mating by Male and Female Gypsy Moth Adults
Report Period: October - December, 1974
Report Type: Preliminary
Project Leaders: E. C. Paszek, J. A. Tanner, L. Kennedy

Groups of 10 ♀ NJ F_{11} generation moths with 2.5 ug of disparlure applied to their wings were placed on individual stakes in a 14' X 14' X 7.5' chamber (75°F, 60% RH, 14D:10N). Fifty newly emerged adult ♂ moths were released. When a ♀ attracted a ♂ and copulation commenced the mating pair was transferred to a 16 oz. cardboard container and the length of the copulatory period timed. After completion of mating the ♂ was transferred to a new container with a virgin ♀ and again allowed to mate. This proceedure was repeated until the ♂ ceased mating. Resulting egg masses were numbered, allowed to embryonate for 30 days, sealed in double Baggies® plastic bags and refrigerated at 40°F to complete diapause.

Out of a total of 106 ♀♀ placed in the chamber, 39 ♀♀ (38%) mated. Twenty-nine of the ♂♂ moths were multiple maters and mated the following number of times:

5 ♂♂ each mated 7 times
7 ♂♂ " " 6 times
3 ♂♂ " " 5 times
8 ♂♂ " " 4 times
5 ♂♂ " " 3 times
1 ♂♂ " " 2 times
5 ♂♂ " " 1 time

The egg masses that resulted will be incubated in the spring quarter of 1975 after 150 days of refrigeration to break diapause.

Project Number: GM 5.2.6
Project Title: Trap Design and Evaluation
Report Period: October - December, 1974
Report Type: Interim
Project Leader: J. G. R. Tardif

This is an ongoing research effort to develop efficient trap designs suitable for gypsy moth survey, detection and control. Prototype traps are constructed and evaluated with conventional field and laboratory bioassay techniques.

Appendix III details the design and evaluation of a newly developed "Delta" trap. The project is continuing to determine if scaling down the size of the Delta trap will adversely affect its efficiency. Future reports under this section will deal with those studies.

Project Number: GM 5.2.7
Project Title: Attractiveness of Disparlure-Baited Traps as Affected by Florescent Pigments
Report Period: July - December, 1974
Report Type: Final
Project Leader: J. G. R. Tardif

A series of tests was designed to determine if visual stimuli (in the ultraviolet range) modifies or enhances male moth orientation to disparlure-baited traps.

Open-ended triangular traps (4.75 inches long with 4 inch sides) were treated with 2 coats of latex-based ultraviolet-sensitive pigments. Ten traps each were treated with white, pink, red, orange, blue, and green pigments. Standard floral-orange traps served as controls. Although the ultraviolet-sensitive pigments were invisible, shades of white and pale orange were noticeable.

Two separate tests were conducted. Test A was designed with individual traps placed at intervals of 5 feet along a wooded road in a moderate infestation. Test B consisted of 7 traps mounted on two stakes at each of 5 positions, 50 feet apart. In each test, 5 replicates of each trap type were used.

The results are shown in Tables I - III

Table I

Test A - Replicate Totals

Trap Color	Time Recorded			
	18 Hours	24 Hours	42 Hours	Sum of Treatments
Blank	10	14	13	37
Orange	14	16	9	39
Pink	16	9	8	33
Red	16	11	12	39
Blue	16	6	14	36
Green	15	11	6	32
White	18	7	5	30
	105	74	67	246

Analysis of variance indicated no significant differences between traps treated with various florescent pigments. Captures varied significantly at different recording times and this is presumably due to climatological variations and unequal sampling periods.

Table II

Test B - Replicate Totals				
Trap Color	Time Recorded			
	24 Hours	48 Hours	72 Hours	Sum of Treatments
Blank	12	5	6	23
Orange	0	3	2	5
Pink	3	3	5	11
Red	18	5	5	28
Blue	3	4	8	15
Green	3	3	2	9
White	3	1	5	9
	42	24	33	99

There were no significant differences between times and treatments and between treatments themselves at the 5% confidence level (analysis of variance).

Table III

Test B - Position vs Treatment				
Trap Color	Trap Position			
	High(3')	Medium(1.5 - 2.5')	Low(1')	Sum of Treatments
Blank	1	2	20	23
Orange	0	2	3	5
Pink	2	9	0	11
Red	2	12	14	28
Blue	0	2	13	15
Green	0	8	0	8
White	0	4	5	9
	5	39	55	99

Positioning of traps at various heights did not significantly alter the results of the test at the 5% confidence level. However, trends in the data seem to indicate greater captures at lower positions. It would appear from these studies that ultraviolet-sensitive pigments have no effect on male moth orientation to and capture in pheromone-baited traps.

Project Number: GM 5.2.8
Project Title: Attractiveness of Disparlure-Baited Traps as Affected by Trap Color
Report Period: July, 1974 - August, 1974
Report Type: Final
Project Leaders: E. C. Paszek, J. G. R. Tardif

A trap color study in 1948 (E. D. Burgess and R. F. Holbrook)[1/] indicated that the color of a trap might have some influence on its attractiveness. Red or white was not as effective as gray, yellow or green. Graham traps painted green, gray, yellow, yellow-orange and orange were field tested in 1949 with the natural gypsy moth sex attractant. This study showed no significance of trap color in influencing moth captures.

In the spring of 1974 laboratory tests conducted in bioassay chambers with 9 different colored pheromone baited traps (12.5 cm long with 9 cm X 9 cm open ends) indicated that gold or orange traps outcaptured red, green, blue, black, silver, yellow and white colored traps. This study was repeated outdoors in 2 lightly infested areas using both the Hercon dispenser and the cotton wick dispenser. The traps were replicated 8 times in blocks of 11 traps with a 15 m distance between traps.

No color preference to pheromone baited traps was indicated in this study (Table No. 1). However, yellow and white appeared to be the most detrimental colors. They attracted more aphids and other non-target insects than the other 7 colors.

Orange colored traps should be used in rural wooded areas to facilitate an easy relocation of traps. However, in urban areas where traps are stolen or molested, dark green traps would help to camouflage them with their background. White and yellow traps should not be used as they attract more aphids and other non-target insects.

1/ Experimental Gypsy Moth Trapping, Summer of 1949, p. 8.

Test—1
GREEN GRAHAM
GREEN JOHNSON
SILVER
BLUE
GOLD
BLACK
RED
GREEN
ORANGE
WHITE
YELLOW

Test—2
GREEN GRAHAM
GREEN JOHNSON
GOLD
GREEN
BLACK
RED
BLUE
ORANGE
SILVER
YELLOW
WHITE

Project Number: GM 5.2.9
Project Title: Mating Enhancement of Female Gypsy Moths with Small Amounts of Disparlure
Report Period: October - December, 1974
Report Type: Preliminary
Project Leaders: E. C. Paszek, J. A. Tanner, L. Kennedy

Attempts were made to enhance attractiveness of ♀♀ moths by topically applying small amounts of disparlure to their wings. Mating behavior of treated ♀♀ and untreated controls was observed. Relative attractiveness, length of time of copulation and fertility of egg masses were recorded.

A total of 120 NJ F_{11} ♀♀ moths of age groups 0, 24, 48, 72, 96, and 120 hours were treated individually on the wings with 5, 2.5, and 1 ug of disparlure and allowed to mate on 2' stakes in a 14' X 14' X 7.5' bioassay chamber (75°F, 60% RH, 14D:10N) with released♂ moths. A similar number of untreated ♀♀ were used as controls. Data was taken on time elapsed before mating began and length of time of copulation. Egg masses were allowed to embryonate for 30 days; hatch data will be taken after diapause is completed.

Table 1 - Mating Enhancement of ♀♀ with Small Amounts of Disparlure

			TIME IN MINUTES					
	♀♀ Age Hrs.	No. Matings	Time Elapsed Before Mating	Period of Copulation		No. Matings	Time Elapsed Before Mating	Period of Copulation
Treated-	0	6	60	183	Control	5	289	145
5 ug	24	6	10	163		4	245	123
Disparlure	48	6	23	145		5	278	108
	72	6	35	150		2	57	65
	96	6	11	102		4	78	67
Total		30(100%)	139	743		20(66%)	947	508
Avg.			27	148			189	101
Treated-	0	6	25	209	Control	3	90	201
2.5 ug	24	10	~~10~~ 0	212		5	156	143
Disparlure	48	6	14	178		3	988	145
	72	10	30	162		7	234	238
	96	6	7	169		2	375	195
	120	6	20	154		3	225	465
Total		44(91%)	106	1084		23(47%)	2068	1387
Avg.			17	180			344	231
Treated-	0	5	22	220	Control	4	255	167
1 ug	24	4	135	182		4	245	182
Disparlure	48	5	279	310		1	75	255
	72	6	15	225		6	240	168
	96	6	10	185		3	291	210
	120	10	37	211		7	238	170
Total		36(85%)	498	1333		25(59%)	1344	1152
Avg.			83	222			224	192

Treating virgin ♀♀ with disparlure greatly enhances attractiveness to free flying ♂♂ as evidenced by greater % mating and less time required for males to locate females and begin mating. There are indications that the length of copulatory period decreases with increasing female age. Additional studies will be directed toward this phenomenon.

Project Number: GM 5.3.1
Project Title: Insect Production and Distribution
Report Period: July - December, 1974
Report Type: Interim
Project Leader: Leonard F. Kennedy

The primary object of the rearing facility of this laboratory is to produce sufficient quantities of all phases of the gypsy moth life cycle in support of research projects at this laboratory and several universities and experiment stations in the U.S. and foreign countries. Following is a summary of production and distribution of such material from July 1st to December 31st.

Summary of Production and Distribution
July 1, 1974 - January 1, 1975

Eggs Incubated	Larvae Hatched	Larvae Canned	Pupae Harvested	
			♂	♀*
4,757,000	717,255	522,823	146,198	102,180

* During October and November, large ♀ only were collected, resulting in a considerable decrease in production.

Insect Distribution:

Otis Methods Development:
- Insecticide Screening...2nd Instar Larvae.....28,440
- Lure Bioassay.....Adults.....83,955♂ + 500♀
- Repellency Tests.....5th Instar ♂, 6th Instar ♀...8645♂ + 8645♀
- Experimental.....Newly Hatched Larvae.....200
- Experimental.....2nd Instar Larvae.....120

Field Tests of Disparlure:
- Michigan.....9928♀ pupae
- Massachusetts.....7950♀ pupae
- New Hampshire.....3250♀ pupae

University of Maine - Dr. Dave Leonard.....873♀ pupae
Michigan State University - Dr. Walner.....400 Egg Masses
West Germany - Dr. Kasang.....792♂ pupae + 750♀ pupae

Project Number: GM 5.3.2
Project Title: Fertility and Hatchability of Eggs Within Egg Masses
Report Period: July - December, 1974
Report Type: Final
Project Leaders: John Allen Tanner and L. F. Kennedy

Porthetria dispar L. eggs, reared at Otis Laboratory, have been found to produce a low hatch rate. Because of egg mass pooling techniques employed to handle large numbers of egg masses prior to incubation, it is not known whether this low hatch rate is due to some egg masses being completely infertile, or to a large number of infertile eggs within a mass.

One hundred egg masses (Ludlow F_{10}) were placed into individual plastic petri dishes (70 X 15 mm) and incubated (25°C, 80-90% RH, 14L:10D). Larvae were removed daily and upon completion of hatch the remaining unhatched eggs were counted. Also, four masses with high, medium, or low hatch were randomly selected and the percent embryonation determined. The results of this study are summarized in Tables 1 and 2.

Table 1 - Hatch Rate of Laboratory Reared *P. dispar* Egg Masses

Percent Hatch Range	Percentage of Egg Masses
0	18
1.0 - 20.0	43
21.0 - 40.0	15
41.0 - 60.0	6
61.0 - 80.0	10
81.0 - 100.0	8

Table 2 - Percent Embryonation of Unhatched *P. dispar* Eggs From Egg Masses with High, Medium, or Low Percent Hatch

Percent Hatch	Percent Embryonation
96.6	78.9
48.0	97.3
00.0	98.6

Eighteen percent of the egg masses failed to produce larvae, with 61% of the egg masses producing less than 20% hatch (Table 1). The mean embryonation rate of unhatched eggs was 97% (Table 2), with most of the embryos dead and dehydrated. The high embryo mortality indicates that careful investigation of the presently used culture methods should be undertaken. The wide variation in the percent hatch (Table 1) of the egg masses may also indicate that the problem is of genetic or nutritional origin.

Project Number: GM 5.3.3
Project Title: Hatchability of Eggs as Affected by Position in the Storage Container During Refrigeration
Report Period: July - December, 1974
Report Type: Final
Project Leaders: John A. Tanner, and L. F. Kennedy

Data from the study "Fertility and Hatchability of Eggs Within Egg Masses" (Project Number GM 5.3.2, July - December, 1974 Laboratory Report) demonstrated a slight trend of increasing mean hatch rate in the order of egg mass selection from the egg storage container. It was hypothesized that the mass location within the storage receptacle may have an effect on the survival of P. dispar eggs during refrigeration.

Three P. dispar egg mass storage receptacles constructed from 250 ml urine cups covered with four layers of plastic and stored inverted during refrigeration, were selected and divided into three sections - top, middle, and bottom (cup area nearest the plastic covering). Ten masses were selected from each section and placed into individual plastic petri dishes. The masses were incubated (25°C, 80-90% RH, 14L:10D) and the larvae removed daily. Upon completion of hatch the number of unhatched embryonated eggs and unembryonated eggs was determined and the percent hatch, based on the number of embryonated eggs, was calculated.

Table I - The percent hatch of P. dispar egg masses as affected by the location of the mass within the storage receptacle.

Mass Position	Mean Percent Hatch[1/, 2/] Replication			
	1	2	3	$\bar{X}$
Top	85.4	91.6	85.0	87.2
Middle	77.7	90.6	88.4	85.6
Bottom	92.4	95.5	91.6	93.1

1/ Based on ten masses
2/ Differences were non-significant at the 5% level

No significant differences in the hatch rate of P. dispar egg masses located in different sections of the storage receptacle were observed. However, those masses located nearest to the plastic cover produced a consistently higher hatch rate. The high hatch rate observed in this experiment is not consistent with egg hatchability normally found in the culture. Also, a large variation in the hatch rate observed in the study "Fertility and Hatchability of Eggs Within Egg Masses"(Project Number GM 5.3.2, July - December, 1974 Laboratory Report) tends to indicate that other factors (genetic, nutritional), may play an important role in the survival of eggs during storage and should be tested in future experiments.

Project Number: GM 5.3.4
Project Title: Effect of the Number of Egg Masses per Storage Container on the Hatchability of Eggs.
Report Period: July - December, 1974
Report Type: Preliminary
Project Leader: John Allen Tanner and Leonard F. Kennedy

Mortality of laboratory-reared P. dispar eggs during diapause may be caused by asphyxiation mediated by the accumulation of CO_2 within the storage container (a 250 ml urine cup covered with four layers of plastic). However, the utilization of a more porous container results in dehydration of eggs. A possible solution to these problems may be to use the present containers with fewer numbers of masses per container.

To test this hypothesis 810 P. dispar egg masses will be selected prior to precooling and divided into 27 groups, nine groups each of 10, 30, and 50 egg masses. Each individual group of egg masses will be placed into 250 ml urine cups and covered with four layers of plastic. After ten days of precooling (15.5°C, 65% RH, 14L:10D), the cups will be stored in a refrigerator (4°C). Hatch rates will be determined after 3, 4, and 5 months of refrigeration.

Project Number: GM 5.3.5
Project Title: Hatchability of Eggs Produced by Hybridized Wild and Laboratory Reared Gypsy Moths
Report Period: July - December, 1974
Report Type: Preliminary
Project Leaders: John Allen Tanner and L. F. Kennedy

Turner (1960) observed that inbred progeny of Oncopeltus fasciatus Dal. had reduced vigor and, in some cases, lower survival when compared to crossbred progeny.[1] The following study was undertaken to determine if crossing laboratory strains with wild strains of P. dispar increases the survival rate of eggs during refrigeration.

Twenty four of the following crosses - wild ♂ X wild ♀; wild ♂ X lab ♀; lab ♂ X wild ♀; and lab ♂ X lab ♀ - were made by individually pairing newly emerged male and female moths in 16 oz. Dixie® cups. The resultant egg masses were embryonated (25°C, 65% RH, 14L:10D) within the containers for forty days. After embryonation the egg masses were removed from the containers and placed into individual 1 oz. plastic cups. Each cup was covered with four layers of plastic and precooled (15.5°C, 65% RH, 14L:10D) for ten days.

The egg masses are currently under a five month refrigeration (5.5°C) for diapause. At the completion of refrigeration the egg masses will be placed into individual plastic petri dishes and incubated (25°C, 80-90% RH, 14L:10D). At the termination of hatch, the remaining unhatched embryonated eggs will be ascertained and the hatch rate calculated.

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[1] Turner, N. 1960. The effect of inbreeding and crossbreeding on numbers of insects. Ann. Entomol. Soc. 53(5). 686-688.

Project Number: GM 5.3.6
Project Title: Comparison of Different Egg Storage Techniques on the Hatchability of Eggs
Report Period: July - December, 1974
Report Type: Preliminary
Project Leaders: John Allen Tanner and Leonard F. Kennedy

Desiccation of refrigerated P. dispar eggs is prevented by storing them in 250 ml urine cups covered with four layers of plastic (50 masses/cup). However, P. dispar eggs are known to respire at the storage temperature of 4°C (Patyukhov, 1964) and it is possible that the plastic covering restricts the exchange of gases, thus resulting in suffocation of the embryos.

This is one of a series of experiments developed to determine the etiology of embryo mortality.

Three hundred laboratory reared P. dispar egg masses were selected for this study and storage conditions were as follows.

No. Egg Masses	Container	Location
50	250 ml urine cup + 4 layers plastic wrap	Refrigerator[1]
"	" + "	Field[2]
"	" + cheese cloth cover	Refrigerator
"	" + "	Field
"	stapled to log	Refrigerator
"	stapled to tree	Field

1/ Refrigerator conditions are 2 - 5° C, 60 - 80% RH.
2/ Wooded area near the laboratory.

A similar experiment utilizing 300 field-collected egg masses was developed simultaneously with the laboratory eggs.

Both the laboratory and wild eggs are completing their required five months refrigeration. Upon completion, the egg masses will be individually incubated and the hatch rate ascertained.

Reference Cited: Patyukhov, G. A. 1964. The effect of negative temperatures on populations of brown-tail moth, Euproctis chrysorrhoc L., and the gipsy moth Lymantria dispar L. (Lepidoptera: Orgyidae). Ent. Obozr. 43(1):94-111

Project Number: GM 5.3.7
Project Title: Effects of Pupal Weight on Adult Fecundity and Larval Development Rate of the Gypsy Moth
Report Period: October - December, 1974
Report Type: Interim
Project Leaders: Leonard F. Kennedy and John Allen Tanner

A currently critical problem in mass rearing of the gypsy moth is the declining hatch rate of eggs from various laboratory strains. The practice of selecting the largest female and male pupae for mating and egg production has resulted in strains of vigorous and uniform development but with steadily declining hatch rates. This decline may be a result of the current selection and culling process.

A test was designed to determine if adult size (pupal weight) influences fecundity, hatch rate and quality of the larvae produced. Fifty male and fifty female pupae were selected randomly and weighed. These pupae were paired and placed one pair in each of fifty 90 ml plastic cups. Resultant eggs embryonated for 30 days at 25.5°C (78°F) and precooled at 16.1°C (60°F) for 10 days in preparation for refrigeration. The eggs are presently under refrigeration at 4.4°C (40°F) and will be removed and incubated 4/10/75. Rates of embryonation and hatchability will be determined. Larval development and uniformity will be monitored.

Project Number: GM 5.3.8
Project Title: Effect of Relative Humidity on Hatch Rate
Report Period: July - December, 1974
Report Type: Preliminary
Project Leaders: John Allen Tanner and Leonard F. Kennedy

P. dispar eggs are stored at this laboratory in frost-free refrigerators. These refrigerators tend to dehydrate materials and it is thought that the high mortality of the eggs may be due to desiccation, even though the eggs are stored in plastic cups covered with four layers of plastic. The following study has been designed to determine if relative humidity affects stored-egg hatchability.

Relative humidities of 23, 50, 73, and 100% will be maintained inside four desiccators (200 mm dia) with varying concentrations of KOH solutions. Into each desiccator will be placed one plastic-sealed urine cup containing 50 masses and one group of 20 free masses. Each desiccator will be placed into a refrigerator (2°C). A plastic-sealed urine cup and 20 free masses will be placed directly into the refrigerator as controls.

After five months refrigeration the egg masses in each group will be incubated to determine the hatch rate.

Project Number: GM 5.3.9
Project Title: Effect of Chilling Duration on Egg Hatchability
Report Period: July - December, 1974
Report Type: Interim
Project Leaders: John Allen Tanner and Leonard F. Kennedy

Field-collected P. dispar eggs are normally given a five month chilling period. This treatment yields the greatest hatch in the shortest period of time. Laboratory eggs are treated in a similar manner. However, over a period of generations the hatch rate has decreased. Preliminary experiments concerning the reduction of the chilling period have produced some favorable data and it is thought that, through selection, strains which require less chilling have been developed.

To test this hypothesis 270 newly laid, laboratory reared P. dispar egg masses were sectioned in half and each half labeled A or B. The "A" group was placed into 125 ml plastic cups and stored in a wooded area. "B" half-masses were placed into a similar container which was then covered with four layers of plastic. These were embryonated (25°C, 70-80% RH, 14L:10D) for 40 days followed by ten days of precooling (15.5°C, 65% RH, 14L:10D) and finally refrigerated (4°C).

Commencing 31 days after the egg masses were laid and continuing at 31 day intervals, one group of complementary A - B masses were removed and incubated to determine hatch rate.

A similar experiment was developed with field eggs.

Project Number: GM 5.3.10
Project Title: Hatch Rates of Laboratory Produced Eggs as Affected by Duration of Refrigeration
Report Period: July - December, 1974
Report Type: Preliminary
Project Leaders: John Allen Tanner and Leonard F. Kennedy

Preliminary data from other studies have shown that the hatchability of egg masses from laboratory strains of P. dispar varies considerably with changes in the duration of refrigeration. This study was designed to attempt to correlate hatch rates with length of refrigeration for each generation of each laboratory strain currently maintained at this laboratory. From these curves the optimum duration of the chilling period will be determined for each strain and these data will be applied to minimizing embryo mortality due to excessive refrigeration.

Each of the first 200 egg masses produced by each strain of P. dispar will be divided into one 1/2 mass, one 1/4 mass, and two 1/8 masses and treated as follows.

200 1/2 masses - Refrigerated (4°C) intact in 250 ml urine cups covered with 4 layers of plastic wrap (100 1/2 masses/cup).
200 1/4 masses - Egg masses broken up and thoroughly mixed (but not dehaired) and refrigerated as above.
200 1/8 masses - Egg masses dehaired and refrigerated as above.
200 1/8 masses - Egg masses dehaired, surface sterilized with 0.1% sodium hypochlorite, treated with Captan and refrigerated as above.

Commencing the day of refrigeration and continuing at bi-weekly intervals, ten samples of intact half masses, three samples of broken masses, and three - 100 egg samples of each dehaired, untreated and dehaired, treated eggs will be selected and placed into individual plastic petri dishes for incubation (25°C, 80-90% RH, 14L:10D). Hatch rates will be calculated and curves developed. The information will be used to determine the optimum length of refrigeration for eggs of each strain and the best egg storage technique. Strains will be tested each generation to detect possible changes in optimum parameters.

APPENDIX I

Field Evaluations of Insecticides Against the Gypsy Moth *Porthetria dispar* (L.)

by

Larry L. Herbaugh, W. H. McLane and C. R. Stacy

Introduction

The gypsy moth, Porthetria dispar (L.) continues to be one of the major destructive pests of deciduous forests. In recent years thousands of acres of hardwood forests have been defoliated in 9 northeastern states. In 1973 alone, caterpillars defoliated about 1,744,000 acres of woodland (Mulhern 1973). Scientists have yet to develop control methods that can contain this unique insect to a limited area. Survey traps capture adult males in virtually all parts of the country.

The gypsy moth has only one generation per year with larvae hatching from overwintering eggs in the spring at the time oak foliage begins to unfold. These larvae feed and cause defoliation until the first part of July and then go into pupation for approximately 2 weeks, emerge as adults, mate and deposit egg masses, each containing several hundred eggs, completing the cycle (Forbush and Fernald 1896).

Many different types of control techniques have been attempted since the insect was accidentally released in Massachusetts in 1869. Most successful of these techniques is the use of pesticides. However, with the restricted use of chemicals, primarily

DDT, that were previously used for control, a continuing search is being made for an effective pesticide. Because of our concern with environmental pollution, it becomes increasingly important that we screen materials before using them in the field. This type of screening process is carried out with materials at the USDA, Gypsy Moth Methods Development Laboratory, Otis Air Force Base, Massachusetts (McLane 1973). After extensive laboratory screening, only those materials that show a minimal environmental hazard and good potential for field control are then tested under field conditions. Field trials reported here were conducted in the 1974 season from materials previously used and/or tested in the laboratory at Otis AFB (McLane 1974).

Materials and Methods

All of the materials used in the 1974 field trials were selected on the basis of their performance in laboratory conditions against artificial diet reared gypsy moth larvae(McLane 1973). Some of the materials had been previously field tested with inconclusive results that needed further decisive tests.

Bioethanomethrin, a synthetic pyrethroid, is a safe material

from the standpoint of toxicity. Laboratory tests showed it to be very effective as a control poison against gypsy moth larvae (McLane 1973). This material had been tested in field plots in 1973 in Pennsylvania but a general population collapse occurred and it was felt that for a true effectiveness evaluation of this material it should be retested. This material was tested at 0.02 lbs ai/gal/A and at 0.05 lbs ai/gal/A with a 15% CIB molasses concentrate (see Table 1).

CGA-18809, an organophosphate, shows an acute oral LD 50 of 1180 mg/kg (rat) and no phytotoxicity under limited field evaluations (CIBA-GEIGY). Laboratory tests showed it gave excellent results both as a contact and a stomach poison against lab-reared gypsy moth larvae (McLane, unpublished). This material was applied at 1.0 lbs ai/qt/A with a 3% Chevron sticker (see Table 1).

In laboratory tests, experimental formulations of encapsulated Diazinon and Sumithion performed sufficiently long after technical formulation tests had concluded for lack of activity. This work was conducted in cooperation with Pennwalt Corp. for formulation of the experimental encapsulated materials. Materials were applied at 0.5 lbs ai/gal/A and 1.0 lbs ai/gal/A respectively.

Imidan is an organophosphate insecticide that exerts its toxic action by inhibiting cholinesterace in insects and other living organisms which have a cholinergic system (Stauffer Chemical Co. November 1969). This was tested in 1973 but because of a general natural collapse in the area it was decided to retest it in 1974 at 0.5 lbs ai/gal/A (see Table 1).

Orthene, commonly called acephate, is an organic phosphate insecticide of moderate persistence with a relatively short 5-10 day residual activity. This material has an acute oral toxicity in purebred beagle dogs of 681 mg/kg minimum lethal dose. The acute oral LD 50 of technical Orthene for chickens is 852 mg/kg and 350 mg/kg for mallard ducks (Chevron Chemical Co. 1972). This material was tested as orthene + H_2O at 0.5 lbs ai/2 qt/A and orthene + propolene glycol at the same rate (see Table 1).

TH 6040 is an insect growth regulator which showed excellent promise under laboratory conditions. The mode of action is to inhibit chitin formation of larvae upon molting. This shows no phytoxicity at 10,000 ppm spray concentration and has an oral LD 50 on male mice of 3160 mg/kg (14 day) and an LC 50 to guppy

of 100 ppm (5 day exposure), (Thompson-Hayward Chemical Co.). This material was applied at 0.06 lbs ai/gal/A and 0.3 lbs ai/gal/A with 3% Chevron sticker (see Table 1).

Table 1. Details of 1974 formulations field-tested.

Material	Application rate/acre	Chemical Concentration	Sticker
Bioethanomethrin			
a	1 gal/acre	0.02# ai/gal	CIB at 15% concentration
b	1 gal/acre	0.05# ai/gal	"
CGA-18809	1 gal/acre	0.5# ai/gal	Chevron at 3% concentration
Encap Diazinon	1 gal/acre	0.5# ai/gal	None
Encap Sumithion	1 gal/acre	1.# ai/gal	None
Imidan	1 gal/acre	0.5# ai/gal	None
Orthene + Propolene Glycol	2 qt/acre	.5# ai/2 qt	None
Orthene + H O	2 qt/acre	.5# ai/2 qt	None
TH 6040			
a	1 gal/acre	0.06# ai/gal	Chevron at 3% concentration
b	1 gal/acre	0.3# ai/gal	"

Plot Establishment: An area in Hamden county, Mass. was selected in 1974 as meeting the criteria for establishing experimental plots. The criteria are the following. (1) an area in which the population is building and in which there had been no more than 1 year's noticeable defoliation prior to the test year; (2) a readily measureable population within the range of 100 to 900 egg masses per acre; (3)predominance of preferred host trees (oaks).

Each plot was laid out by establishing an accessible base corner and running boundary lines along compass headings resulting in a square with sides of 1476 ft and a 50 acre plot. A marker was placed at all four corners for aircraft guidance. These markers consisted of white canvas bags slipped over folded branches on the ends of saplings. The saplings, in turn, were raised through the canopy and fastened so that the bags were 10 to 15 ft above tree top level.

Within each 50 acre plot, 5 subplots or sampling units were established. Each encompassed 66 sq ft or 0.1 acre and were randomly placed throughout the plot. These subplots were chosen to represent the entire plot and served as sampling points throughout the experiment. A series of these sampling points were established in untreated check areas to measure natural conditions.

For guidance and convenience to the ground crews a tag was placed on the base corner tree and identified its location, e.g., NW corner of plot 3. The perimeter boundaries were marked in orange ribbon, the lines to the subplots in blue ribbon and the subplots in white ribbon with a tag on a corner identifying it.

Application: The application schedule was designed so that material was to be applied when the majority of larvae were in the late 2nd instar stage and the oak foliage was 50-75 percent expanded. However, due to circumstances beyond our control only plots 22 and 23 and part of 20 had material applied on this schedule. The remaining plots were delayed a week before application resumed. During this time rain and warm weather caused rapid leaf expansion and insect growth. As a result, most target insects were in the 3rd instar and leaf expansion on preferred host plants was nearly 100 percent.

All plots were treated with a Piper Pawnee aircraft equipped with a propeller-driven impeller pump and a conventional spray system. The airplane dispersed the material in 75 foot swaths at 100 mph as near to tree top level as possible with a ground wind velocity of less than 5 mph.

Materials were mixed and put into aircraft with conventional mixing equipment consisting of 2 mixing tanks, pumps, hoses, measuring devices, and necessary safety equipment. All mixing and spraying equipment was thoroughly cleaned between each treatment to avoid adulteration.

The following table shows the different arrangements used on the conventional spray system.

Material	Orifice	Screen Mesh	psi	Degree to Slipstream
Bioethanomethrin	18-8008 flat fan	25-mesh	40	90°
CGA-18809	18-8008 flat fan	25-mesh	40	90°
Encap Diazinon	18-8008 flat fan	no screen	42	90°
Encap Sumithion	18-8008 flat fan	no screen	42	90°
Imidan	18-8008 flat fan	25-mesh	40	90°
Orthene + Propolene glycol	18-8002 flat fan	25-mesh	40	straight aft
Orthene + H_2O	18-8004 flat fan	25-mesh	40	straight aft
TH-6040	18-8008 flat fan	25-mesh	40	90°

During spray operations, radio communications were maintained between the ground crew and the observation plane in respect to ground conditions such as wind velocity and material dispersement. The observation plane was used to guide the pilot to the plot, indicate the boundaries and general observation of the work.

Evaluation: Each treatment was evaluated from the standpoint of foliage protection and population reduction.

The degree of foliage protection was estimated by visual examination of the degree of defoliation in each of the sampling plots at the termination of larval feeding. These estimates were made in 20% increments and were all made by the same crew so that human judgement would remain constant (see Table 3).

Population reduction was estimated by using a system similar to that described by Campbell (1967) in which the beginning larval population is estimated from egg mass density and viability data.

In early spring, the egg masses were counted in each subplot to

determine number of egg masses/acre before treatment. Egg masses were collected adjacent to the sampling plots and were stratified to represent above and below the snowline. These collections were incubated in the laboratory to provide the following data: Number of eggs/mass, number of larvae successfully hatched, and the percent hatch for each egg mass. An estimate of beginning larval population was computed by: (number egg mass/acre) (number eggs/mass) (% hatch) = number of beginning larvae per acre (see Table 4).

The percent reduction in egg mass population was calculated by counting the egg masses in each subplot after leaf drop and using the following formula $\frac{\text{fall egg mass/acre}}{\text{spring egg mass/acre}} \times 100 = \%$ reduction in egg masses (see Table 4).

To determine residual effects on larval mortality a 3' X 3' white drop cloth was placed under a representative preferred host tree in each of the sampling units. Daily readings were made and recorded on each of these until mortality ceased to be significant. With the exception of TH 6040 this was 96 hours or less (see Table 5).

Table 3.

Material		Plot	% Defoliation
Imidan	.5 lb/gal/ac	1	4-23
Imidan	.5 lb/gal/ac	4	44-63
Imidan	.5 lb/gal/ac	24	60-80
Orthene + H_2O	.5 lb/2 qt/ac	20	0-19
Orthene + H_2O	.5 lb/2 qt/ac	23	16-35
Orthene + Propolene Glycol	.5 lb/2 qt/ac	22	28-43
Orthene + Propolene Glycol	.5 lb/2 qt/ac	18	8-27
Orthene + Propolene Glycol	.5 lb/2 qt/ac	12	12-31
Bioethanomethrin	.05 lb/gal/ac	10	20-39
Bioethanomethrin	.05 lb/gal/ac	16	56-75
Bioethanomethrin	.05 lb/gal/ac	13	40-59
Bioethanomethrin	.02 lb/gal/ac	2	40-59
Bioethanomethrin	.02 lb/gal/ac	9	32-51
Bioethanomethrin	.02 lb/gal/ac	11	28-47
TH-6040	.06 lb/gal/ac	3	0-19
TH-6040	.06 lb/gal/ac	5	4-23
TH-6040	.06 lb/gal/ac	8	0-19
TH-6040	.3 lb/gal/ac	6	12-23
TH-6040	.3 lb/gal/ac	19	0-19
TH-6040	.3 lb/gal/ac	21	32-51
Encap Diazinon	.5 lb/gal/ac	14	48-67
Encap Sumithion	1 lb/gal/ac	17	44-63
CGA-18809	.5 lb/gal/ac	15	0-19
Control		1	40-59
"		2	80-100
"		3	80-100
"		4	20-39
"		5	48-67
"		6	68-83
"		7	80-100
"		8	76-96

TABLE 4.

Treatment	Plot No.	Sub Plot No.	Pre Spray em/acre	Average Number eggs/mass	% Hatch	Number larvae/acre	Post Spray em/acre	Post em population % decrease / increase
Bioethanomethrin .02 lb/gal/ac	2	1	1,400	308	85	366,800	30	- 98%
		2	1,400	308	85	366,800	240	- 83
		3	1,400	308	85	366,800	70	- 95
		4	1,400	308	85	366,800	90	- 94
		5	1,400	308	85	366,800	0	-100
Average			1,400 1/	308	85	366,800	86	- 94%
	9	1	450	308	85	117,900	30	- 93%
		2	450	308	85	117,900	60	- 87
		3	450	308	85	117,900	20	- 96
		4	450	308	85	117,900	240	- 47
		5	450	308	85	117,900	300	- 33
Average			450 1/	308	85	117,900	130	- 71%
	11	1	130	329	87	37,209	60	- 54%
		2	1,520	528	88	706,252	1,380	- 9
		3	220	408	95	84,436	330	+ 50
		4	2,070	393	89	724,023	730	- 65
		5	3,090	283	77	673,341	1,370	- 56
Average			1,406	388	87	445,052	774	- 45%
Treatment Averages			1,085	335	86	309,917	330	- 70%

1/ Estimated

TABLE 4. Continued

Treatment	Plot No.	Sub Plot No.	Pre Spray em/acre	Average Number eggs/mass	% Hatch	Number larvae/acre	Post Spray em/acre	Post em population % decrease / increase
Bioethanomethrin .05 lb/gal/ac	10	1	650	308	85	34,060	200	- 69%
		2	650	308	85	34,060	100	- 85
		3	650	308	85	34,060	120	- 82
		4	650	308	85	34,060	1,320	+103
		5	650	308	85	34,060	310	- 52
Average			650 1/	308	85	34,060	410	- 37%
	13	1	1,010	329	87	37,209	90	- 91%
		2	1,880	528	88	706,252	250	- 87
		3	1,050	408	95	84,436	200	- 81
		4	1,990	393	89	724,023	50	- 97
		5	2,130	283	77	673,341	40	- 98
Average			1,612	388	87	445,052	126	- 92%
	16	1	1,090	219	92	215,613	240	- 78%
		2	1,540	232	92	328,697	450	- 71
		3	2,850	180	85	436,050	480	- 83
		4	1,640	243	81	322,801	580	- 65
		5	570	218	82	101,893	660	+ 15
Average			1,538	218	86	281,011	482	- 69%
Treatment Averages			1,267	305	86	253,374	339	- 73%

1/ Estimated

TABLE 4. Continued

Treatment	Plot No.	Sub Plot No.	Pre Spray em/acre	Average Number eggs/mass	% Hatch	Number larvae/acre	Post Spray em/acre	Post em population % decrease + increase
CGA-18809	15	1	420	386	88	142,665	0	-100%
0.5 lbs/gal/A		2	100	388	71	35,388	0	-100
		3	150	410	73	44,895	0	-100
		4	260	428	90	100,152	10	- 96
		5	210	414	89	77,376	0	-100
Average			456	405	82	80,095	2	- 99%
Treatment Averages			456	405	82	80,095	2	- 99%
Encapsulated	14	1	670	334	77	172,310	190	- 72%
Diazinon		2	1,580	218	86	296,218	120	- 92
0.5 lbs/gal/A		3	2,900	218	80	505,760	120	- 96
		4	5,550	317	86	1,513,041	110	- 98
		5	3,440	250	81	696,600	300	- 91
Average			2,828	267	82	636,785	168	- 94%
Treatment Averages			2,828	267	82	636,785	168	- 94%
Encapsulated	17	1	290	249	83	59,934	70	- 76%
Sumithion		2	2,360	289	85	579,734	650	- 72
1.0 lbs/gal/A		3	1,520	316	89	425,484	350	- 77
		4	1,060	385	86	350,966	240	- 77
		5	390	355	79	107,375	150	- 62
Average			1,124	319	84	304,699	292	- 74%
Treatment Average			1,124	319	84	304,699	292	- 74%

TABLE 4. Continued

Treatment	Plot No.	Sub Plot No.	Pre Spray em/acre	Average Number eggs/mass	% Hatch	Number larvae/acre	Post Spray em/acre	Post em population % decrease / increase
Imidan 0.5 lbs/gal/A	1	1	300	308	85	78,600	540	+ 80%
		2	300	308	85	78,600	720	+140
		3	300	308	85	78,600	300	0
		4	300	308	85	78,600	270	- 10
		5	300	308	85	78,600	470	+ 57
Average			300 1/	308	85	78,600	460	+ 87%
	4	1	1,400	308	85	366,800	310	- 78%
		2	1,400	308	85	366,800	450	- 68
		3	1,400	308	85	366,800	420	- 70
		4	1,400	308	85	366,800	160	- 89
		5	1,400	308	85	366,800	240	- 83
Average			1,400 1/	308	85	366,800	596	- 57%
	24	1	570	387	90	198,531	930	+ 63%
		2	450	343	87	134,284	410	- 8
		3	1,650	351	89	515,443	890	- 46
		4	500	282	82	115,620	1,430	+186
		5	310	266	82	67,617	120	- 61
Average			696	326	86	206,299	756	+ 8%
Treatment Average			799	314	85	217,233	604	- 24%

1/ Estimated

Treatment	Plot No.	Sub Plot No.	Pre Spray em/acre	Average Number eggs/mass	% Hatch	Number larvae/acre	Post Spray em/acre	Post em population % decrease + increase
Orthene+H20 0.5 lbs/2 qt/A	20	1	820	408	80	267,648	10	- 99%
		2	1,660	309	94	492,163	70	- 96
		3	1,930	295	92	523,802	280	- 85
		4	1,150	338	89	345,943	missed by spray	
		5	1,590	232	77	284,037	missed by spray	
Average			1,470	337	89	427,871	120	- 92%
	23	1	1,070	438	88	412,420	740	- 31%
		2	250	636	95	155,800	140	- 44
		3	640	384	91	223,641	270	- 58
		4	870	297	90	238,032	380	- 56
		5	750	304	90	205,200	160	- 79
Average			716	416	91	247,019	338	- 53%
Treatment Average			1,093	377	90	337,445	229	- 79%
Orthene + Propolene Glycol 0.5 lbs/2 qt/A	12	1	660	228	92	138,441	660	0%
		2	230	330	88	66,792	250	+ 9
		3	80	329	95	25,004	0	-100
		4	430	335	87	125,323	40	- 91
		5	460	341	90	147,174	650	+ 41
Average			372	313	90	100,547	320	- 14%
	18	1	1,100	308	85	288,200	0	-100%
		2	1,100	308	85	288,200	0	-100
		3	1,100	308	85	288,200	90	- 92
		4	1,100	308	85	288,200	30	- 97
		5	1,100	308	85	288,200	10	- 99
Average			1,100 1/	308	85	288,200	26	- 98%

1/ Estimated

TABLE 4. Continued

Treatment	Plot No.	Sub Plot No.	Pre Spray em/acre	Average Number eggs/mass	% Hatch	Number larvae/acre	Post Spray em/acre	Post em population % decrease / increase
Orthene + Propolene Glycol 0.5 lbs/gal/A	22	1	850	403	91	311,720	1,240	+ 46%
		2	370	443	94	141,451	240	- 35
		3	660	364	94	225,825	670	+ 2
		4	590	332	92	180,209	470	- 20
		5	1,010	353	96	342,268	820	- 19
Average			696	379	93	240,294	688	- 1%
Treatment Average			723	540	89	209,680	345	- 52%
TH-6040 .06 lb/gal/ac	3	1	1,200	308	85	314,400	0	-100%
		2	1,200	308	85	314,400	0	-100
		3	1,200	308	85	314,400	0	-100
		4	1,200	308	85	314,400	0	-100
		5	1,200	308	85	314,400	0	-100
Average			1,200 1/	308	85	314,400	0	-100%
	5	1	1,500	308	85	393,000	0	-100%
		2	1,500	308	85	393,000	0	-100
		3	1,500	308	85	393,000	0	-100
		4	1,500	308	85	393,000	0	-100
		5	1,500	308	85	393,000	0	-100
Average			1,500 1/	308	85	393,000	0	-100%

1/ Estimated

TABLE 4. Continued

Treatment	Plot No.	Sub Plot No.	Pre Spray em/acre	Average Number eggs/mass	% Hatch	Number larvae/acre	Post Spray em/acre	Post em population % decrease + increase
Orthene + Propolene Glycol 0.5 lbs/gal/A	22	1	850	403	91	311,720	1,240	+ 46%
		2	370	443	94	141,451	240	- 35
		3	660	364	94	225,825	670	+ 2
		4	590	332	92	180,209	470	- 20
		5	1,010	353	96	342,268	820	- 19
Average			696	379	93	240,294	688	- 1%
Treatment Average			723	540	89	209,680	345	- 52%
TH-6040 .06 lb/gal/ac	3	1	1,200	308	85	314,400	0	-100%
		2	1,200	308	85	314,400	0	-100
		3	1,200	308	85	314,400	0	-100
		4	1,200	308	85	314,400	0	-100
		5	1,200	308	85	314,400	0	-100
Average			1,200 1/	308	85	314,400	0	-100%
	5	1	1,500	308	85	393,000	0	-100%
		2	1,500	308	85	393,000	0	-100
		3	1,500	308	85	393,000	0	-100
		4	1,500	308	85	393,000	0	-100
		5	1,500	308	85	393,000	0	-100
Average			1,500 1/	308	85	393,000	0	-100%

1/ Estimated

TABLE 4. Continued

Treatment	Plot No.	Sub Plot No.	Pre Spray em/acre	Average Number eggs/mass	% Hatch	Number larvae/acre	Post Spray em/acre	Post em population % decrease + increase
TH-6040 .06 lb/gal/ac	8	1	1,200	308	85	314,400	0	-100%
		2	1,200	308	85	314,400	0	-100
		3	1,200	308	85	314,400	0	-100
		4	1,200	308	85	314,400	0	-100
		5	1,200	308	85	314,400	0	-100
Average			1,200 1/	308	85	314,400	0	-100%
Treatment Average			1,300	308	85	340,600	0	-100%
TH-6040 .3 lb/gal/ac	6	1	1,400	308	85	366,800	0	-100%
		2	1,400	308	85	366,800	0	-100
		3	1,400	308	85	366,800	0	-100
		4	1,400	308	85	366,800	0	-100
		5	1,400	308	85	366,800	0	-100
Average			1,400 1/	308 1/	85 1/	366,800	0	-100%
	19	1	1,100	308	85	288,200	0	-100%
		2	1,100	308	85	288,200	0	-100
		3	1,100	308	85	288,200	0	-100
		4	1,100	308	85	288,200	0	-100
		5	1,100	308	85	288,200	0	-100
Average			1,100 1/	308 1/	85 1/	288,200	0	-100%

1/ Estimated

TABLE 4. Continued

Treatment	Plot No.	Sub Plot No.	Pre Spray em/acre	Average Number eggs/mass	% Hatch	Number larvae/acre	Post Spray em/acre	Post em population % decrease / increase
TH-6040	21	1	320	200	85	54,400	0	-100%
.3 lb/gal/ac		2	440	361	93	147,721	0	-100
		3	320	323	91	94,057	0	-100
		4	730	514	87	326,441	0	-100
		5	980	952	95	234,612	0	-100
Average			558	470	90	171,446	0	-100%
Treatment Average			1,019	362	87	275,482	0	-100%

TABLE 4. Continued

Treatment	Plot No.	Sub Plot No.	Pre Spray em/acre	Average Number eggs/mass	% Hatch	Number larvae/acre	Post Spray em/acre	Post em population % decrease + increase
Check	1	1	1,300	308	85	340,600	630	- 52%
		2	1,300	308	85	340,600	430	- 67
		3	1,300	308	85	340,600	700	- 46
		4	1,300	308	85	340,600	310	- 76
		5	1,300	308	85	340,600	510	- 61
Average			1,300 1/	308	85	340,600	516	- 60%
Check	2	1	850	403	91	311,720	2,670	+214%
		2	370	444	94	154,423	1,310	+254
		3	660	365	90	216,810	1,700	+158
		4	590	332	92	180,209	220	- 63
		5	1,010	354	96	343,238	90	- 91
Average			696	380	93	241,280	1,198	+ 72%
Check	3	1	6,090	233	87	1,234,503	30	- 99%
		2	1,900	213	68	275,196	0	-100
		3	1,830	113	70	144,753	50	- 97
		4	1,580	204	82	264,302	60	- 96
		5	2,500	262	87	569,850	60	- 98
Average			2,780	205	79	497,721	40	- 99%

1/ Estimated

TABLE 4. Continued

Treatment	Plot No.	Sub Plot No.	Pre Spray em/acre	Average Number eggs/mass	% Hatch	Number larvae/acre	Post Spray em/acre	Post em population % decrease + increase
Check	4	1	550	330	92	166,930	1,750	+218%
		2	460	484	89	198,149	230	- 50
		3	380	345	88	115,368	800	+110
		4	200	344	84	57,792	870	+335
		5	590	390	88	202,488	3,190	+440
Average			436	379	88	148,145	1,368	+214%
Check	5	1	2,700	241	86	559,602	2,030	- 25%
		2	2,140	192	83	341,030	2,060	- 4
		3	2,900	318	86	793,092	960	- 66
		4	2,650	147	79	307,744	530	- 80
		5	1,700	258	85	372,810	200	- 88
Average			2,418	231	84	474,856	1,156	- 52%
Check	6	1	1,120	245	84	230,496	150	- 87%
		2	6,500	269	91	1,591,135	1,300	- 80
		3	1,990	253	88	443,053	170	- 91
		4	1,380	205	87	246,123	380	- 72
		5	2,560	229	91	533,478	580	- 77
Average			2,710	240	88	608,857	516	- 81%

TABLE 4. Continued

Treatment	Plot No.	Sub Plot No.	Pre Spray em/acre	Average Number eggs/mass	% Hatch	Number larvae/acre	Post Spray em/acre	Post em population % decrease / increase
Check	7	1	1,200	308	85	314,400	0	-100%
		2	1,200	308	85	314,400	20	- 98
		3	1,200	308	85	314,400	10	- 99
		4	1,200	308	85	314,400	40	- 97
		5	1,200	308	85	314,400	30	- 98
Average			1,200 1/	308	85	314,400	20	- 98%
Check	8	1	9,750	175	75	1,279,687	2,480	- 75%
		2	3,670	176	86	555,491	80	- 98
		3	2,330	167	80	311,288	70	- 97
		4	3,000	152	73	332,880	30	- 99
		5	1,090	146	79	125,720	440	- 60
Average			3,968	163	79	521,013	620	- 84%

Table 5. Gypsy Moth Larval Mortality in Dropcloths 1974

Insecticide	Plot No.	Dosage lbs a i/acre	Average accumulation of dropcloth mortality counts at end of 96 hours based on 5 subplots	
Bioethanomethrin	2	0.02	14	
	9	"	36	
	11	"	11	
Bioethanomethrin	10	0.05	58	
	16	"	6	
	13	"	60	
CGA-18809	15	0.5	154	
Encap Diazinon	14	0.5	73	
Encap Sumithion	17	1.0	66	
Imidan	1	0.5	16	
	4	"	48	
	24	"	15	
Orthene + Propolene Glycol	22	0.5	67	
	18	0.5	59	
	12	0.5	34	
Orthene + H_2O	20	0.5	109	*based on
	23	0.5	76	3 subplots
			Average at end of 144 hours	
TH 6040	3	0.06	20	40 at 168 hr
	5	"	21	38 at "
	8	"	92	
TH 6040	6	0.3	47	
	19	"	49	
	21	"	14	

Results and Conclusions

Spring egg mass densities ranged from 80 to 5550 per acre. The average number of eggs per mass per sampling unit was from 200 to 656 with a hatching percentage range of 71% to 96%. The beginning larvae population ranged from 25,004 per acre to 1,591,135 per acre. The egg masses were generally of good size, which would indicate a healthy population.

Application of materials with USDA aircraft and pilot began on May 30, 1974 and was completed on June 9, 1974. During this time 23 plots of 50 acres each were treated with chemical insecticides.

Plots 22 and 23 were sprayed on May 30 in the pm. No material was applied on May 31 because of fog, wind, and, eventually, rain. Operations resumed early afternoon on June 1. However, due to unavoidable circumstances, operations were temporarily delayed until June 6.

Spray operations resumed on June 6, 1974 with a contracted spray plane and a USDA observation plane that was used for guidance and general observation of the work.

On June 8, 1974 operations were again terminated for the day because of irresponsible flying by the pilot and failure to follow instructions. The pilot was replaced and plots 4, 12, 18, and 24 were finished on June 9.

Because of the delays in spraying, most of the target insects were in the very late 2nd or early 3rd instar. Also, foliage was almost completely expanded by the time the insecticide was applied.

The following are evaluations of efficacy data from the different chemicals tested.

Bioethanomethrin: Although an emulsifier was used in this formulation it appeared that a stable suspension was not achieved. The formulation used was not a workable field formula. A small amount of foliage protection was realized with an egg mass reduction ranging from 37 - 94%. Results were similar with both rates and dosages. The treatments did not yield the contact mortality that is customarily observed with bioethanomethrin. Work should be done with this material to find a suitable uv screening agent that can be readily used with the standard

formulation.

CGA-18809: Even after this material was mixed with water and remained within the mixing tank for 5 days before being sprayed, it gave outstanding results. Foliage protection was complete with egg mass reduction of 99%. Approximately 10 days after treatment expert ground crews were unable to find a single gypsy moth larvae within the sprayed plot. Within the untreated area surrounding the plot 100% defoliation occurred with hordes of larvae active to the edge of the sprayed area. Other insect activity in the treated plot continued to be active, indicating that the material is somewhat selective. The material mixed very well and no difficulties were encountered in dispersion. This material gave control that has not been observed with any other available or experimental insecticide. It was unfortunate that additional material was not availabel for replication. However, in 1975, CGA-18809 will be tested thoroughly with as much efficacy data as possible being compiled.

Encapsulated Diazinon: The formulation was a workable field formula for loading and dispersion. Some foliage protection was realized and egg mass reduction was 94%. Residual activity

was not as pronounced as we had hoped with this formulation.

Encapsulated Sumithion: Treatment and results were very similar to the encapsulated diazinon treatment with some foliage protection and a 74% reduction in egg masses. The foliage protection was very spotty and this was in part due to skipping by the aircraft. Days after treatment larvae were readily noticeable and considerable frass was falling within the plot.

Imidan: Little if any foliage protection was achieved with only a 24% reduction in egg masses realized. Although the material gave good laboratory results, the field results were poor. The formulation was very easy to work with.

Orthene: Formulated in water, orthene caused a 79% reduction in egg masses. In propolene glycol, a 52% reduction took place. Both formulations gave excellent foliage protection, however, a greater egg mass reduction was anticipated. No difficulties were encountered in mixing or dispersing the formulations. Instar development and foliage expansion were nearly ideal when applications were made.

TH-6040: This compound is by far the most impressive material to be tested against gypsy moth during the past decade. Egg mass reduction was 100% in all treated plots. This would indicate that a dosage lower than .06 lb/gal/A could possibly be effective. Some defoliation occurred in all plots. This was due mainly to the size of the larvae (3rd instar) when treatments were made and as a growth regulator, larval mortality does not occur until ecdysis. Three weeks after treatment there was an absence of any living gypsy moth stages within all TH-6040 treated plots. At this time they were very active in surrounding woodlands. Mortality is similar to that of virus in that the cadavers hang from the underside of foliage.

In 1975, TH-6040 will be tested thoroughly with as much efficacy data as possible being compiled. This material should be tested on 1st instar larvae if suitable foliage is available.

In summarizing the activities of 1974, it is considered that the 3 materials, Orthene + H_2O, CGA-18809, and TH-6040 may become materials useful for control of the gypsy moth and assist in protecting thousands of acres of hardwood forests.

Research involving encapsulation work with pesticides should

without question continue. However, based on 1974 field data, diazinon and sumithion may not be the most promising compounds to continue this work with. Pyrethrins or similar compounds may prove to be more workable materials.

Mention of a proprietory product in this publication does not constitute a guarantee or warranty of the product by the U. S. Department of Agriculture nor imply its approval by the Department to the exclusion of other products that may be suitable also.

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APPENDIX II

Devices Used in Fumigation of Gypsy Moth Eggs

L. L. Herbaugh and C. R. Stacy

The gypsy moth constitutes a major regulatory problem as an introduced defoliator of hardwood forest areas in the northeastern United States. Methyl bromide fumigation studies have been conducted to establish suitable fumigation schedules for commodity treatments. These studies have resulted in the development of the described devices in determining gypsy moth egg mortality with methyl bromide treatment.

The fumigation chambers are constructed from standard 55 gallon oil drums with airtight, removable lids (Richardson and Roth, 1966). The drums have a perforated steel platform about six inches from the bottom, on which commodities are placed for fumigation. A small, spark resistant box fan mounted under this platform circulates vapors during fumigation. A commercial vacuum cleaner attached to the exhaust port of the fumigation chamber effects rapid and efficient purging of the system. Note in Figure 1 that the chambers are connected in sequence (with valves at each chamber) so that one vacuum source can expell the methyl bromide vapors to a safe area. With this type of evacuation system any number of chambers can be emptied in any sequence or simultaneously.

As a means of facilitating the fumigation of quarantined plant products with methyl bromide as a basis for certification, a dispenser that

accurately measures small quantities of gas used in fumigation chambers has been developed (Cain, 1940).

Methyl bromide is supplied as a liquid under pressure in steel cylinders of various volumes. As a liquid it can readily be measured in a graduated cylinder. However, immediately upon releasing the pressure the liquid volatizes. To overcome this, the dispenser was designed to admit liquid under pressure from a small supply reservoir. The methyl bromide dispenser components are shown in Figure 2. A. Methyl bromide supply tank valve. B. High-pressure gate valve. C. Metering valve. D. Bleed-off valve. E. Discharge valve. F. Small reservoir. G. Measurement Flask. H. Chamber filler lead.

Detailed procedure for delivering methyl bromide from the storage cylinder to the fumigation chamber is as follows. 1. Close valves B, C, D, and E. 2. Open valve A <u>slowly</u> and allow liquid methyl bromide to enter reservoir F until the desired amount is accumulated. 3. Close valve A (very tight). 4. Open valve B slightly. 5. Open valve C and watch measurement in graduated glass tube G. 6. When nearing the proper desired volume, close valves C and B. Precise adjustment of the liquid volume is accomplished by additional metering through valve C. 7. Close valve C. 8. If the measurement tube is overfilled, open valve D and bleed off liquid slowly until desired measurement is attained. 9. Close valve D. 10. Attach filler lead to fumigation chamber and open lead petcock. 11. Valve E

on the dispenser remains closed during the filling of the dispenser. As the temperature begins to rise the gas in the head of the dispenser expands and exerts a downward pressure on the column of liquid in the glass tube. To discharge the gas in the dispenser it is only necessary to open the discharge valve E, and the gas pressure will force the liquid up through the expelling tube and out through the filler lead into the fumigation chamber.

Several devices are used for different types of monitoring during a typical fumigation study. One of these, the fumiscope, is a portable scientific instrument completely contained in a compact metal cabinet, that requires no auxiliary equipment (Shirakawa, 1971). It operates on 115 volt alternating current and is specifically designed to quantitatively measure concentrations of gases within a chamber or other enclosure while the actual fumigation is being conducted. The fumiscope contains an electric pump that draws air samples at a constant rate through a thermal conductivity cell that compares the mixture of methyl bromide and dry air to that of pure dry air. The concentration of a fumigant in air is recorded on a scale (in ounces per 1,000 cubic feet). A gas drying tube containing a dessicant is inserted in the gas sampling line upstream of the flow rate meter when extreme accuracy at low concentrations is required.

A hygrothermograph measures and records relative humidity and temperature

and is used to monitor these conditions near the fumigatorium.

For reasons of accuracy and safety, the chamber must effectively hold the gas during the exposure period. To assure this, the chamber must pass a pressure-leakage test whereby the time elapsed for internal pressure as registered on an open-arm kerosene filled monometer to recede from 50 mm to 5 mm is more than 22 seconds.

A timer is used to indicate when fumiscope readings should be taken or any other pertinent observations made. A time lapsed meter records in tenths of a minute the elapsed time between significant events.

A number of safety devices are incorporated into use around a fumigatorium. The halide gas detector (Monro, 1961) is used to indicate the presence and approximate concentration of methyl bromide in the air. This is acomplished by passing air to be tested over a red hot copper plate or cone through which a flame is passing. The intensity of colors imparted to the flame indicates the presence and concentration of methyl bromide in the air.

The following are the approximate methyl bromide concentrations associated with the color intensity of the flame.

ppm	lbs/1000 ft^3	flame color
0	0	no reaction
25	0.00625	faint fringe of green
50	0.0125	moderate green
125	0.031	green
250	0.0625	strong green
500	0.125	strong green - blue fringe
800	0.20	strong blue-green
1000	0.25	blue

The halide gas detector is an operational, as well as a safety device, since the elimination of fumigant leaks increases the efficacy of operation and reduces harmful concentrations outside the area under treatment.

The gas mask is the most critical item used for the protection of persons working with fumigants. The properly assembled and fitted gas mask is a compact air purifying unit which furnishes protection against harmful gases or vapors listed on the canister label. The gas mask should always be examined for defects before use. It must be a new canister, effective for the fumigant being used, with a valid expiration date on it.

Because of the unlikelihood of gas leakage with the previously described chambers and dispensing system, the gas mask is infrequently used. However, as a safety feature, plastic eye goggles are used when measuring and dispensing methyl bromide. A fire extinguisher and a safety eye wash station are also located near the fumigatorium.

Acknowledgements

The authors would like to give special thanks to the following for their help and ideas.

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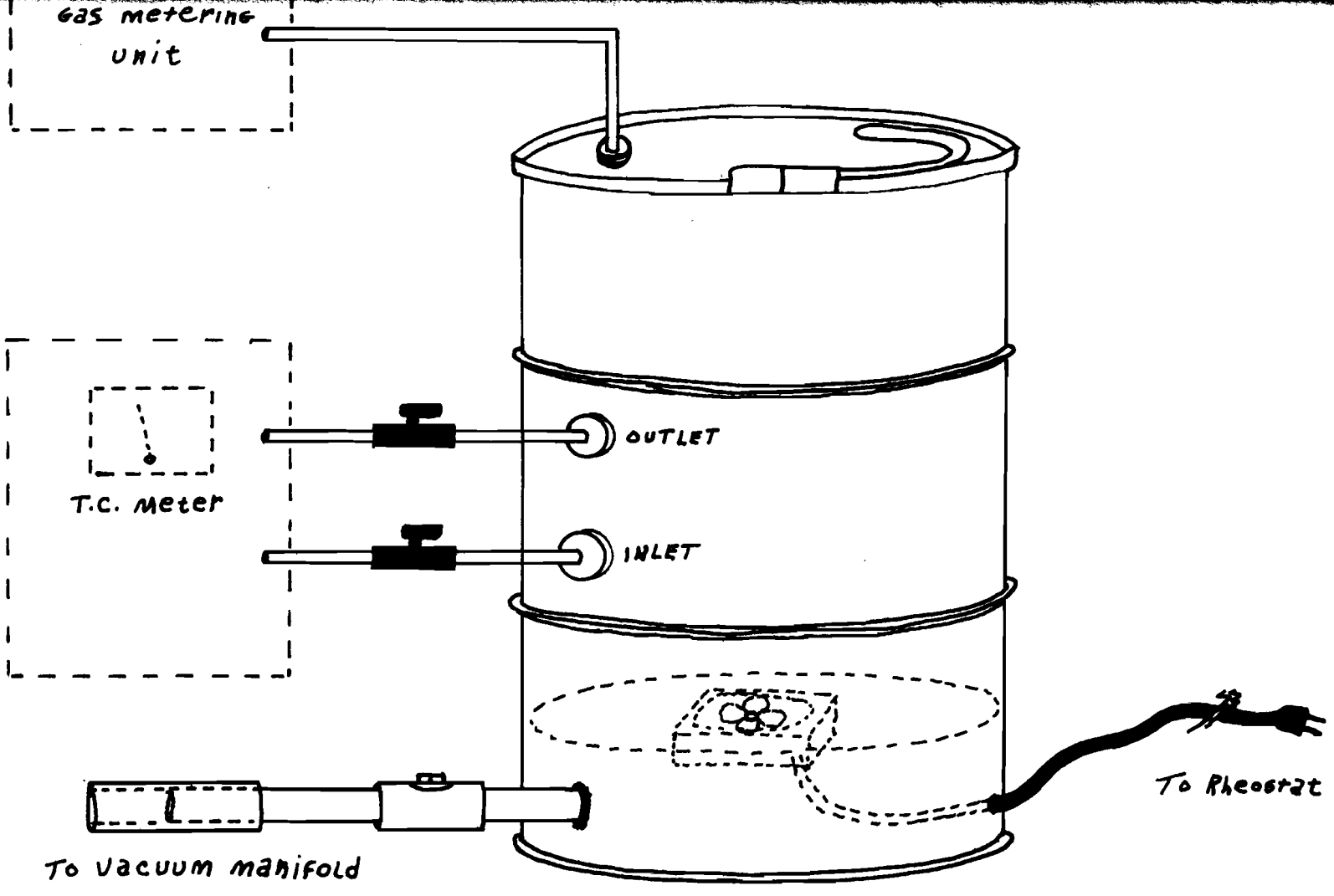

Fig. 1 55Gallon drum treating chamber

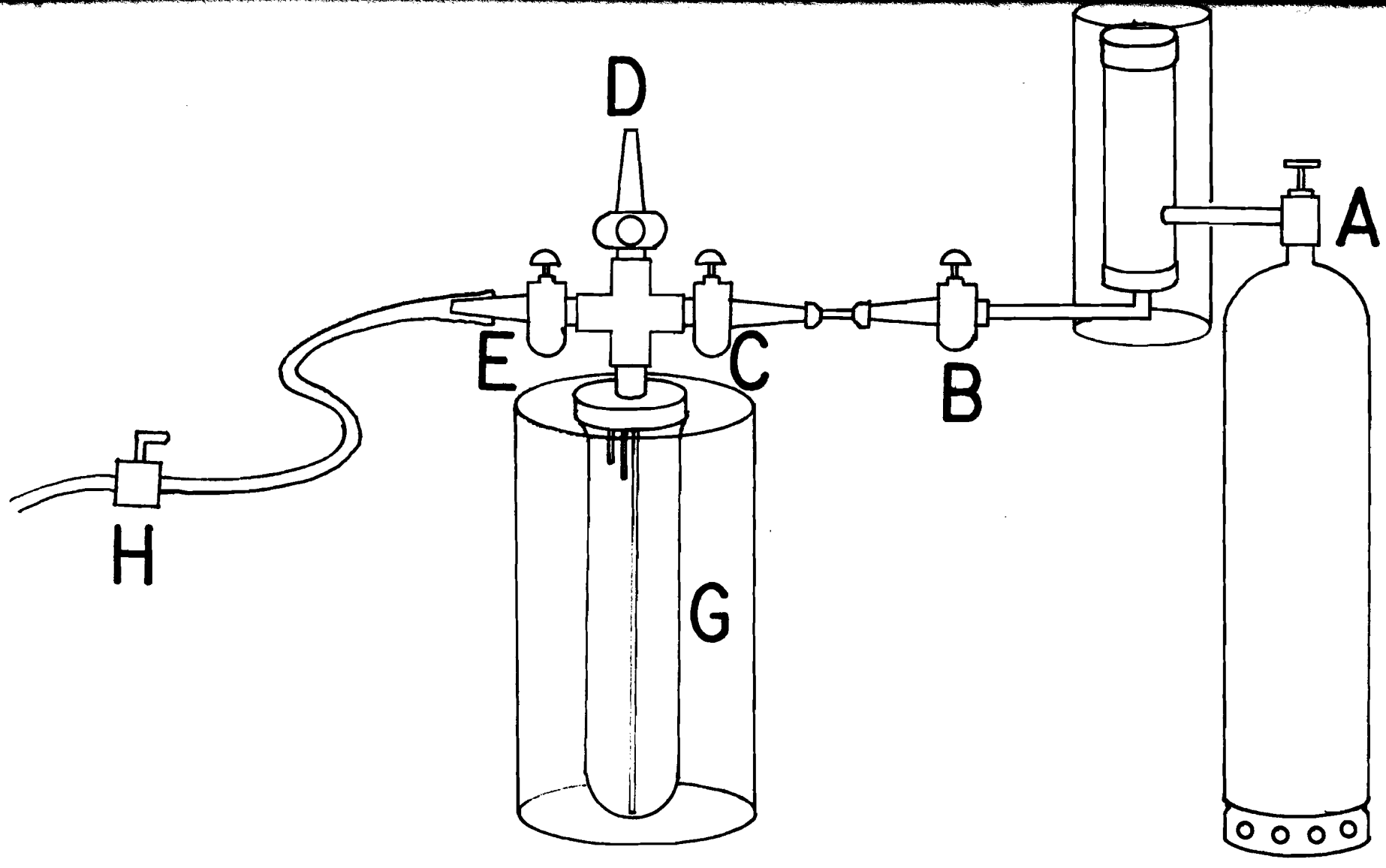

Fig. 2 Operational diagram (not scaled)

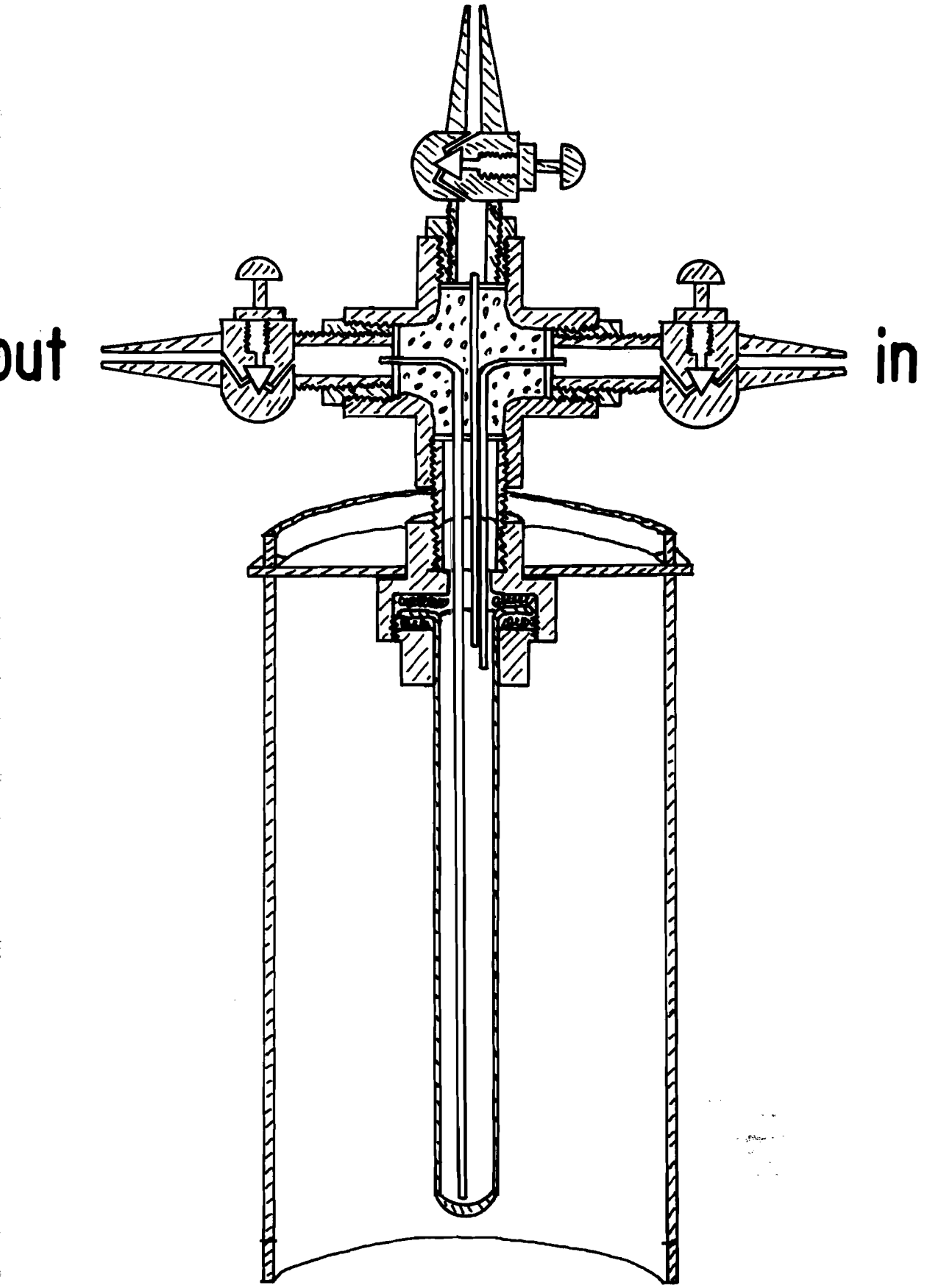

Fig. 3 Cross-section, metering device

APPENDIX III

For: J. Econ. Entomol.

Please send proof to:

Charles P. Schwalbe
U. S. Department of Agriculture
Building 268
Otis AFB, MA 02542

Delta Trap for Male Gypsy Moths, Porthetria dispar (L.)[1/]

Joseph G. R. Tardif[2/], E. C. Paszek[2/], M. Beroza[3/],
and C. P. Schwalbe[2/]

Pheromone-baited traps have been used since the late 1940's to monitor the whereabouts of the gypsy moth, Porthetria dispar L., and thereby aid in directing operations aimed at preventing spread of this pest from the generally infested northeastern U. S. Although the modified Graham trap (Holbrook et al 1960) performed efficiently in such surveys, it has been replaced by the less efficient Johnson (drinking cup) trap because of considerations relating to cost, availability, and ease in handling.

This paper describes a trap of new design, called the delta trap. It is as efficient as the modified Graham trap, yet is simple, durable, low in cost, of high capacity (up to 40 moths), and easily deployed.

Fabrication. -- The delta trap is cut from 185 lbs/ream solid bleach paperboard upon which 10 lbs/ream of polyethylene has been extruded.[4/] The color, floral orange, was selected to facilitate retrieval of the trap in forested areas. Although studies have shown that color does not influence trap attractiveness (Holbrook et al. 1960 and Paszek et al 1975), white and yellow traps have been found undesirable because they attract diptera and aphididae. (A dark-green trap, less visible in forested regions, would be desirable near populated areas to prevent vandalism.) The paper is die cut 42 cm in length by 24 cm in width and pre-creased and cut out as shown in Fig. 1. The delta trap along

with the modified Graham and Johnson traps are shown in Fig. 2. The new trap is prepared for field use as follows: Heated Tack Trap® adhesive[5/] is applied with a small short-napped paint roller to surfaces A and B (Fig. 1), leaving untreated a border approximately 1.3 cm wide along the side, bottom, and top creases of the treated area to prevent the adhesive from contaminating the trap exterior. The trap is then folded on crease AB thereby enclosing the adhesive and forming a flat easily stacked trap. A Hercon®, 2.5-cm-square plastic laminated pheromone dispenser (Beroza et al 1974) centrally located on panel C is stapled (in advance or in the field) through one corner so that with the trap in place, the laminate hangs free with ample air circulation on both sides. (The trap with adhesive and bait may now be further folded at crease BC or left flat.) With the dispensers in place, the traps may be stacked with the laminates facing each other when traps are taken to the field. For long storage, a protective film over the bait is desirable to minimize exterior contamination with pheromone from adjacent traps. Thus, a square of foil that covers the wick at the time it is stapled to the trap may be removed to expose the fresh dispenser just before trap placement. For ease in opening, e.g. for repeated servicing or examination, the trap is stapled to the tree at point D with 1.43-cm-long staples and then folded into the delta configuration with flap E over flap F; 2 paper

clips are placed horizontally at each end. This arrangement secures the baffle ends and provides a weather-resistant closure. If repeated examinations are unnecessary, the trap appropriately folded is secured to a tree by 1.43 cm-long staples driven through all 3 flaps, with a heavy duty tacker. A small hand-held stationery stapler may be used to secure the flap ends. In areas of high-value timber production where use of staples is undesirable the trap may be hung from a wire through a hole punched in all three flaps.

Evaluation. -- Ten replicates of the delta, modified Graham, and Johnson traps were set 15 m apart along a grid pattern in a woodland area, and adult male moths were released from the center of each quadrant within the plots. On 8 separate occasions, a total of 17,334 laboratory-reared male moths was released with moth captures being recorded 1 h after release. (Data gathered after the first h in preliminary experiments did not alter trap-catch ratios.) Fig. 3 shows the number of moths captured in the traps. (Although other designs were tested, they have not been discussed for brevity.) The modified Graham trap outcaught the delta and Johnson (as well as other) traps with respective catches of 346, 332, and 137 male moths. The delta trap, however captured only 14 moths less than the modified Graham (difference not statistically significant at the 5 percent confidence level) but 195 more moths than the Johnson (statistically

different at the 5 percent confidence level). The delta trap weathered well through 55 days of field aging. There was evidence of the baffles puffing out slightly in about 10% of the early prototypes that did not have the extra flap (F in Fig. 1); its inclusion avoids this difficulty.

Conclusions. -- The delta trap is as efficient as the modified Graham trap and far superior to the Johnson survey trap. It is low in cost, weathers better than the currently used Johnson trap, is easier to service, and of much higher capacity, which suggests its possible use in control. Its design is adaptable to automated preparatory procedures for adhesive application and pheromone dispenser installation. Finally, because of its light weight and ease of storage and handling, the delta trap is an improved replacement for the Johnson and modified Graham traps in gypsy moth survey and detection.

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Footnotes

1/ Mention of proprietory products does not constitute an endorsement by the USDA.

2/ USDA, APHIS, Gypsy Moth Methods Development Laboratory, Otis AFB, Massachusetts 02542.

3/ USDA, ARS, Agricultural Environmental Quality Institute, Agricultural Research Center, Beltsville, Maryland 20705.

4/ Information supplied by W. J. Oppermann of American Can Company, Neenah, Wis. 54956.

5/ Animal Repellents, Inc., Buffalo, NY. Heating reduces the viscosity of the adhesive and allows a thinner film to be spread in addition to greater ease of application.

Captions

Fig. 1 Schematic diagram of the delta trap layout.

Fig. 2 Traps used in evaluation study. Left to right, Modified Graham, Delta, Johnson.

Fig. 3 Trap design vs. performance. The profiles illustrate the total number of laboratory-reared gypsy male moths recaptured by the three trap types in 8 releases.

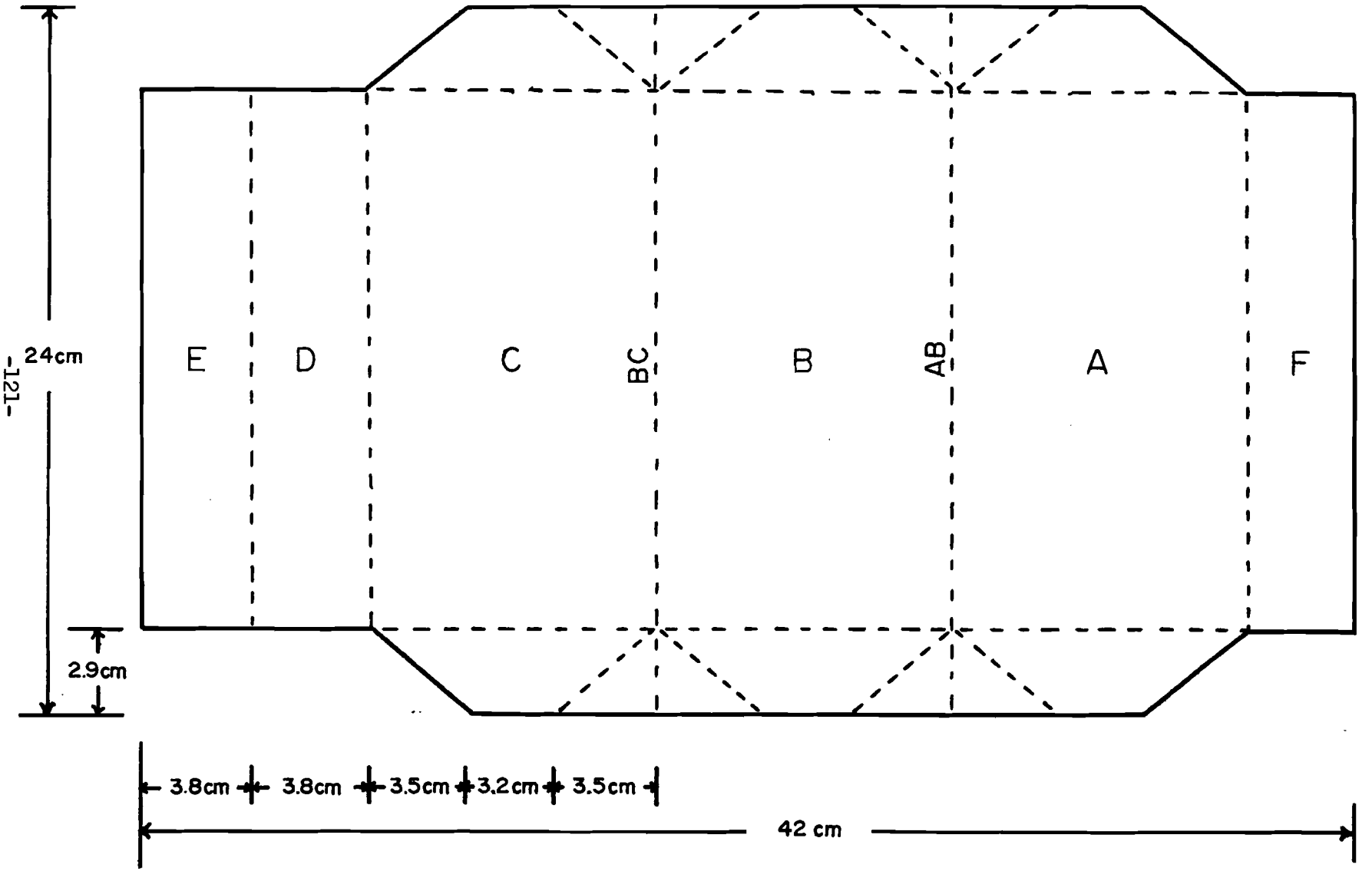
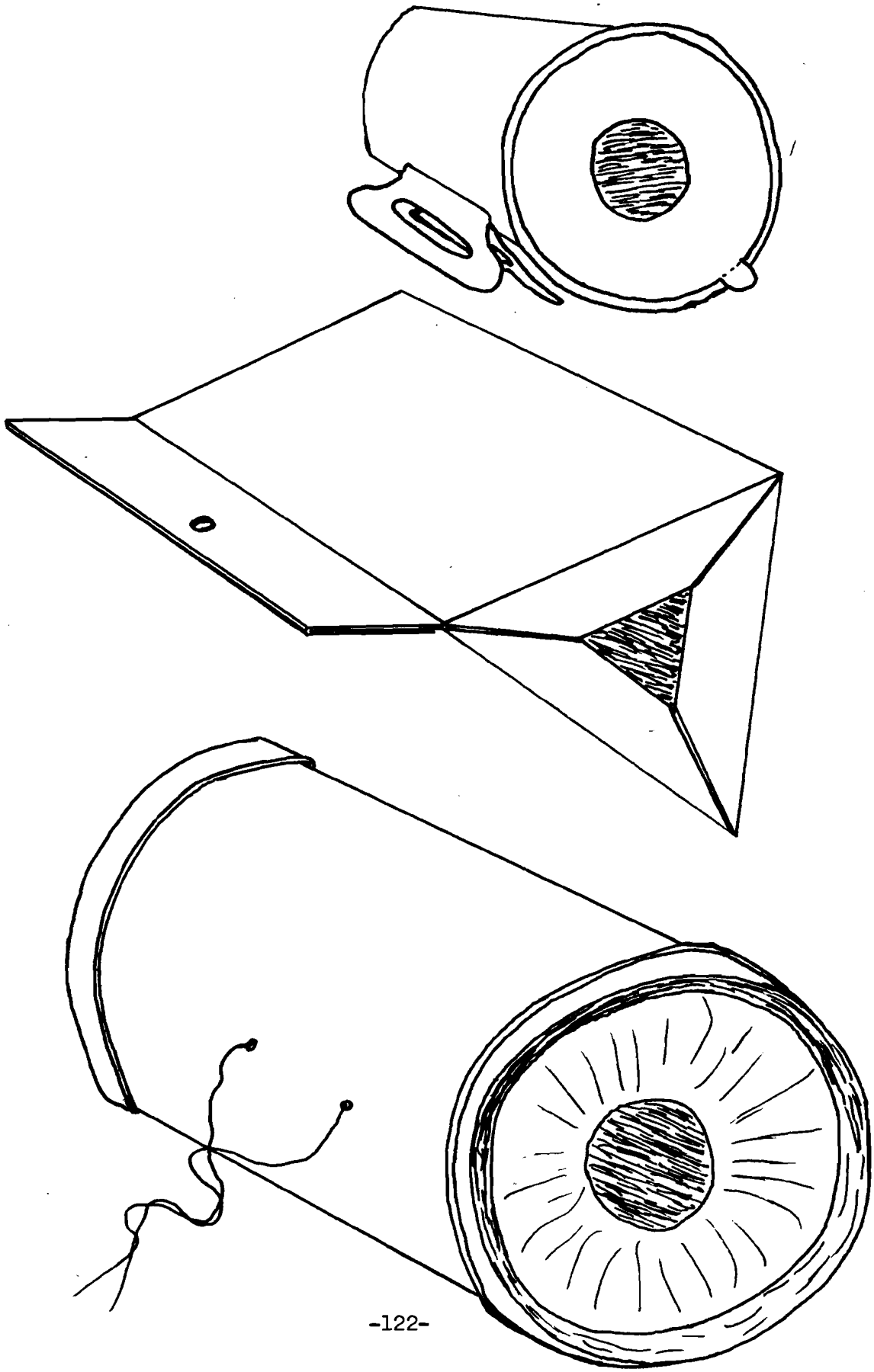
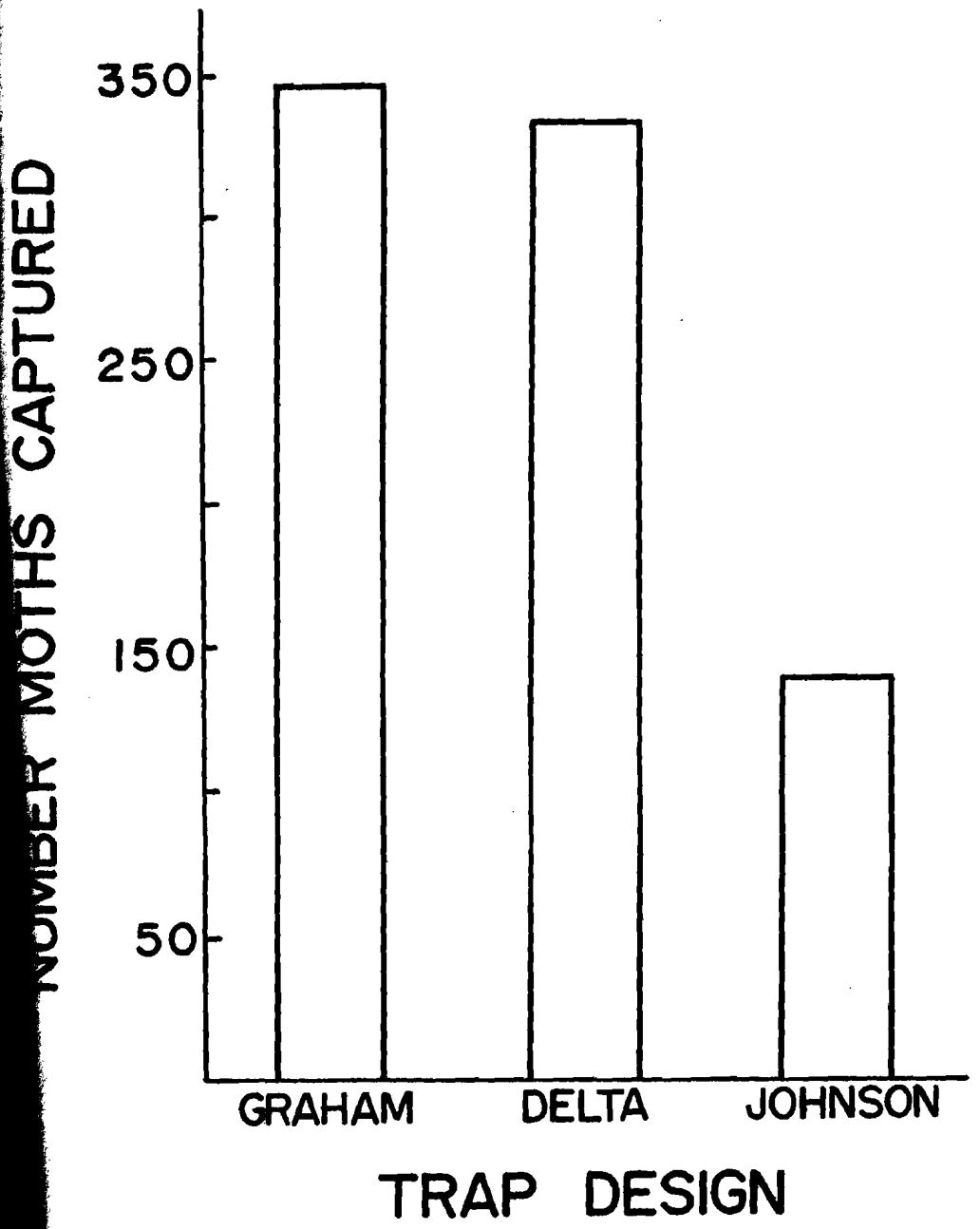


Fig. 1




NUMBER MOTHS CAPTURED
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JOHNSON
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3