

COMPARISON OF THE PHYSIOLOGICAL EFFECTS OF BIRD
MANAGEMENT CHEMICALS, ON HOUSE SPARROWS
AND STARLINGS

By

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CHAPTER I

INTRODUCTION

The data presented are the results of a study of the effects of toxic chemicals on two species of wild birds. Seven of the chemicals were tested on House Sparrows (Passer domesticus, Linnaeus) and Starlings (Sturnus vulgaris, Linnaeus) were treated with one chemical. All of the chemicals were tested at varying amounts and at various temperatures to determine the gross physiological effects produced.

The author was stimulated to carry on this study by the findings that certain chemicals applied to baits produced acute physiological reactions which frightened other birds of the same species away from the baited areas. These reactions were primarily loud distress calls and violent convulsive flipping and rolling (North, 1963).

The purpose of this study was to determine the gross acute physiological reactions of the Phillips Petroleum Co. Compound No. 2133 on two species of wild birds and compare these reactions to the reactions produced by chemical materials frequently used to reduce House Sparrows and other noxious birds. The study was begun in April, 1963 and continued until July, 1964. The chemicals were provided by Phillips Petroleum Company of Bartlesville, Oklahoma.

The principle objectives of the study were to determine:

1. The gross effects of the chemicals on species of wild birds.

2. Variation in the effects of the chemicals upon male and female birds, if any.
3. The effects upon different species.
4. The relationships between temperature and the reaction and survival of the birds.
5. The approximate LD 50 for each species and sex.
6. The comparative physiological effects of these chemicals, particularly Phillips Petroleum Co. Compound No. 2133.

CHAPTER II

METHODS AND MATERIALS

Capture of Birds

The method used in the capture of the birds varied according to the species and age. Starlings and adult or older juvenile House Sparrows were caught with a "mist" net. The net was made of a small mesh of fine black nylon strands strung loosely on a nylon cord frame. Five larger cords were in horizontal positions across the mesh, and a small "pocket" formed around the bird when it hit the loose mesh. Techniques for using the mist net to capture birds are discussed by Mosby (1963).

Juvenile House Sparrows, a few days to several weeks out of the nest, were trapped readily with double funnel traps built from hardware cloth (Lincoln and Baldwin, 1929). These traps were placed in holding pens for cattle and other livestock, or in grain fields where part of the grain had been harvested.

Test Materials

Phillips Petroleum Company supplied the chemicals. Seven chemicals and two control materials were tested on House Sparrows. Phillips Petroleum Company Compound No. 2133 (P 2133)* in 40% acetone and water was

*The chemical name of the compound cannot be released until patent rights are obtained.

tested on Starlings as well as House Sparrows. The other chemicals, tested only on House Sparrows, were Endrin (1,2,3,4,10,10-hexachloro-exo-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo, endo-5,8-dimethanonaphthalene), strychnine sulfate $[(C_{21}H_{22}N_2O_2)_2 \cdot H_2SO_4]$, dichlorodiphenyltrichloroethane (DDT), thallium sulfate (Tl_2SO_4), zinc phosphide (Zn_3P_2), and sodium monofluoroacetate ($F \cdot CH_2 \cdot COONa$). All were aqueous solutions except the DDT which contained croton oil and water as a solvent, and P 2133. Sodium monofluoroacetate will be referred in this study as 1080.

Procedure

All birds tested appeared to be healthy. This was based upon physical activity, alertness and weight. During captivity the birds of each species were held in large separate flying pens. Sufficient water and proper food were available at all times.

One or two birds were treated at the same time with a specific chemical dosage. Usually, two birds of the opposite sex were used initially, and later, more tests at the same dosage level were administered to determine the degree of variation at that dosage. On some of the chemicals, the dosage was varied depending on the results of the initial test. The birds were weighed to the nearest half a gram. The mg/kg dosage was calculated and recorded on a data sheet along with the sex and weight. All birds were legbanded with numbered aluminum bands and often a colored plastic collar was placed around the neck of one bird if two birds of the same sex were being tested simultaneously. Several small cages of hardware cloth and small commercially produced metal-wire cages were used to hold the treated birds while they were under

observation.

The liquid chemical material was injected into the throat of the bird by means of a 1 cc hypodermic syringe. A 15 cm length of plastic tubing, approximately 1.5 mm in diameter was attached to the needle of the syringe. The tube was then gently forced, as far as possible, down the throat of the bird to insure adequate retention of the chemical material. Inadequate insertion of the tube, or holding the bird on its back, rather than with the head up, often resulted in immediate regurgitation of part of the material administered. The results from birds which regurgitated were not tabulated as the amount retained by the bird was not known. The treated birds were then placed in small cages and observed constantly until apparent recovery or death occurred. All gross, observable reactions were recorded on data sheets (Fig. 1.). Three data sheets were developed as the tests progressed with Figure 1 being the final data sheet used. The time of the beginning and end, and the intensity of the reactions were recorded in so far as possible. The following data were considered important and recorded. Unexpected reactions were added as they were observed.

1. Chemical Used - The name and carrier of each chemical used in treatment.
2. Species and Sex of the Bird.
3. Band Number of the Bird.
4. Dosage - The exact dosage of the treatment in mg/kg.
5. Treatment Time - The date and time of treatment of each bird.
6. Temperature - The temperature was recorded as closely as possible. Often this varied within a 5 F range.

LABORATORY TESTS ON REACTIONS OF BIRDS TO CHEMICALS

Chem. Used _____ Species & Sex _____ Band No. _____ Test No. _____ Mg/kg dose _____
 Date _____ Temp. _____ °F Rel. Hum. _____ % Gm.Wt. _____ Location _____ Method of Application _____
 Amt. Given & Concentration (and Carrier) _____
 Time of Treatment _____ First Evidence _____ Length of Total Reaction _____ Time of Recovery or Death _____

Reaction in Minutes	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5	0	5
Nervousness																				
Weakness																				
Tremors																				
Loss of balance																				
Loss of Flight and Wing Control																				
Awareness (sight)																				
(sound)																				
Eye Reactions																				
Voice																				
Breathing																				
Vomiting (Color & Consistency)																				
Salivation																				

Key: 1. Excellent 4. Extreme Sp - Spasmodic
 2. Good 5. None
 3. Slight c - Continuous Observer _____

Figure 1. Example of the final data sheet used in laboratory tests.

7. First Effects - The time and nature of the first observable reactions due to the chemical administered were carefully recorded. These varied with the chemical but hyperexcitation or weakness characterized by sluggish movements were commonly the first symptoms observed.
8. Hyperexcitation - A state of extreme nervousness was often noticed initially or just prior to recovery with many of the chemicals.
9. Sluggish Movements - With some of the chemicals the state of weakness was assumed to be evident by inability to hold to the side of the wire mesh or by sitting down in a state of abnormal inactivity for prolonged periods. Weakness was rather difficult to determine. As a result, the word "sluggish" was applied rather than weakness to the reaction.
10. Tremors - The intensity of these varied from slight to very severe body jerks. They were called convulsions when the bird flipped and rolled about in the cage and most of the skeletal muscles were involved. When the wing muscles exhibited uncertain, awkward and incoordinated movements the data were listed under the heading of wing ataxia.
11. Loss of Balance - With some of the birds the loss of balance was characterized by staggering movements in an attempt to regain balance. In others there were short periods of violent flipping and rolling.
12. Loss of Flight and Wing Control - With some of the chemicals the bird lost all ability to fly. With many of the tests it was impossible to determine this reaction since the other effects

appeared so rapidly and the testing area was not equipped to test this by prompting flight. When the birds showed signs of wing ataxia the assumption was made that flight was limited or impossible.

13. Response - It was noticed that some of the chemicals caused extreme sensitivity to sound, whereas, others appeared to cause a complete loss of response as well as both sight and sound.
14. Eye Reactions - In some cases spasmodic, rapid blinking of the eyes was noticed.
15. Distress calls - After treatment with some of the chemicals the birds gave distress calls of varying loudness and duration. Normal sounds were not recorded.
16. Abnormal Breathing - Some of the chemicals caused the rate and depth of breathing to change. Often it was hard to distinguish between rapid breathing due to the chemical and rapid breathing caused by previous violent physical activity.
17. Vomiting - In some cases, part of the chemical was regurgitated after a few minutes after treatment. This was considered to be a part of the reaction to the chemical rather than a result of the method of treatment.
18. Salivation - This reaction was anticipated but was observed only in rare cases.
19. Paraplegia - The paralysis of the posterior part of the body and hind limbs was observed with two chemicals.
20. Time of Death or Recovery - The time of death or the approximate time of recovery was recorded for each bird. A bird was considered to be recovered when awareness and normal body movements were regained.

Criteria for Determining the Intensity of the Reactions

The intensity of the reactions were evaluated on the basis of a pre-determined scale. The following classification was set up for all reactions to which such an evaluation could be applied.

- I. Extreme - Very strong tremors or convulsions, very loud distress calls, or extreme sluggishness.
- II. Moderate - Moderate tremors or distress calls.
- III. Slight - Very limited tremors or very weak distress calls.
- c - Continuous.
- Sp - Spasmodic reactions at various intervals.

Often the effects of the chemicals varied, and the intensity often changed as the reaction proceeded. Also the effects of some of the chemicals varied with equal dosages under constant conditions. The consistency of these reactions will be discussed in a later section.

All of the major tables from the study are listed in the Appendix. A list of the abbreviations used in the tables is also included in the Appendix.

CHAPTER III

RESULTS

Tests were run on House Sparrows and Starlings to determine the gross physiological effects of certain bird management chemicals. The results are summarized in the following pages and tables. The results are listed by the chemical, species of bird, gross reactions, sequence, intensity, approximate LD 50, and effects of dosage and temperature.

Weights

Starlings and House Sparrows. As shown in Tables V and VI of the Appendix, the male Starlings and House Sparrows used in the tests were slightly heavier than the respective females. However, this difference does not appear to be significant.

Gross Responses of Birds to P 2133

Gross General Reactions

Starling. Upon treatment with dosages of P 2133 Starlings were found to exhibit tremors, convulsions, distress calls, blinking of the eyes, wing ataxia, panting; as well as, loss of response, sight and balance (Table I).

House Sparrow . As shown in Table I the gross reactions of 110 House Sparrows treated with P 2133 were hyperexcitation, tremors, convulsions, sluggish movements, eye blinking, distress calls, wing ataxia, panting and gasping, and loss of balance. In one bird loss of response was observed.

TABLE I

SUMMARY OF DATA COLLECTED FOLLOWING THE APPLICATION OF TEN CHEMICALS
TO HOUSE SPARROWS AND STARLINGS

(Reaction time in minutes)

	Starling			House Sparrow						
	P 2133	Water Control	40% Acetone	P 2133	Endrin	Strych- nine Sulfate	1080	DDT	Zinc Phosphide	Thallium Sulfate
Average Body Weight g	84.2	25.8	25.6	24.6	24.0	25.0	25.8	25.1	25.3	25.3
Temperature F	77 (65-85)	65	65 (45-65)	83 (66-95)	65	56 (40-65)	65	75	75	75
No. Females Tested	6	4	11	67	8	13	10	3	13	12
No. Males Tested	14	2	10	43	8	14	8	9	13	12
Total No. Tested	20	6	21	110	16	27	18	12	26	24
% Females Recovered	66.6	100	100	30	0	23	0	0	23	50
% Males Recovered	38	100	100	46	0	21	0	11	15	16
% of Total Recovered	40	100	100	36	0	22	0	8	20	33.3

Table I (Continued)

	Starling			House Sparrow						
	P 2133	Water Control	40% Acetone	P 2133	Endrin	Strychnine Sulfate	1080	DDT	Zinc Phosphide	Thallium Sulfate
Lowest mg/kg Dosage Died										
Females	4.0	-	-	2.0	1.5	9.0	0.5	350.0	21.0	35.0
Males	6.0	-	-	2.0	1.4	8.0	0.5	200.0	23.0	33.8
Highest mg/kg Dosage Survived										
Females	9.9	20.0	20.0	6.0	-	10.0	-	-	221.0	332.0
Males	8.3	25.0	20.0	6.0	-	10.0	-	300.0	46.0	121.0
Total Length of Reaction in minutes	19 (1-61)		22 (0-59)	17 (1-166)	16 (2-64)	16 (1-126)	329 (42-440)	887 (290-1312)	941 (340-1420)	896 (375-1555)
Hyperexcitation			8 (0-59)	4 (0-75)	0.9 (0-64)	13 (0-126)	6 (0-48)	326 (0-694)	58 (0-460)	68 (0-615)
Tremors	4 (0-28)			3 (0-85)	0.5 (0-49)	0.2 (0-4)	0.6 (0-3)	155 (0-230)	14 (0-60)	7 (0-35)
Convulsions	5 (0-24)			4 (0-45)	3 (0-14)	3 (0-11)				
Paraplegia					0.8 (0-7)	3 (0-20)				
Minutes Before Vomiting					6 (0-21)					

Table I (Continued)

	Starling	House Sparrow								
	P 2133	Water Control	40% Acetone	P 2133	Endrin	Strychnine Sulfate	1080	DDT	Zinc Phosphide	Thallium Sulfate
Sluggish Movements (Weakness)			14 (0-52)	15 (0-164)	12 (0-62)	8 (0-36)	159 (0-394)	396 (65-898)	365 (0-1005)	231 (15-825)
Hypersensitive to sound						3 (0-27)				
Eye Reaction	6 (0-17)			0.6 (0-14)		0.1 (0-1)				0.5 (0-5)
Distress Calls	7 (0-41)		2 (0-38)	2 (0-30)	1 (0-6)	0.7 (0-4)	0.7 (0-7)	0.7 (0-6)		
Wing Ataxia	12 (0-109)			3 (0-88)	0.1 (0-2)	7 (0-42)		152 (0-750)	36 (0-325)	6 (0-35)
Loss of: Sight	10 (0-36)		2 (0-35)			0.3 (0-5)				
Hearing			2 (0-35)							
Balance	7 (0-24)		6 (0-49)	5 (0-45)	3 (0-14)		3 (0-30)	45 (0-197)	36 (0-80)	86 (0-825)
Normal Respiration	7 (0-37)		7 (0-58)	4 (0-164)	0.3 (0-2)	2 (0-5)	8 (0-30)	97 (0-770)	55 (0-235)	46 (0-290)
Response	0.8 (0-9)		3 (0-48)	0.1 (0-11)			205 (0-430)	180 (0-660)	267 (0-1005)	219 (0-825)

40% Acetone Control for P 2133. The 40% acetone in water control for P 2133 was tested on House Sparrows. As shown in Table I, there was 100% recovery within a period of approximately 62 minutes. The reactions observed commonly were hyperexcitation, vomiting, sluggish movements, panting and distress calls. One female treated at a higher dosage was found to also lose her sight, hearing, balance and response. Two birds treated at a higher dosage and lower temperature were inconsistent in their reactions. In addition to those reactions previously mentioned, convulsions, staggering and loss of hearing were noted.

Sequence of Reactions

Starlings. Initially, Starlings frequently exhibited distress calls, wing ataxia and general body tremors, panting, followed by blinking of the eyes were later noted. Loss of sight, when observed, occurred at this point. At high dosages convulsions and loss of balance occurred. Recovery seldom occurred when convulsions were present (Table I).

House Sparrows. In response to P 2133, House Sparrows became hyperexcited and later, sluggish. Usually, tremors, wing ataxia, panting or gasping and spasmodic distress calls occurred simultaneously. Blinking of the eyes occasionally accompanied tremors. Convulsions, flipping and rolling usually occurred prior to death. As shown in Appendix, Table VI, the sequence of the reactions varied somewhat at different dosages and temperatures.

40% Acetone Control for P 2133. House Sparrows when treated with 40% acetone initially exhibited hyperexcitation followed by distress calls or sluggishness. Panting often occurred just prior to the distress calls. Loss of sight, hearing and response followed the distress calls at higher

dosages but did not occur at the lower dosages. Loss of balance was the final reaction which began prior to the beginning of recovery (Table II).

Intensity of Certain Reactions.

Starlings. As shown in Table III type II spasmodic tremors were most common in Starlings treated with P 2133 with type I and III being less common. Convulsions and distress calls were type I and type II. Wing ataxia was type III, and balance type I. Panting was much more frequent than gasping.

House Sparrows. As shown in Table III, the intensity of the reactions of House Sparrows to P 2133 varied quite widely. Hyperexcitation was most often type III with some type II. The most common tremors were type III with type II and type I being less common. Convulsions were usually type I with some type II. Sluggish movements were type I and type III. Blinking, panting, and gasping were noted. Spasmodic distress calls were type II and wing ataxia was type III intensity. Loss of balance was generally type I but occasionally, type III.

40% Acetone Control for P 2133. The reactions shown by House Sparrows in response to 40% acetone were not severe. Hyperexcitation of type I and type II was the most intense reaction. Sluggish movements, distress calls, and convulsions were type III (Table III).

Approximate LD 50.

Starlings. The approximate LD 50 of P 2133 for Starlings appeared to decrease with an increase in temperature. As shown by Table IV, the approximate LD 50 for males appeared to be between 4.0 and 6.0 mg/kg of body weight. For females the range appeared to be slightly broader.

TABLE II

A COMPARISON OF THE USUAL SEQUENCE OF REACTIONS OF HOUSE SPARROWS AND
STARLINGS TO CHEMICALS IN ORDER OF OCCURRENCE

	Starling	House Sparrow							
	P 2133	40% Acetone	P 2133	Endrin	Strych- nine Sulfate	1080	DDT	Zinc Phosphide	Thallium Sulfate
Hyperexcitation		0,1	1	1	1	1	1,2	1	1
Tremors	1		3	2,3	0,3	5	2,3,5	5	6
Wing Ataxia	1		3	0,3	0,2		3,2,4	5	6
Convulsions	4		5	4	2,6				
Paraplegia				0,4	5				
Minute of Vomiting				3					
Sluggish Movements		0,2,3	2	2,3	2	1,2	1,2,3,4,5	1,2	1,2
Hypersensitive Eye Reaction	3		4		0,3,4				5
Distress Calls	1	0,3,4	3	4,5	0,3,4		0,4		
Loss of:									
Sight	0,3	0,5		5					
Hearing		0,5							
Balance	4	0,6	5	4		5	2,4,3	6	6
Normal									
Respiration	2	0,3	3	0,2	4	4	0,1,5	3	3
Response		0,5	5			3	0,1,2,3,4	4	4

TABLE III

A COMPARISON OF THE INTENSITY OF SOME OF THE MAJOR ACUTE REACTIONS OF HOUSE SPARROWS AND STARLINGS TO VARIOUS CHEMICALS ARRANGED IN ORDER OF MOST COMMON OCCURRENCE

	Starling	House Sparrow							
	P 2133	40% Acetone	P 2133	Endrin	Strych- nine Sulfate	1080	DDT	Zinc Phosphide	Thallium Sulfate
Hyperexcita- tion		I,II	III,II	III,II : I	II,III I	III,II	III	III	III
Tremors	II,I III Sp		III,II I	III,II I	III,II	III	III	III Sp	III Sp
Convulsions	I,II	III	I,II	I	I,II,III				
Sluggish Movements		III	I,III	II,I	I,II	II	II,I	II,I	II Sp
Hypersensitive to Sound					I,II				
Eye Reaction	blinking Sp		blinking		blinking				
Distress Calls	I,II Sp	III	II Sp	II Sp	II Sp				
Wing Ataxia	III		III	III	II,III,I		II,III :	III	III
Loss of Balance	I		I,III	I			III : III		III
Normal Respiration	panting gaspng	panting	panting gaspng	panting	panting	panting	slow	panting slow	slow

TABLE IV

A COMPARISON OF THE APPROXIMATE LD 50 FOR HOUSE SPARROWS AND STARLINGS
OF CERTAIN CHEMICALS AT GIVEN TEMPERATURES

	Approximate LD 50 in mg/kg of body weight	
	<u>males</u>	<u>females</u>
Starlings		
P 2133		
65 - 70 F	> 5.0	> 10.0
75 F	5.0 - 6.0	< 5.0
80 F	4.0 - 6.0	
85 F	< 6.0	< 4.0
House Sparrows		
P 2133		
66 - 71 F	4.0	4.0 - 5.0
77 - 81 F	3.0 - 4.0	2.0 - 4.0
82 - 85 F	3.0 - 4.0	4.5
86 - 90 F	1.0 - 2.0	2.0 - 3.0
91 - 95 F	4.0	3.0 - 4.0
Endrin 65 F	< 1.5	< 1.5
Strychnine Sulfate		
40 - 50 F	10.0	8.0 - 10.0
55 - 65 F	9.0	8.0 - 10.0
1080 65 F	< 0.5	< 0.5
DDT 75 F	< 300.0	< 300.0
Zinc Phosphide 75 F	20.0 - 50.0	< 20.0
Below 75 F	20.0 - 50.0	20.0 - 220.0
Thallium Sulfate 75 F	< 30.0	< 35.0
Below 75 F	60.0 - 170.0	> 330.0

An insufficient number of birds were treated to accurately determine the LD 50 or the effects of temperature and sex on the birds.

House Sparrows. There appeared to be very little difference between the LD 50 for male and female House Sparrows treated with P 2133. As shown in Table IV, the approximate LD 50 appeared to be 3.0 to 5.0 mg/kg of body weight for both males and females.

40% Acetone Control for P 2133. All of the House Sparrows survived when treated with 40% acetone in water dosages up to 20.0 mg/kg of body weight. Insufficient tests were run to determine the MLD.

Effect of Dosage and Temperature.

Starlings. Insufficient tests were run to adequately determine the effect of temperature and dosage on the survival of Starlings treated with P 2133. A comparison of the percent survival of the lowest and highest temperatures reveals the fact that the birds did not survive as well at the higher temperatures (Appendix, Table V).

House Sparrows. In House Sparrows treated with P 2133 below 2.0 mg/kg of body weight 100% survival occurred at all temperatures. Likewise, none of the birds survived dosages above 6.0 mg/kg of body weight. Within the 2.0 to 5.0 mg/kg of body weight range, the effects of dosage and temperature were not consistent with respect to survival.

As shown in Table I, the lowest dosage at which a male died was the same as that of the lowest female. However, there was a difference in the temperature range. The highest dosage survived was also the same for both sexes but the female survived at a higher temperature. However, it is doubtful that these differences are significant.

40% Acetone Control for P 2133. Insufficient tests were administered to determine the effect of temperature on the reactions of House Sparrows when treated with 40% acetone. The responses varied widely with the dosage. Distress calls and hyperexcitation were the only reactions noted when dosages less than 5.0 mg/kg of body weight were given. In addition, vomiting and sluggish movements occurred above 6.0 mg/kg of body weight. Panting began following dosages above 10.0 mg/kg of body weight, whereas, loss of response, sight, hearing and balance occurred above 15.0 mg/kg of body weight dosages. Convulsions occurred in one bird at 20.0 mg/kg of body weight. As this chemical is volatile it would evaporate when applied to baits, thus these reactions are actually of no importance in the applied form.

Effects of Water Control on House Sparrows

As shown in Appendix, Table VI, no reactions were observed in House Sparrows given quantities of water equal to the amount of water and chemical in the largest dosage.

Effects of Endrin on House Sparrows

Gross General Reactions. As shown in Table I, all House Sparrows treated with Endrin died within 2 hours after treatment. Hyperexcitation, tremors, convulsions, sluggish movements, panting, spasmodic distress calls, vomiting, and loss of balance were observed in the birds treated. Two birds showed signs of leg paralysis and one exhibited wing ataxia.

Sequence of Reactions. As shown in Table II, the exact order of the reactions of House Sparrows to Endrin depended on the dosage. At lower

dosages few reactions were evident prior to death.

Intensity of Certain Reactions. House Sparrows, in response to Endrin, most frequently exhibited hyperexcitation and tremors of type III and less frequently type II and type I. Convulsions were type I. Sluggish movements were type II and type I. Distress calls were spasmodic and type II. Wing ataxia was type III. Loss of balance was type I. Panting was the only abnormal respiratory response noted (Table III).

Approximate LD 50. As shown in Table IV, all of the House Sparrows treated with Endrin died. The LD 50 is apparently below 1.5 mg/kg of body weight.

Effect of Dosage and Temperature. At the lower dosage levels a variation in response was noticed. At dosages below 10.0 mg/kg of body weight the onset of the reaction was delayed. Also, at low dosage levels the reactions were not violent. Females consistently tended to live longer than males treated at the same dosage.

The effect of temperature was not determined as the tests were all conducted at 65 F.

Effects of Strychnine Sulfate on House Sparrows

Gross General Reactions. Hyperexcitation, convulsions, paraplegia, sluggish movements, distress calls, wing ataxia and panting were reactions common to House Sparrows treated with strychnine sulfate. The birds were also acutely sensitive to sound. Tremors and blinking of the eyes were noticed only in the higher temperature range. Loss of sight was noticed only at the higher dosages (Table I).

Sequence of Reactions. In House Sparrows treated with strychnine sulfate hyperexcitation was the initial reaction followed by sluggish movements and wing ataxia. Convulsions usually followed but in a few tremors preceded convulsions. Hypersensitivity to sound, distress calls, panting and blinking of the eyes all occurred after convulsions or severe tremors began and were followed in most cases by paraplegia and death (Table II).

Intensity of Certain Reactions. In House Sparrows treated with strychnine sulfate, hyperexcitation and wing ataxia were most frequently type II and type III with some type I intensity. Tremors were type III and type II, whereas, convulsions were most frequently type I with some type II and III. Commonly, sluggish movements and hypersensitivity to sound were both type I and occasionally, were type II. Distress calls were type II but occasionally were spasmodic (Table III).

Approximate LD 50. As shown in Table IV, the approximate LD 50 for House Sparrows treated with strychnine sulfate appeared to be between 8.0 and 10.0 mg/kg of body weight.

Effect of Dosage and Temperature. As shown in Appendix, Table V, the effect of dosages of strychnine sulfate and the temperature did not seem to have consistent effects upon House Sparrows.

Effects of 1080 on House Sparrows

Gross General Reactions. As shown in Table I, all of the House Sparrows treated with 1080 exhibited sluggish movements, loss of response and panting. About 50% of the birds showed signs of short periods of

initial hyperexcitation and very short tremors prior to death. One was observed to lose balance indicated by an extended period of staggering movements.

Sequence of Reactions. The initial reactions of House Sparrows treated with 1080 were sluggish movements or hyperexcitation. Loss of response followed, and later, panting. Prior to death tremors were exhibited, and in one, prolonged staggering occurred (Table II).

Intensity of Certain Reactions. In House Sparrows treated with 1080 hyperexcitation and tremors were commonly type III. Sluggish movements were all type II. Panting was the only observable respiratory difficulty (Table III).

Approximate LD 50. The survival dosage of House Sparrows treated with 1080 was below 0.5 mg/kg of body weight (Table IV).

Effect of Dosage and Temperature. In House Sparrows treated with 1080 the length of the total reaction usually decreased as the dosage increased. No other effects due to variation of dosage were found and since the temperature was kept constant with those under continual observation the effects of temperature variation were not determined.

Effects of DDT on House Sparrows

Gross General Reactions. The common reactions of House Sparrows treated with DDT under controlled conditions were hyperexcitation, tremors, wing ataxia, sluggish movements, loss of balance and loss of response. Distress calls were heard only once and panting was observed about one fourth of the time (Table I).

Sequence of Reactions. As shown in Table II there seems to be no sequence of the reactions of House Sparrows treated with DDT.

Intensity of Certain Reactions. House Sparrows treated with DDT were observed to have tremors, loss of balance and show signs of hyperexcitation all of type III intensity. Sluggish movements were type II and type I. Wing ataxia was most often type II with occasional type III. Slowed breathing was the only respiratory difficulty noted (Table III).

Approximate LD 50. The survival and LD 50 of DDT for House Sparrows appeared to be below 300.0 mg/kg of body weight. Possibly the LD 50 at a lower temperature was higher than that at 75 F (Table IV).

Effect of Dosage and Temperature. Generally, the individual reaction time of House Sparrows decreased with an increase in the dosage of DDT. The males in most cases lived much longer than females treated with the same dosage.

The effect of temperature could not be determined accurately but the results imply that the LD 50 may be higher at lower temperatures.

Effects of Zinc Phosphide on House Sparrows

Gross General Reactions. As shown in Table I, tremors, sluggish movements, wing ataxia, loss of balance, panting and loss of response were common to House Sparrows treated with zinc phosphide. Hyperexcitation was observed occasionally and it was especially obvious in the birds which survived.

Sequence of Reactions. In House Sparrows treated with zinc phosphide

sluggish movements and hyperexcitation were the most common initial responses and were generally, followed by panting or a decreased respiration rate. Later, loss of response, followed by tremors and wing ataxia, occurred. Staggering was the last reaction which began prior to death (Table II).

Intensity of Certain Reactions. House Sparrows treated with zinc phosphide exhibited spasmodic tremors, wing ataxia, loss of balance and hyperexcitation of type III intensity. Sluggish movement was most often type II and less frequently type I. At lower dosages, panting, and at higher dosages, a decreased respiration rate were observed (Table III).

Approximate LD 50. Male House Sparrows treated with zinc phosphide at the lower and higher temperatures were found to have an LD 50 between 20.0 and 50.0 mg/kg of body weight. Females were found to have an LD 50 below 50.0 mg/kg of body weight at 75 F. The LD 50 appeared to be much higher for females treated at lower temperatures (Table IV).

Effect of Dosage and Temperature. In the treatment of House Sparrows with zinc phosphide, variation of the dosage or the temperature appeared to have no definite effect on the length of the reaction. The only effect noticed was panting at the lower temperatures and slower respiration at higher temperatures.

Temperature variation appeared to have some effect on the survival. Female House Sparrows were found to survive at higher dosages with lower temperatures.

Effects of Thallium Sulfate on House Sparrows

Gross General Reactions. As shown in Table I, House Sparrows treated

with thallium sulfate had sluggish movements and lost response. Most of them had slowed respiration, tremors, and staggering movements. Some had wing ataxia, a few were hyperexcited, and one treated with a very high dosage was found to exhibit eye blinking.

Sequence of Reactions. The most frequent initial reaction of House Sparrows treated with thallium sulfate was sluggish movement. In a few sluggishness occurred after the initial hyperexcitation. Slower respiration, loss of response, tremors, wing ataxia and loss of balance occurred after sluggish movements (Table II).

Intensity of Certain Reactions. House Sparrows treated with thallium sulfate were observed to have spasmodic tremors, hyperexcitation, wing ataxia and loss of balance of type III intensity. Spasmodic sluggish movement was of type II intensity. A decreased rate of respiration was the only abnormal respiratory response observed (Table III).

Approximate LD 50. The MLD, as well as the LD 50, for House Sparrows treated with thallium sulfate at 75 F appeared to be below 30.0 mg/kg of body weight for males and below 35.0 mg/kg of body weight for females. As shown in Table IV, the LD 50 was much higher for both males and females at lower temperatures.

Effect of Dosage and Temperature. Variation of the dosage in House Sparrows treated with thallium sulfate had no definite effect. At lower temperatures a variation of the dosage influenced the survival of the birds but did not effect the length of the reaction.

CHAPTER IV

DISCUSSION

Problems Involved

Genetic variation is one of the major problems involved in using species of wild birds for chemical tests. This leads to a much greater variation in response and survival than would be found in a group of domestic laboratory animals.

Temperature variation was another major problem encountered in analyzing the tests. It was difficult to run adequate tests at all of the desired temperature levels in a laboratory in which the temperature fluctuated over a wide range in the period of a day.

The age of the birds varied to some extent as they were caught and treated over a one year period. However, most of the House Sparrows were first year birds, whereas, all of the Starlings were adults. Due to this age difference between the two species tested the severity of the reactions possibly should not be compared. However, in most cases in which a comparison of physiological responses between different age groups has been made the most severe reaction was most frequently observed in the younger animals (Sherman and Rosenberg, 1953; Prosser and Brown, 1961). In the tests administered on these birds the adult Starlings were more severely affected than the juvenile House Sparrows.

In some of the birds regurgitation was a problem. Often this oc-

curred in cases in which the plastic tube had not been inserted deeply enough into the gullet. Regurgitation also occurred when the bird was held on its back during treatment.

Determination of the total time length for recovery was very difficult. The bird was considered recovered when normal body movement and response to environment were regained. Thus, the time length of reaction in birds which survived is an approximate figure.

Comparison of the Results With the Literature

Endrin -- The results obtained appear to correspond with the findings that Endrin is a central nervous system stimulant (Haynes, 1963). House Sparrows appear to be more sensitive to the chemical than chicks at various ages (Sherman and Rosenberg, 1953) or adult or young quail and pheasants (DeWitt, 1955). However, the difference could be due to the difference in testing methods.

The symptoms observed with House Sparrows treated with Endrin are quite similar to those observed in quail and pheasant chicks by DeWitt (1956).

Strychnine Sulfate -- When treated in the same manner, House Sparrows appear to be more sensitive to strychnine sulfate than immature and adult female Sage Grouse which survived slightly higher dosages than those given the House Sparrows (Ward, et al., 1942).

1080 -- House Sparrows appear to be much more sensitive to 1080 when treated with liquid oral doses than when the chemical is administered in the food (Ward and Spencer, 1947). Other birds appear more resistant even with similar methods of treatment. This is shown by Ward and Spencer (1947) for the Turkey and Black Vultures as well as for Mallard,

Pintail and Widgeon Ducks, Cottrel et al. (1947) and Schwarte (1947) also illustrate this with White Leghorn chickens treated in the same manner. California Quail appear to have symptoms similar to House Sparrows but the MLD for California Quail is slightly higher than for the House Sparrow (Sayama and Burnett, 1952).

The compound 1080 appears to interfere with acetate metabolism, as well as, effect the cardiovascular or nervous system, or both, in some species, (Haynes, 1963; Busch and Potter, 1952). The chemical did not appear to affect the central nervous system of the House Sparrows tested.

DDT --- Chickens appear to be more resistant to DDT than House Sparrows and exhibit many of the same general symptoms when treated in the same manner (Woodward, et al., 1944). However, House Sparrows appear more resistant than similarly treated Bobwhite Quail and less resistant than Starlings or Mallard and Pintail Ducks (Coburn and Treichler, 1946).

In response to acute dosages of DDT most of the symptoms observed in House Sparrows were similar to those exhibited by laying hens in response to prolonged exposure to DDT in the food (Rubin, et al., 1947).

Zinc Phosphide --- Hayne (1950) found pheasants to be quite sensitive to zinc phosphide given in capsule form. This sensitivity, as well as, the time length prior to death corresponds to the results obtained on House Sparrows.

Thallium Sulfate --- Thallium sulfate has been found to be a cellular toxin (Hayes, 1963) and is thought to affect the sympathetic nervous system (Munch and Silver, 1931). The symptoms observed in House Sparrows treated with thallium sulfate appear to be a result of sympathetic nervous system stimulation. The symptoms observed by Shaw (1932) in quail,

geese and ducks do not correspond to those found in House Sparrows. However, the MLD for the House Sparrow appears to be quite similar to that for quail, geese and ducks (Shaw, 1932; Shaw, 1933).

Comparison of the Physiological Effects of P 2133 on House Sparrows and Starlings

Starlings were found to exhibit more violent reactions than House Sparrows in response to P 2133. Starlings did not exhibit hyperexcitation and sluggish movements as did House Sparrows. House Sparrows did not appear to have a loss of sight as did the Starlings. Starlings were observed to have more distress calls, eye blinking and wing ataxia than House Sparrows. Both were observed to have tremors, convulsions, loss of balance, panting, gasping, and some loss of response in addition to the reactions previously mentioned.

The average total length of reaction for both species treated with this chemical were relatively short and less than 20 minutes in length (Fig. 2).

The approximate LD 50 of this chemical varied very little between the two species and appeared to be between 4.0 and 6.0 mg/kg of body weight.

Comparison of P 2133 and 40% Acetone on House Sparrows

Most of the major acute physiological reactions of the House Sparrow appear to be due to the chemical in P 2133 rather than the 40% acetone and water carrier. The initial hyperexcitation and distress calls in dosages of the chemical below 5.0 mg/kg of body weight could

Starlings
P 2133



House Sparrows
Water Control

40% Acetone in Water Control of P 2133



P 2133



Endrin



Strychnine Sulfate



1080



DDT



Zinc Phosphide



Thallium Sulfate



0 100 200 300 400 500 600 700 800 900

Time in Minutes

0 1 2 3 4 5 6 7 8 9 10 11 12 13 15 16

Time in Hours

Fig. 2. Averages of the Total Length of Reaction for All Chemicals and Controls of House Sparrows and Starlings Without Regard for Sex, Age, Temperature or Dosage.

be due to the 40% acetone carrier. Hyperexcitation began within one minute after treatment with 40% acetone with dosages below 5.0 mg/kg of body weight. Hyperexcitation occurs much later as the dosage increases. The initial sluggish movement, which occurred in response to dosages below 5.0 mg/kg of body weight, are assumed to be due to the P 2133 rather than the 40% acetone. Sluggish movements began with dosages above 5.0 mg/kg of body weight of 40% acetone. However, acetone was not administered at temperatures above 65 F and the different responses due to an increase in temperature were not determined.

Tremors, convulsions, sluggish movements, eye reactions, wing ataxia, loss of balance, panting or gasping and loss of response which occurred in House Sparrows treated with P 2133 are assumed to be due to the chemical rather than the carrier. This assumption is based on the observations that the reactions which occurred in tests with the chemical and the carrier occurred much later in the 40% acetone and at much higher dosages than in the P 2133.

Comparison of the Chemicals on House Sparrows

Phillips Petroleum Company Compound No. 2133, Endrin and strychnine sulfate appear to be neurotoxins when administered to House Sparrows. Although the mechanism of each appears to be quite different the short average reaction time, sequence and many acute physiological reactions were quite similar. Endrin is without a doubt the most toxic of the three but all are highly toxic to House Sparrows with the approximate LD 50 dosage of each being below 10.0 mg/kg of body weight. P 2133 gave the most rapid and most severe reaction, whereas, with Endrin, death may occur after a long period with very few reactions occurring.

The initial response was more delayed in strychnine sulfate but more consistent reactions were observed than in response to Endrin of P 2133.

The compound 1080 has a distinctly different mode of action on House Sparrows as shown by the general lack of severe acute symptoms and prominent loss of response and sluggish movements. The chemical was one of the most highly toxic chemicals tested with only Endrin comparing in toxicity. The intensity and order of the reactions were similar to those of zinc phosphide and thallium sulfate. The average length of reaction was much longer than that of P 2133, Endrin, or strychnine sulfate but much shorter than that of DDT, zinc phosphide or thallium sulfate (Fig. 2).

DDT appeared to be a neurotoxin but the area of the nervous system affected apparently is different from that of P 2133, Endrin, or strychnine sulfate. The LD50 dosage is higher, loss of response, slowed respiration and sluggish movements appear to be much more prominent, and the average length of the reaction is quite longer in DDT than in the other neurotoxins.

Zinc phosphide and thallium sulfate appeared to be very similar in almost all of the reactions. Both chemicals have very slow action with approximately the same sequence and intensity of the reactions. The approximate LD50 dosage is quite similar for both chemical materials and the female House Sparrows appear to be able to survive both chemicals at a much higher dosage at a low temperature than the males or the females treated at 75 F. Possibly both are neurotoxins due to certain reactions which imply stimulation of the sympathetic nervous system.

Chemicals Suggested as Possible

Bird Repellants

P 2133 is the only chemical tested which produced the acute physiological reactions necessary for a potential bird repellent. However, House Sparrows do not appear to be affected severely enough to merit the use of P 2133 in this manner for this species.

Many of the other chemicals tested are too toxic for such use. In others the reaction is delayed, or of such nature, that there is no fright produced in birds of the same species. The chemicals which do not produce rapid, severe tremors or convulsions and loud distress calls do not appear to be useful as an ideal bird repellent.

CHAPTER V

SUMMARY AND CONCLUSIONS

Previous studies have determined that when certain chemicals which have been applied to baits are ingested acute physiological reactions are produced which frightened other birds of the same species away from the areas in which they are causing damage to crops or creating a nuisance or hazard to man. These reactions were due to certain toxins which produced violent tremors and/or convulsions and loud distress calls. Seven chemical materials were tested in the laboratory on House Sparrows and Starlings. The gross physiological reactions were observed. The severity, sequence, approximate MLD, and approximate LD 50 were determined for each chemical and species of bird at various temperatures. An attempt was made to evaluate each chemical according to the acute physiological responses as a potential ideal bird repellent which produced severe distress calls, as well as violent tremors.

All of the chemicals were found to be highly toxic to the birds tested. P 2133 was the only chemical which appeared to be a potential ideal bird repellent, and then only for Starlings. Endrin, strychnine sulfate, and P 2133 produced rapid severe tremors and convulsions in House Sparrows but very little distress calls. These chemicals could be used as bird repellents but would not be as effective as a chemical which produced loud distress calls. DDT produced slight tremors but no distress calls in House Sparrows. Zinc phosphide and thallium sulfate

appeared to completely depress House Sparrows and only very slight tremors were obtained.

Chemicals in which only slight tremors or depression occurred, as well as those in which the initial response was delayed for an extended period of a few hours length were not considered suitable for use as bird repellants. Chemicals which produced severe tremors and convulsions, but no distress calls, could possibly be used as bird repellants but would not appear to be as effective as a chemical which caused the bird to give loud distress calls.

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A P P E N D I X

Abbreviations Employed in Tables

- D - died.
- R - recovered.
- M - male.
- F - female.
- * - treated at 65 F and released into a colder area.
- mg/kg - milligrams per kilogram of body weight.
- p - panting.
- g - gasping.
- G - gagging in an attempt to regurgitate.
- c - continuous.
- Sp - spasmodic.
- St - fixed stare.
- b - blinking.
- NR - no reaction.
- NCR - no complete record of reactions.
- I - Extreme - very strong tremors or convulsions, very loud distress calls or extreme sluggishness.
- II - Moderate - moderate tremors or distress calls.
- III - Slight - very limited tremors or very weak distress calls.

TABLE V
EFFECTS OF PHILLIPS PETROLEUM COMPANY #2133 ON STARLINGS
(Showing Beginning, End and Length of Reaction in Minutes)

Test No.	Dosage mg/kg	Temp. °F	Sex	Result	Grams Wt.	Total Length of Reaction	Hyperexcitation	Tremors	Convulsions	Paralysis	Minutes Before Vomiting
1	2.0	80	F	R	78.0	12	-	-	-	-	4
2	2.2	65	M	R	85.0	3	-	1	-	-	3
3	4.0	85	F	D	73.0	20	-	3-4 8 III 2-4 16-21	11 I 4-15	-	-
4	4.0	80	M	R	81.5	61	-	3 III 3-5	24 I 5-29	-	4
5	4.4	70	M	R	99.0	39	-	4 II 2-5	-	-	2
6	5.1	65	F	R	77.5	33	-	20 Sp 3-23	-	-	3
7	5.2	75	F	D	87.0	43	-	28 Sp 6-27 III 27-43 II	-	-	-
8	6.0	80	M	D	76.0	18	-	8 Sp 1-6 16-19	9 7-16	-	-
9	6.0	75	M	D	87.5	10	-	-	10 Sp 2-12	-	-
10	6.0	85	M	D	83.5	13	-	-	11 2-13	-	2
11	8.0	80	M	D	83.0	9	-	-	9 1-10	-	-
12	8.0	75	M	D	85.0	9	-	-	9 1-10	-	-
13	8.2	65	F	R	97.0	20	-	8 1-9	-	-	4
14	8.3	75	M	R	96.5	16	-	5 1-6	-	-	2
15	9.9	65	F	R	88.0	48	-	16 Sp 1-9 11-19	2 9-11	-	7
16	10.0	85	M	D	86.0	-1	-	-1	-	-	-
17	10.0	85	M	D	83.0	8	-	-	8 1-9	-	-
18	10.0	85	M	D	76.0	7	-	-	6 2-8	-	-
19	10.0	85	M	D	85.0	-1	-	-	-1	-	-
20	10.9	75	M	D	77.5	9	-	-	9 1-10	-	-

Table V (Continued)

Sluggish Movements (Weakness)	Hypersensi- tive to Sound	Eye Reaction	Distress Calls	Wing Ataxia	Sight	Hearing	Loss Of		Response	Test No.
							Balance	Normal Respiration		
-	-	5-6 ^b	-	-	Poor 2-?	-	-	1 ^p 2-3 ^p	-	1
-	-	-	1	-	-	-	1	3 ^p	-	2
-	-	-	3-4	-	-	-	3-4	3-6	-	3
-	-	-	6 Sp	18	18	-	18	7 ^p	-	3
-	-	-	2-8	3-21	3-21	-	3-21	14-21	-	4
-	-	17 b	41 Sp	20	?	-	24	1 ^p	-	4
-	-	6-23	2-43	10-30	5-?	-	5-29	2-3	-	5
-	?	4 b	3 Sp	-	12	-	?	1 ^p	-	5
-	5-?	2-5	1-19	-	1-13	-	-	4-5	-	6
-	-	3 Sp b	3 Sp	?	17	-	2 Sp	5 ^p	7	6
-	-	4-9	3-17	17-?	7-24	-	17-24	2-7	17-24	7
-	-	7 Sp b	22 Sp	37	36	-	10	37 ^p	9	7
-	-	8-22	6-40	6-43	7-43	-	33-43	6-43	8-17	8
-	-	17 b	9 Sp	17	17	-	14	16 ^g	-	9
-	-	2-19	1-15	2-19	2-19	-	2-16	3-19	-	9
-	-	10 b	7 c	9	9	-	9	9	-	10
-	-	2-12	5-12	3-12	3-12	-	3-12	3-12	-	10
-	-	7 Sp b	8 Sp	11	11	-	11	12 ^p	-	11
-	-	2-12	1-11	2-13	2-13	-	2-13	1-13	-	11
-	-	1 b	9	10	8	-	10	-	-	12
-	-	3-4	2-11	1-11	3-11	-	1-11	-	-	12
-	-	8 b	6 Sp	9	8	-	9	7 ^g	-	13
-	-	2-10	1-10	1-10	2-10	-	1-10	3-10	-	13
-	-	5 b	2 Sp	-	7	-	-	17 ^p	-	14
-	-	5-10	1-6	-	4-11	-	-	2-19	-	14
-	-	16 b	1	-	8	-	-	7	-	15
-	-	1-17	1-2	-	1-9	-	-	1-8	-	15
-	-	11 b	4 Sp	12	23	-	2	19	-	16
-	-	3-14	1-14	2-14	3-26	-	9-11	2-21	-	17
-	-	-1 b	-1	-	-	-	-	-	-	16
-	-	7 b	8	-	8	-	8	-	-	17
-	-	1-8	1-9	-	1-9	-	1-9	-	-	18
-	-	2 b	3	-	6	-	6	5	-	18
-	-	1-3	1-4	-	2-8	-	2-8	3-8	-	19
-	-	-	-1	-	-	-	-1	-	-	20
-	-	2 b	3 Sp	-	8	-	9	-	-	19
-	-	1-3	1-6	-	2-10	-	1-10	-	-	20

TABLE VI
EFFECTS OF CHEMICALS ON HOUSE SPARROWS
(Showing Beginning and End of Reaction in Minutes)

Test No.	Dosage mg/kg	Temp. °F	Sex	Result	Grams Wt.	Total Length of Reaction	Hyperexcitation	Tremors	Convulsions	Paraplegia	Minutes Before Vomiting
<u>Water Controls</u>											
1	0.22	65	F	NR	27.5	NR					
2	0.3	65	F	NR	25.5	NR					
3	0.3	65	M	NR	25.5	NR					
4	0.37	65	F	NR	24.5	NR					
5	0.52	65	M	NR	26.5	NR					
6	0.63	65	F	NR	25.5	NR					
40% Acetone in Water-Control for 2133											
7	1.0	65	M	NR	26.0	NR					
8	2.0	65	M	NR	25.5	NR					
9	3.0	65	M	R	25.0	2	2	-	-	-	-
10	4.0	65	M	R	26.5	9	1-3 9 I	-	-	-	-
11	5.0	65	M	R	22.5	14	1-10 14 1-8 I 8-15 III	-	-	-	-
12	6.0	65	M	R	26.5	31	1 II 1-2	-	-	-	-
13	7.0	65	M	R	26.0	53	2	-	-	-	8
14	10.0	65	M	R	26.0	17	2-4 17	-	-	-	4,15
15	15.0	65	M	R	25.0	35	3-20 2	-	-	-	6,14
16	20.0	45 (Burning 55-60)	M	R	31.5	62	8-10 4 55-60	-	49 III 1-50	-	9
17	1.0	65	F	NR	26.0	NR					
18	2.0	65	F	R	25.0	2	2	-	-	-	-
19	3.0	65	F	R	25.0	4	1-3 4 III	-	-	-	-
20	4.0	65	F	R	25.5	4	1-5 4 II	-	-	-	-
21	5.0	65	F	R	25.0	17	1-5 17 I	-	-	-	-
22	6.0	65	F	R	25.0	34	1-18 5	-	-	-	-
23	7.0	65	F	R	24.5	59	1-2 30-34 59	-	-	-	-
24	10.0	65	F	R	26.0	39	1-55 II 55-60 III	-	-	-	4
25	15.0	65	F	R	24.5	14	10	-	-	-	5
26	15.0	65	F	R	25.0	59	5-15 15 II 45-60	-	-	-	7
27	20.0	45	F	R	27.5	49	-	-	-	-	-

Table VI (Continued)

Sluggish Movements (Weakness)	Hypersensi- tive to Sound	Eye Reaction	Distress Calls	Wing Ataxia	Sight	Hearing	Loss Of		Response	Test No.
							Balance	Normal Respiration		
										1
										2
										3
										4
										5
										6
										7
										8
-	-	-	-	-	-	-	-	-	-	9
			1							10
			1-2							
			5							11
			1-6							
30 II	-	-	1							12
2-32			1-2							
52			-							13
3-55			-							
-			-							14
35			-					13 p		15
1-36			-					3-16		
49 I			-		12	12	49	58 p	12	16
1-50			-		3-15	3-15	1-50	2-60	3-15	
			-							17
			-							18
			2							19
			1-3							
			-							20
			-							21
			-							22
20 II			1							
10-30			1-2							
-			38							23
			1-39							
38 II			1					4 p		24
1-39			1-2					2-6		
-			1					10 p		25
			1-2					1-11		
48 II			-		35 II	35 II	35 II	31 p	48 II	26
2-50			-		10-45	10-45	10-45	1-32	2-50	
49 II			-		?	6 II	49 II	48 p	?	27
1-50			-			3-9	1-50	2-50		

Table VI (Continued)

Test No.	Dosage mg/kg	Temp. °F	Sex	Result	Grams Wt.	Total Length of Reaction	Hyperexcitation to Sound	Tremors	Convulsions	Paraplegia	Muscles Before Vomiting
Phillips Petroleum Company Compound #2133 in 40% Acetone											
28	0.14	80	F	R	20.5	2	2 3-5	-	-	-	-
29	0.5	80	F	R	25.5	5	5 III 4-9	-	-	-	-
30	0.5	80	F	R	26.5	25	25 1-26	6 III 5-12	-	-	-
31	0.75	80	M	R	25.0	50	50 II 2-52	-	-	-	-
32	0.75	80	F	R	25.5	8	-	3 III 2-5	-	-	-
33	1.0	78	M	R	25.0	7	7 III 2-9	-	-	-	-
34	1.0	82	M	R	24.5	9	9 III 2-11	-	-	-	-
35	1.0	77	F	R	23.0	17	17 III -3-20	-	-	-	-
36	1.0	82	F	R	25.5	9	9 III 2-11	-	-	-	-
37	1.0	82	F	R	23.0	3	3 III 2-5	-	-	-	-
38	1.0	90	F	R	23.0	6	-	-	-	-	-
39	1.25	80	F	R	22.0	11	11 III 2-13	-	-	-	-
40	1.5	70	M	R	24.5	18	18 III 1-19	-	-	-	-
41	1.5	95	M	R	25.0	42	-	12 III 2-6 14-22	4 I 6-10	-	-
42	1.5	80	F	R	23.0	12	12 1-13	1 III 2-3	-	-	-
43	1.5	80	F	R	23.0	14	14 I 1-15	1 III 3-4	-	-	-
44	1.75	80	M	R	25.0	25	25 III 1-26	10 III 1-11	-	-	-
45	2.0	70	M	R	25.5	29	-	4 I 3-4 10-13	5 I 4-8 14-15	-	-
46	2.0	70	M	R	24.5	2	-	2 III 6-8	-	-	-
47	2.0	78	M	R	24.5	32	-	3 III 3-6	-	-	-
48	2.0	80	M	R	28.0	25	-	14 1-6 III 6-8 I 12-15 III	-	-	-
49	2.0	82	M	R	25.0	14	14 III 1-15	1 III 1-2	-	-	-
50	2.0	85	M	R	20.5	26	1 1-2	6 II 1-7	-	-	-
51	2.0	90	M	D	24.0	7	-	1 II 1-2	6 I 2-8	-	-
52	2.0	78	F	D	22.5	2	-	-	1 I 2-3	-	-
53	2.0	78	F	D	21.5	11	-	8 III 1-5 6-12	2 I 3-4 12	-	-
54	2.0	80	F	R	22.5	25	25 III 1-26	5 III 1-6	-	-	-

Sluggish Movements (Weakness)	Hypersensi- tive to Sound	Eye Reaction	Distress Calls	Wing Ataxia	Sight	Hearing	Loss Of		Response	Test No.
							Balances	Normal Respiration		
1	-	-	-	-	-	-	-	-	-	28
3-4	-	-	-	-	-	-	-	-	-	29
13 I	-	-	1 Sp	13 III	-	-	-	9 p	-	30
2-16	-	-	2-5	2-15	-	-	-	2-12	-	31
50	-	-	-	20	-	-	19 III	13 p	-	32
2-52	-	-	-	2-22	-	-	3-22	15-32	-	33
3 III	-	-	-	-	-	-	-	2 p	-	34
2-5	-	-	-	-	-	-	-	2-4	-	35
-	-	-	-	-	-	-	-	-	-	36
8 III	-	-	-	-	-	-	8	-	-	37
3-11	-	-	-	-	-	-	3-11	-	-	38
-	-	-	-	-	-	-	3	-	-	39
-	-	-	-	-	-	-	3-6	-	-	40
1 III	-	-	-	1 III	-	-	-	4 g	-	41
7-8	-	-	-	7-8	-	-	-	2-6	-	42
-	-	-	-	-	-	-	-	-	-	43
1 III	-	-	-	-	-	-	-	1 p	-	44
10-11	-	-	-	-	-	-	-	4-5	-	45
-	-	-	-	-	-	-	-	-	-	46
27 III	-	-	6 Sp	4	?	-	6	25 g	-	47
2-29	-	-	3-14	6-10	8-7	-	4-10	4-29	-	48
-	-	-	-	-	-	-	-	10 p	-	49
-	-	-	-	-	-	-	-	3-13	-	50
12	-	-	3	-	-	-	-	3 p	-	51
2-14	-	-	5-8	-	-	-	-	3-6	-	52
14	-	-	-	9	-	-	-	14 p	-	53
1-15	-	-	-	2-11	-	-	-	2-16	-	54
29	-	-	1	-	-	-	22	2 p, g	11	55
1-30	-	-	13-14	-	-	-	4-26	1-2	15-26	56
-	-	-	-	-	-	-	-	16-17	-	57
-	-	-	-	-	-	-	2 III	-	-	58
-	-	-	-	-	-	-	6-8	-	-	59
34 II	-	-	-	1 III	-	-	-	2 p	-	60
1-35	-	-	-	5-6	-	-	-	4-6	-	61
20	-	-	-	10	-	-	-	8 p	-	62
1-21	-	-	-	1-11	-	-	-	3-11	-	63
-	-	-	-	1 III	-	-	-	2 p	-	64
-	-	-	-	2-3	-	-	-	4-6	-	65
26	-	-	-	8	-	-	5 III	-	-	66
1-27	-	-	-	2-10	-	-	2-7	-	-	67
-	-	4 b	5 Sp	-	-	-	7	7 p	-	68
-	-	1-5	3-8	-	-	-	1-8	1-8	-	69
-	-	-	-	-	-	-	1	-	-	70
-	-	-	-	-	-	-	2-3	-	-	71
-	-	-	-	-	-	-	10	-	-	72
-	-	-	-	-	-	-	2-12	-	-	73
20 I	-	-	-	-	-	-	-	6 p	-	74
1-21	-	-	-	-	-	-	-	3-10	-	75

Table VI (Continued)

Test No.	Dosage mg/kg	Temp. °F	Sex	Result	Grams Wt.	Total Length of Reaction	Hyperexcitation	Tremors	Convulsions	Paraplegia	Minutes Before Venting
55	2.0	82	F	R	23.5	7	7 III 2-7	-	-	-	-
56	2.0	95	F	D	23.5	166	-	1 II 2-3	30 I 3-33	-	-
57	2.5	80	F	R	23.0	30	29 II 1-30	-	-	-	-
58	2.5	80	F	R	25.0	8	8 3-11	-	-	-	-
59	2.5	80	F	R	21.5	63	-	3 III 3-6	-	-	-
60	3.0	80	M	D	24.0	2	-	1 II 1-2	1 I 2-3	-	-
61	3.0	82	M	R	25.5	19	-	1 III 1-2	-	-	-
62	3.0	85	M	D	21.5	1	-	1 I 1-2	-	-	-
63	3.0	89	M	D	23.5	2	1 1-2	1 II 2-3	-1 I 3-4	-	-
64	3.0	90	M	D	24.5	6	-	5 I 1-2 3-7	1 I 2-3	-	-
65	3.0	90	M	D	23.0	12	-	-	12 I 1-13	-	-
66	3.0	68	F	D	23.0	12	-	-	12 I 1-13	-	-
67	3.0	80	F	R	23.0	55	-	45 3-24 III 24-33 II 33-48 III	-	-	-
68	3.0	89	F	R	22.5	90+	-	8 III 1-10	-	-	-
69	3.0	91	F	D	24.5	7	-	-	7 I 1-8	-	-
70	3.0	91	F	R	26.5	70+	6 1-7	3 Sp III 25-42	-	-	-
71	3.0	92	F	R	25.5	11	11 1-12	2 III 2-4	-	-	-
72	3.5	70	M	R	25.5	49	49 1-50	39 III 1-40	-	-	-
73	3.5	80	F	R	24.0	26	5 22-27	3 Sp I 1-10	1 I 2-3	-	-
74	3.5	80	F	R	24.0	60+	-	6 II 24-30	29 I 1-24	-	-
75	3.75	70	M	D	26.0	1	-	1 I 1-2	-1 I 2-2	-	-
76	4.0	66	M	R	29.5	8	-	4 III 2-6	-	-	-
77	4.0	67	M	D	25.5	-1	-	-	1 I 1-2	-	-
78	4.0	89	M	D	22.0	4	-	2 I 2-4	-1 4-5	-	-
79	4.0	94	M	R	26.5	45+	-	1 III 4-5	-	-	-
80	4.0	91	M	D	26.0	49+	-	-	45 I 1-46	-	-
81	4.0	67	F	R	27.5	7	7 2-9	-	-	-	-
82	4.0	67	F	R	23.5	115+	-	85 III 30-115	-	-	-
83	4.0	70	F	R	24.5	84	-	2 II 1-3	37 II 3-40	-	-

Sluggish Movements (Weakness)	Hypersensitive to Sound	Eye Reaction	Distress Calls	Wing Ataxia	Loss Of					Test No.
					Sight	Hearing	Balance	Normal Respiration	Response	
-	-	-	-	1 III 4-5	-	-	-	1 p 4-5	-	55
164 I 2-166	-	-	15 3-18	-	-	-	30 I 3-33	164 p 2-166	-	56
13 II 2-15	-	-	-	8 2-10	-	-	-	2 p 2-4	-	57
-	-	-	-	-	-	-	-	-	-	58
62 II 3-65	-	-	-	31 4-35	-	-	3 3-6	61 p 4-65	-	59
2 I 1-3	-	-	1 3-3	-	-	-	1 2-3	1 p 2-3	-	60
18 III 2-20	-	-	-	16 3-19	?	-	-	1 p 3-4	-	61
1 I 1-2	-	-	-	1 I 1-2	-	-	1 1-2	-	-	62
2 I 2-4	-	-	-	1 3-4	-	-	1 I 3-4	1 p 2-3	-	63
6 I 1-7	-	-	2 2-4	6 I 1-7	-	-	6 1-7	-	-	64
12 1-13	-	12 St 1-13	3 Sp 1-13	12 1-13	-	-	12 1-13	9 g 4-13	-	65
12 I 1-13	-	-	2 3-5	12 1-13	-	-	12 1-13	-	-	66
55 3-58	-	-	4 Sp 11-28	40 3-43	-	-	-	6 Sp 9-10 p 28-33 g	-	67
88 I 2-90	-	-	-	88 III 2-90	-	-	-	12 p 3-15	-	68
7 I 1-8	-	-	-	7 1-8	-	-	7 1-8	-	-	69
68 III 2-70	-	6 b 1-7	-	-	-	-	? 25-?	27 1-7 p 15-36 g	-	70
5 III 1-6	-	-	-	-	-	-	-	2 p 2-4	-	71
35 I 15-50	-	-	-	-	-	-	-	-	-	72
20 I 2-22	-	13 b 3-16	20 2-22	23 Sp 1-24	-	-	? 2-?	1 p 1-2	-	73
33 I 1-34	-	2 b 8-10	17 Sp 2-24	23 1-24	-	-	23 1-24	5 Sp g 3-30	-	74
1 I 1-2	-	-	-	1 1-2	-	-	-1 2-2	-	-	75
8 2-10	-	-	-	4 III 2-6	-	-	4 2-6	1 g 2-3	-	76
1 I 1-2	-	-	-	1 1-2	-	-	1 1-2	-	-	77
4 I 1-5	-	-	-	3 2-5	-	-	-1 4-5	2 g 3-5	-	78
44 II 1-45	-	1 b 2-3	-	-	-	-	-	1 p 2-3	-	79
48 + 1-49+	-	-	-	-	-	-	45 1-46	-	-	80
3 6-9	-	-	-	2 7-9	-	-	-	4 p 4-9	-	81
113 2-115+	-	-	1 30-31	-	-	-	-	-	-	82
84 I 1-85	-	2 b 4-6	30 5-35	-	-	-	37	-	-	83
							3-40			

Table VI (Continued)

Test No.	Dosage mg/kg	Temp. °F	Sex	Result	Grams Wt.	Total Length of Reaction	Hyperexcitation	Tremors	Convulsions	Paraplegia	Minutes Before Vomiting
84	4.0	84	F	D	24.5	9	-	1 I 1-2	8 2-10	-	-
85	4.0	85	F	D	27.5	1	-	1 I 2-3	-	-	-
86	4.0	88	F	R	23.5	33	-	-	-	-	-
87	4.5	71	M	R	26.5	81	-	-	18 II 1-19	-	-
88	4.5	83	F	R	24.0	14	-	-	-	-	-
89	4.5	84	F	D	27.0	6	-	1 I 1-2	5 I 2-7	-	-
90	4.5	85	F	R	25.0	10	10 1-11	-	-	-	-
91	4.5	85	F	D	22.5	1	-	1 1-2	-	-	-
92	5.0	67	M	D	22.5	28	-	2 I 1-3	26 I 3-29	-	-
93	5.0	66	M	R	25.0	14	14 1-15	6 III 6-12	-	-	-
94	5.0	67	M	D	28.0	1	-	-	1 I 1-2	-	-
95	5.0	85	M	D	20.5	8	-	8 I 1-9	-	-	-
96	5.0	89	M	D	25.5	4	-	3 I 1-4	-	-	-
97	5.0	89	M	D	26.5	-1	-	-1 -1-1	-	-	-
98	5.0	89	M	D	26.5	2	-1 -1-1	1 I 1-2	1 I 2-3	-	-
99	5.0	66	F	D	21.5	19	-	1 I 2-3	17 I 3-20	-	-
100	5.0	84	F	D	26.5	3	-	2 I 1-3	1 I 3-4	-	-
101	5.0	85	F	R	23.5	18	7 III 2-9	5 III 3-8	-	-	-
102	5.0	85	F	R	23.0	5	5 2-7	-	-	-	-
103	5.0	85	F	D	24.0	1	-	1 III 1-2	-	-	-
104	5.0	85	F	D	22.0	8	-	-	8 I 1-9	-	-
105	5.0	85	F	D	23.0	7	-	-	7 I 2-9	-	-
106	5.5	90	M	R	25.0	6	6 II 3-9	-	-	-	-
107	5.5	84	F	D	26.0	18	-	-	18 I 1-19	-	-
108	6.0	84	M	R	25.5	59	-	1 II 1-2	33 I 2-35	-	-
109	6.0	90	M	D	23.5	6	-	-	6 I 1-7	-	-
110	6.0	92	M	D	23.0	1	-	-	1 I 1-2	-	-
111	6.0	88	F	D	26.0	4	-	-	4 I 1-5	-	-
112	6.0	88	F	R	27.5	76+	75+ II 1-76	-	-	-	-
113	6.0	88	F	D	31.5	1	-	-	1 I 1-2	-	-
114	6.0	89	F	D	23.5	-1	-	-1 I -1-1	-	-	-

Sluggish Movements (Weakness)	Hypersensi- tive to Sound	Eye Reaction	Distress Calls	Wing Ataxia	Sight	Hearing	Loss Of		Respiration	Tent. No.
							Balance	Normal		
9 I	-	-	8	-	-	-	8	-	-	84
1-10	-	-	2-10	-	-	-	2-10	-	-	
1	-	-	1	1	-	-	1	1 p	-	85
2-3	-	-	2-3	2-3	-	-	2-3	2-3	-	
33 III	-	-	-	-	-	-	-	3 p	-	86
2-35	-	-	-	-	-	-	-	2-5	-	
81	-	-	9 Sp	-	-	-	18	3 p	-	87
1-82	-	-	2-17	-	-	-	1-19	19-22	-	
14 III	-	1 b	-	-	-	-	-	3 R	-	88
3-17	-	3-4	-	-	-	-	-	3-5	-	
6 I	-	-	5 c	5	-	-	5	-	-	89
1-7	-	-	2-7	2-7	-	-	2-7	-	-	
-	-	-	-	-	-	-	-	8 p	-	90
-	-	-	-	-	-	-	-	1-9	-	
1	-	-	-	1	-	-	1	-	-	91
1-2	-	-	-	1-2	-	-	1-2	-	-	
28 I	-	14 b	11 c	-	-	-	26	14 g	-	92
1-29	-	15-29	3-14	-	-	-	3-29	15-29	-	
13 III	-	-	-	-	-	-	-	-	-	93
2-15	-	-	-	-	-	-	-	-	-	
1	-	1 b	-	-	-	-	1	-	-	94
1-2	-	1-2	-	-	-	-	1-2	-	-	
8	-	-	1	7	-	-	7	-	-	95
1-9	-	-	2-3	2-9	-	-	2-9	-	-	
3 I	-	1 b	1	3	-	-	3	-	-	96
1-4	-	2-3	1-1	1-4	-	-	1-4	-	-	
-1	-	-	-	-1	-	-	-1	-	-	97
-1-1	-	-	-	-1-1	-	-	-1-1	-	-	
2 I	-	-	-1	-	-	-	1	1 p	-	98
1-3	-	-	1-1	-	-	-	2-3	1-2	-	
19 I	-	-	1	-	-	-	17	-	-	99
1-20	-	-	3-4	-	-	-	3-20	-	-	
3 I	-	-	1 Sp	-	-	-	1	-	-	100
1-4	-	-	3-4	-	-	-	3-4	-	-	
13 III	-	-	1	-	-	-	-	8 p	-	101
7-20	-	-	3-4	-	-	-	-	2-10	-	
-	-	-	-	-	-	-	-	1 p	-	102
-	-	-	-	-	-	-	-	2-3	-	
1 III	-	-	1	1	-	-	1	-	-	103
1-2	-	-	1-2	1-2	-	-	1-2	-	-	
8 I	-	-	1	-	-	-	8	-	-	104
1-9	-	-	2-3	-	-	-	1-9	-	-	
7 I	-	1 b	5	-	-	-	7	1 p	-	105
2-9	-	4-5	4-9	-	-	-	2-9	2-3	-	
-	-	-	-	-	-	-	-	-	-	106
18 I	-	-	10 Sp	-	-	-	18	-	-	107
1-19	-	-	4-19	-	-	-	1-19	-	-	
59 I	-	1 b	16 Sp	-	-	-	33	32 g	-	108
1-60	-	20-21	3-35	-	-	-	2-35	3-35	-	
6 I	-	-	3 Sp	-	-	-	6	-	-	109
1-7	-	-	4-7	-	-	-	1-7	-	-	
1 I	-	-	1	-	-	-	1	-	-	110
1-2	-	-	-1-1	-	-	-	1-2	-	-	
4 I	-	-	1	-	-	-	4	1 p	-	111
1-5	-	-	1-2	-	-	-	1-5	1-2	-	
72+ III	-	-	13 Sp	-	-	-	1 III	-	-	112
4-76+	-	-	1-21	-	-	-	2-3	-	-	
1 I	-	-	-	-	-	-	1	-	-	113
1-2	-	-	-	-	-	-	1-2	-	-	
-1	-	-	-	-1	-	-	-1	-	-	114
-1-1	-	-	-	-1-1	-	-	-1-1	-	-	

Table VI (Continued)

Test No.	Dosage mg/kg	Temp. °F	Sex	Result	Grams Wt.	Total Length of Reaction	Hyperexcitation	Tremors	Convulsions	Paraplegia	Minutes Before Vomiting
115	6.0	89	F	D	27.5	2	-	1 I -1-2	1 I 2-3	-	-
116	6.0	89	F	D	26.5	-1	-	-	-1 I -1-1	-	-
117	6.5	84	F	D	26.5	5	-	1 I 2-3	4 I 3-7	-	-
118	7.0	88	M	D	28.5	1	-	-	1 I 1-2	-	-
119	7.0	88	M	D	28.0	1	-	-	1 I 1-2	-	-
120	7.0	91	M	D	27.5	1	-	-	1 I 1-2	-	-
121	7.0	82	F	D	23.0	5	-	-	5 I 1-6	-	-
122	7.0	90	F	D	23.5	7	-	-	7 I 1-8	-	-
123	7.5	82	F	D	25.0	4	-	-	4 I 1-5	-	-
124	7.5	85	F	D	25.0	6	-	-	6 I 2-8	-	-
125	7.5	85	F	D	23.0	1	-	1 I 1-2	-	-	-
126	10.0	82	M	D	23.0	1	-	-	1 I 1-2	-	-
127	10.0	85	F	D	26.0	5	-	-	5 I 1-6	-	-
128	10.0	89	F	D	25.5	3	-	1 I 1-2	1 I 2-3	-	-
129	10.0	92	F	D	22.5	1	-	-	1 I 1-2	-	-
130	15.0	85	M	D	26.0	3	-	-	3 I 1-4	-	-
131	15.0	88	F	D	26.5	1	-	1 II 1-2	-	-	-
132	15.0	91	F	D	22.5	6	-	6 I 1-7	-	-	-
133	15.0	92	F	D	22.0	1	-	-	1 I 1-2	-	-
134	15.0	92	F	D	25.5	1	-	-	1 I 1-2	-	-
135	20.0	85	M	D	24.5	4	-	2 I 1-3	3 I 3-6	-	-
136	20.0	91	M	D	26.0	-1	-	-	-1 I -1-1	-	-
137	20.0	82	F	D	24.5	-1	-	-	-1 I -1-1	-	-
138	20.0	91	F	D	25.5	-1	-	-	-1 I -1-1	-	-
139	20.0	91	F	D	28.5	3	-	-	3 I 1-4	-	-
<u>Endrin:</u>											
140	1.4	65	M	D	25.0	2/62	2 III 60-62	-	-	-	-
141	1.5	65	F	D	23.0	31/92	4 III Sp 60-62 90-92	2 III 90-92	-	-	-
142	3.2	65	F	D	22.0	64/71	64 III 6-70	49 III 26-70	1 I 70-71	-	-
143	3.6	65	M	D	24.0	34/40	34	13 II 27-39	1 I 39-40	-	-

Sluggish Movements (Weakness)	Hypersensi- tive to Sound	Eye Reaction	Distress Calls	Wing Ataxia	Sight	Hearing	Loss Of		Response	Test No.
							Balance	Normal Respiration		
2 I	-	-	-	-	-	-	1	1 p	-	115
1-3	-	-	-	-	-	-	2-3	1-2	-	
-1 I	-	-	-	-	-	-	-1	-	-	116
-1-1	-	-	-	-	-	-	-1-1	-	-	
5 I	-	1 b	1	-	-	-	4	-	-	117
2-7	-	2-3	4-5	-	-	-	3-7	-	-	
1 I	-	-	-	-	-	-	1	1 p	-	118
1-2	-	-	-	-	-	-	1-2	1-2	-	
1 I	-	-	-	-	-	-	1	-	-	119
1-2	-	-	-	-	-	-	1-2	-	-	
1 I	-	-	-	-	-	-	1	-	-	120
1-2	-	-	-	-	-	-	1-2	-	-	
5 I	-	-	5	-	-	-	5	-	-	121
1-6	-	-	1-6	-	-	-	1-6	-	-	
7 I	-	-	6	-	-	-	7	-	-	122
1-8	-	-	2-8	-	-	-	1-8	-	-	
4 I	-	-	3	-	-	-	4	1 g	-	123
1-5	-	-	2-5	-	-	-	1-5	1-2	-	
6 I	-	-	4 Sp	-	-	-	6	-	-	124
2-8	-	-	3-8	-	-	-	2-8	-	-	
1 I	-	-	-	1	-	-	1	1 g	-	125
1-2	-	-	-	1-2	-	-	1-2	1-2	-	
1 I	-	-	1	-	-	-	1	-	-	126
1-2	-	-	2-2	-	-	-	1-2	-	-	
5 I	-	5 St	4	-	-	-	4	1 p	-	127
1-6	-	1-6	2-6	-	-	-	2-6	1-2	-	
2 I	-	1 b	-	-	-	-	1	-	-	128
-1-3	-	2-3	-	-	-	-	2-3	-	-	
1 I	-	-	-	-	-	-	1	1 g	-	129
1-2	-	-	-	-	-	-	1-2	1-2	-	
3 I	-	-	3	-	-	-	3	-	-	130
1-4	-	-	1-4	-	-	-	1-4	-	-	
1 II	-	-	-1	1 II	-	-	1	-	-	131
1-2	-	-	2-2	1-2	-	-	1-2	-	-	
6 I	-	-	4	6	-	-	6	-	-	132
1-7	-	-	1-5	1-7	-	-	1-7	-	-	
1 I	-	-	-	-	-	-	1	-	-	133
1-2	-	-	-	-	-	-	1-2	-	-	
1 I	-	-	-1	-	-	-	1	-	-	134
1-2	-	-	-1-1	-	-	-	1-2	-	-	
5 I	-	5 St	4	-	-	-	3	5 p	-	135
1-6	-	1-6	2-6	-	-	-	3-6	1-6	-	
-1 I	-	-	-	-	-	-	-1	-	-	136
-1-1	-	-	-	-	-	-	-1-1	-	-	
-1 I	-	-	-	-	-	-	-1	-	-	137
-1-1	-	-	-	-	-	-	-1-1	-	-	
-1 I	-	-	-	-	-	-	-1	-	-	138
-1-1	-	-	-	-	-	-	-1-1	-	-	
3 I	-	-	-	-	-	-	3 I	-	-	139
1-4	-	-	-	-	-	-	1-4	-	-	
-	-	-	-	-	-	-	-	-	-	140
2 III	-	-	-	-	-	-	2	-	-	141
90-92	-	-	-	-	-	-	90-92	-	-	
62 I	-	-	-	-	-	-	1	-	-	142
8-70	-	-	-	-	-	-	70-71	-	-	
32 II	-	-	-	-	-	-	1	-	-	143
8-40	-	-	-	-	-	-	39-40	-	-	

Table VI (Continued)

Test No.	Dosage mg/kg	Temp. °F	Sex	Result	Grams Wt.	Total Length of Reaction	Hyperexcitation	Tremors	Convulsions	Paraplegia	Minutes Before Vomiting
144	8.8	65	F	D	22.0	16/24	-	3 III Sp 19-24	-	-	21
145	9.0	65	M	D	21.5	7/13	-	2 III 10-12	1 III 12-13	-	-
146	17.0	65	F	D	28.5	10/20	1 III 10-11	-	7 I 13-20	7 13-20	-
147	17.5	65	M	D	24.0	7/15	1 III 10-11	2 II 13-15	-	-	8
148	26.0	65	F	D	23.5	14/18	1 III 4-5	1 I 10-11	7 I 11-15	-	8
149	27.0	65	M	D	26.0	12/16	4 II 4-8	-	1 I 15-16	-	-
150	33.0	65	F	D	21.0	14/18	10 IX 4-14	1 III 12-13	4 III 14-18	-	9, 12
151	35.0	65	M	D	22.5	8/13	5 II 5-10	1 I 11-12	1 I 12-13	-	8
152	39.0	65	M	D	27.5	10/15	6 I 5-11	-	5 I 10-15	-	14
153	41.0	65	F	D	25.5	25/35	-	6 I 15-21	14 I Sp 21-35	-	6(4) 10-14
154	85.0	65	F	D	27.0	15/20	10 I 5-15	-	6 I 14-20	-	12
155	90.0	65	M	D	21.5	12/17	-	1 I 15-16	1 I 16-17	1 16-17	6(3) 10-13
<u>Strychnine Sulfate</u>											
156	8.0	62	M	D	23.5	2/3	2 I 1-3	-	1 I 2-3	-	-
157	8.0	62	M	D	26.0	10/12	10 I 2-12	-	7 I 5-12	7 5-12	-
158	8.0	50	F	R	25.0	40/43	32 II 3-6 14-43	-	11 III 14-25	-	-
159	9.0	58	M	R	24.5	42/45	42 3-6 II 6-24 I 24-45 II	-	5 III 7-12	20 6-26	-
160	9.0	62	M	R	25.5	37/39	34 2-15 II 15-36 I	-	4 II 4-8	16 7-23	-
161	9.0	58	F	D	25.5	2/5	2 I 3-5	-	1 III 4-5	-	-
162	9.0	62	F	D	23.5	7/8	7 I 1-8	-	1 I 7-8	-	-
163	10.0	40	M	R	27.5	126/140	126 III 14-140	-	-	-	-
164	10.0	45	M	D	24.5	10/13	10 III 3-13	-	2 II 11-13	4 9-13	-
165	10.0	65	M	D	26.0	11/16	-	-	8 I 8-16	2 14-16	-
166	10.0	45	F	R	24.5	27/30	21 III 3-24	-	5 II 11-16	8 10-18	-
167	10.0	65	F	R	24.5	25/30	7 III 5-12	1 III 13-14	-	-	-
168	11.0	45	M	D	26.5	6/9	6 III 3-9	-	1 I 8-9	-	-
169	11.0	45	F	D	23.0	3/5	3 II 2-5	-	-	1 4-5	-
170	12.0	45	M	D	27.5	21/23	21 II 2-23	-	-	8 15-23	-
171	12.0	62	F	D	26.5	7/9	7 II 2-9	-	3 I Sp 6-9	-	-

Sluggish Movements (Weakness)	Hypersensi- tive to Sound	Eye Reaction	Distress Calls	Wing Ataxia	Sight	Hearing	Loss of Balance	Normal Respiration	Response	Test No.
16 II	-	-	-	-	-	-	-	1 p	-	144
8-24	-	-	-	-	-	-	-	7-8	-	
7 II	-	-	1	-	-	-	1	1 p	-	145
5-12	-	-	10-11	-	-	-	12-13	7-8	-	
-	-	-	1	-	-	-	7	1 p	-	146
-	-	-	18-19	-	-	-	13-20	13-14	-	
4 II	-	-	-	2	-	-	2	2 p	-	147
11-15	-	-	-	13-15	-	-	13-15	13-15	-	
1 II	-	-	2 Sp	-	-	-	7	-	-	148
10-11	-	-	11-17	-	-	-	11-18	-	-	
9 II	-	-	-	-	-	-	1	-	-	149
6-15	-	-	-	-	-	-	15-16	-	-	
-	-	-	-	-	-	-	4	1p	-	150
-	-	-	-	-	-	-	14-18	14-15	-	
3 II	-	-	1	-	-	-	1	-	-	151
10-13	-	-	12-13	-	-	-	12-13	-	-	
5 I	-	-	6 Sp	-	-	-	5	-	-	152
10-15	-	-	6-15	-	-	-	10-15	-	-	
25 I	-	-	2 Sp	-	-	-	14	-	-	153
10-35	-	-	23-29	-	-	-	21-35	-	-	
6 I	-	-	4 Sp	-	-	-	6	-	-	154
14-20	-	-	5-19	-	-	-	14-20	-	-	
12 I	-	-	1	-	-	-	1 I	-	-	155
5-17	-	-	10-11	-	-	-	16-17	-	-	
2 II	2 I	-	-	2	-	-	-	-	-	156
2-3	2-3	-	-	2-3	-	-	-	-	-	
7 I	6 I	-	3 Sp	8	-	-	-	4 Sp	-	157
5-12	6-12	-	6-10	4-12	-	-	-	3-11	-	
27 II	8 II	-	-	-	-	-	-	6 p Sp	-	158
14-41	17-25	-	-	-	-	-	-	17-36	-	
24 II	19 I	-	-	42	-	-	-	2 p	-	159
6-30	8-27	-	-	3-25 II	-	-	-	10-12	-	
-	-	-	-	25-35 III	-	-	-	-	-	
-	-	-	-	35-45 II	-	-	-	-	-	
36 II	27 I	-	1	31	-	-	-	5 pSp	-	160
4-40	2-29	-	9-10	6-12 II	-	-	-	3-28	-	
-	-	-	-	12-35 I	-	-	-	-	-	
-	-	-	-	35-37 III	-	-	-	-	-	
1 III	1 I	-	-	-	-	-	-	-	-	161
4-5	4-5	-	-	-	-	-	-	-	-	
3 I	6 I	-	-	6 I	-	-	-	-	-	162
5-8	2-8	-	-	2-8	-	-	-	-	-	
-	-	-	-	9 Sp	-	-	-	2 p	-	163
-	-	-	-	27-36	-	-	-	30-50	-	
8 I	-	-	1	7 III	-	-	-	-	-	164
5-13	-	-	12-13	6-13	-	-	-	-	-	
11 I	-	1 b	1	11	-	-	-	5 p	-	165
5-16	-	14-15	15-16	5-16	-	-	-	11-16	-	
25 I	-	-	-	20	-	-	-	-	-	166
5-30	-	-	-	5-21 II	-	-	-	-	-	
-	-	-	-	21-25 III	-	-	-	-	-	
12 II	-	-	-	6	-	-	-	1 p	-	167
13-25	-	-	-	19-25	-	-	-	13-14	-	
4 II	-	-	-	4	-	-	-	2 p	-	168
5-9	-	-	-	5-9	-	-	-	3-5	-	
1 II	-	-	-	1	-	-	-	-	-	169
4-5	-	-	-	4-5	-	-	-	-	-	
13 I	-	-	-	13	-	-	-	1 p	-	170
10-23	-	-	-	10-23	-	-	-	16-17	-	
4 I	-	-	-	4	-	-	-	2 p	-	171
5-9	-	-	-	5-9	-	-	-	7-9	-	

Table VI (Continued)

Test No.	Dosage mg/kg	Temp. °F	Sex	Result	Grams Wt.	Total Length of Reaction	Hyperexcitation	Tremors	Convulsions	Paraplegia	Minutes Before Vomiting
172	13.0	60	M	D	28.0	7/8	4 III 1-5	-	2 I 6-8	2 6-8	-
173	13.0	60	F	D	25.5	5/8	5 II 3-8	-	1 III 7-8	-	-
174	14.0	60	M	D	26.0	3/5	1 III 2-3	-	2 Sp II 3-5	-	-
175	14.0	60	F	D	22.5	6/8	3 II 2-5	-	5 II Sp 3-8	5 3-8	-
176	15.0	65	M	D	22.5	2/8	-	-	1 I 7-8	-	-
177	15.0	65	F	D	23.0	8/11	8 II 3-11	2 II 8-10	1 I 10-11	-	-
178	20.0	65	M	D	26.5	8/10	8 II 2-10	4 III 2-6	4 I 6-10	4 6-10	1 (blood)
179	20.0	65	F	D	27.5	5/7	-	-	2 I 5-7	2 5-7	-
180	25.0	46	M	D	25.5	-1/1	-	-	-1 I -1-1	-1 -1-1	-
181	25.0	46	F	D	24.5	8/12	-	-	4 I 7-11	4 7-11	-
182	25.0	46	F	D	24.5	7/12	-	-	4 I 8-12	5 7-12	-
<u>Sodium Monofluoroacetate - "1080"</u>											
183	*0.5	65	M	D	25.5	-24 Hr. (NCR)	-	-	-	-	-
184	0.5	65	M	D	26.5	363	3 III 17-20	1 II 362-363	-	-	-
185	*0.5	65	F	D	24.5	-48 Hr. (NCR)	-	-	-	-	-
186	0.5	65	F	D	25.0	403	-	-	-	-	-
187	1.0	65	M	D	29.0	405+	-	-	-	-	-
188	1.0	65	F	D	25.5	440	-	-	-	-	-
189	1.5	65	M	D	25.0	305	5 III 5-10	3 Sp III 285-305	-	-	-
190	1.5	65	F	D	26.0	390	1 II 5-6	1 III 389-390	-	-	-
191	*2.0	65	M	D	26.5	(NCR)	? II 27-?	-	-	-	-
192	*2.0	65	F	D	25.5	(NCR)	? 15-?	-	-	-	-
193	3.0	65	M	D	26.5	225	48 III 12-60	-	-	-	-
194	*3.0	65	F	D	24.5	(NCR)	II 15-?	-	-	-	-
195	*5.0	65	M	D	25.5	(NCR)	-	-	-	-	-
196	*5.0	65	F	D	25.5	(NCR)	II 1-?	-	-	-	-
197	10.0	65	M	D	26.5	42/45	-	1 I 44-45	-	-	-
198	*10.0	65	F	D	24.5	(NCR)	? 3-?	-	-	-	-
199	*15.0	65	F	D	27.5	(NCR)	? 17-?	-	-	-	-
200	*15.0	65	F	D	25.5	(NCR)	? I 2-?	-	-	-	-

Table VI (Continued)

Test No.	Dosage mg/kg	Temp. °F	Sex	Result	Grams Wt.	Total Length of Reaction	Hyperexcitation	Tremors	Convulsions	Paraplegia	Minutes Before Vomiting
<u>Dichloro-diphenol-trichloroethane - "DOT"</u>											
201	*200.0	65	M	D	25.5	-48 Hrs. (NCR)					
202	*300.0	65	M	R	28.0	(NCR)					
203	300.0	75	M	D	25.5	913	694 III 15-709	206 III,II 709-907 907-913	-	-	-
204	325.0	75	M	D	24.0	800	550	230 Sp 570-800	-	-	-
205	335.0	75	M	D	24.0	1270	30-580 530 Sp 590-1120	120 Sp 1150-1270	-	-	-
206	*350.0	65	M	D	25.0	-24 Hrs. (NCR)					
207	350.0	75	M	D	26.0	1312	585 605-1190	90 1225-1315	-	-	-
208	350.0	75	F	D	24.0	350	-	195 155-350	-	-	-
209	375.0	75	M	D	25.0	960	165 Sp 735-900	-	-	-	-
210	*400.0	65	M	D	28.0	-24 Hrs. (NCR)					
211	400.0	75	F	D	21.5	290	35 75-110	215 Sp 75-290	-	-	-
212	450.0	75	F	D	25.0	1207	50 740-790	190 1020-1210	-	-	-
<u>Zinc Phosphide</u>											
213	* 21.0	65	F	D	25.5	-48 Hrs. (NCR)					
214	22.7	75	M	R	26.0	1230	815 Sp 415-1230	-	-	-	-
215	22.7	75	F	D	24.0	1080	-	15 Sp 1065-1080	-	-	-
216	* 23.0	65	M	D	23.5	-24 Hrs. (NCR)					
217	* 45.0	65	F	D	26.5	-24 Hrs. (NCR)					
218	* 46.0	65	M	R	26.0	(NCR)					
219	50.0	75	M	D	28.0	825	-	5 III 820-825	-	-	-
220	50.0	75	F	D	22.0	340	-	10 330-340	-	-	-
221	* 88.0	65	F	R	26.0	(NCR)					
222	* 93.0	65	M	D	29.5	-24 Hrs. (NCR)					
223	93.0	75	M	D	24.5	925	-	25 900-925	-	-	-
224	97.0	75	F	D	23.5	670	-	-	-	-	-
225	127.0	75	M	D	25.0	565	-	5 Sp 560-565	-	-	-
226	*137.0	65	M	D	26.5	-48 Hrs. (NCR)					
227	139.0	75	F	D	23.0	1290	-	60 Sp 1230-1290	-	-	-
228	*140.0	65	F	R	26.0	(NCR)					

Table VI (Continued)

Test No.	Dosage mg/kg	Temp. °F	Sex	Result	Grams Wt.	Total Length of Reaction	Hyperexcitation	Tremors	Convulsions	Paralysis	Minutes Before Yessing
229	178.0	75	M	D	23.0	600	-	20 Sp 580-600	-	-	-
230	182.0	75	F	D	25.0	1170	-	55 Sp 1115-1170	-	-	-
231	*185.0	65	M	D	27.0	-48 Hrs. (NCR)					
232	*188.0	65	F	D	26.5	-5 Days (NCR)					
233	*215.0	65	M	D	27.5	-24 Hrs. (NCR)					
234	*221.0	65	F	R	22.5	(NCR)					
235	224.0	75	M	D	26.5	1150	-	-	-	-	-
236	224.0	75	M	D	26.5	1385	360 Sp 750-1110	-	-	-	-
237	224.0	75	F	D	26.5	1420	460 840-1300	-	-	-	-
238	238.0	75	F	D	23.0	530	-	30 Sp 500-530	-	-	-
<u>Thallium(ous) Sulfate</u>											
239	* 33.0	65	F	R	26.5	(NCR)					
240	33.8	75	M	D	24.0	540	-	-	-	-	-
241	* 34.4	65	M	R	29.5	(NCR)					
242	35.0	75	F	D	25.5	740	-	35 705-740	-	-	-
243	* 64.0	65	F	R	27.5	(NCR)					
244	* 66.5	65	M	D	25.5	-48 Hrs. (NCR)					
245	68.0	75	F	D	25.0	895	-	25 870-895	-	-	-
246	77.0	75	M	D	24.0	490	-	-	-	-	-
247	*121.0	65	M	R	28.0	(NCR)					
248	*132.0	65	F	R	24.5	(NCR)					
249	138.0	75	M	D	24.5	1080	-	-	-	-	-
250	138.0	75	F	D	24.5	1350	-	-	-	-	-
251	*172.0	65	M	D	25.5	-48 Hrs. (NCR)					
252	*200.0	65	F	R	24.5	(NCR)					
253	203.0	75	M	D	30.0	1095	-	-	-	-	-
254	212.0	75	F	D	25.5	1165	-	2 Sp 1135-1165	-	-	-
255	260.0	75	M	D	26.0	1555	615 535-1150	20 1535-1555	-	-	1455
256	281.0	75	F	D	21.5	770	-	5 Sp 765-770	-	-	-

Sluggish Movements (Weakness)	Hypersensi- tive to Sound	Eye Reaction	Distress Calls	Wing Ataxia	Sight	Hearing	Loss Of		Responses	Test No.
							Balance	Normal Respiration		
80	-	-	-	20 Sp	-	-	80	40	90	229
520-600	-	-	-	580-600	-	-	520-600	560-600	520-600	
55	-	-	-	55 Sp	-	-	55	50	55	230
1115-1170	-	-	-	1115-1170	-	-	1115-1170	1120-1170	1115-1170	231
										232
										233
										234
795	-	-	-	-	-	-	20	25	25	235
355-1150	-	-	-	-	-	-	1130-1150	1125-1150	1125-1150	
1005 Sp	-	-	-	325	-	-	-	105	1005 Sp	236
380-750	-	-	-	1060-1385	-	-	-	1280-1385	380-750	
1280-1385	-	-	-	-	-	-	-	1280-1385	1280-1385	
120	-	-	-	-	-	-	65	90	120	237
1300-1420	-	-	-	-	-	-	1355-1420	1330-1420	1300-1420	
180	-	-	-	-	-	-	55	30	180	238
350-530	-	-	-	-	-	-	475-530	500-530	350-530	
										239
180	-	-	-	10	-	-	-	15	180	240
360-540	-	-	-	530-540	-	-	-	525-540	360-540	241
										242
180	-	-	-	35	-	-	40	40	40	243
560-740	-	-	-	705-740	-	-	700-740	700-740	700-740	244
										245
40	-	-	-	25	-	-	25	40	40	246
855-895	-	-	-	870-895	-	-	870-895	855-895	855-895	247
290	-	-	-	-	-	-	-	290	290	248
200-490	-	-	-	-	-	-	-	200-490	200-490	249
										250
15	-	-	-	-	-	-	-	-	15	251
1065-1080	-	-	-	-	-	-	-	-	1065-1080	
825	-	-	-	-	-	-	825	15	825	252
525-1350	-	-	-	-	-	-	525-1350	1335-1350	525-1350	253
										254
15	-	-	-	-	-	-	-	15	15	255
1080-1095	-	-	-	-	-	-	-	1080-1095	1080-1095	
70	-	-	-	2 Sp	-	-	-	30	70	256
1095-1165	-	-	-	1135-1165	-	-	-	1135-1165	1095-1165	
405	-	-	-	-	-	-	90	50	405	257
1150-1555	-	-	-	-	-	-	1465-1555	1505-1555	1150-1555	
310	-	-	-	-	-	-	50	50	310	258
460-770	-	-	-	-	-	-	720-770	720-770	460-770	

Table VI (Continued)

Test No.	Dosage mg/kg	Temp. °F	Sex	Result	Grams Wt.	Total Length of Reaction	Hyperexcitation	Tremors	Convulsions	Paraplegia	Minutes Before Vomiting
257	*318.0	65	M	D	25.5	-48 Hrs. (NCR)					
258	*318.0	65	F	R	25.5	(NCR)					
259	*331.0	65	M	D	26.5	-48 Hrs. (NCR)					
260	*332.0	65	F	R	24.5	(NCR)					
261	360.0	75	M	D	22.5	375	-	1 375-375	-	-	-
262	360.0	75	F	D	22.5	700	210 Sp 485-695	-	-	-	-

TABLE VII

A COMPARISON OF THE AVERAGE LENGTH IN MINUTES OF THE APPARENT
REACTION OF MALE AND FEMALE STARLINGS TO P 2133
AT GIVEN TEMPERATURES

(Dosage rounded to the nearest whole number)

Dosage mg/kg	Temperature in F							
	Males				Females			
	65 - 70	75	80	85	65 - 70	75	80	85
2.0	R 3							R 12
4.0	R 39			R 61				D 20
5.0					R 33	D 43		
6.0		D 10	D 18	D 13				
8.0		D,R 12 (9-16)	D 9		R 20			
10.0				D 5 (-1-8)	R 48			
11.0		D 9						
Total No. Tested	2	4	3	5	3	1	1	1

TABLE VIII

A COMPARISON OF THE AVERAGE LENGTH IN MINUTES OF THE APPARENT REACTION OF MALE AND FEMALE HOUSE SPARROWS TO P 21.33 AT GIVEN TEMPERATURES

Dosage mg/kg	Temperatures in F									
	Males					Females				
	66-71	77-81	82-85	86-90	91-95	66-71	77-81	82-85	86-90	91-95
0.14							R 2			
0.5							R 15 (5-25)			
0.75		R 50					R 8			
1.0		R 7	R 12				R 17	R 6 (3-9)	R 6	
1.25							R 11			
1.5	R 18				R 42		R 13 (12-14)			
1.75		R 25								
2.0	R 27 (2-29)	R 28 (25-32)	R 20 (14-26)	D 7			R,D 12.6 (2-25)	R 7		D 166
2.5							R 33 (8-63)			
3.0		D 2	R,D 10 (1-19)	D 6 (2-12)		D 12	R 55		R 90	R,D 29 (7-70)
3.5	R 49						R 43 (26-60)			
3.75	D 1									
4.0	4.5 R-8 D-1			D 4	R,D 47 (45-49)	R 68 (7-115)		D 5 (1-9)	R 33	
4.5	R 81							R,D 8 (1-14)		
5.0	D 14.5 (1-28)		D 8	D 2 (1-4)		D 19		R,D 7 (1-18)		

Table VIII (Continued)

Dosage mg/kg	Temperature in F									
	Males					Females				
	66-71	77-81	82-85	86-90	91-95	66-71	77-81	82-85	86-90	91-95
5.5				R 6				D 18		
6.0			R 59	D 6	D 1				R,D 14 (-1-76)	
6.5								D 5		
7.0				D 1	D 1			D 5	D 7	
7.5								D 4 (4-6)		
10.0			D 1					D 5	D 3	D 1
15.0			D 3						D 1	D 3 (1-6)
20.0			D 4		D-1			D-1		D 2 (-1-3)
Total No. Tested	10	6	10	12	6	5	17	23	12	10

TABLE IX

A COMPARISON OF THE AVERAGE LENGTH IN MINUTES OF THE APPARENT REACTION OF MALE AND FEMALE HOUSE SPARROWS TO STRYCHNINE SULFATE AT GIVEN TEMPERATURES

Dosage mg/kg	Temperature in F			
	Males		Females	
	40-50	55-65	40-50	55-65
8.0		D 6 (2-10)	R 40	
9.0		R 39 (37-42)		D 5 (2-7)
10.0	R, D 68 (D=10)(R=126)	D 11	R 27	R 25
11.0	D 6		D 3	
12.0	D 21			D 7
13.0		D 7		D 5
14.0		D 3		D 6
15.0		D 2		D 8
20.0		D 8		D 5
25.0	D-1		D 8 (7-8)	
Total No. Tested	5	9	5	8

VITA

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