

EXPERIMENTAL LEAD POISONING OF BOBWHITE QUAIL AND MOURNING DOVES

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INTRODUCTION

Lead poisoning as a mortality factor of waterfowl in North America was recognized as early as 1874 (Phillips and Lincoln, 1930). Since then there have been numerous investigations concerning this problem. These studies have shown that large numbers of our waterfowl succumb to lead poisoning each year.

This study was initiated to determine if quail and doves may be encountering a similar situation. With the growing number of hunters, our hunting areas will have an increasing amount of lead shots on them each year.

Managed dove fields grow in popularity each season and many hunters frequent these small areas. Billions of lead shots fired from shotguns fall on these areas each year. Large concentrations of lead shots may be present on some of our fields. Some of our doves and quail are eating these shots.

Investigators located lead shots in several quail crops during quail food habits studies in Alabama (this author) and Oklahoma (C. J. Barstow, personnel communication, 1966). No holes were apparent in the crop walls except where the esophagus and proventriculus were severed. It is believed that these shots were swallowed by the quail while feeding.

Stoddard (1931) reported many young quail died in propagating pens which were situated on grounds where trap shooting had been carried on. Dissections showed that a single small shot retained in the gizzard with the grinding material was sufficient to cause death from lead poisoning. Birds up to 41 days of age were lost from this cause over ground where shooting had been heavy. Stoddard further reported that two young wild quail found dead in the field were dissected. A flattened lead shot was found in the gizzard of one of these chicks.

Stoddard reported only one record of an adult Bobwhite dying from lead poisoning. This quail was picked up afield in a partially paralyzed condition and was very thin and weak. Examination of the quail revealed two worn lead shots in the gizzard and the usual appearance of lead poisoning.

During his investigations, Stoddard experimentally fed one or two lead shots at a time, both smooth and battered to several adult Bobwhites. Negative results were reported from this experiment.

McClure reported juvenile mourning doves killed by storms were examined and lead pellets were in their gizzards. The lead pellets were apparently fed to the doves by the parents. The pellets were worn down to much smaller than their original size. (Discussion by Dr. H. Elliott McClure, Dr. Cheatum and Mr. Jordon during the Fifteenth North American Wildlife Conf., p. 169.)

Locke and Bagley (1967) reported a case of lead poisoning in one dove found in a weakened condition. They also located lead shots in the gizzards of 4 hunter-killed doves.

Sick chickens taken to a diagnostic laboratory were examined and a number of lead pellets were located in their gizzards (Shifrine, Steck and Kusch, 1964). Further investigations showed that some chickens were also obtaining traces of lead by drinking water from troughs with lead-soldered seams.

Fuchs (1842) reported that chickens, turkeys and doves are likewise, although to lesser extent than waterfowl, susceptible to the injurious effects of lead poisoning.

The sperm of male chickens and rabbits is affected adversely by lead poisoning. Offspring of rabbits and chickens which had ingested lead

acetate had a lower average vitality and were smaller in average size than normal offspring of unpoisoned males (Cole and Bachhuber, 1914).

If quail and doves in the field do succumb to lead poisoning the probability of locating their bodies would be very small. Due to predator activity most sick birds would probably be eaten before they died. Coloration and size of these birds would also hinder the possibilities of noticing their bodies in the type of habitat in which they live.

This study was initiated because of the lack of knowledge of the effects of lead poisoning on quail and doves.

Materials and Methods: Bobwhite quail (*Colinus virginianus*) were furnished for this project by Buffalo Spring Experimental Bird Farm and Napier Game Farm.

Seven groups of quail of various ages were used in the study. Six of these groups were held in outdoor pens with wire bottoms. Shelter was provided in the pens. Cedar and pine trees were placed in the pens for cover. These pens were located within a six-foot-high poultry wire enclosure which was surrounded by an electric wire fence to minimize disturbances by animals. One group of young birds was placed in wire cages located in a brooder house with controlled temperature.

Cages were numbered one through seven and quail in them designated as groups I through VII. Group I through IV were adult quail with sexes approximately evenly distributed. Groups V through VII consisted of young quail with ages ranging from 8 to 66 days.

A diet of commercial game bird mash, cracked corn, wheat, milo millet and water was provided ad libitum for Groups I through V and VII. Crushed oyster shells and slag were provided for grit. Group VI was fed commercial game bird mash with no grit for 25 days and then mixed seeds were added for 15 additional days.

All quail were held in their cages 8 days or longer to allow them to become adjusted to their new environment before they were exposed to lead.

After adjustment periods, birds were banded with numbered aluminum leg bands and colored tape and weighed. Four colors of plastic tape were used, each color indicating the number of pellets ingested so birds could be identified in pens without handling them.

Quail were force-fed predetermined numbers of lead shots (nos. 6 and 7½). Some shots had been on the ground several weeks to simulate field conditions and some were new. The quails' beaks were held open and shots were placed into the esophagus openings with small forceps. The birds' throats were massaged to insure swallowing after each shot was force-fed.

Birds were observed daily after exposure to lead. Records were made of their behavior. All birds which died were autopsied to determine if any shots could be located in their crops, gizzards or intestines. Surviving quail from Groups I through IV were studied further to determine if their fecundity, fertility or hatchability was affected by the lead they were exposed to. Some quail were removed from each group to reduce the number of birds per cage in an effort to make nesting conditions more suitable. Nests were placed in the cages. The results were recorded.

Eggs were collected daily and records kept on production. Eggs were delivered biweekly to Buffalo Springs Experimental Bird Farm for incubation. Records were kept concerning the fertility of the eggs, number of birds hatching normal, number of birds hatching deformed and number of fertile eggs failing to hatch.

A shallow wooden box (3 x 3 ft.) was filled with soil and placed in a pen with 8 quail. Lead shots from 2 number 7½ shotgun shells were scattered over the surface of the soil. The quail were observed to determine if they would freely ingest the shots.

Six quail were force-fed lead shots and confined in small cages. Sheets of paper were placed under the cages to catch all droppings. Papers were changed daily. Droppings were analyzed to determine the number and condition of shots which passed through the digestive system and the time required for passage.

Eight quail were force-fed an average of 13 lead shots (no. 7½). Blood samples were drawn from the brachial vessels of each of these quail and from eight quail that had not been exposed to lead. A chemical analysis was made of the samples to compare quantities of lead in the blood.

Mourning doves (*Zenaidura macroura*) used in this study were trapped by the project leader.

The doves were held in 4 cages as described by Hanson and Kossack (1963:87). The cages were lined with burlap cloth to prevent injuries caused when the doves flew into the wire sides. The cages were located in the fenced enclosure with the quail pens. A food mixture consisting of wheat, millet, sorghum, corn, various kinds of weed seeds and cod liver oil (one tablespoon per 5 lbs. of grain) was provided ad libitum. Crushed oyster shells, sand and fine gravel were provided for grit. Water was available at all times.

Thirty doves were placed in pens for 14 days to allow them time to become better adjusted to their new environment before they were exposed to lead. After adjustment periods, they were banded with aluminum leg bands and weighed.

The doves were force-fed predetermined numbers of lead shots (no. 7½). Some shots had been placed on the ground several weeks previously to simulate field conditions and some were new. The doves were closely observed for one month after exposure to lead. Records were kept concerning their behavior. All doves which died were autopsied and the results recorded.

Four doves were force-fed small numbers of lead shots to study any effects of small quantities of lead on them. They were removed from the large cages and confined in a cardboard box (3 x 3 x 3 feet) with a transparent plastic window. The doves did not injure themselves in the box and they could be observed more easily and often. The observation box was placed in my office for convenience and because of adverse weather. A 75-watt light bulb was suspended near the top of the box. The room lights could be turned off and the doves observed without their knowledge.

Four doves were force-fed lead shots and confined in a small cage. Sheets of paper were placed under the cage to catch all droppings. Papers were changed daily. Droppings were analyzed to determine the number and condition of shots which passed through the digestive systems and the time required to pass through.

Lead shots were placed in food containers in an observation box with three doves. Close observations were made on these birds to determine if they would freely ingest the shots. Records were kept concerning their behavior.

Findings:

Physical data and symptoms of quail experimentally fed lead shots: Group I Twenty-four adult quail were force-fed from 1 to 4 lead shots (no. 7½) on November 23, 1965. All quail appeared normal during the 30-day observation period. No noticeable symptoms of lead poisoning occurred. Food and water consumption remained normal.

One quail which ingested four lead shots was sacrificed after 15 days for autopsy. Lead shots were not located in the digestive system nor were any symptoms of lead poisoning evident.

One female quail which had ingested two shots escaped but was observed in the vicinity of the pens several times during the following months.

Group II. Fifteen adult quail were force-fed from 15 to 100 lead shots (nos. 6 and 7½), on March 21, 1966. They were closely observed and weighed five times during the following 25 days. Ten of these quail exhibited varying degrees of sickness and three died. Physical data concerning each quail is shown in Table 1.

TABLE 1—PHYSICAL DATA ON 15 ADULT QUAIL EXPERIMENTALLY FORCE-FED LEAD SHOTS ON MARCH 21, 1966 (GROUP II).

Number	Quail Sex	No. of Lead Shots		Weight (ounces)				Days to Overt Signs	Days to Death	
		Original	Autopsy	Original	5th Day	11th Day	15th Day			24th Day
1	F	15	..	6.00	6.00	5.25	5.12	5.75	7	..
2	F	20	..	5.50	5.00	5.25	5.00	5.50	0	..
3	M	25	..	6.25	6.25	6.25	6.00	6.25	0	..
4	M	25	..	5.75	5.25	5.75	5.75	5.75	5	..
5	F	25	7	6.00	4.75	3.12	..	..	4	11
6	F	25	4	5.75	5.50	4.75 ¹	4.50	..	7	13
7	M	35	..	6.00	6.00	5.75	5.50	5.50	0	..
8	F	35	..	5.75	5.25	5.50	5.50	5.75	5	..
9	M	40	..	6.00	6.00	6.00	6.00	6.25	0	..
10	F	45	..	6.50	6.50	6.50	6.25	6.50	0	..
11	M	50	..	6.50	6.00	6.25	6.50	6.75	4	..
12	F	50	..	6.50	6.50	6.25	6.00	6.50	7	..
13	M	65	24	6.50	6.00	4.75	3.80 ²	..	5	14
14	M	75	..	7.00	6.50	5.75	5.90	6.50	5	..
15	M	100	..	6.50	6.25	4.90	5.25	4.75	5	..

¹ Weight on 13th day.

² Weight on 14th day.

Overt signs of lead poisoning in experimental quail included weakness, lethargy, diarrhea, and loss of weight. The desire for food appeared normal even though at times sick birds could hardly stand at the food containers. Sick birds continued to eat until they were unable to move to the trays. The first overt signs of sickness was lethargy, which was noticeable in two quail on the fourth day after shots were ingested (Table 1). Sickness was evident in other birds on days 5 and 7. Birds remained sick for an average of 5 days. Birds which died remained sick an average of 8 days. The first death occurred 11 days after shots were ingested. Birds which became sick, but recuperated, lost an average of 13 percent of their original body weight. Weight losses were regained after recuperation. Prior to death, birds lost an average of 36 percent of their original body weight.

Autopsy findings of experimentally poisoned quail included full crops and gizzards, roughened and dark green to dark brown stained gizzard linings, and intestines full of watery, dark brown fecal matter. In some cases, lead shots, worn varying amounts, were located in gizzards and intestines of birds autopsied.

Group III. Nine quail were force-fed 5 lead shots each and 9 received 6 shots each (nos. 6 and 7½) at various times during a 5-month period. Two quail exhibited overt symptoms of lead poisoning and died. None of the other birds in this group showed signs of sickness (Table 2).

TABLE 2—PHYSICAL DATA ON 18 ADULT QUAIL EXPERIMENTALLY FORCE-FED LEAD SHOTS (GROUP III).

Quail		No. of Lead Shots		Weight (ounces)		Days to Overt Signs	Days to Death	
Sex	Number	Date	Original	Autopsy	Original			Death
1	F	12/ 2/65	6	..	5.75	..	0	..
2	M	12/ 2/65	6	..	6.00	..	0	..
3	F	12/ 3/65	6	..	5.75	..	0	..
4	F	12/ 3/65	6	..	6.00	..	0	..
5	F	12/ 3/65	6	0	5.75	3.00	9	32
6	F	12/ 3/65	6	..	5.00	..	..	..
7	M	12/ 8/65	5	..	6.00	..	..	..
8	M	12/ 8/65	5	..	6.25	..	..	..
9	F	12/ 8/65	5	0	5.75	5.00	(Killed by other quail)	
10	F	12/ 8/65	5	..	6.00	..	..	..
11	F	4/28/66	5	2	6.00	3.50	9	20
12	F	4/28/66	5	..	5.75	..	..	..
13	F	4/28/66	5	..	5.50	..	..	..
14	F	4/28/66	6	..	5.75	..	..	..
15	M	4/28/66	5	..	6.00	..	..	..
16	F	4/28/66	6	..	6.00	..	..	..
17	M	4/28/66	5	..	6.00	..	..	..
18	F	4/28/66	6	..	6.00	..	..	..

The first apparent signs of lead poisoning and autopsy findings were similar to those described previously for Group II. The first signs of sickness occurred after 9 days and the first death occurred 20 days after shots were ingested. These birds lost an average of 44 percent of their original body weight prior to death.

Group IV. These 24 quail served as the control group for this phase of the study. None of these birds became sick or died during the study.

Group V. Fifty immature quail (21 were 43 days old; 19 were 55 days old; 10 were 66 days old) with sexes approximately evenly distributed were force-fed from 1 to 15 lead shots (no. 7½) on August 19, 1966. All quail appeared normal during the observation period.

Group VI. Forty immature quail (four groups of 10 birds each with ages of 8, 15, 21, and 33 days) were force-fed from 1 to 7 lead shots (no. 7½) on June 5, 1966. A diet of game bird mash was fed to this group for 25 days and then mixed grains and mash were fed for 15 additional days. Twelve of these birds exhibited signs of sickness and 10 died. Three of them died after being without water for 15 hours. Their water jar had been accidentally knocked over.

These 10 birds were autopsied and their gizzards contained the same number of shots as had been force-fed. Two quail died on the 3rd day; 3 on the 14th day; 2 on the 15th day; and one each on the 32nd, 33rd and 35th days after ingesting lead shots. Six of the birds gained weight prior to death.

Illness was not apparent in these birds between the 15th and 25th day following feeding. On the 25th day mixed grains were added to their diet. On the 29th day three more birds appeared sick. These died on days 32, 33 and 35.

Group VII. Eleven immature quail (5 were 25 days old; 6 were 35 days old) were force-fed from 1 to 16 lead shots (no. 7½) on July 18, 1967. Five became sick and one died on day 5 post exposure.

Egg production results for quail experimentally fed lead shots: Fifty-seven quail from Groups I through IV used in earlier phases of this study remained separated in four pens according to the number of lead shots they had ingested. Nests were placed in the pens. Eggs were collected each day for 87 days and records kept on production. All birds had the same diet throughout the experiment. Table 3 shows the

TABLE 3—EGG PRODUCTION RESULTS FOR QUAIL EXPERIMENTALLY FED LEAD SHOTS (NOS. 6 AND 7½).

	Group I	Group II	Group III	Group IV
Number of quail	5 cocks 10 hens	5 cocks 5 hens	5 cocks 10 hens*	5 cocks 12 hens
Number lead shots ingested	1-4	15-100	5-7	None
Eggs produced	407	250	475	552
Avg. eggs/hen	40.7	50.0	48.7	46.0

*Nine hens during last 26 days.

sex and number of quail in each pen, number of lead shots ingested, total number of eggs produced, and average number of eggs per hen by groups.

Average egg production for penned quail under normal conditions is 75 eggs per laying season at Buffalo Springs Experimental Bird Farm (Ballinger, 1967). Unusual disturbances normally cause a decrease in production. The quail in this experiment were caught, placed in transfer crates for approximately 23 hours and moved to a new location. Egg production was halted for four days and gradually returned to normal by the end of the 14th day after the move. Egg collection was also terminated approximately 30 days prior to the end of the normal laying season.

Hatching results of quail eggs laid by quail experimentally fed lead shots: Eggs collected daily were placed in incubators bi-weekly. Normal incubation methods were followed.

Records were kept concerning the number of eggs incubated, number of fertile eggs, and hatching data (Table 4).

Normal birds (Group IV) exceeded the leaded birds in fertility, hatchability, and percentage of chicks hatching normal. The three groups of leaded birds did not differ appreciably in fertility, hatchability or chicks hatching normal.

Free choice ingestion of lead shots by quail: Eight quail were observed for an hour immediately after lead shots (no. 7½) were scattered over the surface of soil in their pen. All eight quail readily pecked at the shots and swallowed some. Three of these quail became sick within five days, one of which died on the 15th day after exposure to lead.

The sick quail exhibited symptoms similar to those previously described. Autopsy revealed the crop was full of food and 10 slightly worn shots were in their gizzards.

Results of analyses of quail feces: Four quail were force-fed five lead shots each and two quail were fed one shot each (no. 7½). The birds were placed in two small cages with wire bottoms. Sheets of paper were placed under the cages to catch all droppings for 23 days. The paper was changed daily and the accumulated fecal matter analyzed to locate lead shots which passed through the quails' digestive systems. Results of the analysis is shown in Table 5. Figure I is a photograph of shots located during analysis.

Six shots were not located during the analysis. They may have been overlooked because they were worn to a small size.

During the 23 days the quail were observed at least once each day. None exhibited symptoms of lead poisoning although some shots were worn small in their digestive systems.

TABLE 4—HATCHING RESULTS OF EGGS LAID BY QUAIL EXPERIMENTALLY FED LEAD SHOTS.

Group	Eggs Incubated		Fertile Eggs					Infertile Eggs		Chicks		
	Total Number	Number Broken	Total	Percent	Percent Hatched	Percent Not Hatching	Percent Hatched Normal	Total	Percent	Normal	Deformed	
I	407	13	341	86.6	88.5	39	11.4	85.6	53	13.4	292	10
II	247	13	210	89.7	86.6	28	13.3	81.9	24	10.3	172	10
III	471	16	384	84.4	88.0	46	11.9	83.5	71	15.6	321	17
IV	532	35	455	91.5	93.4	30	6.5	90.1	42	8.5	410	15
Total	1,662	82	1,390			143			190			52

TABLE 5—RESULTS OF ANALYSIS OF QUAIL FECES FROM 6 QUAIL FORCE-FED 22 NO. 7½ LEAD SHOTS ON DECEMBER 8, 1965.

No. days since shots ingested	No. shots located in feces	Approximate amount of shot deterioration
4	1	No noticeable deterioration
5	2	No noticeable deterioration
6	2	No noticeable deterioration
7	3	No noticeable deterioration on 2 shots. One shot worn slightly
10	2	Both worn to ½ size
11	2	Both worn to 1/3 size
12	2	One shot worn to 1/3 size. One worn to ¼ size
22	2	Both worn to 1/6 size

Results of chemical analyses of quail blood: Eight adult quail (4 males and 4 females) were force-fed an average of 12.5 lead shots each. Nine days later, blood samples (1.25cc.) were drawn from the brachial vessels of each of these quail and from eight quail which had not been exposed to lead. Data from previous phases of this study indicated most quail which became sick exhibited severe symptoms of lead poisoning 9 days postexposure. Individual samples in each group were combined to have adequate amounts of blood for chemical analysis.

A chemical analysis of the samples was made to compare quantities of lead in the blood of the two groups. Normal lead levels in quail were found to be 0.03 milligrams per 100 grams of blood. Normal lead levels in geese is approximately 0.026mg/100g (Cook and Trainer 1966:5) and in man 0.05mg/100g blood (Kozelka and Kluchesky 1941:493). Lead levels in the lead-poisoned quail were found to average 4.30 milligrams per 100 grams of blood. Cook and Trainer (1966) reported the lead levels of blood of lead-poisoned geese reached a peak between the third and tenth day, and ranged from 0.320-1.680 milligrams per 100 grams. In their study, all nine geese with lead levels reaching these amounts died. One male quail which had ingested 15 shots died 24 days later. Lead poison symptoms were obvious on day 11 postexposure. Autopsy revealed six slightly worn shots in the gizzard and the usual signs of lead poisoning. No symptoms were evident in the other seven birds.

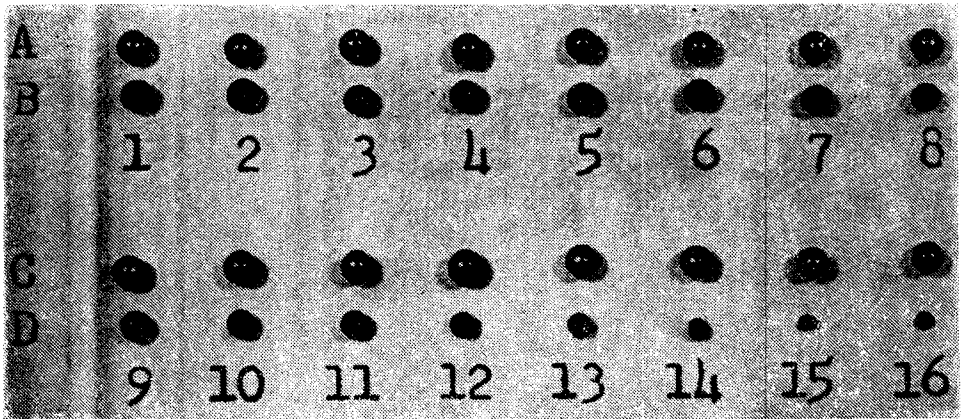


Figure 1 — Erosion of No. 7½ lead shot located during quail fecal analysis: Lines A and C show normal No. 7½ shots for comparison; Lines B and D show No. 7½ shots which passed thru the quails' digestive systems. (1) 4th day; (2-3) 5th day; (4-5) 6th day; (6-8) 7th day; (9-10) 10th day; (11-12) 11 day; (13-14) 12th day; (15-16) 22nd day.

Physical data and symptoms for doves experimentally fed lead shots: Thirty doves were force-fed 1 to 35 lead shots (No. 7½). One female dove was force-fed 35 lead shots on March 8, 1966. Six days later the bird died. No overt lead poisoning symptoms were apparent prior to death. Original weight was 4 ounces. Weight at death was 2.75 ounces. The crop was approximately one-fourth full. The gizzard lining and contents were dark green. One slightly worn shot was located in the gizzard. Other parts of the digestive system appeared normal.

Eleven doves were force-fed shots on September 16, 1966. Eight of them died during the 30-day observation period. Autopsies were made of each dead bird and the information recorded. Physical data concerning these doves is shown in Table 6.

Eighteen doves were force-fed shots on June 16, 1967. Only four showed signs of sickness and two of these died during the observation period. Autopsies were made of dead birds and the information recorded (Table 6).

Symptoms of lead poisoning in experimental doves included loss of weight, weakness, and lethargy. Diarrhea was apparent in some cases. Captured doves are extremely nervous and the weakness symptom was difficult to observe until the sick doves were too weak to fly. The first overt signs of sickness occurred on the fourth day and the first death occurred on the sixth day after shots were ingested (Table 6.)

Four doves were force-fed from 1 to 3 lead shots on January 26, 1966. They were closely observed and weighed five times during the following 23 days. Observations continued for 45 days. None of these doves exhibited overt signs of sickness. Each of them lost small amounts of weight during this period (Table 7).

These doves exhibited several interesting behavioral traits while confined in close quarters.

On the fifth day of confinement it was noticed that the doves were pecking one another. They were observed for long periods of time during the next several days. The doves established a peck order which was continued during the confinement period. The larger male dove had the alpha position and a female had the omega position of the peck order. At times the dominant male would not allow the other doves to eat until he was finished. When the others attempted to eat he would peck them.

On the 23rd day of confinement pecking became severe on the female in the omega position. The feathers on top of her head were all pecked

Table 6. Physical data for 30 doves experimentally fed lead shots (No. 7½)

Age*	Sex	Date Fed Shots	No. of Lead Shots		Weight (Ounces)		Days To Overt Signs	Days To Death
			Original	Autopsy	Original	Death		
Ad	F	6/16	3	-	3.75	-	-	-
55	M	6/16	4	-	3.75	-	-	-
59	M	9/16	5	5	4.50	2.50	6	9
Ad	F	6/16	5	-	4.25	-	-	-
59	F	9/16	6	3	4.50	2.65	4	6
Ad	M	6/16	6	-	4.00	-	-	-
40	F	9/66	7	0	4.50	2.65	6	10
Ad	M	6/16	7	-	4.00	-	-	-
59	?	9/16	8	-	4.25	-	-	-
Ad	F	6/16	8	-	4.00	-	-	-
49	?	9/16	9	-	3.75	-	-	-
Ad	F	6/16	9	-	4.00	-	-	-
Ad	M	9/16	10	0	5.00	3.00	4	6
Ad	M	6/16	10	-	4.50	-	-	-
Ad	F	9/16	11	2	4.75	3.80	14	20
Ad	M	6/16	11	6	4.00	2.50	7	11
Ad	M	9/16	12	-	5.00	-	-	-
Ad	F	6/16	12	-	4.00	-	-	-
59	F	6/16	13	-	3.75	-	10	-
50	M	6/16	14	-	3.75	-	-	-
49	M	9/16	15	1	4.50	3.50	4	8
Ad	M	6/16	15	-	4.75	-	10	-
Ad	M	6/16	16	-	4.00	-	-	-
55	F	6/16	17	5	3.75	2.75	6	10
Ad	M	6/16	18	-	4.00	-	-	-
Ad	M	6/16	19	-	4.00	-	-	-
Ad	F	9/16	20	5	4.00	2.50	6	9
Ad	F	6/16	20	-	3.75	-	-	-
Ad	M	9/16	30	9	5.00	3.25	4	7
Ad	F	3/8	35	1	4.00	2.75	-	6

* Age in days or (Ad) Adult

TABLE 7—PHYSICAL DATA FOR 4 ADULT DOVES EXPERIMENTALLY FED LEAD SHOTS (NO. 7½) ON JANUARY 26, 1966.

Sex	No. of Lead Shots		Body Weight (ounces)				
	Original	Autopsy	Original	5th Day	10th Day	15th Day	23rd Day
F	1	..	4.00	3.75	3.50	3.50	3.50
M	1	..	4.00	3.50	3.50	3.50	3.75
F	2	..	4.00	3.50	3.50	3.50	3.75
M	3	..	5.00	4.50	4.50	4.50	4.15

off. On the 24th day the skin on her head was broken and began bleeding. Medication was applied and the pecking stopped that day. On the 25th day pecking started again. The birds were left alone for 3 hours and when they were observed later the pecked dove was dead. The head was a mass of blood. The bird was autopsied to determine if any lead shots were still in the digestive system. None were located.

Results of analyses of dove feces: Four doves were force-fed a total of seven (No. 7½) lead shots and confined in a small pen. Paper was placed under the pen to catch all droppings. Paper was changed daily for 26 days. The accumulated feces were examined for any lead shots which passed through the doves' digestive systems. Results of the analysis is shown in Table 8. Figure 2 is a photograph of the shots located during analysis. None of these doves exhibited signs of lead poisoning.

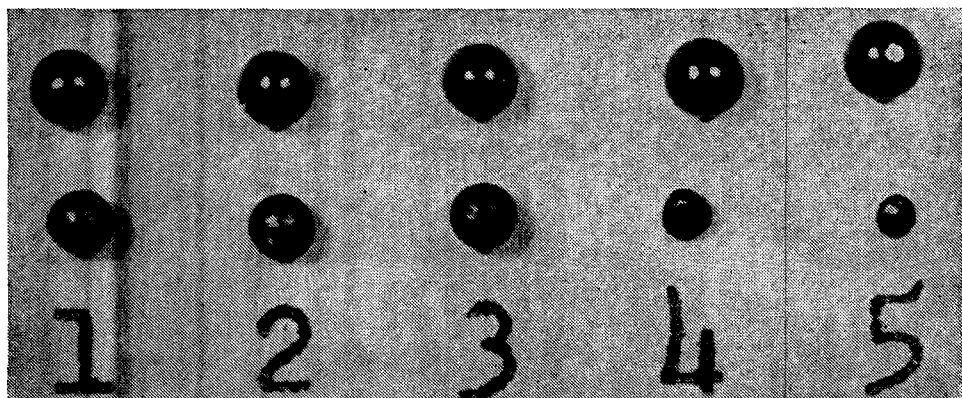


Figure 2 — Erosion of No. 7½ lead shot located during dove fecal analysis: The top line shows normal No. 7½ shots for comparison. The bottom line shows No. 7½ shots which passed thru the doves' digestive systems. (1-3) 6th day; (4) 15th day; (5) 17th day.

TABLE 8 — RESULTS OF EXAMINATION OF FECES FROM DOVES FORCE-FED LEAD SHOTS ON JANUARY 26, 1966.

No. Days Since Shots Ingested	No. Shots Located In Feces	Approximate Amount of Deterioration of Shot
6	3	All worn to 1/2 size
15	1	worn to 1/4 size
17	1	worn to 1/6 size

Free choice ingestion of lead shots by doves: Lead shots were mixed with various species of seeds and placed in an observation box with three doves to determine if the doves would voluntarily ingest the shots. Observations were made several times each day and no apparent changes were noticed in the doves' condition.

Seven days later, all food was removed and only lead shots remained in the food tray for 48 hours. On one occasion, a dove was observed as it picked up a shot in its beak and then dropped it. I do not know if any of the shots were ingested. Shots were scattered over the cage floor by the doves and became mixed with feces preventing accurate counts of the shots.

Small amounts of food were placed in the tray daily with the shots for 18 additional days. I do not know if any of the shots were ingested but the doves remained in good condition throughout the 29 days. The only indication that some of the shots may have been ingested was that much of the fecal matter was green and watery.

Discussion:

During this study 170 quail and 34 doves of various ages and sexes were force-fed known quantities of lead shots. Numbers of shots fed to the quail ranged from 1 to 100 and for the doves 1 to 35.

Thirty-one (19 percent) quail exhibited signs of sickness and eighteen (10 percent) died. Thirteen (38 percent) doves exhibited signs of sickness and 11 (32 percent) died. Young birds had a higher rate of mortality than older birds. Eleven (11 percent) quail under 36 days old died as compared with 7 (4 percent) older than 36 days. Five (50 percent) doves under 60 days of age died as compared with 6 (30 percent) over 60 days. Elder (1954) reported that juvenile ducks are much more resistant to the effects of ingested lead than as adults of the same species. With doves and quail the reverse appears to be true.

The sex of the birds or the number of shots force-fed them did not appear to be determining factors for sickness or death. No certain number of shots was determined to be lethal. Doves fed shots during the peak of nesting season (June) had a lower mortality rate than those fed shots in September.

Quail used in this study were domestic game farm birds. Eight wild quail were trapped for the study but released after they severely injured themselves by flying into the sides of the pen. Jordan and Bellrose (1950) and Elder (1954) reported that domestic mallards were obviously more tolerant of lead than wild ducks. Preliminary work by Jordan and Bellrose (1950) suggests that, in the case of domestic mallards, it may be the result of greater food consumption.

A mixed grain and commercial game bird mash diet was fed to the quail and mixed grains fed to the doves in this study with one exception. Group VI (40 young quail) were fed a diet of commercial game bird mash for 25 days and then mash and mixed grain for 15 days. Three quail died after the diet change. Quail consumed grain in much larger proportions than the mash. Jordan and Bellrose (1950) showed that diet was of major importance when considering lead poisoning in waterfowl. Ducks on a seed diet were more subject to the effect of lead poisoning than ducks on a seed diet supplemented with an abundance of green, leafy food. The green leafy food was reported to minimize the susceptibility of waterfowl to lead poisoning. Cedar and pine trees were cut and placed in the quail pens as cover (except in Group VI). The quail pecked at these trees and probably consumed small amounts of them. If this vegetation was ingested it may have had some influence on the susceptibility of the quail to lead poisoning. The doves in this study were not exposed to any green vegetation during the time they were under observation.

Wild quail and doves have access to and commonly consume small amounts of leafy foods during all seasons of the year. If quail and doves happen to ingest lead shots in their natural habitat and if green leafy foods do minimize their susceptibility to lead poisoning, the problem will probably never become important. An important part of the young quail's diet is insects, which may also have some influence on the susceptibility of lead poisoning.

Overt symptoms of lead poisoning in quail and doves were similar in several respects to those described for waterfowl by Cook and Trainer (1966) and Coburn, Metzler and Treichler (1951). One major difference was that lead-poisoned quail did not lose their desire for food as did geese (Cook and Trainer 1966). Sick quail that could hardly stand were observed as they ate. Autopsies revealed full crops in most dead quail and doves and all crops had some food in them.

Experimental quail were observed as they readily ingested lead shots which were placed in their pen. Only one dove was observed to pick up a shot but then immediately dropped it. One dove was sacrificed for autopsy 4 days after being exposed to a mixture of shots and grain. No shots were located in the digestive system. Locke and Bagley (1967) showed that doves do consume lead shots from the field.

Lead shots which were force-fed to quail and doves were retained in the birds' digestive systems for various periods of time. An analysis of quail and dove feces revealed that shots were excreted regularly after the third day (Tables 5 and 8). Cook and Trainer (1966) reported that in geese, all lead pellets which passed via the intestinal tract did so within 3 days after treatment. The shots erode progressively while in the quail and doves' digestive systems (Figures 1 and 2) and some of this material entered the blood stream. Autopsies revealed that young quail retain shots in their gizzards for longer periods of time than do adult birds. This probably explains the higher mortality rate in young birds.

Chemical analyses of blood, from quail which had been exposed to lead, revealed that lead from the erosion of shots entered the blood stream in large quantities. The average lead level of 4.30 mg/100g blood for eight quail exposed to lead shots was shown to be approximately 2.5 times the lethal amount for geese. This supports the contention that quail are difficult to poison with lead.

Fecundity did not appear to be affected by the number of lead shots ingested by quail. Two groups of quail which had ingested lead shots had a higher average egg production per hen than the control group. The group ingesting the smallest number of shots also had the smallest average egg production per hen. In waterfowl Elder (1954) reported that normal hens surpassed leaded hens in fecundity for two seasons.

Normal quail surpassed leaded quail in egg fertility and hatchability (Table 4). Normal quail also had the highest percentage of birds hatching normal. In waterfowl Elder (1944) reported that normal birds did not exceed leaded birds in fertility, embryonic success, or hatchability.

Several factors in this study may have had some differing effects on the fecundity, fertility and hatchability of the four groups of quail.

1. Quail were kept in pens as groups during the laying season. Quail egg production is reduced in colony type laying pens.
2. The hen-cock ratio per pen varied. Fighting by the cocks may have caused more disturbances in some pens.
3. The total number of quail per pen varied. Crowded quail usually produce less eggs.

All attempts to study fecundity, fertility, and hatchability in doves have been unsuccessful to date.

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