THE KILLING EFFECT OF VEGETABLE, ANIMAL, AND MINERAL OILS ON THE EGGS OF THE CODLING MOTH AND THE ORIENTAL FRUIT MOTH

BY

R. N. JEFFERSON

A Thesis Submitted to the Graduate Committee for the Degree

of

MASTER OF SCIENCE

in

BIOLOGY

Major - Entomology

Approved:

W. D. Pierce
Prof. of Entomology

Wilson
Head of Department of Biology

Dean of Agriculture

Virginia Polytechnic Institute

1936

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ACKNOWLEDGMENTS

The writer is deeply grateful for the invaluable aid and helpful suggestions of Dr. W. J. Schoene, Entomologist of the Experiment Station, under whose guidance this work was carried on. The writer also wishes to express his appreciation to Dr. I. D. Wilson for his interest in the problem, to Mr. R. H. Hurt for his suggestions on emulsification of oils, to Miss Mary McBryde for the photomicrographs, to Mr. R. G. Henderson, who made the electric mixer used in emulsifying the oils, and to Professor F. H. Fish for the use of the viscosimeter used in the viscosity tests.

INTRODUCTION

The ovicidal properties of various vegetable, animal, and mineral oils were tested in an effort to develop a supplementary method of control for the codling moth and the oriental fruit moth. The reasons for undertaking this problem are twofold: first, the codling moth has become exceedingly difficult to hold in check; and, second, in the case of the oriental fruit moth, there is no satisfactory method of control. The studies could be carried on with both insects because they are very closely related and also, because the oriental fruit moth is a pest of apples as well as peaches.

REVIEW OF LITERATURE

The Codling Moth[1]

In recent years ovicidal sprays have received some attention in codling moth control experiments. The materials that have been most widely tested are nicotine and a type of mineral oil known as summer oil. The summer oils most generally recommended by entomologists are

1 - Carpocapsa pomonella L.

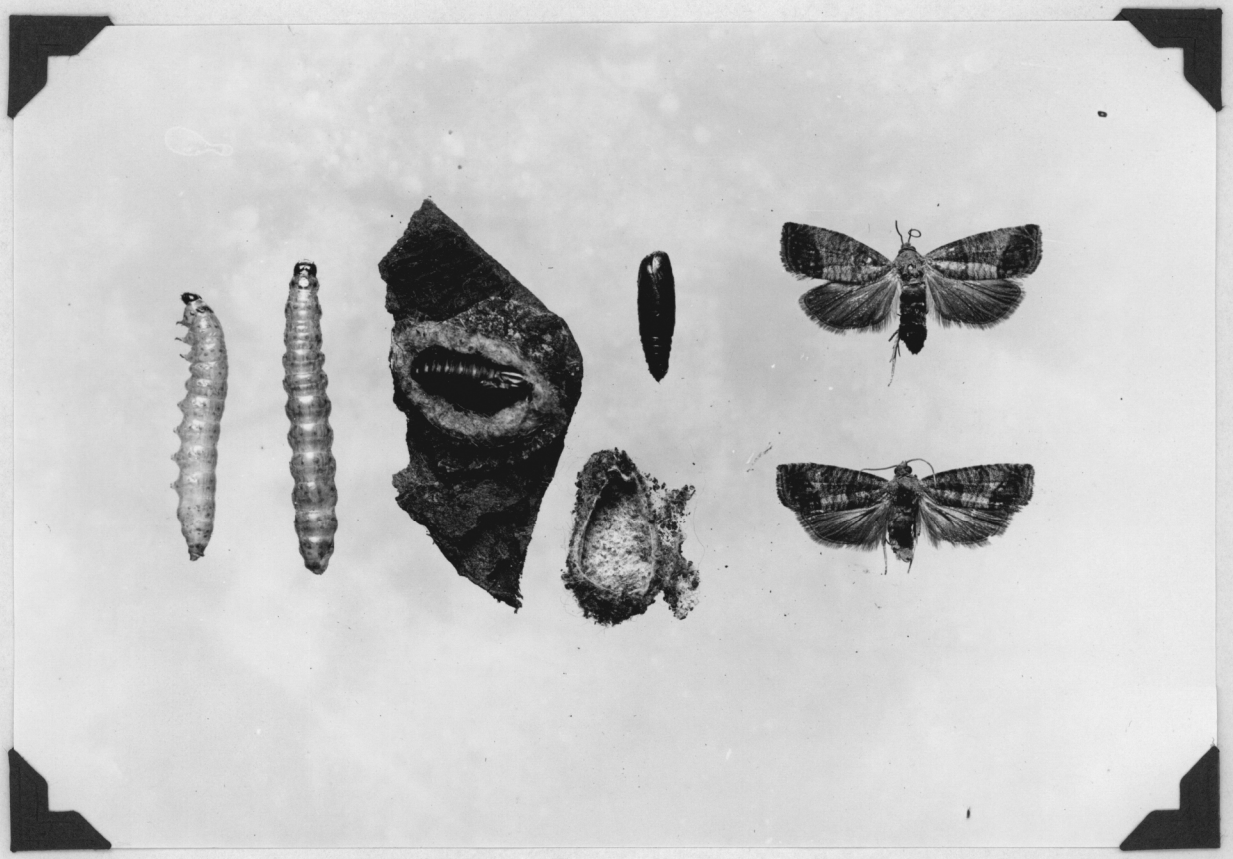

Fig. 1.—Codling Moth

highly refined light oils having a sulphonation test of not less than 85 and a viscosity of 65-75 seconds Saybolt. Nicotine and summer oils have appeared to good advantage when used to supplement lead arsenate. Alone they have not proved effective. Nicotine-oil combinations have been shown to be fairly effective but still are not as economical as lead arsenate or lead arsenate and oil.

In the great majority of cases where ovicides have been tried, the tests were made in the orchard. The material tested was added to the regular spray program in some cases. The results were interpreted on the basis of sound, wormy, and stung fruit obtained. Comparatively little work has been done to determine the direct killing power of various materials on the eggs. This is also true in regard to experiments with ovicides for the eggs of the oriental fruit moth.

Nicotine has given varying results when tested against the eggs of the codling moth. McIndoo (1) reports that nicotine sulphate did not seem to be very effective; at a strength of 1 part nicotine to 800 parts water it killed only about 20 percent of the eggs laid on apple tree foliage. On the other hand, Lovett (2),

after spraying a small number of eggs, states that nicotine sulphate is an efficient ovicide and that the addition of soap makes it practically perfect.

In Colorado in 1924, List and Hoerner (3) tested the following materials against codling moth eggs: kerosene emulsion, Black Leaf 40, Black Leaf 40 and potash-fish oil soap, Black Leaf 40 and Kayso, Kero (kerosene emulsion), Keresol, nicotine sulphur dust, nicotine lime, Target brand oil, Scalecide, Scalecide and lead arsenate, Target brand oil and lead arsenate, Target brand oil and lead arsenate and soap, Scalecide with lead arsenate and soap, Dormoil, Aphoil, red engine oil emulsion, Petrolatum oil emulsion, and Barber oil. The miscible oils and oil emulsions (except kerosene) gave the most promise. Red engine oil emulsion 1 percent, prepared by the boiled process and using red engine oil 1 gallon, water 0.5 gallon, and potash-fish oil soap 1 pound, appeared to be the most practical material.

In 1928, results of insectary tests by James Marshall (4) showed that mineral oils, 0.75 percent, killed from 85 to 98 percent of the codling moth eggs and that the ovicidal value of the oil increases with the viscosity. Marshall found that it was necessary for the oils actually to hit the eggs, as eggs laid on an oil-

sprayed surface showed a relatively high rate of hatch.

In 1929 Pettey and Mossop (5) tested light, medium, and heavy oils (about 99 percent unsulphonated residue) in concentrations from 0.75 to 2 percent against 7846 codling moth eggs. They found, in general, that calcium caseinate spreader at the rate of one-half pound in 80 imperial gallons slightly increased the effectiveness of the oils. All of the oils gave a high percentage of kill except in the case of the lower concentrations of the light oils when the spreader was omitted.

Childs (6) in 1925 stated that a safe and effective ovicide would be feasible as an auxiliary to lead arsenate in codling moth control, the effectiveness of which would largely depend upon the prevailing temperatures during first brood activities.

The Oriental Fruit Moth[1]

Nicotine sulphate seems to be the material most widely tested against the eggs of the oriental fruit moth. Stearns (7) in 1919 tested nicotine sulphate using sea moss and casein-lime as spreaders and also in combination

1 - Grapholitha molesta (Busck)

Fig. 2.—Oriental Fruit Moth

with lead arsenate, arsenate of lime, and self-boiled lime-sulphur. His results show a gradual decrease in the effectiveness from 88 percent for eggs sprayed the day they were deposited down to 56 percent for eggs sprayed just before hatching.

Stearns (8) continued his tests with nicotine in 1920 with the following results;
nicotine sulphate, 1-1600, 8.7 percent failed to hatch, nicotine sulphate, 1 -800, 70.3 percent failed to hatch, nicotine sulphate, 1 -500, 80.5 percent failed to hatch. The percentage of checks failing to hatch was never more than 10 percent.

Where sea moss or casein-lime was used as a spreader a higher percentage of kill was obtained:
nicotine sulphate, 1-1600, plus spreader, 44.4 percent failed to hatch, nicotine sulphate, 1-800 plus spreader, 75.4 percent failed to hatch, nicotine sulphate, 1-500 plus spreader, 84.5 percent failed to hatch, of the check eggs, 87 percent hatched. The caseinate was applied at the rate of 1 pound to 50 gallons of water and the sea moss at 2 pounds to 50 gallons. Both seemed equally effective.

Stearns and Neiswander (9) (10) have reported that summer oils, 2 percent, plus hydrated lime, are very ef-

fective ovicides for the oriental fruit moth; a heavy hydrated lime spray (15-40 pounds to 50 gallons of water) was only 10 to 20 percent effective.

Peterson (11) expressed the opinion that an ovicide would be useful in oriental fruit moth control and that the infestation might be considerably reduced if the ovicide were combined with the regular sprays.

PROCEDURE

Laboratory Routine

Preliminary work was started in the summer of 1934. Codling moth larvae were collected in an orchard at Salem and were reared in the insectary for use that summer. About 9000 larvae were collected in the fall from the same orchard to be used the next year. A sufficient number of oriental fruit moths was obtained from the life history material in the insectary both years.

The same procedure was used for both the codling moth and the oriental fruit moth. As the moths emerged, they were placed in two-gallon crocks (about 50 to 75 moths to a crock). A glass sheet was placed over the top, and the crocks were inverted on racks (Fig. 3). Moisture was supplied by a piece of absorbent cotton dipped in sweetened water. The moths deposited their eggs

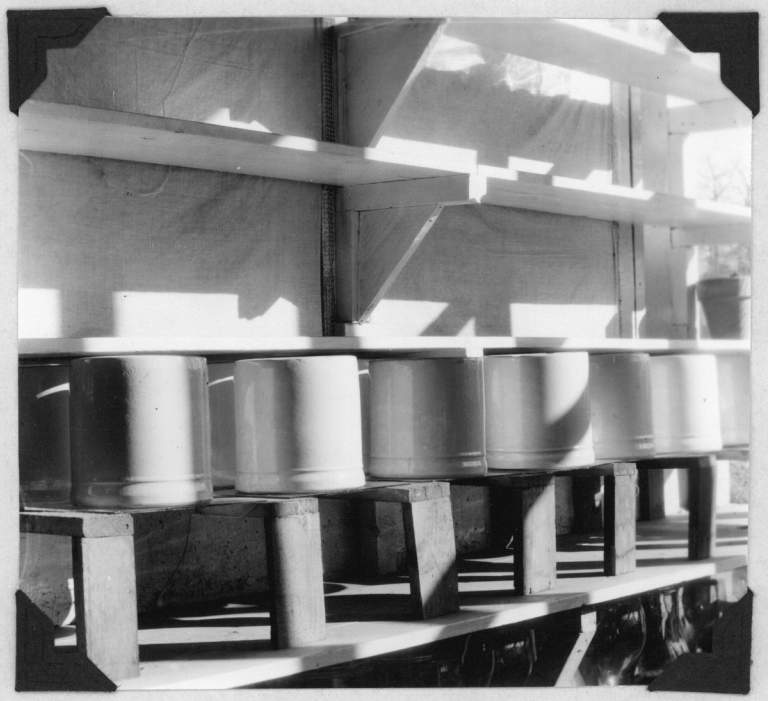

Fig. 3.—Crocks containing moths in laboratory

on the glass sheets, which were changed daily. New moths were added from time to time in order to keep the number of eggs laid per day fairly constant. The crocks were cleaned out every four or five days, as egg deposition fell off when they became dirty and dead moths accumulated.

Spraying

The glass sheets containing the eggs were arranged in sets, or groups, so that eggs of different ages could be sprayed at the same time with the same solution. Many eggs were left untreated as checks. Early in the summer of 1934, it was observed that often a high percentage of the check eggs were infertile. After that the infertile eggs were removed from the sheets and only fertile eggs were used in the tests. The percentage of checks failing to hatch was very low from then on. The fertility of eggs one day old or older was easily determined with a hand lens. In fertile eggs the embryo could plainly be seen (Fig. 4 to 11) while in the infertile eggs there was no development.

Spraying was done with an atomizer type hand sprayer and the eggs were thoroughly drenched. After sufficient time had elapsed for the eggs to hatch, they were

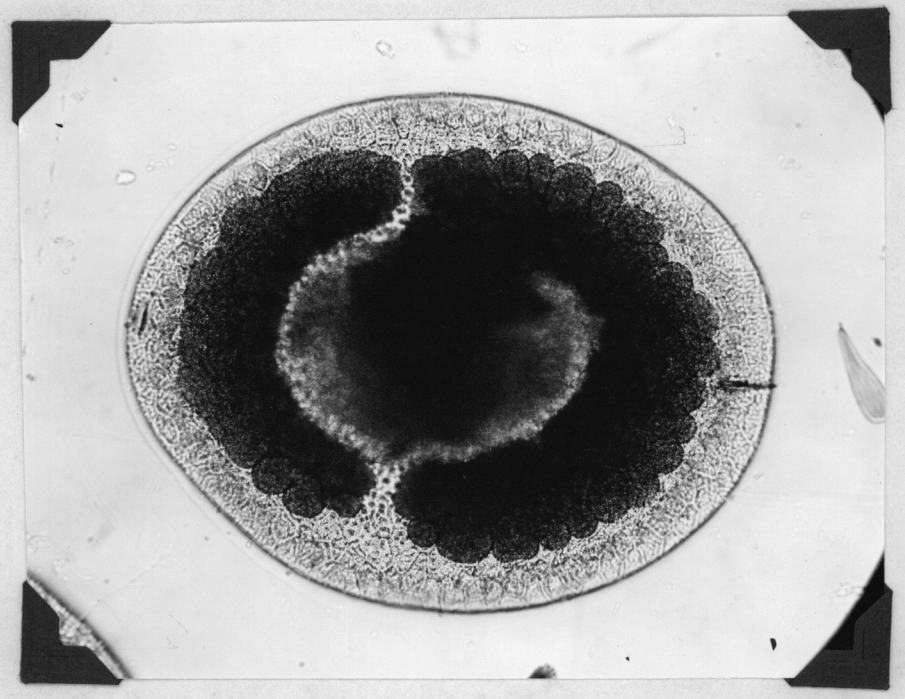

Fig. 4.—Codling moth embryo (greatly enlarged), 17 hours

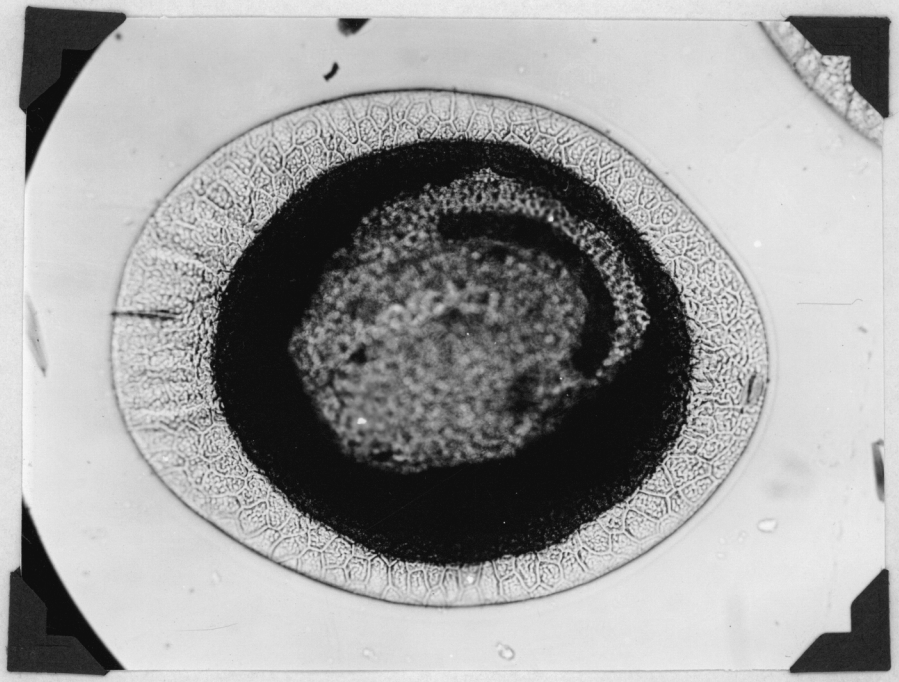

Fig. 5.—Codling moth embryo (greatly enlarged), 40 hours

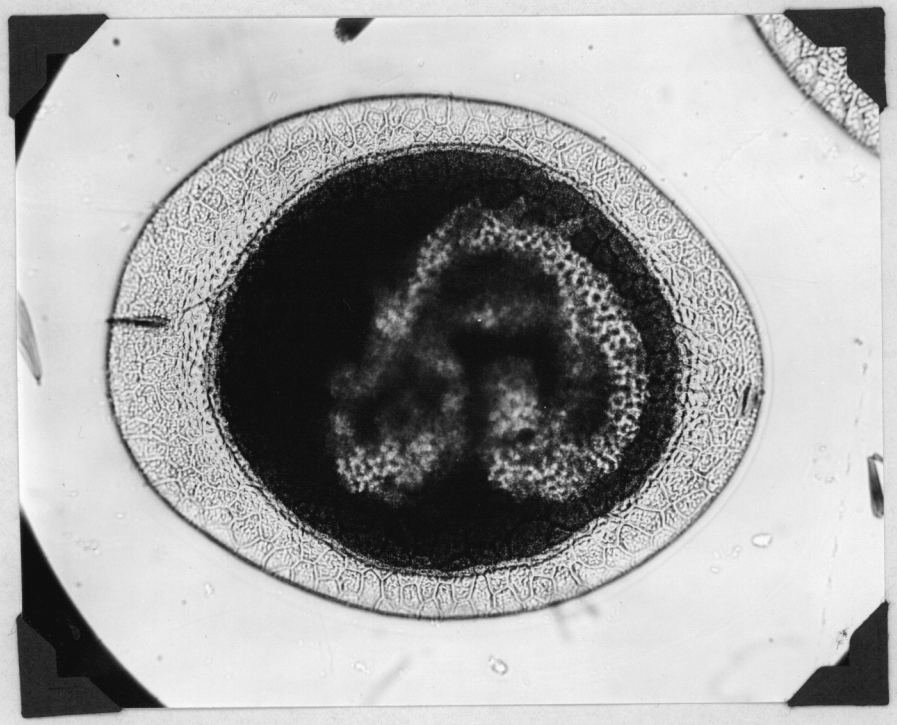

Fig. 6.—Codling moth embryo (greatly enlarged), 62 hours

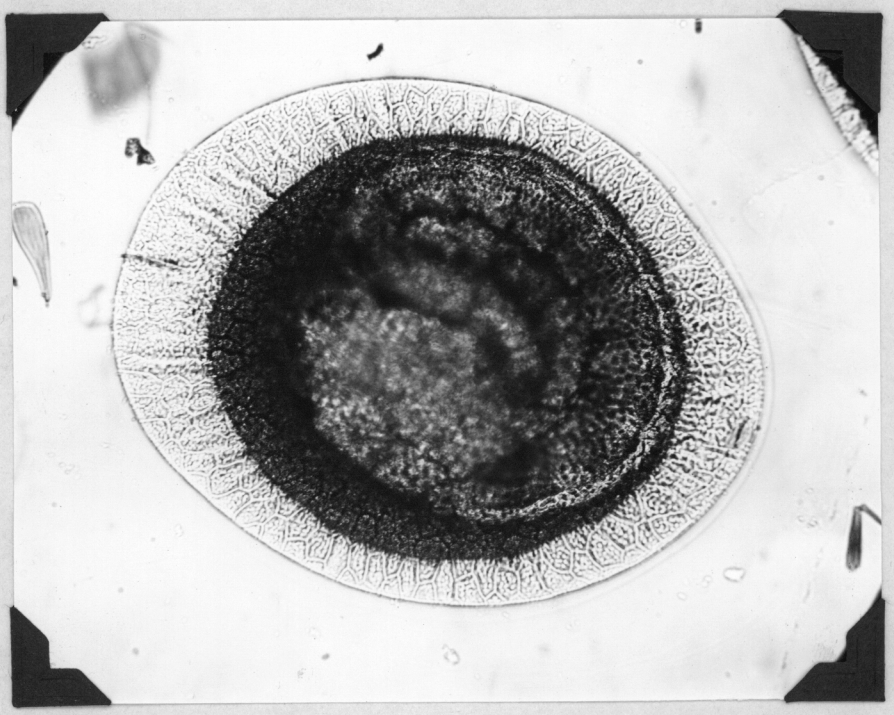

Fig. 7.—Codling moth embryo (greatly enlarged), 89 hours

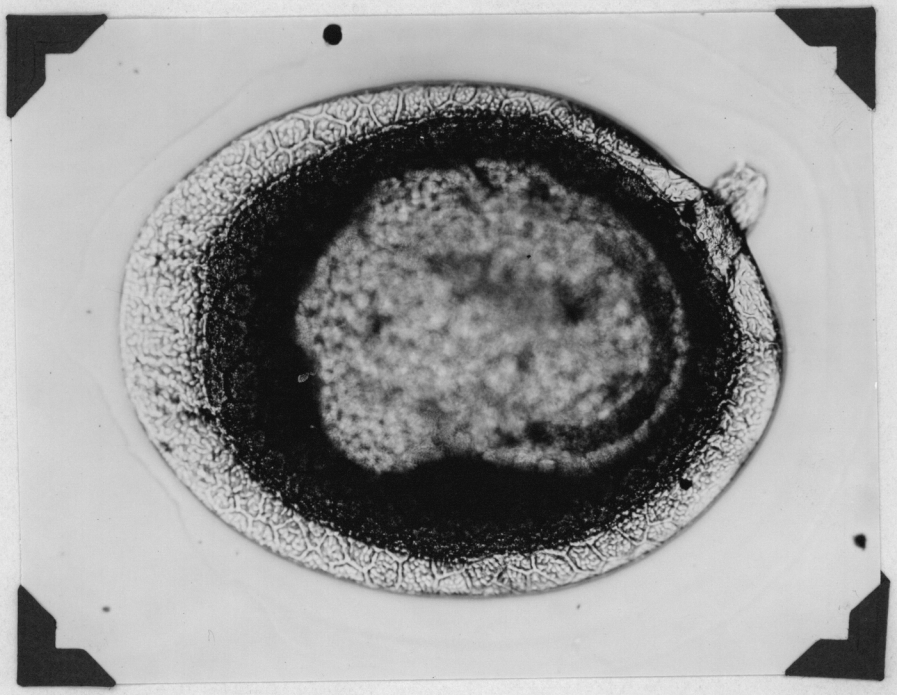

Fig. 8.—Oriental fruit moth embryo (greatly enlarged), 18 hours

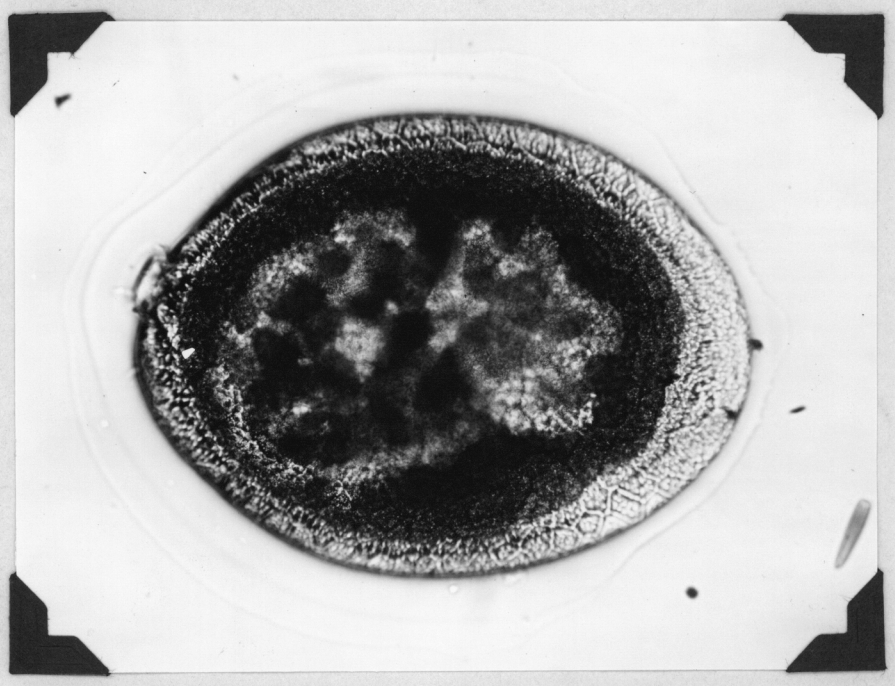

Fig. 9.—Oriental fruit moth embryo (greatly enlarged), 40 hours

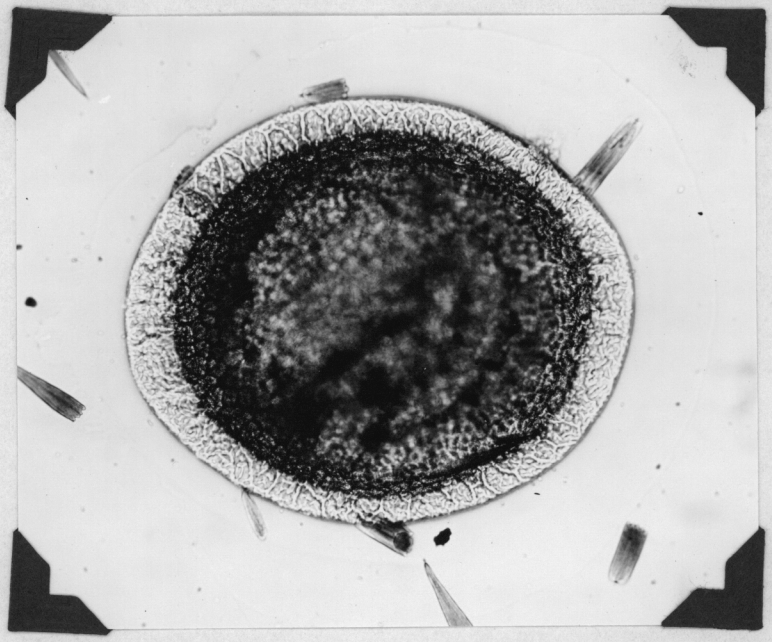

Fig. 10.—Oriental fruit moth embryo (greatly enlarged), 67 hours

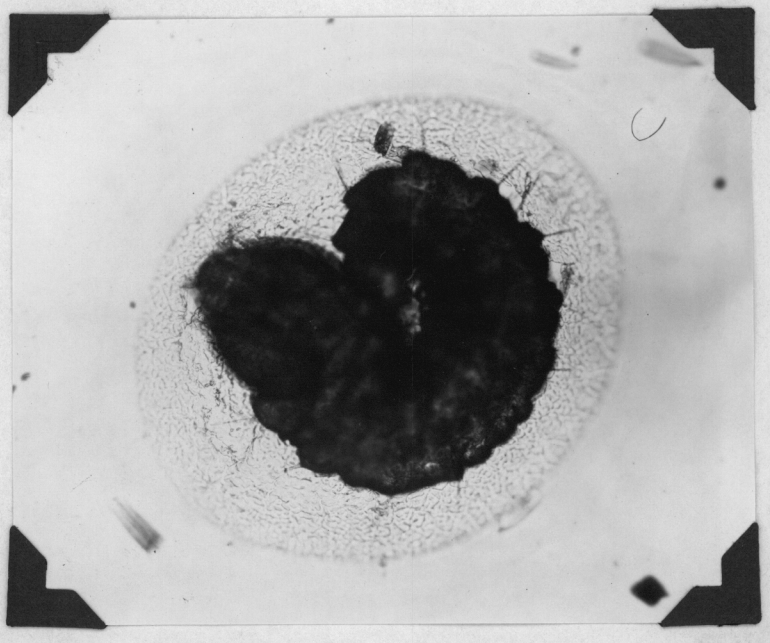

Fig. 11.—Oriental fruit moth embryo (greatly enlarged), 89 hours

examined again with a hand lens and the percent failing to hatch for each test was determined. In warm weather the oriental fruit moth eggs hatched in about four days and the codling moth eggs in about six.

Emulsification of the Oils

A bentonite-water mixture was used in emulsifying the oils. It was prepared by soaking 60 grams of bentonite in a quart of hot water, not stirring or agitating until the bentonite had settled to the bottom of the container. Four oils, cocoanut oil, corn oil, cottonseed oil and soybean oil were emulsified by agitating the bentonite-water mixture while slowly adding the oil. Bentonite alone would not emulsify the other oils and it was necessary to use powdered acacia in addition. It was found that better emulsions were obtained by mixing the acacia with the bentonite-water and then adding the oil. Agitation was accomplished with an electric mixer (Fig. 12) similar to a milk-shake mixer.

These stock emulsions were diluted with water except those marked with an asterisk (*).

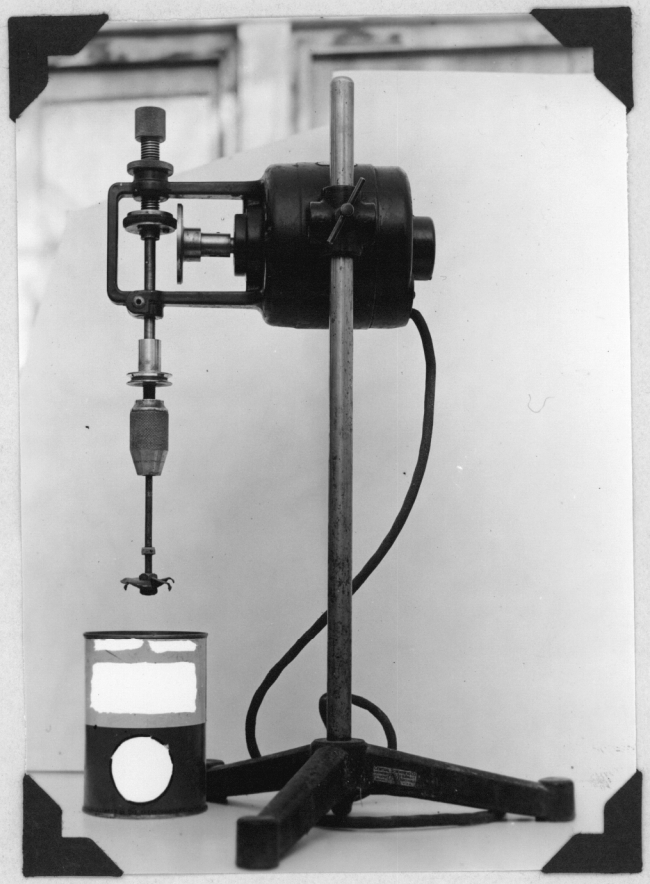

Fig. 12.—Electric Mixer Used in Emulsifying the Oils

Table 1.—Preparation of Stock Emulsions.

Oil	Bentonite-water	Acacia
Coconut oil*, 100 cc.	200 cc.	-
Castor oil*, 150 cc.	100 cc.	10 g.
Codliver oil, 150 cc.	150 cc.	5 g.
Corn oil, 100 cc.	200 cc.	-
Cottonseed oil*, 200 cc.	100 cc.	-
Lard oil, 150 cc.	150 cc.	10 g.
Linseed oil, 100 cc.	100 cc.	20 g.
Menhaden oil, 150 cc.	150 cc.	5 g.
Neatsfoot oil, 150 cc.	150 cc.	10 g.
Paraffine oil, 150 cc. (Eimer & Amend)	150 cc.	15 g.
Paraffine oil, 150 cc. (Diamond)	150 cc.	15 g.
Pine oil, 150 cc.	30 cc.	5 g.
Rosin oil, 150 cc.	100 cc.	10 g.
Soybean oil, 100 cc.	200 cc.	-
Whale oil, 150 cc.	150 cc.	5 g.
Havoline S.A.E. 10, 150 cc.	150 cc.	15 g.
Texaco S.A.E. 20, 150 cc.	150 cc.	20 g.
Texaco S.A.E. 30, 150 cc.	150 cc.	25 g.
Texaco S.A.E. 40, 150 cc.	150 cc.	25 g.
Texaco S.A.E. 50, 150 cc.	150 cc.	25 g.
Havoline S.A.E. 60, 150 cc.	150 cc.	25 g.

* - Diluted with one and one-half percent bentonite-water mixture.

Viscosity Tests

Viscosity tests were run on all the oils tested in 1935 except linseed oil and the commercial preparations. A Saybolt Standard Universal Viscosimeter was used.

The California Spray-Chemical Corporation gives the viscosities of the oil stocks used in Greenhouse Volck, Nursery Volck, and Volck Concentrate as approximately 50, 65, and 90 seconds Saybolt, respectively. These oil stocks have a sulphonation test of about 98-100 percent.

All the linseed oil obtained from Eimer and Amend was used in the spray tests. Raw linseed oil obtained locally had a viscosity of 139 seconds at 100 degrees F.

Table 2.--Viscosity Tests of Oils Used in 1935 Experiments. A Saybolt Standard Universal Viscosimeter was Used.

Oil	Viscosity	Temperature (F.)
Coconut oil	141	100
Codliver oil	154	100
Corn oil	168	100
Cottonseed oil	187	100
Lard oil	212	100
Linseed oil	-	-
Menhaden oil	132	100
Neatsfoot oil	205	100
Paraffine oil (Eimer & Amend)	82	100
Paraffine oil (Diamond)	115	100
Pine Oil	32	100
Soybean oil	161	100
Whale oil	191	100
Castor oil	528	130
Rosin oil	244	130
Havoline S.A.E. 10	94	130
Texaco S.A.E. 20	133	130
Texaco S.A.E. 30	221	130
Texaco S.A.E. 40	363	130
Texaco S.A.E. 50	441	130
Havoline S.A.E. 60	708	130

Temperature Records

The United States Department of Agriculture Weather Bureau maintains a Cooperative Observers' Station in Blacksburg. The daily temperatures for 1934 and 1935 were obtained from its records.

Table 3.—U. S. D. A., Weather Bureau, Coop. Observers' Meteorological Record, Blacksburg, Va., 1934.

Day	July		August		September	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
1	82	67	81	62	73	45
2	87	65	80	65	77	41
3	91	60	82	66	80	47
4	92	60	86	70	85	50
5	91	62	82	61	79	49
6	89	66	84	57	75	52
7	88	64	80	65	75	57
8	85	63	82	64	81	61
9	81	66	82	65	82	57
10	81	65	87	70	84	53
11	74	62	87	64	85	53
12	87	65	80	65	82	56
13	88	65	87	66	77	64
14	87	65	86	66	86	61
15	93	64	86	63	77	58
16	93	70	85	65	77	65
17	88	70	83	63	73	56
18	90	60	82	67	76	44
19	90	64	81	67	77	53
20	94	68	83	69	76	57
21	97	74	79	63	77	58
22	95	67	79	57	83	57
23	91	77	83	60	83	58
24	89	70	83	64	82	58
25	96	70	83	65	82	58
26	99	66	75	65	82	58
27	91	66	78	50	80	60
28	84	66	79	62	70	57
29	80	66	76	53	79	62
30	86	68	69	57	72	62
31	86	67	67	56		
Mean Max.	88.5		81.1		78.7	
Mean Min.	66.0		62.9		55.6	
Mean	77.2		72.0		67.1	

Table 4.—U. S. D. A., Weather Bureau, Coop. Observers' Meteorological Record, Blacksburg, Va., 1935.

Day	May			June			July			August		
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
1				78	48	63.0	89	60	74.5	90	65	77.5
2				73	52	62.5	87	61	72.5	91	68	79.5
3				80	60	70.0	80	62	71.0	90	69	79.5
4				77	63	70.0	84	59	71.5	87	68	77.5
5				76	49	62.5	85	65	75.0	88	63	75.5
6				74	46	60.0	85	63	74.0	92	58	75.0
7				82	49	65.5	84	64	74.0	88	64	76.0
8				81	54	67.5	83	66	74.5	74	66	70.0
9				71	58	64.5	75	63	69.0	76	63	69.5
10				75	45	60.0	85	63	74.0	85	64	74.5
11				75	50	62.5	89	65	77.0	87	62	74.5
12				82	56	69.0	89	68	78.5	90	62	76.0
13				83	60	71.5	84	65	74.5	91	63	77.0
14				86	55	70.5	81	65	73.0	90	66	78.0
15	66	50	58.0	81	63	72.0	85	64	74.5	87	64	75.5
16	52	46	49.0	82	63	72.5	86	60	73.0	86	65	75.5
17	67	44	55.5	84	62	73.0	82	64	73.0	80	68	74.0
18	70	38	54.0	89	66	77.5	82	65	73.5	80	66	73.0
19	65	42	53.5	88	63	75.5	85	61	73.0	79	66	72.5
20	60	51	55.5	78	48	63.0	88	63	75.5	86	65	75.5
21	65	48	56.5	88	57	72.5	84	65	74.5	87	68	77.5
22	72	46	59.0	79	60	69.5	82	67	74.5	82	63	72.5
23	70	50	60.0	74	56	65.0	85	65	75.0	83	66	74.5
24	66	46	56.0	77	49	63.0	86	68	77.0	80	53	66.5
25	67	37	52.0	83	49	66.0	84	66	75.0	82	47	64.5
26	75	38	56.0	87	55	71.0	82	69	75.5	85	49	67.0
27	79	43	61.0	89	55	72.0	76	64	70.0	84	57	70.5
28	81	48	64.5	87	58	72.5	83	60	71.5	81	64	72.5
29	84	51	67.5	88	61	74.5	84	65	74.5	71	52	61.5
30	81	61	71.0	91	64	77.5	85	58	71.5	76	50	63.0
31	78	53	65.5				82	55	68.5	74	44	59.0

Table 4 continued

Day	September			October		
	Max.	Min.	Mean	Max.	Min.	Mean
1	71	57	64.0	75	34	54.5
2	80	57	68.5	61	34	47.5
3	77	62	69.5	73	34	53.5
4	76	65	70.5	70	43	56.5
5	70	65	67.5	69	29	49.0
6	77	62	69.5	59	36	47.5
7	71	61	66.0	58	25	41.5
8	77	61	69.0	60	31	45.5
9	81	60	70.5	65	29	47.0
10	76	56	66.0	71	32	51.5
11	73	50	61.5	79	40	59.5
12	82	58	70.0	79	43	61.0
13	79	50	64.5	78	57	67.5
14	80	49	64.5	81	50	65.5
15	81	51	66.0	79	50	64.5
16	82	58	70.0	70	45	57.5
17	63	56	59.5	74	30	52.0
18	78	57	67.5	75	40	57.5
19	82	56	69.0	77	49	63.0
20	83	55	69.0	76	51	63.5
21	85	55	70.0			
22	82	53	67.5			
23	80	46	63.0			
24	76	51	63.5			
25	79	46	62.5			
26	79	43	61.0			
27	78	51	64.5			
28	76	56	66.0			
29	76	48	62.0			
30	70	34	52.0			
#1						

Materials Tested

In the preliminary work of 1934 the following commercial preparations were tested, singly and in combinations: Black Leaf 40 (nicotine sulphate, 40 percent), Black Leaf 155 (nicotine-bentonite), Grandpa's Tar Soap, Pyrocide (pyrethrum extract), Summer Scalecide, and Orthol K (summer oil).

Of the oils tested in 1935, the following were obtained from Eimer and Amend, New York: castor oil, coconut oil, codliver oil, corn oil, cottonseed oil, lard oil, linseed oil, menhaden oil, neatsfoot oil, paraffine oil, pine oil, rosin oil, soybean oil, and whale oil. The other oils tested in 1935 were obtained directly from the manufacturers or their agents and are listed below: Diamond paraffine oil, Havoline Motor Oil, S. A. E. 10 and 60, Texaco Motor Oil, S. A. E. 20, 30, 40, and 50, Orthol K, Volck Concentrate, Nursery Volck, Greenhouse Volck, and Summer Scalecide.

The commercial preparations, Pyrocide, Summer Scalecide, Orthol K, Nursery Volck, Greenhouse Volck, and Volck Concentrate were diluted according to the percentages given in the tables and not on the basis of the actual oil content of the solutions. The percentages for the other oils refer to the actual oil content of the solutions used.

The materials were applied in concentrations ranging from a fourth to one and a half percent.

RESULTS

The results of the preliminary work which was done in 1934 are summarized in Table 5. For complete details see Entomological Investigations for 1934 by R. N. Jefferson, Entomology Department, Virginia Agricultural Experiment Station.

The complete results of the ovicidal tests on the eggs of the codling moth and of the oriental fruit moth in 1935 are shown in Table 6. Table 6 also gives the concentrations of the materials used, the date the eggs were sprayed, the age of the eggs in days when sprayed, the total number of eggs sprayed, the percent failing to hatch, the mean temperature for the period from the time the eggs were sprayed until all the eggs had hatched, the number of check eggs used, and the percent of check eggs failing to hatch.

Table 5.—Laboratory Experiments on the Eggs of the Codling Moth and Oriental Fruit Moth, Blacksburg, Virginia, 1934.

Material used		Codling Moth: Percent dead	Codling Moth: Mean temp	Oriental Fruit Moth: Percent dead	Oriental Fruit Moth: Mean temperature
Black Leaf 40, 1-1200 plus tar soap	½ lb.	--	--	*20	72
	1 lb.	--	--	*23	72
	2 lbs.	*19	75	*27	72
	4 lbs.	*34	74	*95	72
Black Leaf 40, 1-800 plus tar soap	½ lb.	--	--	46	73
	1 lb.	47	74	29	73
	2 lbs.	*35	74	51	73
	Check			20	73
Black Leaf 40, 1-1200 plus Orthol K	⅛%	--	--	97	74
	¼%	--	--	100	74
	½%	--	--	*100	74
	¾%	--	--	*100	74
Black Leaf 40, 1-800 plus Orthol K	⅛%	--	--	*98	74
	⅛%	--	--	*100	68
	¼	100	82	*100	70
	½%	99	79	98	80
	¾%	100	82	99	80
Orthol K	⅛%	*79	70	63	76
	¼%	--	--	70	76
	½%	*99	70	98	76
	¾%	100	81	100	76
	¾%	--	--	99	76
	Check			14	76
Orthol K, ½% plus Pyrethrum**	1-100	--	--	*100	72
	1-200	--	--	*98	72
	1-400	--	--	*60	68
	1-600	--	--	*53	68
	1-800	--	--	*53	68
	1-1000	--	--	*57	68
Black Leaf 155	5 lbs.	*16	73	--	--
	5 lbs.	*7	75	--	--
Tar Soap	2 lbs.	--	--	10	74
	4 lbs.	--	--	25	74
	8 lbs.	--	--	62	74
	12 lbs.	--	--	90	74
	Check	--	--	9	74
Summer Scalecide	⅛%	--	--	*19	61
	¼%	--	--	*25	61
	½%	--	--	*53	61
	¾%	--	--	*42	61
	¾%	--	--	*78	68

* - All eggs fertile.
** - Pyrocyde, McLaughlin Gormley King Co., Minneapolis, Minn.

Table 6.—Ovicidal Tests on Oriental Fruit Moth and Codling Moth in 1935.

Material used	Oriental Fruit Moth					Codling Moth				
	Date sprayed	Age of eggs	Number of eggs	Percent failing to hatch	Mean temp.	Date sprayed	Age of eggs	Number of eggs	Percent failing to hatch	Mean temp.
3% Bentonite - water	7-18	2	23	4.3		7-20	4	124	16.9	
	7-18	1	40	2.5		7-20	3	77	13.2	
	Totals		63	3.2		7-20	2	69	5.8	
	Check		46	0.0		Totals		270	12.2	75.3
	8-30	3	108	2.8		Check		141	.7	
	8-30	2	109	13.8						
	Totals		217	8.3						
	Check		309	2.9						
Orthol K, ½%	5-31	8	55	70.9		6-5	7	56	80.4	
	5-31	4	28	71.4		6-5	5	80	65.0	
	5-31	3	109	94.5		6-5	3-4	44	88.6	
	5-31	2	33	90.9		6-5	2	62	75.8	
	Totals		225	85.3		Totals		242	74.0	64.8
	Check		67	0.0		Check		102	3.9	
Orthol K, ¾%	6-5	6	67	91.0		6-14	10	33	63.5	
	6-5	5	77	94.8		6-14	9	23	56.5	
	6-5	3-4	254	100.0		6-14	8	23	74.0	
	Totals		398	97.5		6-14	7	45	71.0	
	Check		94	3.3		Totals		124	66.9	71.7
						Check		176	4.0	
Orthol K, 1%	6-14	7	61	86.9		6-14	10	48	75.0	
	6-14	5-6	95	100.0		6-14	9	22	68.0	
	Totals		156	94.9		6-14	8	44	82.0	
	Check		166	4.2		6-14	7	101	100.0	
						6-14	5-6	109	100.0	
						Totals		324	91.7	71.7
						Check		176	4.0	

Table continued

Orthol K, 1½%	6-14	7	88	87.5		6-17	6-7	85	90.0		
	6-14	5-6	214	96.7		6-17	5	116	96.5		
	Totals		302	94.0		6-17	4	105	96.1		
	Check		166	4.2		6-17	3	62	98.5		
						Totals		368	95.4	72.0	
						Check		238	3.8		
Orthol K, 1½%	6-14	7	87	71.3		6-17	6	146	79.5		
	6-14	5-6	164	86.0		6-17	5	134	98.5		
	Totals		251	80.9		6-17	3	52	98.1		
	Check		166	4.2		Totals		332	90.1	72.0	
						Check		238	3.8		
Cottonseed oil, ½%	9-8	6	50	58.0							
	9-8	5	56	87.5							
	9-8	4	45	91.1							
	Totals		151	78.8							
	Check		135	3.0							
Cottonseed oil, ¾%	7-7	5	32	96.9		7-10	6	60	98.3		
	7-7	4	34	97.1		7-10	5	58	93.1		
	7-7	3	33	93.9		7-10	3-4	87	89.8		
	Totals		99	96.0		7-10	2	84	100.0		
	Check		79	1.3		Totals		289	95.2	76.0	
						Check		122	17.2		
Cottonseed oil ¼%	7-10	5	87	46.0		7-16	6	59	100.0		
	7-10	3-4	290	94.5		7-16	4	90	100.0		
	7-10	2	198	93.4		7-16	2-3	97	92.8		
	Totals		575	86.8		Totals		246	97.2	73.6	
	Check		113	0.9		Check		60	6.7		
Cottonseed oil 1%	7-1	4	130	96.9		7-24	3-4	227	98.5		
	7-1	3	74	97.3		7-24	2	37	100.0		
	7-1	2	203	98.0		7-24	1	42	95.2		
	Totals		407	97.5		Totals		396	98.4	73.3	
	Check		32	0.0		Check		68	0.0		

Table 6 continued

Material used	Oriental Fruit Moth					Codling Moth				
	Date sprayed	Age of eggs	Number of eggs	Percent failing to hatch	Mean temp.	Date sprayed	Age of eggs	Number of eggs	Percent failing to hatch	Mean temp.
Cottonseed oil 1¼%	7-10	5	44	95.5		7-31	7	54	90.1	
	7-10	3-4	53	100.0		7-31	6	127	100.0	
	7-10	2	46	97.8		7-31	5	90	100.0	
	Total		143	97.9		7-31	4	127	100.0	
	Check		113	.9		Total		398	98.7	76.3
						Check		139	.7	
Cottonseed oil, 1½%	7-7	5	40	100.0		8-3	5	41	97.7	
	7-7	4	39	100.0		8-3	4	48	100.0	
	7-7	3	48	91.7		8-3	3	106	100.0	
	Totals		127	96.9		8-3	2	79	100.0	
	Check		79	1.3		Totals		274	99.6	76.9
						Check		108	1.9	
Oil (Corn), ¼%	8-28	5	84	78.6						
	8-28	3-4	118	78.0						
	8-28	2	53	64.2						
	Totals		255	75.3						
	Check		179	6.1						
Corn oil, ½%	7-10	5	32	75.0		8-3	5	56	96.5	
	7-10	3-4	48	89.6		8-3	4	27	100.0	
	7-10	2	51	76.5		8-3	3	39	100.0	
	Totals		131	80.9		8-3	2	135	100.0	
	Check		113	.9		Totals		257	99.2	76.9
						Check		108	1.9	
Corn oil, ¾%	7-13	4	126	88.9		8-7	5	52	100.0	
	7-13	3	39	100.0		8-7	4	140	100.0	
	7-13	2	98	100.0		8-7	3	50	100.0	
	Totals		263	94.7		8-7	2	25	100.0	
	Check		111	.9		Totals		267	100.0	72.9
						Check		224	8.9	

Table 6 continued

Corn oil, 1%	7-10	5	32	75.0		8-7	5	46	98.0			
	7-10	3-4	98	100.0		8-7	4	90	100.0			
	Totals		130	93.8		8-7	3	80	100.0			
	Check		113	.9		8-7	2	104	100.0			
						Totals		320	99.7	72.9		
						Checks		224	8.9			
Corn oil, 1¼%	7-13	4	34	85.3		8-7	5	138	100.0			
	7-13	3	441	98.2		8-7	4	91	100.0			
	7-13	2	48	100.0		8-7	3	97	100.0			
	Totals		523	97.5		8-7	2	61	100.0			
	Check		111	.9		Totals		387	100.0	72.9		
						Check		224	8.9			
Corn oil, 1½%	7-10	5	64	95.2		8-8	4-5	34	100.0			
	7-10	3-4	116	100.0		8-8	2	66	100.0			
	Totals		200	98.0		8-8	1	108	100.0			
	Check		113	.9		Totals		208	100.0	73.6		
						Check		224	8.9			
Soya Bean Oil, ¼%	8-28	5	80	85.0								
	8-28	3-4	72	93.0								
	8-28	2	38	63.2								
	Totals		190	83.7								
	Check		179	6.1								
Soya Bean Oil, ⅜%	7-13	4	30	56.7		8-8	4-5	78	100.0			
	7-13	3	63	95.2		8-8	2	33	100.0			
	7-13	2	198	92.4		8-8	1	50	100.0			
	Totals		291	89.3		Totals		161	100.0	73.6		
	Check		111	.9		Check		224	8.9			
Soya Bean Oil, ½%	7-13	4	20	65.0		8-14	6	27	100.0			
	7-13	3	78	87.2		8-14	5	62	98.5			
	7-13	2	96	99.0		8-14	3-4	87	100.0			
	Totals		194	90.7		8-14	2	121	100.0			
	Check		111	.9		Totals		297	99.7	75.2		
						Check		176	6.3			

Table 6 continued

Material used	Oriental Fruit Moth: Date sprayed	Age of eggs	Number of eggs	Percent failing to hatch	Mean temp.	Codling Moth: Date sprayed	Age of eggs	Number of eggs	Percent failing to hatch	Mean temp.
Soya Bean Oil, 1%	7-16	4	50	98.0		8-14	6	65	100.0	
	7-16	2-3	62	100.0		8-14	5	61	100.0	
	7-16	1	65	100.0		8-14	3-4	132	100.0	
	Totals		177	99.4		8-14	2	59	100.0	
	Check		228	2.6		Totals		317	100.0	75.2
						Check		176	6.3	
Soya Bean Oil, 1¼%	7-16	4	48	89.6		8-14	3	113	100.0	
	7-16	2-3	50	96.0		8-14	2	22	100.0	
	7-16	1	51	98.0		8-14	1	75	100.0	
	Totals		149	94.6		Totals		207	100.0	74.9
	Check		228	2.6		Check		131	3.1	
Soya Bean Oil, 1½%	7-16	4	56	96.4		8-14	3	80	100.0	
	7-16	2-3	94	100.0		8-14	2	111	100.0	
	7-16	1	48	100.0		Totals		191	100.0	74.9
	Totals		198	99.0		Check		131	3.1	
	Check		228	2.6						
Linseed oil, ¼%	8-28	5	74	41.9						
	8-28	3-4	80	62.5						
	8-28	2	31	9.7						
	Totals		185	45.4						
	Check		179	6.1						
Linseed oil, ½%	7-21	5	34	44.1		8-16	3	22	72.7	
	7-21	4	49	87.8		8-16	2	135	67.3	
	7-21	3	124	71.8		8-16	1	72	34.8	
	Totals		207	71.0		Totals		229	57.6	74.4
	Check		126	0.0		Check		149	4.0	
Linseed oil, ¾%	7-21	5	19	15.8		8-16	3	91	95.5	
	7-21	4	132	85.6		8-16	2	107	81.3	
	7-21	3	107	73.8		8-16	1	24	95.7	
	Totals		258	75.6		Totals		222	88.7	74.4
	Check		126	0.0		Check		149	4.0	

Table 6 continued

Linseed oil, 1%	7-22	4	37	94.6		8-16	3	208	95.7		
	7-22	3	197	92.9		8-16	2	105	91.5		
	7-22	1-2	77	85.7		8-16	1	42	85.7		
	Totals		311	91.3		Totals		355	93.2	74.4	
	Check		147	.7		Check		149	4.0		
Linseed oil, 1¼%	7-22	4	31	93.5		8-26	6	49	100.0		
	7-22	3	120	91.7		8-26	5	54	100.0		
	7-22	1-2	153	94.8		8-26	4	124	100.0		
	Totals		304	93.4		Totals		227	100.0	66.9	
	Check		147	.7		Check		71	4.2		
Linseed oil, 1½%	7-22	4	86	93.0		8-29	6	90	100.0		
	7-22	3	176	85.2		8-29	4-5	44	100.0		
	7-22	1-2	134	96.3		8-29	3	13	100.0		
	Totals		396	90.7		Totals		147	100.0	65.4	
	Check		147	.7		Check		32	3.1		
Rosin Oil, ¼%	8-28	5	56	16.1							
	8-28	3-4	112	28.6							
	8-28	2	31	3.2							
	Totals		199	21.1							
	Check		179	6.1							
Rosin Oil, ½%	7-25	4-5	264	73.9		8-29	6	45	77.8		
	7-25	3	138	76.8		8-29	4-5	92	63.1		
	7-25	2	33	78.8		8-29	3	11	54.5		
	Totals		435	75.2		Totals		148	66.9	65.4	
	Check		135	.7		Check		32	3.1		
Rosin Oil, ¾%	7-25	4-5	45	91.1		9-4	8	92	91.8		
	7-25	3	191	85.3		9-4	7	48	66.7		
	7-25	2	30	70.0		9-4	5	24	75.0		
	Totals		266	84.6		Totals		164	84.8	68.8	
	Check		135	.7		Check		50	4.0		
Rosin Oil, 1%	7-25	4-5	183	73.8							
	7-25	3	137	89.8							
	7-25	2	36	77.8							
	Totals		356	80.3							
	Check		135	.7							

Table 6 continued

Material used	Oriental Fruit Moth: Date sprayed	Age of eggs	Number of eggs	Percent failing to hatch	Mean temp.	Codling Moth: date sprayed	Age of eggs	Number of eggs	Percent failing to hatch	Mean temp.
Rosin oil, 1¼%	7-27	4	131	100.0						
	7-27	3	51	88.2						
	7-27	2	70	81.4						
	Totals		252	92.5						
	Check		135	.7						
Rosin oil, 1½%	7-27	4	30	76.7						
	7-27	3	83	98.8						
	7-27	2	94	89.4						
	Totals		207	91.3						
	Check		135	.7						
Diamond Paraffine oil, 1½%						8-24	3	49	100.0	
Pine oil, ¼%	9-8	6	50	4.0						
	9-8	5	47	8.5						
	9-8	4	55	3.6						
	Totals		152	5.3						
	Check		135	3.0						
Pine oil, ½%	7-18	4-5	60	6.7						
	7-18	3	64	18.8						
	7-18	2	128	3.9						
	Totals		252	8.3						
	Check		228	2.6						
Pine oil, ¾%	7-18	4-5	55	1.8						
	7-18	3	39	2.6						
	7-18	2	68	4.4						
	Totals		162	3.1						
	Check		228	2.6						
Pine oil, 1%	7-18	4-5	40	2.5						
	7-18	3	30	3.3						
	7-18	2	109	1.8						
	Totals		179	2.2						
	Check		228	2.6						

Table 6 continued

Material used	Date sprayed	Age of eggs	Number of eggs	Percent failing to hatch	Mean temp.
	Oriental Fruit Moth				
Pine oil, 1¼%	7-21	5	125	3.2	
	7-21	4	53	3.8	
	7-21	3	65	0.0	
	Total		243	2.5	
	Check		126	0.0	
Pine oil, 1½%	7-21	5	52	0.0	
	7-21	4	44	0.0	
	7-21	3	75	4.0	
	Totals		171	1.8	
	Check		126	0.0	
Coconut oil, ½%	7-22	4	82	81.7	
	7-22	3	58	75.9	
	7-22	1-2	108	77.8	
	Totals		248	78.6	
	Check		147	.7	
Coconut oil, ¾%	7-22	4	82	92.7	
	7-22	3	57	100.0	
	7-22	1-2	59	93.2	
	Totals		198	94.9	
	Check		147	.7	
Coconut oil, 1%	7-22	4	61	100.0	
	7-22	3	35	97.1	
	7-22	1-2	326	96.9	
	Totals		422	97.4	
	Check		147	.7	
Coconut oil, 1¼%	7-23	4	106	99.1	
	7-23	2-3	106	97.2	
	7-23	1	37	100.0	
	Totals		249	98.4	
	Check		203	1.5	
Coconut oil, 1½%	7-23	4	81	100.0	
	7-23	2-3	122	96.7	
	7-23	1	42	95.2	
	Totals		245	97.6	
	Check		203	1.5	
Castor oil, ¼%	9-8	6	46	26.1	
	9-8	5	57	52.6	
	9-8	4	30	46.7	
	Totals		133	42.1	
	Check		135	3.0	
Castor oil, ½%	7-27	4	78	62.8	
	7-27	3	69	76.8	
	7-27	2	41	65.9	
	Totals		188	68.6	
	Check		135	.7	

Table 6 continued

Castor oil, ¼%	7-27	4	66	63.6	
	7-27	3	123	91.9	
	7-27	2	58	89.7	
	Totals		247	83.8	
	Check		135	.7	
Castor oil, 1%	7-27	4	41	100.0	
	7-27	3	72	83.3	
	7-27	2	50	96.0	
	Totals		163	91.4	
	Check		135	.7	
Castor oil, 1¼%	7-31	4	15	100.0	
	7-31	3	67	97.0	
	7-31	2	117	93.2	
	Totals		199	95.0	
	Check		112	2.7	
Castor oil 1½%	7-31	4	48	97.9	
	7-31	3	48	97.9	
	7-31	2	75	100.0	
	Totals		171	98.8	
	Check		112	2.7	
Summer Scalecide, ½%	8-21	4	56	55.6	
	8-21	3	34	47.1	
	8-21	2	144	43.1	
	Totals		214	45.8	
	Check		169	5.9	
Summer Scalecide, ¾%	8-21	4	106	39.6	
	8-21	3	30	45.7	
	8-21	2	45	51.1	
	Totals		181	43.6	
	Check		169	5.9	
Summer Scalecide, 1%	7-23	4	127	44.1	
	7-23	2-3	99	31.3	
	7-23	1	57	38.6	
	Totals		283	38.5	
	Check		203	1.5	
Summer Scalecide, 1¼%	8-21	4	41	39.0	
	8-21	3	62	45.2	
	8-21	2	44	34.1	
	Totals		147	40.1	
	Check		169	5.9	
Summer Scalecide, 1½%	8-21	4	39	10.3	
	8-21	3	70	51.4	
	8-21	2	56	5.4	
	Totals		165	26.1	
	Check		169	5.9	
Paraffine oil, 2%	8-28	5	45	88.9	
	8-28	3-4	94	96.8	
(Eimer & Amend)	8-28	2	73	97.2	
	Totals		212	95.3	
	Check		179	6.1	

Table 6 continued

Material used	Oriental Fruit Moth				
	Date sprayed	Age of eggs	Number of eggs	Percent failing to hatch	Mean temp.
Paraffine oil, ½% (Eimer & Amend)	7-29	5	99	93.9	
	7-29	4	17	94.1	
	7-29	3	58	89.7	
	Total		174	92.5	
	Check		171	0.0	
Paraffine oil, ¾% (Eimer & Amend)	8-1	4	113	99.1	
	8-1	3	45	100.0	
	8-1	2	53	100.0	
	Totals		211	99.5	
	Check		174	0.0	
Paraffine oil, 1% (Eimer & Amend)	7-31	4	57	98.2	
	7-31	3	51	100.0	
	7-31	2	64	100.0	
	Totals		172	99.4	
	Check		112	2.7	
Paraffine oil, 1¼% (Eimer & Amend)	8-1	4	141	98.6	
	8-1	3	49	100.0	
	8-1	2	40	100.0	
	Totals		230	99.1	
	Check		174	0.0	
Paraffine oil, 1½% (Eimer & Amend)	8-1	3	57	100.0	
	8-1	2	68	100.0	
	8-1	1	59	100.0	
	Totals		184	100.0	
	Check		174	0.0	
Diamond Paraffine Oil, ¼%	8-28	5	38	97.4	
	8-28	3-4	71	98.6	
	8-28	2	61	91.8	
	Totals		170	95.9	
	Check		179	6.1	
Diamond Paraffine Oil, ½%	8-21	4	40	100.0	
	8-21	3	159	96.2	
	8-21	2	44	97.7	
	Totals		243	97.1	
	Check		169	5.9	
Diamond Paraffine Oil, ¾%	8-21	4	115	100.0	
	8-21	3	60	96.7	
	8-21	2	26	96.2	
	Totals		201	98.5	
	Check		169	5.9	
Diamond Paraffine Oil, 1%	8-21	4	48	100.0	
	8-21	3	104	100.0	
	8-21	2	32	100.0	
	Totals		184	100.0	
	Check		169	5.9	

Table 6 continued

Material used	Date sprayed	Age of eggs	Number of eggs	Percent failing to hatch	Mean temp.
Diamond Paraffine Oil, 1¼%	8-21	4	79	100.0	
	8-21	3	149	100.0	
	8-21	2	183	10010	
	Totals		411	100.0	
	Check		169	5.9	
Diamond Paraffine Oil, 1½%	8-24	4	50	100.0	
	8-24	2	31	100.0	
	Totals		81	100.0	
	Check		314	1.9	
Havoline S. A. E. 10 ¼%	8-28	5	149	98.7	
	8-28	3-4	42	92.9	
	8-28	2	26	100.0	
	Totals		217	99.7	
	Check		179	6.1	
Havoline S. A. E. 10, ½%	8-1	3	35	100.0	
	8-1	2	57	100.0	
	8-1	1	65	98.5	
	Totals		157	99.4	
	Check		174	0.0	
Havoline S. A. E 10, ¾%	8-1	3	45	100.0	
	8-1	2	45	100.0	
	8-1	1	65	100.0	
	Totals		155	100.0	
	Check		174	0.0	
Havoline S. A. E. 10, 1%	8-3	4	56	100.0	
	8-3	3	133	100.0	
	Totals		189	100.0	
	Check		136	2.2	
Havoline A. S. E. 10, 1¼%	8-3	4	85	100.0	
	8-3	3	48	100.0	
	8-3	2	52	100.0	
	Totals		185	100.0	
	Check		136	2.2	
Havoline S. A. E. 10, 1½%	8-3	4	111	100.0	
	8-3	3	93	100.0	
	8-3	2	40	100.0	
	Totals		244	100.0	
	Check		136	2.2	
Texaco S. A. E. 20, ¼%	8-28	5	34	76.5	
	8-28	394	68	86.8	
	8-28	2	63	92.1	
	Totals		165	86.7	
	Check		179	6.1	

Table 6 continued

Texaco S. A. E. 20, ½%	8-3	4	191	99.0	
	8-3	3	112	92.9	
	8-3	2	32	96.9	
	Totals		335	96.7	
	Check		136	2.2	
Texaco S. A. E. 20, ¾%	8-3	3	51	98.0	
	8-3	2	58	100.0	
	8-3	1	87	100.0	
	Totals		196	99.5	
	Check		136	2.2	
Texaco S. A. E. 20, 1%	8-3	3	104	100.0	
	8-3	2	84	100.0	
	8-3	1	49	100.0	
	Totals		237	100.0	
	Check		136	2.2	
Texaco S. A. E. 20, 1½%	8-4	3	65	100.0	
	8-4	2	111	99.1	
	8-4	1	62	98.4	
	Totals		238	99.2	
	Check		383	3.1	
Texaco S. A. E. 20, 1½%	8-4	3	69	100.0	
	8-4	2	159	99.4	
	8-4	1	131	100.0	
	Totals		359	99.7	
	Check		383	3.1	
Texaco S. A. E. 30, ¼%	8-8	6	57	26.3	
	8-8	5	34	73.5	
	8-8	4	33	72.7	
	Totals		124	51.6	
	Check		135	3.0	
Texaco S. A. E. 30, ½%	8-4	3	153	97.4	
	8-4	2	150	92.7	
	8-4	1	47	91.5	
	Totals		350	94.6	
	Check		383	3.1	
Texaco S. A. E. 30, ¾%	8-4	3	228	98.2	
	8-4	2	214	98.6	
	8-4	1	137	97.1	
	Totals		579	98.1	
	Check		383	3.1	
Texaco S. A. E. 30, 1%	8-4	3	246	98.8	
	8-4	2	97	100.0	
	8-4	1	146	99.3	
	Totals		489	99.2	
	Check		383	3.1	
Texaco S. A. E. 30, 1¼%	8-4	3	44	100.0	
	8-4	2	108	100.0	
	8-4	1	176	100.0	
	Totals		328	100.0	
	Check		883	3.1	

Table 6 continued

Texaco S. A. E. 30, 1½%	8-7	3-4	79	96.2	
	8-7	2	41	100.0	
	8-7	1	60	100.0	
	Totals		180	98.3	
	Check		114	6.1	
Texaco S. A. E. 40, ½%	8-8	6	27	44.4	
	8-8	5	34	67.6	
	8-8	4	77	71.4	
	Totals		138	65.2	
	Check		135	3.0	
Texaco S. A. E. 40, ¼%	8-7	3-4	59	78.0	
	8-7	2	51	90.2	
	8-7	1	55	98.2	
	Totals		165	88.5	
	Check		114	6.1	
Texaco S. A. E. 40, ⅛%	8-7	3-4	90	54.4	
	8-7	2	54	90.7	
	8-7	1	41	100.0	
	Totals		185	75.1	
	Check		114	6.1	
Texaco S. A. E. 40, 1%	8-7	3-4	38	100.0	
	8-7	2	77	97.4	
	8-7	1	46	100.0	
	Totals		161	98.8	
	Check		114	6.1	
Texaco S. A. E. 40, 1½%	8-7	3-4	60	88.3	
	8-7	2	88	98.9	
	8-7	1	46	100.0	
	Totals		194	95.9	
	Check		114	6.1	
Texaco S. A. E. 40, 1⅓%	8-7	3-4	59	89.8	
	8-7	2	55	100.0	
	8-7	1	49	93.0	
	Totals		163	95.7	
	Check		114	6.1	
Texaco S. A. E. 50, ¼%	8-8	6	35	48.6	
	8-8	5	37	94.6	
	8-8	4	57	80.7	
	Totals		129	76.0	
	Check		135	3.0	
Texaco S. A. E. 50, ½%	8-14	3-4	124	98.4	
	8-14	2	109	98.2	
	8-14	1	27	85.2	
	Totals		260	96.9	
	Check		264	2.7	
Texaco S. A. E. 50, ¼%	8-14	3-4	157	97.5	
	8-14	2	121	98.3	
	8-14	1	21	85.7	
	Totals		299	97.0	
	Check		264	2.7	

Table 6 continued

Material used	Oriental Fruit Moth				
	Date sprayed	Age of eggs	Number of eggs	Percent failing to hatch	Mean temp.
Texaco S. A. E. 50, 1%	8-14	3-4	64	96.9	
	8-14	2	49	100.0	
	8-14	1	75	97.3	
	Totals		188	97.9	
	Check		264	2.7	
Texaco S. A. E. 50, 1¼%	8-16	3	32	100.0	
	8-16	2	34	100.0	
	8-16	1	51	98.0	
	Totals		117	99.1	
	Check		97	4.1	
Texaco S. A. E. 50, 1½%	8-16	3	35	100.0	
	8-16	2	46	97.8	
	8-16	1	111	100.0	
	Totals		192	99.5	
	Check		97	4.1	
Havoline S. A. E. 60, ¼%	9-8	6	39	38.5	
	9-8	5	52	84.6	
	9-8	4	45	55.6	
	Totals		136	61.8	
	Check		135	3.0	
Havoline S. A. E. 60, ½%	8-21	5	133	91.7	
	8-21	4	36	83.3	
	8-21	3	36	97.2	
	Totals		205	91.2	
	Check		169	5.9	
Havoline S. A. E. 60, ¾%	8-21	4	39	92.3	
	8-21	3	23	95.7	
	8-21	2	68	100.0	
	Totals		130	96.9	
	Check		169	5.9	
Havoline S. A. E. 60, 1%	8-21	4	143	93.7	
	8-21	3	44	100.0	
	8-21	2	57	100.0	
	Totals		244	96.3	
	Check		169	5.9	
Havoline S. A. E. 60, 1¼%	8-21	4	41	100.0	
	8-21	3	41	100.0	
	8-21	2	44	100.0	
	Totals		126	100.0	
	Check		169	5.9	
Havoline S. A. E. 60, 1½%	8-21	4	79	100.0	
	8-21	3	23	100.0	
	8-21	2	43	100.0	
	Totals		145	100.0	
	Check		169	5.9	

Table 6 continued

Codliver oil, ¼%	9-4	7	80	25.0	
	9-4	5	65	63.1	
	9-4	3-4	41	58.5	
	Totals		186	45.7	
	Check		172	6.4	
Codliver oil, ½%	8-10	3	42	97.6	
	8-10	2	45	95.6	
	8-10	1	65	80.0	
	Totals		152	89.5	
	Check		140	1.4	
Codliver oil, ¾%	8-10	3	39	100.0	
	8-10	2	46	97.8	
	8-10	1	113	100.0	
	Totals		198	99.5	
	Check		140	1.4	
Codliver oil, 1%	8-12	3	70	100.0	
	8-12	2	203	99.5	
	8-12	1	257	100.0	
	Totals		530	99.8	
	Check		105	2.9	
Codliver oil, 1¼%	8-14	3-4	100	99.0	
	8-14	2	56	100.0	
	8-14	1	39	97.4	
	Totals		195	99.0	
	Check		264	2.7	
Codliver oil, 1½%	8-14	3-4	47	100.0	
	8-14	2	104	100.0	
	8-14	1	42	97.6	
	Totals		193	99.5	
	Check		264	2.7	
Lard oil, ¼%	9-4	7	43	9.3	
	9-4	5	56	33.9	
	9-4	3-4	36	47.2	
	Totals		135	29.6	
	Check		172	6.4	
Lard oil, ½%	8-14	3-4	122	96.7	
	8-14	2	33	97.0	
	8-14	1	73	90.4	
	Totals		228	94.7	
	Check		264	2.7	
Lard oil, ¾%	8-14	3-4	110	96.4	
	8-14	2	19	89.5	
	8-14	1	57	94.7	
	Totals		186	95.2	
	Check		264	2.7	
Lard oil, 1%	8-14	3-4	90	98.9	
	8-14	2	24	95.8	
	8-14	1	125	92.8	
	Totals		239	95.5	
	Check		264	2.7	

Table 6 continued

Material used	Oriental Fruit Moth				
	Date sprayed	Age of eggs	Number of eggs	Percent failing to hatch	Mean temp.
Lard oil 1¼%	8-14	3-4	36	100.0	
	8-14	2	194	99.0	
	8-14	1	31	100.0	
	Totals		261	99.2	
	Check		264	2.7	
Lard oil, 1½%	8-14	3-4	51	100.0	
	8-14	2	104	99.0	
	8-14	1	83	100.0	
	Totals		238	99.6	
	Check		264	2.7	
Neatsfoot oil, ¼%	9-4	7	25	12.0	
	9-4	5	63	52.4	
	9-4	3-4	62	67.7	
	Totals		150	52.0	
	Check		172	6.4	
Neatsfoot oil, ½%	8-14	3-4	102	98.0	
	8-14	2	162	98.8	
	8-14	1	33	100.0	
	Totals		297	98.7	
	Check		264	2.7	
Neatsfoot oil, ¾%	8-14	3-4	54	100.0	
	8-14	2	49	98.0	
	8-14	1	63	100.0	
	Totals		166	99.4	
	Check		264	2.7	
Neatsfoot oil, 1%	8-14	3-4	68	98.5	
	8-14	2	56	100.0	
	8-14	1	49	98.0	
	Totals		173	98.8	
	Check		264	2.7	
Neatsfoot oil, 1¼%	8-14	3-4	54	98.1	
	8-14	2	86	100.0	
	8-14	1	75	100.0	
	Totals		215	99.5	
	Check		264	2.7	
Neatsfoot oil, 1½%	8-14	3-4	62	98.4	
	8-14	2	131	100.0	
	8-14	1	56	100.0	
	Totals		249	99.6	
	Check		264	2.7	
Menhaden oil, ¼%	9-4	7	15	20.0	
	9-4	5	79	55.7	
	9-4	3-4	42	45.2	
	Totals		136	48.5	
	Check		172	6.4	

Table 6 continued

Mehaden oil, ½%	8-9	5	208	89.4	
	8-9	4	88	94.3	
	8-9	3	85	95.3	
	Totals		381	91.9	
	Check		115	0.0	
Mehaden oil, ¼%	8-9	5	159	100.0	
	8-9	4	91	94.5	
	8-9	3	96	94.8	
	Totals		346	97.1	
	Check		115	0.0	
Mehaden oil, 1%	8-10	3	35	100.0	
	8-10	2	31	100.0	
	8-10	1	144	99.3	
	Totals		210	99.5	
	Check		140	1.4	
Mehaden oil, 1¼%	8-10	3	32	100.0	
	8-10	2	61	98.4	
	8-10	1	45	97.8	
	Totals		138	98.6	
	Check		140	1.4	
Mehaden oil, 1½%	8-10	3	126	100.0	
	8-10	2	34	97.1	
	8-10	1	54	100.0	
	Totals		214	99.5	
	Check		140	1.4	
Whale oil, ¼%	9-4	7	30	13.3	
	9-4	5	65	40.0	
	Totals		95	31.6	
	Check		172	6.4	
Whale oil, ½%	8-10	3	61	67.2	
	8-10	2	29	48.3	
	8-10	1	133	56.4	
	Totals		223	58.3	
	Check		140	1.4	
Whale oil, ¾%	8-10	3	60	98.3	
	8-10	2	46	91.3	
	8-10	1	75	93.3	
	Totals		181	94.5	
	Check		140	1.4	
Whale oil, 1%	8-10	3	34	94.1	
	8-10	2	97	97.9	
	8-10	1	51	9611	
	Totals		182	96.7	
	Check		140	1.4	
Whale oil, 1¼%	8-10	3	32	100.0	
	8-10	2	73	98.6	
	8-10	1	61	100.0	
	Totals		166	99.4	
	Check		140	1.4	

Table 6 continued

Material used	Oriental Fruit Moth				
	Date sprayed	Age of eggs	Number of eggs	Percent failing to hatch	Mean temp.
Whale oil, 1½%	8-10	3	104	100.0	
	8-10	2	52	98.1	
	8-10	1	57	98.2	
	Totals		213	99.1	
	Check		140	1.4	
Volck, ½% Concentrate	8-24	4	124	63.7	
	8-24	3	64	78.1	
	8-24	2	16	100.0	
	Totals		204	71.1	
	Check		314	1.9	
Volck, ¾% Concentrate	8-24	4	66	63.6	
	8-24	3	146	86.3	
	8-24	2	30	93.3	
	Totals		242	81.0	
	Check		314	1.9	
Volck, 1% Concentrate	8-24	4	48	93.8	
	8-24	3	120	99.2	
	8-24	2	28	100.0	
	Totals		196	98.0	
	Check		314	1.9	
Volck, 1¼% Concentrate	8-24	4	75	100.0	
	8-24	3	113	99.1	
	8-24	2	24	100.0	
	Totals		212	99.5	
	Check		314	1.9	
Volck, 1½% Concentrate	8-24	4	41	100.0	
	8-24	3	40	100.0	
	8-24	2	85	100.0	
	Totals		166	100.0	
	Check		314	1.9	
Nursery Volck, ½%	8-24	4	116	93.1	
	8-24	3	36	91.7	
	8-24	2	79	100.0	
	Totals		231	95.2	
	Check		314	1.9	
Nursery Volck, ¾%	8-24	4	32	96.9	
	8-24	3	74	100.0	
	8-24	2	120	100.0	
	Totals		226	99.6	
	Check		314	1.9	
Nursery Volck, 1%	8-24	4	40	100.0	
	8-24	3	63	100.0	
	8-24	2	95	100.0	
Totals	Totals		198	100.0	
	Check		314	1.9	

Table 6 continued

Nursery Volck, 1¼%	8-24	4	93	100.0	
	8-24	3	112	100.0	
	8-24	2	77	100.0	
	Totals		282	100.0	
	Check		314	1.9	
Nursery Volck, 1⅓%	8-24	4	84	100.0	
	8-24	3	110	99.1	
	8-24	2	139	100.0	
	Totals		333	99.7	
	Check		314	1.9	
Greenhouse Volck, ½%	8-24	4	75	90.7	
	8-24	3	91	60.4	
	8-24	2	80	80.0	
	Totals		246	76.0	
	Check		314	1.9	
Greenhouse Volck, ¼%	8-24	4	34	85.3	
	8-24	3	109	91.7	
	8-24	2	82	86.6	
	Totals		225	88.9	
	Check		314	1.9	
Greenhouse Volck, 1%	8-28	5	78	98.7	
	8-28	3-4	65	92.3	
	8-28	2	85	98.8	
	Totals		228	96.9	
	Check		179	6.1	
Greenhouse Volck, 1¼%	8-28	5	124	91.1	
	8-28	3-4	75	100.0	
	8-28	2	34	100.0	
	Totals		233	95.3	
	Check		179	6.1	
Greenhouse Volck, 1½%	8-28	5	65	100.0	
	8-28	3-4	73	100.0	
	8-28	2	45	100.0	
	Totals		183	100.0	
	Check		179	6.1	

DISCUSSION OF RESULTS

The Effect of Oils on Eggs of Different Ages

Stearns (7) testing nicotine sulphate against the eggs of the oriental fruit moth reported a gradual decrease in effectiveness as the age of the eggs (when sprayed) increased. Newcomer and Yothers (12) working with codling moth eggs have stated that the age of the eggs when sprayed did not seem to have any effect on the percentage failing to hatch.

The results obtained from the experiments set forth in this thesis coincided, in general, with those of Newcomer and Yothers. There was no marked gradation in effectiveness, either up or down, as the age of the eggs increased or decreased. This is shown in Tables 7 and 8.

The following system was used in compiling Tables 7 and 8: a plus sign (+) indicates that the effectiveness of the material increased as the age of the eggs increased, a minus sign (-) indicates that the effectiveness increased as the age of the eggs decreased, and an asterisk (*) indicates that there was no gradation of effectiveness or that the material was effective for all ages.

Both Table 7 and 8 show that in the majority of cases there was either no gradation of effectiveness or that the

material was effective for eggs of all ages. In Table 7 the effectiveness increased as the age increased in 35 cases while the reverse was true in 18 cases. In 98 cases, there was no gradation in effectiveness or else the material was effective for eggs of all ages. When the spray was not effective for eggs of all ages and when there was no gradation of effectiveness, there appeared to be a higher percentage of kill for eggs three or four days old than for eggs of other ages. This is evident from the results with the oriental fruit moth eggs given in Table 6.

The preliminary work in 1934 indicated that when a spray was effective it killed the eggs in all stages of development, but when the spray was not effective the results were usually irregular. These results were borne out by the 1935 tests.

The Effect of Temperature on the Killing Power of Ovicides

It is possible to judge accurately the effect of temperature on the killing power of ovicides only when the same material is tested at different temperatures. Duplicate tests were made only with Orthol K and Summer Scalecide, the results of which are shown in Table 9.

Table 7.—Effect of Age of Eggs on Killing Power of Material - Oriental Fruit Moth, 1935.

Material used	Concentration					
	½%	¾%	¾%	1%	1¼%	1½%
Pine oil	*	*	*	*	*	*
Menhaden oil	*	-	*	*	*	*
Linseed oil	*	*	*	/	*	*
Coconut oil		*	*	/	*	/
Codliver oil	*	/	*	*	*	*
Soybean oil	*	-	-	*	-	-
Corn oil	/	*	-	-	-	-
Cottonseed oil	-	*	-	*	*	/
Whale oil	*	*	*	*	*	*
Neatsfoot oil	-	*	*	*	*	*
Lard oil	-	/	*	/	*	*
Rosin oil	*	*	/	*	/	*
Castor oil	*	*	-	*	/	*
Paraffine oil (E. & A)	-	*	*	*	*	*
Paraffine oil (D.)	/	*	/	*	*	*
Havoline S. A. E. 10	*	*	*	*	*	*
Texaco S. A. E. 20	*	*	*	*	*	*
Texaco S. A. E. 30	-	/	*	*	*	-
Texaco S. A. E. 40	-	-	-	*	-	-
Texaco S. A. E. 50	*	/	/	*	*	*
Havoline S. A. E. 60	*	*	-	-	*	*
Greenhouse Volck		*	*	*	-	*
Nursery Volck		-	*	*	*	*
Volck Concentrate		-	-	-	*	*
Orthol K		-	-	-	-	-
Summer Scalecide		/	-	*	*	*

Explanation: / means effectiveness increased with age.
- means effectiveness decreased with age.
* means effectiveness varied or spray was effective for all stages.

Summary

Effectiveness increased with age ..... 18 cases
Effectiveness decreased with age ..... 35 cases
Effectiveness varied or spray was effective for all ages ..... 98 cases

Table 8.—Effect of Age of Eggs on Killing Power of Materials - Codling Moth, 1935.

Material used	Concentration					
	½%	¾%	1%	1¼%	1½%	
Linseed oil		*	*	≠	*	*
Soybean oil		*	*	*	*	*
Corn oil		*	*	*	*	*
Cottonseed oil		*	≠	≠	-	*
Rosin oil		≠	≠			
Orthol K		*	*	*	-	-

Explanation: ≠ means effectiveness increased with age.
- means effectiveness decreased with age.
* means effectiveness varied or spray was effective for all stages.

Summary

Effectiveness increased with age ..... 5 cases
Effectiveness decreased with age ..... 3 cases
Effectiveness varied or spray was effective for all ages ..... 19 cases

In seven cases a higher percentage of kill was obtained at the higher temperature and in six cases the reverse was true.

In view of the results indicated by the limited data no attempt is made to generalize on the effect of temperature on the killing power of ovicides. It is the opinion of the writer, however, that oils are more effective at high temperatures than at low temperatures.

It is reasonable to expect that as the concentration of a material is increased the effectiveness will increase. In the tests with Summer Scalecide in 1935 against oriental fruit moth eggs, Table 9, it is noted that the effectiveness decreased as the concentration increased.

Codling Moth and Oriental Fruit Moth Eggs Affected in Like Manner by Sprays

In 1934 four sprays were tested against both codling moth and oriental fruit moth eggs (see Table 5). The results of these tests indicate that the eggs of both moths are affected in a like manner by the same sprays.

Of the materials tested in 1935, only six were tested against the eggs of both moths. Table 10 shows

Table 9.—Effect of Temperature on Killing Power of Ovicides.

Material used	Oriental Fruit Moth, 1934		Oriental Fruit Moth, 1935	
	Percent dead	Mean temp.	Percent dead	Mean temp.
Orthol K, ½%	63	76	85.3	66.2
¾%	70	76	97.5	63.9
1%	98	76	94.9	71.3
1¼%	100	76	94.0	71.3
1½%	99	76	80.9	71.3
Summer Scalecide, ½%	19	61	45.8	74.8
¾%	25	61	43.6	74.8
1%	53	61	38.5	74.5
1¼%	42	61	40.1	74.8
1½%	78	68	26.1	74.8
	Codling Moth 1934		Codling Moth 1935	
Orthol K, ½%	79	70	74.0	64.8
¾%			66.9	71.7
1%	99	70	91.7	71.7
1¼%	100	81	95.4	72.0
1½%			90.1	72.0

Table 10.—The Comparative Effectiveness of Sprays on the Eggs of the Codling Moth and of the Oriental Fruit Moth.

Material used		Codling Moth Percent dead	Oriental Fruit Moth Percent dead
Linseed oil,	½%	57.6	71.0
	¾%	88.7	73.8
	1%	93.2	91.3
	1¼%	100.0	93.4
	1½%	100.0	90.7
Soybean oil	½%	100.0	89.3
	¾%	99.7	90.7
	1%	100.0	99.4
	1¼%	100.0	94.6
	1½%	100.0	100.0
Corn oil	½%	99.2	80.9
	¾%	100.0	94.[illegible]
	1%	100.0	93.8
	1¼%	100.0	97.5
	1½%	100.0	98.0
Cottonseed oil	½%	95.2	96.0
	¾%	97.2	86.8
	1%	98.4	97.5
	1¼%	98.7	97.9
	1½%	99.6	96.9
Rosin oil,	½%	66.9	75.2
	¾%	84.8	84.6
Orthol K,	½%	74.0	85.3
	¾%	66.9	97.5
	1%	91.7	94.9
	1¼%	95.4	94.0
	1½%	90.1	80.0

that the results, in general, were the same as in 1934. Though both moths were affected in the same way by the same sprays, the mortality for the codling moth was, on the whole, slightly higher than that for the oriental fruit moth. The percentage of the checks failing to hatch was also slightly higher for the codling moth.

Viscosity

Tables 11 and 12 give the viscosities of the materials tested and the effectiveness of these materials at different concentrations. The animal and vegetable oils are placed in one group and the mineral oils are placed in another.

It is difficult to draw conclusions as to the effect of the viscosity on the effectiveness as nearly all the oils gave a relatively high percentage of kill. Pine oil, a very light vegetable oil, was ineffective against the eggs of the codling moth at all concentrations tried. All the other vegetable oils and the animal oils gave a high percentage of kill in at least one or more concentrations. From this, it appears that medium to heavy vegetable and animal oils are more effective than light

oils. It is noted, however, that for rosin oil and castor oil, two heavy vegetable oils, the percentage of kill was very low for the lower concentrations.

Two commercial preparations containing mineral oil stocks of low viscosity, Greenhouse Volck and Volck Concentrate, were not quite as effective as the other mineral oils at the low concentrations. There was not enough difference, however, to justify a conclusion that the lighter mineral oils were less effective than the heavy oils, especially since the other light oils seemed a shade more effective than the heavy ones.

In the codling moth tests (Table 12) soybean oil and cottonseed oil were the most effective.

James Marshall (4) and Newcomer and Yothers (12) have reported that heavy mineral oils were more effective than light mineral oils against codling moth eggs. The writer did not test mineral oils against codling moth eggs, but the tests with oriental fruit moth eggs gave no definite information on this point.

Table 11.—Summary of Results, Showing Effectiveness at Different Concentrations and the Viscosity of Materials, Oriental Fruit Moth, 1935.

Material used	Vis-cosity	Concentration					
		¼%	½%	¾%	1%	1¼%	1½%
Pine oil	52	5.3	8.3	3.1	2.2	2.5	1.8
Menhadin oil	132	48.5	91.9	97.1	99.5	98.6	99.5
Linseed oil	139	45.4	71.0	75.6	91.3	93.4	90.7
Coconut oil	141		78.6	94.9	97.4	98.4	97.6
Codliver oil	154	45.7	89.5	99.5	99.8	99.0	99.5
Soybean oil	161	83.7	89.3	90.7	99.4	94.6	99.0
Corn oil	168	75.3	80.9	94.7	93.8	97.5	98.0
Cottonseed oil	187	78.8	96.0	86.8	97.5	97.9	96.9
Whale oil	191	31.6	58.3	94.5	96.7	99.4	99.1
Neatsfoot oil	209	52.0	98.7	99.4	98.8	99.5	99.6
Lard oil	212	29.6	94.7	95.2	95.5	99.2	99.6
Rosin oil	244*	21.1	75.2	84.6	80.3	92.5	91.3
Castor oil	526*	42.1	68.6	83.8	91.4	95.0	98.8
Paraffine oil (E. & A.)	82	95.3	92.5	99.5	99.4	99.1	100.0
Paraffine oil (D)	115	95.9	97.1	98.5	100.0	100.0	100.0
Havoline S. A. E. 10	94*	99.7	99.4	100.0	100.0	100.0	100.0
Texaco S. A. E. 20	138*	86.7	96.7	99.5	100.0	99.2	99.7
Texaco S. A. E. 30	221*	51.6	94.6	98.1	99.2	100.0	98.3
Texaco S. A. E. 40	363*	65.2	88.5	75.1	98.8	95.9	95.7
Texaco S. A. E. 50	441*	76.0	96.9	97.0	97.9	99.1	99.5
Havoline S. A. E. 60	708*	61.8	91.2	96.9	96.3	100.0	100.0
Greenhouse Volck	50		76.0	88.9	96.9	95.3	100.0
Nursery Volck	65		95.2	99.6	100.0	100.0	99.7
Volck Concentrate	90		71.1	81.0	98.0	99.5	100.0
Orthol K			85.3	97.5	94.9	94.0	80.9
Summer Scalecide			45.8	43.6	38.5	40.1	26.1

* - Viscosity test made at 130° F.

Table 12.—Summary of Results, Showing Effectiveness at Different Concentrations and the Viscosity of the Materials, Codling Moth, 1935.

Material used	Viscosity	Concentration				
		½%	¾%	1%	1¼%	1½%
Linseed oil	139	57.6	88.7	93.2	100.0	100.0
Soybean oil	161	100.0	99.7	100.0	100.0	100.0
Corn oil	168	99.2	100.0	99.7	100.0	100.0
Cottonseed oil	187	95.2	97.2	98.4	98.7	99.6
Rosin oil	244*	66.9	84.8			
Orthol K		74.0	66.9	91.7	95.4	90.1

* - Viscosity test made at 130° F.

Number of Eggs Used in Tests

More oriental fruit moth eggs than codling moth eggs were available both years. The total number of eggs used, including the checks, is given below:

1934	Codling moth	11,319
	Oriental fruit moth	14,362
1935	Codling moth	9,715
	Oriental fruit moth	50,772
	Total	86,168

Checks

When the infertile eggs were eliminated from the tests as explained in the Procedure, the percentage of check eggs failing to hatch was consistently low. This is shown by the results for 1935, given below:

Codling moth:	Total number of check eggs	1987
	Percent failing to hatch	4.8
Oriental fruit moth:	Total number of check eggs	4732
	Percent failing to hatch	2.6

The highest percentage failing to hatch for any one individual test was 8.9 percent for the codling moth and 8.3 percent for the oriental fruit moth.

Bentonite was used to emulsify the oils because it was believed that the bentonite, being an inert material, would have no effect on the eggs. In order to check on this point, a bentonite-water mixture containing three percent bentonite was applied both to codling moth and to oriental fruit moth eggs with the following results:

Codling moth ..... 12.2 percent failed to hatch

Oriental fruit moth ..... 7.1 percent failed to hatch

SUMMARY

The Mineral oils tested gave a uniformly high rate of kill for oriental fruit moth eggs. Those oils that killed 100 percent and those that killed 97 to 99 percent of the eggs in one or more tests and the concentrations giving these results are listed below:

Oil	Concentrations giving 100 percent kill	Concentrations giving 97 to 99 percent kill
Paraffine oil (E.&A.)	1½	¾, 1, 1¼
Paraffine oil (D.)	1, 1¼, 1½	½, ¾
Havoline S. A. E. 10	¾, 1, 1¼, 1½	½, ½
Texaco S. A. E. 20	1	½, ¾, 1¼, 1½
Texaco S. A. E. 30	1¼	¾, 1, 1½
Texaco S. A. E. 40		1, 1¼, 1½
Texaco S. A. E. 50		½, ¾, 1, 1¼, 1½
Havoline S. A. E. 60	1¼, 1½	½, ¾
Greenhouse Volck	1½	1
Nursery Volck	1, 1½	¾, 1¼
Volck Concentrate	1½	1, 1¼
Orthol K (1934)	1¼	1, 1½

The animal and vegetable oils, though not quite as effective as the mineral oils, in general gave a high percentage of kill at the higher concentrations. Those oils along with the concentrations which killed as many as 97 percent of the oriental fruit moth eggs in one or more tests are listed below:

Oil	Concentration giving 97 percent kill or more
Menhaden oil,	¾, 1, 1¼, 1½
Coconut oil,	1, 1¼, 1½
Codliver oil,	¾, 1, 1¼, 1½
Soybean oil,	1, 1½
Corn oil,	1¼, 1½
Cottonseed oil,	1, 1¼, 1½
Whale oil,	1, 1¼, 1½
Neatsfoot oil,	½, ¾, 1, 1¼, 1½
Lard oil	1¼, 1½
Castor oil,	1½

The mineral oils and animal oils were not tested against the codling moth. The vegetable oils appeared to be slightly more effective against the codling moth than against the oriental fruit moth. Those vegetable oils along with the concentrations that killed 100 percent and those that killed 97 to 99 percent of the codling moth eggs are listed below:

Oil	Concentrations giving 100 percent kill	Concentrations giving 97 to 99 percent kill
Linseed oil	1¼, 1½	
Soybean oil	½, 1, 1¼, 1½	¾
Corn oil	¾, 1¼, 1½	½, 1
Cottonseed oil		¾, 1, 1¼, 1½

Against codling moth eggs in 1934 Orthol K at one and at one and one-fourth percent concentrations killed 99 and 100 percent, respectively.

Summer Scalecide was ineffective for oriental fruit moth eggs at concentrations from one-half to one and one-half percent.

Pine oil was ineffective for oriental fruit moth eggs at concentrations from one-fourth to one and one-half percent.

Black Leaf 155, five pounds to 100 gallons of water, was ineffective for codling moth eggs.

Against oriental fruit moth eggs, Black Leaf 40, 1-1200 plus Orthol K, ½, ¾, 1, and 1½ percent killed 97, 100, 100, and 100 percent, respectively. Black Leaf 40, 1-800 plus Orthol K, ½, ¾, 1, and 1½ percent, killed 99, 100, 98, and 99 percent, respectively.

Against oriental fruit moth eggs, Orthol K, one-half percent, plus pyrethrum, 1-100 and 1-200, killed 100 and 98 percent, respectively.

Light vegetable oils appeared to be less effective than medium to heavy vegetable and animal oils.

When an oil was effective it killed the eggs in all stages of development. When it was not effective its behavior was usually irregular.

When an oil was not effective the mortality seemed to be slightly higher for eggs three and four days old than for eggs of other ages.

No attempt is made to generalize on the effect of temperature on the killing power of oils because of the limited data.

When the same oil was tested against both the codling moth and the oriental fruit moth the results show that the eggs of the two moths were affected in a like manner by the same oils.

When only fertile eggs were used the percentage of check eggs failing to hatch was consistently very low.

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