AN EVALUATION OF THE EFFECTS OF ROOST REPELLENTS UPON STARLINGS

By

VERYL VINCENT BOARD

Bachelor of Science

Oklahoma State University

Stillwater, Oklahoma

1964

Submitted to the faculty of the Graduate School
of the Oklahoma State University
in partial fulfillment of the requirements
for the degree of
MASTER OF SCIENCE
May, 1966

AN EVALUATION OF THE EFFECTS OF ROOST REPELLENTS UPON STARLINGS

Thesis Approved:

Thesis Adviser

Dean of the Graduate College

TABLE OF CONTENTS

Chapter		Page
I.	INTRODUCTION AND ACKNOWLEDGEMENTS	1
II.	MATERIALS AND METHODS	3
	Materials Used	3
	Procedures for Cage Testing	6
	Criteria for Field Testing	7
	Locating Starling Roosts	7
III.	TESTS AND RESULTS	8
	Preliminary Tests	8
	First Field Test	10
	Second Field Test - Donart High School	14
	Cage Tests	14
IV.	DISCUSSION	21
V.	CONCLUSION	25
SELECTED BIBLIOGRAPHY		26

LIST OF TABLES

Table		Page
I.	List of Candidate Chemical Repellent Materials Supplied by Phillips Petroleum Co., Bartlesville, Oklahoma	4
II.	List of Plants Sprayed with Candidate Repellent Materials "X" and "Y"	9
III.	Effects of Candidate Repellent Materials "X" and "Y" Upon Structural Surfaces	11
IV.	Numbers of Starlings Using Dairy Barn and Associated Feed Lots for Feeding and Roosting in Relation to Temperature Extremes and Precipitation January-February, 1965	13
V.	Field Testing Results at Donart High School January-April, 1965	15
VI.	Results of Cage Tests Using Sticky Type Repellents	16
VII.	Results of Cage Tests Using Liquid Chemical Type Repellents	18

LIST OF FIGURES

Figure		Page
1.	Diagram of Electronic Recorder Manufactured by Statham Electronic Company	5
2.	Trends in Numbers of Roosting Starlings on the Oklahoma State University Dairy Barn, January - February, 1965	12

CHAPTER I

INTRODUCTION AND ACKNOWLEDGEMENTS

This study was an attempt to evaluate the effectiveness of certain chemicals as repellents against the starling, Sturnus vulgaris L., and was restricted to starling roosts in the immediate vicinity of Stillwater, Oklahoma. Tests using confined birds employed flight pens at the Oklahoma State University, while field tests were conducted at the University dairy barn and the facade of the Stillwater High School gymnasium. Preliminary tests were made of several chemicals to determine their effect upon building surfaces and upon vegetation in which starlings might roost. The Neff and Meanley (1956) criteria for a roost repellent was used as a guide in evaluating the products employed.

The study was begun in the autumn of 1964 and concluded in November of 1965.

I would like to acknowledge indebtedness to Mr. Louis D. Statham of the Statham Instruments Incorporated who was responsible for the development of the recorder used for the cage tests. Phillips Petroleum Company supplied the chemicals and financed the project and Dr. Lyle Goodhue of the Agricultural Chemicals Department offered many suggestions. Special acknowledgement is due Dr. F. M. Baumgartner who helped initiate and develop this study and to Dr. A.

M. Stebler who supervised the terminal stages of this report. Thanks are also owed Drs. William A. Drew and Bryan P. Glass for their help and support.

CHAPTER II

MATERIALS AND METHODS

Materials Used

Nineteen candidate chemical repellent compounds were tested, all supplied by the Phillips Petroleum Company of Bartlesville, Oklahoma. These chemical compounds were of three general types. The first was a sticky material which relied upon causing physical discomfort to the starlings, but possessed no true chemical repellence. The second type consisted of a variety of compounds that were thought to be chemically repellent. These compounds were used in a liquid form. Some arrived in solid form and required the use of solvents. The last type was a liquid lachrymator (Table I). Most compounds were supplied only in small amounts which limited testing to flight pens, but two were given both cage and field tests.

An electronic recording device designed and built by the Statham Electronics Corporation, and loaned by them for this program, made the cage testing fairly simple (Fig. 1). Observing starlings without disturbing them has always been a problem and this device eliminated the necessity for direct observation. The recorder was capable of showing how many birds perched on the roost, how long they remained, and any activity that might have taken place. In addition, the time that the starlings entered the roost and when they left in the morning

TABLE I

LIST OF CANDIDATE CHEMICAL REPELLENT MATERIALS SUPPLIED BY PHILLIPS PETROLEUM CO., BARTLESVILLE, OKLAHOMA

Code Number	Solvent	Concentration	Type
Bird Stop	None	as supplied	Sticky
"A"	Xylene	as supplied	Sticky
"B"	Xylene	as supplied	Sticky
"X" (air blown)	-	as supplied	Sticky
Crosley's Original Bird Repellent	-	as supplied	Sticky
"C"	Acetone	50%	Liquid
"D"	-	as supplied	Liquid
"E"	Acetone	50%	Liquid
"F"	-	as supplied	Liquid
"G"	-	as supplied	Liquid
"Y"	-	varying	Liquid
"X"	-	50%	Liquid
"X" + latex	-	varying	Liquid
"H"	-	as supplied	Lachrymator
"I"	Acetone	50%	Liquid
"J"	Dimethyl Sulfoxide	50%	Liquid
"K"	Dimethyl Sulfoxide	50%	Liquid
"L"	Dimethyl Sulfoxide	50%	Liquid
"M"	Acetone	50%	Liquid

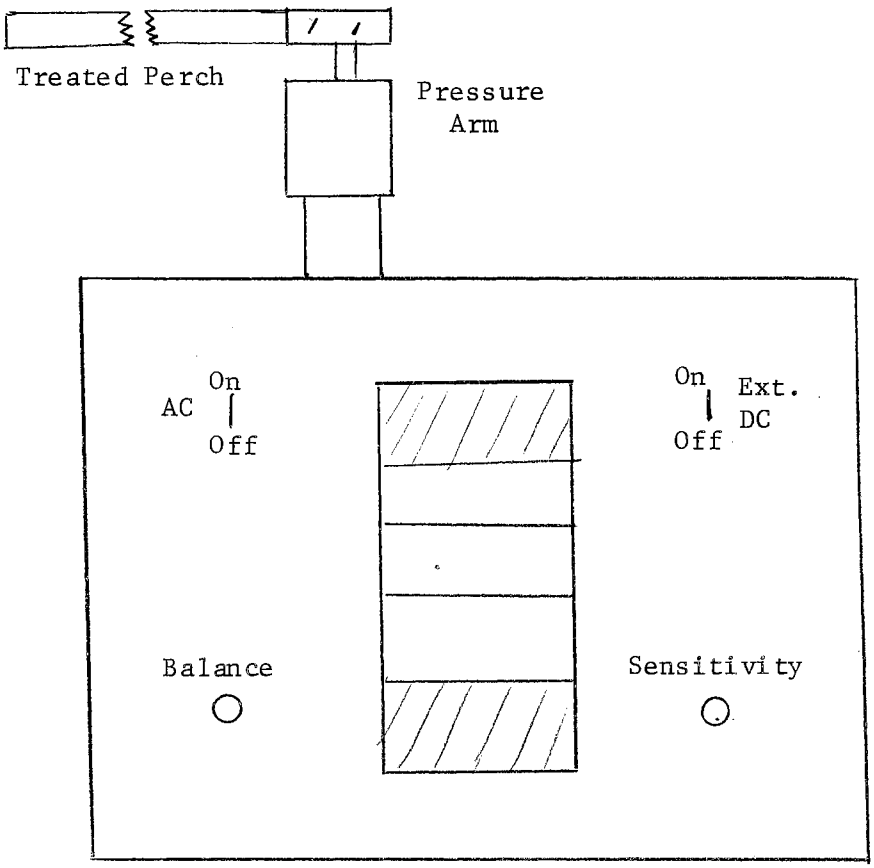

Fig. 1 Diagram of Electronic Recorder manufactured by Statham Electronic Company.

was also recorded on a permanent chart.

Cage tests were conducted in the east flight pen at Oklahoma State University, which had a large roosting chamber fastened to the eaves on the north side. It was 40 inches by 40 inches on the sides and 40 inches high, 31 inches across the top and 10 inches across the bottom on the front and back. Its shape was inverted-triangular in section, with the apex of the triangle cut off. There was one entrance hole, but the starlings were also able to get out at the bottom. Originally, there were two perches inside the roosting chamber, but when the electronic device was installed, only one perch was used.

Procedures for Cage Testing

Liquid chemicals and sticky compounds were used in the condition supplied. Those chemicals requiring solvents were mixed the evening before so the material would be dissolved when applied. The chemicals were applied to the perch in the early evening (1700-1800 hours) before the starlings entered the roost and then the perch was placed on the recorder; therefore, disturbance was negligible. The machine was turned off about 0800 hours the following morning and the chart was removed. The perch allowed six birds to roost without crowding. A repelling effect was considered to be achieved when fewer than three birds used the perch and total usage amounted to less than 50% of the test period. Use in excess of these limits was assumed to indicate lack of repellent action.

The results of the cage tests were rated as positive, negative, or indeterminate. If a chemical showed no repellent effect for three

nights, the test was considered negative. Owing to many variables in the behavior of starlings, five tests were made to assure consistent positive results. If a positive repellent reaction was noted for five consecutive nights, the results were considered positive. An indeterminate rating indicated a substance that might produce positive repellent reactions one night while the next test would show no such effect.

Criteria for Field Testing

The results of the field tests were evaluated in terms of total repellent effect. Each field test was conducted during five days to allow time for the repellent effect to occur. If no repellent reaction was noted, the test was terminated. No field test was considered positive if the birds returned to the roost after the fifth night.

Locating Starling Roosts

The first step in any bird repellent test program is to determine the location of the major roost and the numbers of individuals using it. In Stillwater, this was accomplished by a biweekly census of all University barn areas by means of which the feeding flocks were located. Observations of these flocks in late evening led to the discovery of roosts in the silos at the dairy barn. The starling roost at the high school was located by watching starlings enter the roost in late evening. In addition to these censuses, daily evening observations were made at the roost several days prior to the test in order to determine the behavior patterns of the birds upon entering a roost.

CHAPTER III

TESTS AND RESULTS

Preliminary Tests

Chemical repellent materials "X" and "Y" were supplied in sufficient quantity for field testing. Before actual field tests could be initiated, however, the materials needed to be checked to determine their effects upon plant and animal life as well as their effect upon the surfaces of buildings. These tests were necessary because starlings sometimes roost in emergent aquatic vegetation, trees and shrubs (Mitchell, 1963). If the materials would harm either plant or animal life or if their use would cause staining on buildings, then their use in some situations would be impractical.

Tests were made of the effects of "X" and "Y" upon plant life by spraying aquatic and palustrine vegetation (Table II). These tests suggested that chemical "Y" was responsible for sufficient plant damage to make "X" the better chemical for actual field testing in these situations.

Intensity of the damage caused by chemical repellent materials varied with the season. Damage caused by chemical action was light during fall and winter.

Another important preliminary test was to determine what effects the two chemical repellent materials might have upon architectural

TABLE II

LIST OF PLANTS SPRAYED WITH CANDIDATE REPELLENT MATERIALS "X" AND "Y"

Species Sprayed	Month Sprayed	Effect Upon Vegetation "X"	Effect Upon Vegetation "Y"
Ulmus americana	June	Light burning	Burning*
	September	Light burning	Burning
Carya ovata	June	Light burning	Burning
Salix nigra	June	None	Light burning
Morus rubra	June	None	Light burning
Populus deltoides	June	None	Light burning
Juniperus virginiana	June	None	Yellowing**
Pinus sp.	September	None	Yellowing
Cephalanthes occidentalis	June	Light burning	Light burning
Parthenocissus virginiana	June	Light burning	Light burning
	October	None	Light burning
Typha latifolia	June	Light burning	-
	October	None	None
Polygonum sp.	June	None	-
Juncus Torreyi	October	None	Yellowing
Panicum virgatum	October	None	Yellowing
Sorghum halpense	October	None	Yellowing
Ludwigia palustris	October	None	None
Jussiaea repens	October	None	Yellowing
Najas guadalupensis	October	None	None
Chara sp.	October	None	None

*Burning - A reaction of the plant in which sprayed leaves turn brown or edges become crisped.

**Yellowing - A reaction of the plant caused by some staining effect of the sulfur compound in the chemical repellent.

surfaces. this was especially important as one of the primary roosts of starlings during the winter period is in or on buildings (Jumber, 1956; Beck, 1958). Several types of surfaces were sprayed with both chemicals and the effect on the surface was noted (Table III).

First Field Test

The Oklahoma State University dairy barn was chosen to be the site of the first field test with materials "X" and "Y". The silos at the barn are made in such a way that there is a four-inch ledge formed at the junction of the brick body and tin dome. Starlings were roosting on this ledge in both the southwest and northwest silos, and in the latter they were also roosting on a mechanical screw device. These ledges and the machinery were thoroughly sprayed during the afternoon to avoid disturbing the starlings.

Three tests were conducted during the last week of January and the month of February, 1965 (Fig. 2). Each test continued at least one week before the next application of the repellent material. The number of starlings present on the second night was less than the evening before in most tests, but this drop was only temporary as by the 3rd night the numbers of starlings would have recovered to approximately the original density. This drop on the second night was also noted by Goddard (1964) in his tests in the western part of Oklahoma, where the roosts he observed were in Johnson grass and cattails.

The starlings deserted the silos after initiation of the third test though they still fed in the associated feed lots (Table IV). Birds were seen roosting in smaller sheds after this test.

TABLE III

EFFECTS OF CANDIDATE REPELLENT MATERIALS "X" AND "Y"
UPON STRUCTURAL SURFACES

		Effects of Chemicals Upon Materials	
Type of Material	Surface of Material	"X"	"Y"
Lead pipe	Natural	None	Staining
Wood	White paint	Slight staining	Staining
Brickwork	Rough-natural	Darkening	Darkening
Tin	Smooth	None	Some staining
Finished metal	Smooth	None	Staining
Composition board	Rough	Some staining	Staining
Tarred material	Rough	None	Some staining

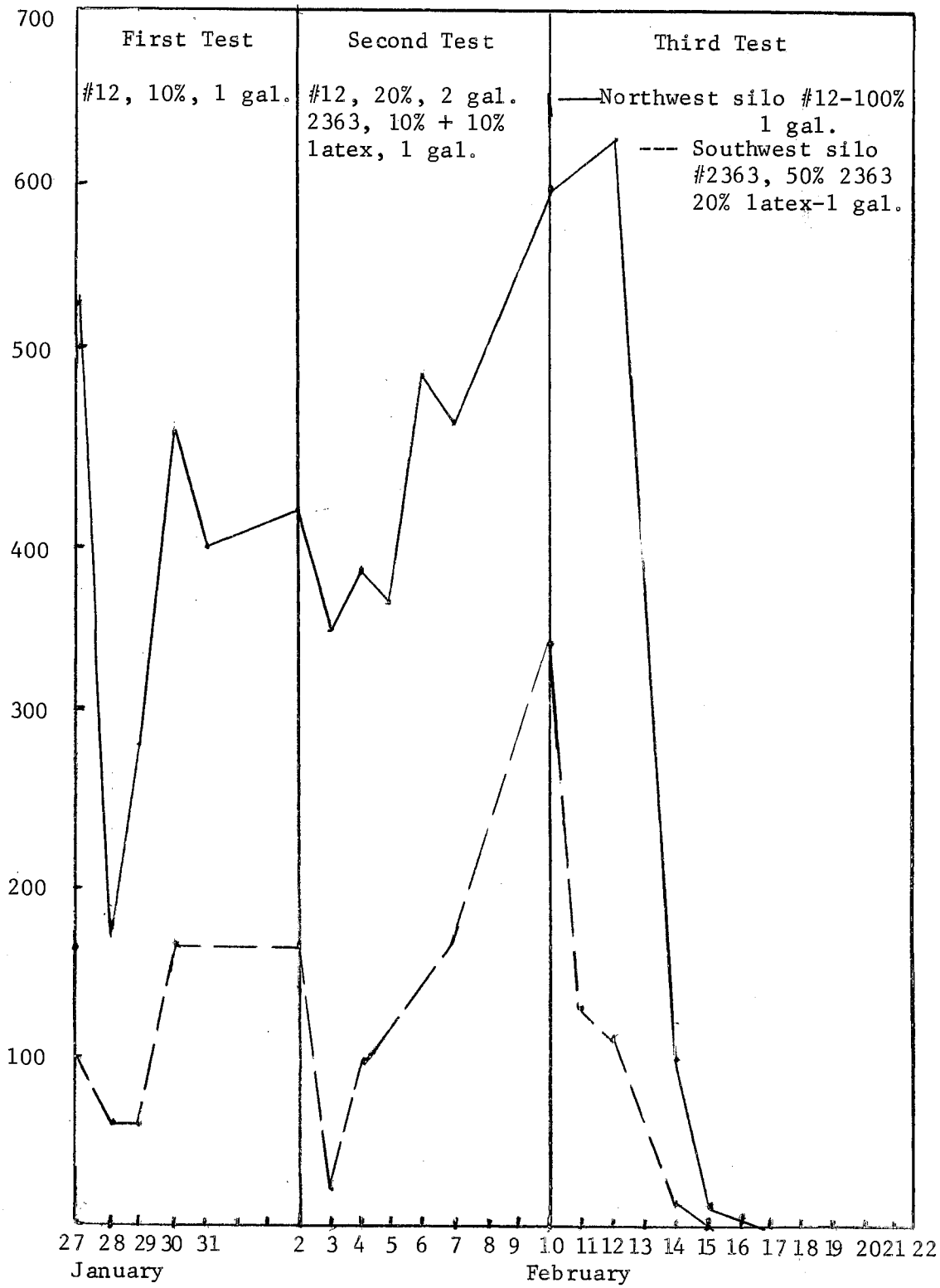

Fig. 2 Trends in numbers of roosting starlings on the Oklahoma State University dairy barn, January - February, 1965.

TABLE IV

NUMBERS OF STARLINGS USING DAIRY BARN AND ASSOCIATED FEED LOTS FOR FEEDING AND ROOSTING IN RELATION TO TEMPERATURE EXTREMES AND PRECIPITATION
JANUARY-FEBRUARY, 1965

Date	Feeding Population	Roosting Population			Temperature		Precipitation
		N.W. Silo	S.W. Silo	Total	Max.	Min.	
7/I/65	600	300	80	38	78	45	0
13/I/65	600	175	120	295	44	26	0
20/I/65	1000	300	75	375	50	33	0
25/I/65	450	250	75	325	67	40	0
28/I/65	600	175	50	225	52	27	0
1/II/65	500	410	155	565	47	15	0
4/II/65	1000	380	100	480	51	19	0
8/II/65	425	475	150	625	56	30	T
11/II/65	450	575	135	710	49	25	T
15/II/65	350	18	0	18	58	33	0
17/II/65	700	0	0	0	58	22	0
22/II/65	1200	0	0	0	52	16	0
24/II/65	800	0	0	0	23	5	.04

Second Field Test - Donart High School

The second series of field tests was made on the brick facade of the Stillwater High School gymnasium. This series of tests amounted to six separate trials between January and April of 1965. Material "Y" was used once, but "X" was used alone and with latex for the remaining tests (Table V).

Unlike the tests at the dairy barn, spraying at the high school had to be accomplished in the evening and it was feared that the physical disturbance might bother the starlings. However, the final results indicated that this did not occur (Table V).

Cage Tests

The sticky type of repellent material produced rather consistent results (Table VI). Two commercial repellents which were also supplied by Phillips were tested as well as two of their own products. A third Phillips product crystallized before it could be tested.

In tests using these chemicals the starlings became smeared with the repellent material. This caused loss of flight and fouling of the feathers in the neck region. Some of the materials were so sticky that feathers were left stuck to the perch, even though the birds had remained on there less than six seconds.

Fouling of feathers resulted in a modification of the testing procedure. Three tests only were made instead of the five usually considered necessary for valid results. This reduction was considered defensible because it was obvious that the number of starlings attempting to use the perch declined after the first night of testing.

TABLE V

FIELD TESTING RESULTS AT DONART HIGH SCHOOL
JANUARY-APRIL, 1965

Date	Chemical	No. of Starlings	Temperature Max.	Temperature Min.	Precip.
Test No. 1					
3 Jan.		65	48	22	0
4 Jan.	1 gallon "X" 10%	51	53	25	0
5 Jan.	1 gallon "Y" 10%	35	52	41	0
6 Jan.		40	56	40	0
7 Jan.		55	78	45	0
Test No. 2					
14 Jan.	2 gal. "X" 20%+10%	75	55	26	0
15 Jan.	latex	35	52	39	0
16 Jan.		60	40	12	0
17 Jan.		60	52	15	0
18 Jan.		75	46	20	0
Test No. 3					
3 Feb.	1 gal. "X" 30%	35	47	14	0
4 Feb.	+ 30% latex	27	51	19	0
5 Feb.		34	62	32	0
6 Feb.		34	56	47	0
7 Feb.		38	60	53	0
Test No. 4					
14 Mar.	1 gal. "X" 60%	35	60	3	0
15 Mar.	+ 5% latex	18	67	30	0
16 Mar.		31	72	34	.23
17 Mar.		33	65	36	.35
18 Mar.		39	40	18	Trace
Test No. 5					
1 April	1 gal. "X" 25%	40	77	49	0
2 April	+ 25% latex	25	72	59	.10
3 April		35	86	63	.49
5 April		30	73	62	0
6 April		30	81	53	.41
Test No. 6					
18 April	1 gal. "X" 40%	20	79	55	0
19 April	30% latex	25	75	48	0
20 April		20	85	47	0
22 April		30	89	59	0

TABLE VI

RESULTS OF CAGE TESTS USING STICKY TYPE REPELLENTS

Chemical	Date	Time of Initiation* of Test	Total Testing Time (Minutes)	Number of Starlings And time each group Spent on perch (minutes)				
				0	1	2	3	4
Bird Stop	28/IX/65	1900	780	780	-	-	-	-
Bird Stop	30/IX/65	2000	720	720	-	-	-	-
Bird Stop	2/X/65	1730	870	870	-	-	-	-
"A"	9/X/65	1915	780	780	-	-	-	-
"A"	10/X/65	1800	768	768	-	-	-	-
"A"	11/X/65	1900	840	840	-	-	-	-
Crosley's Original Bird Repellent	24/X/65	1940	740	740	-	-	-	-
Crosley's Original Bird Repellent	25/X/65	1900	780	780	-	-	-	-
Crosley's Original Bird Repellent	26/X/65	2000	720	720	-	-	-	-
"X" Air Blown	9/XII/65	1900	780	780	-	-	-	-
"X" Air Blown	10/XII/65	1930	765	765	-	-	-	-
"X" Air Blown	11/XII/65	1900	780	780	-	-	-	-

*24 hour time scale

Liquid chemical repellents did not produce the same predictable results as the commercial types (Table VII). When possible, the chemicals were tested the proposed number of times, but in a few cases, there was not enough material for a complete series of tests. Chemical "H" was a lachrymator and produced results which were similar to those obtained by other researchers using ammonia (Hockenyos, 1960). Starlings attempted to use the perch on the first night of the "H" test. By the second night, however, this activity had dropped to zero and tests on other nights were also positive in their results. In addition to the fact that starlings would not use the treated perch, it was noted that starlings would not even use the roosting box. In other tests, starlings had refused to use the perch, but had perched on the bottom wires of the roosting chamber.

Cage tests with material "X" produced variable results. At a concentration of 50%, the material was not effective. However at full concentration the chemical did have some repellent effect, although the results were not consistent (Table VII). The material was not tested in the cage after the addition of latex.

Cage tests with Phillips repellent material "Y" were much more successful than tests with material "X". At full strength, the results obtained were positive and no birds remained on the perch (Table VII). They did attempt to use the perch, but did not remain. These positive results in the cage tests tended to validate the results obtained in the field tests at the dairy barn.

TABLE VII

RESULTS OF CAGE TESTS USING LIQUID CHEMICAL TYPE REPELLENTS

Chemical	Date	Time of Initiation of Test	Time Morning Activity Began	Time Period Birds on Perch (Minutes)	Number of Starlings and time each group spent on perch (minutes)				
					0	1	2	3	4
"F"	22/VI/65	1815	-	310*	0	15	13	25	257
"F"	20/X/65	2140	0550	510	30	480	0	0	0
"F"	21/X/65	2200	0555	486	0	10	2	4	470
"F"	22/X/65	2215	0550	456	3	453	0	0	0
"F"	23/X/65	2020	0550	508	0	0	32	6	470
"X"	30/VII/65	1800	0500	676	100	151	425	0	0
"X"	2/VIII/65	2000	0505	545	0	18	527	0	0
"X"	1/IX/65	1845	0535	750	24	10	60	633	13
"X"	5/IX/65	1815	0535	680	35	25	620	0	0
"X"	22/IX/65	1830	0540	670	70	7	593	0	0
"X" 50%	18/VIII/65	1850	0515	625	0	0	2	178	445
"X" 50%	21/VIII/65	1800	0525	685	0	25	35	625	0
"X" 50%	23/VIII/65	1900	0545	645	5	10	10	85	535
"I"	28/X/65	1800	-	660	660	0	0	0	0
"I"	29/X/65	1900	-	500	500	0	0	0	0
"I"	30/X/65	2000	-	550	550	0	0	0	0
"I"	31/X/65	1900	-	520	520	0	0	0	0

*Did not complete test due to malfunction of recorder

Table VII Continued

Chemical	Date	Time of Initiation of Test	Time Morning Activity Began	Time Period Birds on Perch (Minutes)	Number of Starlings and time each group spent on perch (minutes)				
					0	1	2	3	4
"H"	12/IX/65	1900	0532	632	12	211	409	0	0
"H"	15/IX/65	1900	-	733	720	10	3	0	0
"H"	26/IX/65	2115	-	525	525	0	0	0	0
"H"	27/IX/65	2000	-	240*	240	2	0	0	0
"Y"	7/XI/65	2030	-	780	780	0	0	0	0
"Y"	8/XI/65	1900	-	470	470	0	0	0	0
"Y"	9/XI/65	1840	-	324	20	304	0	0	0
"Y"	10/XI/65	1930	-	650	650	0	0	0	0
"Y"	11/XI/65	1945	-	550	550	0	0	0	0
"K"	12/XI/65	2300	-	490	490	0	0	0	0
"K"	13/XI/65	2100	0616	546	16	6	3	521	0
"K"	14/XI/65	1800	-	450	450	0	0	0	0
"K"	15/XI/65	1915	-	417	40	377	0	0	0
"C"	16/XI/65	1900	0545	656	40	605	4	7	0
"C"	17/XI/65	2100	0550	527	284	243	0	0	0
"C"	18/XI/65	1945	-	315	315	0	0	0	0
"C"	30/XI/65	2230	0600	460	70	390	0	0	0
"G"	1/VIII/65	1830	0503	633	3	127	63	444	0
"G"	2/VIII/65	1730	0510	720	165	1	554	0	0
"G"	3/VIII/65	2250	0515	425	4	15	406	0	0

*Test did not run full term due to malfunction of recorder.

Table VII Continued

Chemical	Date	Time of Initiation of Test	Time Morning Activity Began	Time Period Birds on Perch (Minutes)	Number of Starlings and Time each group spent on perch (minutes)				
					0	1	2	3	4
"E"	4/VIII/65	1830	0515	642	19	20	38	565	0
"E"	6/VIII/65	2010	0520	551	15	7	17	31	481
"E"	9/IX/65	1900	0535	582	3	3	5	6	565
"D"	9/VIII/65	2015	0510	475	11	462	2	0	0
"D"	12/VIII/65	2045	0518	477	32	421	13	11	0
"D"	13/VIII/65	2245	0509	424	2	405	17	0	0
"D"	14/VIII/65	2010	0530	567	8	84	475	0	0
"D"	15/VIII/65	2010	0530	568	7	91	470	0	0
"J"	4/X/65	1930	-	535	535	0	0	0	0
"J"	7/X/65	2000	-	530	530	0	0	0	0
"J"	8/X/65	1730	-	635	630	5	0	0	0

CHAPTER IV

DISCUSSION

The results obtained with material "X" at the dairy barn and at the high school were quite dissimilar. Several factors were responsible for this. The starlings at the dairy barn were part of a transient wintering population and were found about the building only from December through March. The starlings at the high school were part of a smaller population of permanent residents. The actual application of the repellent material also differed in the two series of tests. At the dairy barn it was possible to apply the repellent material to the ledges upon which the starlings were perching. This was impossible at the high school where the starlings roosted on old sparrow nests behind a grillwork of brick.

Starlings show definite reluctance to desert a roost during cold or severe weather. Those that formerly used the dairy barn left their usual roost, and either moved into smaller sheds or left the area completely. The temperature was below freezing at the time. After the third test, there was no recovery in population density although the number of starlings using the dairy barn feed lots remained high. The presence of a starling flock on the feeding lots indicated that the exit of the birds from the silos was not a normal move caused by migration. The largest number of starlings using the feed lots was

counted after the third test when the roosting population was at the zero level (Table IV). Starlings were seen entering the smaller buildings on the dairy barn lots, but did not use their old roost. It appeared that this change of habit might be associated with the repellent materials employed. Because of these facts, the tests at the dairy barn were considered to be successful.

Material "Y" stained the concrete of the silos to some extent. This staining suggested that chemical "Y" would have a limited application on the outside front of buildings where a stain would be unsightly. The fact that this chemical also caused more damage to plants would also limit its use.

The tests at the high school were considered unsuccessful. A similar reaction to that obtained at the dairy barn was noticed in that the numbers dropped on the second night, but the population returned to normal after one or two nights (Table V). Several factors may have been responsible for this. There was greater movement of air, which may have speeded dissipation of the chemical. The problem of control was further complicated by the difficulty of applying the repellent material to the area where the starlings were roosting. The spray was blocked by the brickwork which screened the roosting areas behind.

Material "Y" was only used once and in low concentration at the high school. It is possible that if this chemical were used at a higher concentration, more positive results would be obtained.

The cage tests produced a rather wide range of results. The sticky materials generally were successful, but were not easy to handle. Starlings would light on these materials the first night but

would not remain long enough to mark the chart. Feathers were left on the perch and the next morning several birds would be down with the feathers of the breast, throat, head and wings heavily smeared with the material. These birds were temporarily unable to fly.

Material "A" was the most successful of sticky repellents and was also used on nesting starlings. It was found that if the material was viscous, the birds would desert their eggs. This was an extreme test as nesting starlings seem to be difficult to discourage once the clutch of eggs is complete and incubation is begun. This result further corroborated the effectiveness of this material.

One disadvantage in using sticky substances is that dirt, feathers, and other trash soon coat the surface and reduce its effectiveness. Heat causes most materials to melt, resulting in a loss of effectiveness. The repellency of these materials is a result of their physical properties, and there seems to be nothing in them that is chemically repellent to starlings.

The Phillips Petroleum Company also supplied a lachrymator. It was applied to the perch and after the first night, excellent results were achieved. Total repellency was the final result and more testing, preferably in the field should be done with this chemical.

The other chemical repellents produced a wide gamut of results from total repellency to almost total ineffectiveness. These latter chemicals should be discarded and more work be done on the former. Many of these should be produced in larger quantities and tested under actual field conditions.

The cage test results for material "X" ranged from indeterminate

for the chemical at full strength to no visible repellent effect at a concentration of fifty percent.

Material "Y" produced positive results in the cage tests. The chart from the recorder indicated that the starlings had not remained on the chemically treated perch. This material should be further field tested in areas where plant damage and the possible staining effect would not be important.

Only two chemicals produced negative repellent reactions besides "X" at 50% (Table VII). These chemicals were both in a liquid state when received and may have been weaker than the other chemicals. Neither chemical produced a residue that was very noticeable and neither was very tacky to the touch.

Three chemicals produced results that were rather unusual. One night there would be a positive repellent reaction while the next night there would be no reaction at all (Table VII). These chemicals were considered to produce indeterminate results.

CHAPTER V

CONCLUSION

Material "Y" produced the best repellent effect both in the cage tests and in the actual field tests. Its use was restricted, however, due to the fact that it stained various surfaces.

Material "X" proved to have some repellent effect when used at high concentrations and when the material could be applied to the roosting surface. Lower concentrations were not repellent enough to be considered. This chemical did not cause the staining that was noted with material "Y". When mixed with latex, some lasting quality was achieved which material "Y" did not possess. Cage testing this repellent produced results which again varied with the concentration of the chemical.

SELECTED BIBLIOGRAPHY

Beck, John R. 1958. Primary and secondary bird roost preferences. Pest Control, 26 (7): pp. 18.

Goddard, Stephen. 1964. Personal communication.

Hockenyos, George L. 1960. Driving starlings from Springfield/how it was done, problems encountered. Pest Control, 28 (10): 11-12, 16, 18, 20.

Jumber, Joseph F. 1956. Roosting behavior of the starling in central Pennsylvania. Auk, 73 (3): 411-426.

Mitchell, Robert T. 1963. The floodlight trap/a device for capturing large numbers of blackbirds and starlings at roosts. U.S.F. & W.S. Spec. Sci. Rept. Wildl. #77.

Neff, Johnson A., and Brooke Meanley. 1956. Research on bird repellents. U. S. Fish & Wildlife Serv. Prog. Rept., 1: 3, 8.

VITA

Veryl Vincent Board

Candidate for the Degree of

Master of Science

Thesis: AN EVALUATION OF THE EFFECTS OF ROOST REPELLENTS UPON STARLINGS

Major Field: Zoology

Biographical:

Personal Data: Born Pond Creek, Oklahoma, May 17, 1935, the son of Virgil V. and Thelma L. Board.

Education: Attended grade and high school at Pond Creek, Oklahoma; graduated from Pond Creek High School in 1954; received Bachelor of Science degree from Oklahoma State University in Wildlife Conservation in 1961; completed requirements for Master of Science degree from Oklahoma State University in Zoology in May, 1966.

Professional Experience: Graduate Research Assistant, Department of Zoology, Oklahoma State University, Stillwater, 1964-1966. Graduate Teaching Assistant, 1965-1966.

Professional Organizations: Phi Sigma