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Effects of Chick Stimuli and Dieldrin on Adoptive Behavior of Pinned Hen Pheasants

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EFFECTS OF CHICK STIMULI AND DIELDRIN ON ADOPTIVE BEHAVIOR
OF PENNED HEN PHEASANTS

BY
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A thesis submitted
in partial fulfillment of the requirements for the
degree Master of Science, Major in
Wildlife Biology, South Dakota
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1971

EFFECTS OF CHICK STIMULI AND DIELDRIN ON ADOPTIVE BEHAVIOR
OF PENNED HEN PHEASANTS

This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable as meeting the thesis requirements for this degree, but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Thesis Advisor Date

Head, Wildlife and Fisheries Date
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EFFECTS OF CHICK STIMULI AND DIELDRIN ON ADOPTIVE BEHAVIOR
OF PENNED HEN PHEASANTS

Abstract

K. L. Cool

Studies to determine the effect of chick stimuli and dieldrin on adoptive behavior of penned hen pheasants were conducted in 1969 and 1970. Results indicated that whether caged hens saw or heard chicks had no effect on adoption or killing of chicks. Hens receiving sound stimuli and sight-and-sound stimuli from chicks responded similarly to hens receiving no stimuli. Sublethal doses of dieldrin also had no effect on chick adoption under the conditions of this study.

Results demonstrated that non-incubating pheasant hens will adopt and brood orphan chicks. During the 2 years of the study, respectively, 37 and 49 percent of the hens tested for adoptive behavior adopted and brooded chicks, 38 and 26 percent intentionally killed chicks, 6 and 14 percent both adopted and killed chicks, and 18 and 11 percent neither adopted nor killed orphan chicks.

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INTRODUCTION

A field study by Linder and Agee (1965) demonstrated that stimuli provided by pheasant chicks (Phasianus colchicus) induced nesting pheasant hens to abandon their clutches. As a result of this study, it was theorized that in areas of high pheasant density the total number of young produced may be limited by the number of unattached chicks which come in contact with nesting hens.

Other studies have investigated parental behavior in the form of broodiness or chick adoption. Goodale (1916) induced broody behavior in capons by introduction of chicks, and Burrows and Byerly (1938) were able to induce broodiness in domestic hens by placing them singly in cages with chicks. Ramsay (1953) stated that visual and auditory stimuli alone may trigger broodiness in fowl. He also induced broodiness in 14 bantam hens by introducing small chicks. Stanford (1952) studied chick adoption in bobwhite quail for the purpose of propagation and release of adult quail with adopted broods. Most studies of parental behavior in pheasants have involved administration of hormones, especially prolactin, in an attempt to induce broodiness. Breitenbach and Meyer (1959) studied pituitary prolactin levels at different stages of the reproductive cycle, and Crispens (1956) and Nelson (1963) gave injections of prolactin in an attempt to induce broodiness in hen pheasants for the purpose of propagation and subsequent release of hens and adopted broods.

Many studies have been conducted to evaluate the effects of agricultural chemicals on wildlife, including the effects of chlorinated hydrocarbon

insecticides on pheasants. Studies of insecticide influence on growth, survival, and reproductive physiology by Atkins and Linder (1967), Azevedo et al. (1965), Baxter et al. (1969), DeWitt (1956), Genelly and Rudd (1956), and Lamb et al. (1967) are but a few of those completed.

Few studies have dealt with effects of chlorinated hydrocarbons on animal behavior. Van Gelder et al. (1969) found that dieldrin exposure caused a gradual decrease in the ability of sheep to perform a vigilance task. James and Davis (1965) reported that sublethal amounts of DDT affected the discrimination ability of the bobwhite, and McEwen and Brown (1966) reported aberrant territorial breeding behavior among sharp-tailed grouse given single oral doses of dieldrin and malathion. Studies have also shown that insecticides may alter the behavior of the ring-necked pheasant. Baxter et al. (1969), evaluating chick behavior on the visual cliff, observed that response varied depending on whether parents had been dosed with dieldrin. Dahlgren (1970) found that behavior of pheasant chicks on the visual cliff was affected by polychlorinated biphenyls given the parents, and Dahlgren et al. (1970) showed that dieldrin affected the susceptibility to hand capture of penned pheasants. I know of no studies concerning effects of an insecticide on broodiness or chick adoption in birds.

Objectives of this study were: (1) to evaluate the effect of stimuli provided by pheasant chicks on the adoptive behavior of penned

hen pheasants, and (2) to evaluate the effect of dieldrin on the adoptive behavior of penned hen pheasants.

METHODS AND MATERIALS

Yearling hen pheasants were purchased from Wild Wings of Oneka, Hugo, Minnesota. Since all of these birds were about to enter the first reproductive season, chick-adoption behavior should have been unaffected by previous breeding experience. Hens were randomly assigned to four groups. In 1969, each group consisted of 18 hens and in 1970 each group consisted of 20 hens. The four groups were treated as follows:

- Group I: Lactose capsules only, no dieldrin, no chick stimuli.
- Group II: Lactose capsules only, no dieldrin, chick stimuli provided prior to adoption experiments.
- Group III: Dieldrin capsules, no chick stimuli.
- Group IV: Dieldrin capsules, chick stimuli provided prior to adoption experiments.

Technical grade dieldrin was used in both years of study. It was ground and mixed with lactose powder to obtain the correct level and given in No. 5 gelatin capsules via a glass tube (Fig. 1). Capsules containing only lactose were given to the control hens. Dieldrin doses were set at 6 mg per week based on results of Atkins and Linder (1967) who reported that treatments of 6 mg per week over a 13-week period lowered food consumption and reduced egg production. One 6 mg capsule was given each week for 3 weeks just prior to chick-adoption experiments in 1969. In 1970, 3 mg capsules were given twice weekly for 3 weeks, followed by a single 6 mg capsule just prior to adoption experiments.

Chick stimuli received by Groups II and IV prior to the adoption experiment consisted of sight and sound of 12 pheasant chicks housed in commercial battery brooders in full view of the hens (Fig. 2). In 1969, sound of chicks associated with Groups II and IV was audible to hens belonging to Groups I and III; therefore, only sight stimuli could be analyzed during the 1969 study. In 1970, sound of chicks for Groups II and IV was inaudible to hens from Groups I and III; hence, sight-and-sound stimuli were the variables which were analyzed during the 1970 study.

The duration of chick stimuli varied between years. In 1969, each of the four groups of hens was randomly divided into three subgroups which were exposed to chick stimuli for 8, 15, and 22 days. In 1970, Groups II and IV received chick stimuli for a period of 9 days, and Groups I and III received no chick stimuli.

Hens were housed in individual cages to reduce stress associated with the administration of capsules and to know which hens eventually laid eggs. Cages measured 12 x 18 inches at the base and 12 inches in height (Fig. 1). In 1969, hens were held in cages for periods of 88, 96, or 104 days, depending upon the duration of chick stimuli. In 1970, the length of the caged period was reduced to 58 days for all hens, and cages were equipped with stronger wire bottoms and raised 1 inch to aid in air circulation and drying of feces.

All birds were maintained on commercial pheasant rations formulated by Zip Feed Mills, Sioux Falls, South Dakota. Adult hens were given pheasant breeder ration in pellet form, and chicks and



Fig. 1. Individual hen cages and method of administering capsules.



Fig. 2. Arrangement used to provide sight and sound stimuli from chicks prior to adoption experiments.

hens were given chick starter ration during the adoption experiments.

It was thought that hens would be more receptive to adoption of chicks if they were in the reproductive cycle; accordingly, egg laying was induced by placing caged hens in darkened rooms and regulating photoperiod. A 12-hour light cycle was gradually increased to 16 hours while temperature was held near 72° Fahrenheit. Incandescent lamps used as the light source in 1969 were replaced by fluorescent lamps in 1970. Most hens in both years of the study began laying 1 month after the start of photoperiod regulation.

The adoption phase of the study was carried out after dieldrin or lactose capsules had been administered and chick stimuli had been provided to the respective groups of hens. Hens were transferred from the individual egg-collection cages to individual brooding cages (each 22 x 20 x 22 inches). Cages were completely enclosed with the exception of light and air holes provided by slots in the top and sides (Fig. 3). Sufficient light was available so that both hen and chicks were able to see each other. The amount of light available inside the cage was similar to that used by Stanford (1952) in a study on chick adoption in bobwhite quail. Stanford stated that little or no adoption occurred in dark or dimly lit cages, and that once enough light was admitted so that birds were able to see each other, additional light had no further influence on adoption rates. A thick layer of straw lined the bottom of each cage and commercial chick starter and water were provided in plastic cups available to both hen and chicks.

In 1969, hens were given 2 days to adjust to the brooding cage before chick introduction and adoption tests began. In 1970, this period was reduced to 4 hours. Hens were observed with the aid of a red-lens flashlight (Fig. 3), and were checked for adoptive behavior 1 hour after initial introduction and as often as needed thereafter. Two 2-day old chicks (purchased from Wild Wings of Oneka, Hugo, Minnesota) were introduced to hens in the 1969 study. In 1970, two 1-day old chicks (purchased from South Dakota Pheasant Co., Canton, South Dakota) were introduced. In 1969, two chicks (4 days old) were introduced 2 days after the initial chicks were introduced. In 1970, two retrieval chicks (2 days old) were introduced 1 day after the initial chicks were introduced. No chicks in the adoption study were introduced to more than one hen. A temperature near 72° F was maintained in an attempt to force chicks to the hen for warmth, and 4 days were allowed for adoption experiments in both years of the study.

Criteria relied upon as evidence that hens had adopted chicks included the following:

1. Hen holding body feathers fluffed and wings loosely at the sides.
2. Chicks distributed in and among the body feathers and under the wings, occasionally peeking out, but burrowing under the feathers for warmth; hens permitting this shuffling and burrowing with little movement (Fig. 4).

Hens which did not adopt or brood chicks were classified in one of the following three groups:

1. Hens which killed chicks by pecking.
2. Hens which adopted and killed chicks.
3. Hens which neither adopted nor killed chicks.



Fig. 3. Hens were observed during adoption experiments with a red-lens flashlight.



Fig. 4. Many hens accepted and brooded introduced chicks.

RESULTS AND DISCUSSION

Behavior of Hens with Chicks

1. Observations on adoption behavior of hens.

Most hens, when introduced into brooding cages, constructed nests and laid eggs. In general, my observations indicate that hens in which nesting behavior was more strongly developed were those which usually neither adopted nor killed chicks when tested for adoptive behavior. Some hens which exhibited weak attachment to chicks both brooded and sat on eggs. The broodiest hens were generally those in which the urge to nest was weaker. Even hens which strongly adopted would become excitable when disturbed. Hens which weakly adopted chicks were noted as being more nervous than those which strongly adopted. Hens which did not adopt chicks showed the most excitable behavior as they ran around the periphery of the cage or flew into the cage top when disturbed. Numerous chicks were accidentally injured or killed by this behavior.

During stimuli periods prior to adoption, hens in Groups II and IV were calm, clucked softly, and usually watched the chicks (Fig. 2). Hens in Groups I and III were seldom heard clucking and were notably more nervous than hens in the chick-stimuli groups. However, hens receiving chick stimuli did not display any difference in adoption from hens in the non-stimuli groups (Tables 1 and 2).

Soft clucking by the adopting hen was often noted, but numerous hens which did not adopt often called in this manner. This observation

Table 1. Results of chick adoption experiments, 1969

Hen Group	Chick Stimuli	Length of Stimuli	Number of Hens				
			Tested	Adopting Chicks	Killing Chicks	Adopting and Killing Chicks	Neither Adopting nor Killing Chicks
I (control)	sound	8 days	6	4	1	0	1
		15 days	5 ^a	2	1	1	1
		22 days	<u>5</u>	<u>1</u>	<u>2</u>	<u>0</u>	<u>2</u>
		Group total	16	7	4	1	4
II (control)	sight and sound	8 days	4	1	0	1	2
		15 days	6	3	3	0	0
		22 days	<u>6</u>	<u>2</u>	<u>2</u>	<u>0</u>	<u>2</u>
		Group total	16	6	5	1	4

Table 1. (Continued).

Hen Group	Chick Stimuli	Length of Stimuli	Number of Hens				
			Tested	Adopting Chicks	Killing Chicks	Adopting and Killing Chicks	Neither Adopting nor Killing Chicks
III (dieldrin)	sound	8 days	5	2	2	1	0
		15 days	6	2	4	0	0
		22 days	6	0	5	0	1
		Group total	17	4	11	1	1
IV (dieldrin)	sight and sound	8 days	5	2	1	0	2
		15 days	6	2	3	1	0
		22 days	5	3	1	0	1
		Group total	16	7	5	1	3
Grand total			65	24	25	4	12

^aMortality occurred in sub-groups with less than 6 hens tested.

Table 2. Results of chick adoption experiments, 1970

Hen Group	Chick Stimuli	Length of Stimuli	Number of Hens				
			Tested	Adopting Chicks	Killing Chicks	Adopting and Killing Chicks	Neither Adopting nor Killing Chicks
I (control)	none	9 days	19 ^a	7	7	4	1
II (control)	sight and sound	9 days	19	9	4	3	3
III (dielldrin)	none	9 days	19	12	4	0	3
IV (dielldrin)	sight and sound	9 days	19	9	5	4	1
Grand total			76	37	20	11	8

^aOne hen died in each assigned group of 20.

was consistent with a study by Nelson (1963), who also noted no relationship between clucking and broody behavior toward chicks. Clucking was therefore disregarded as an adoption criteria.

Stanford (1952) observed that bobwhite usually adopted chicks within 4 hours. In my study, it was observed that most adoption by pheasant hens occurred 12 to 24 hours after chick introduction. Hens displaying the strongest adoptive behavior nearly always adopted early in the experiment. If the hen adopted the initial chicks, she nearly always adopted the retrieval chicks. However, of 65 hens (1969 and 1970) which did not adopt chicks initially, 12 adopted retrieval chicks.

2. Hens adopting chicks.

Twenty-four hens (37 percent) of 65 tested for chick adoption in 1969 adopted chicks (Table 1). In the 1970 study, 37 hens (49 percent) of 76 tested for chick adoption adopted chicks (Table 2). Crispens (1956) found that 64 percent of 112 pen-reared pheasant hens adopted chicks, while the adoption rate observed by Nelson (1963) was only 10 percent of 48 pen-reared hens. In both Crispens' and Nelson's study, hens were injected with prolactin prior to adoption experiments, hence study conditions were basically different from mine. Crispens also stated that 10 of 11 wild hens tested in his study became broody and adopted orphan chicks.

Linder (1964) stated that a hen will abandon her clutch to adopt chicks, and this might be a factor in population regulation. In his field studies in Nebraska, he found that 9 wild hens out of 11

abandoned their clutches when chicks were placed in full association with the hen. He believed that wild hen pheasants display weak family bonds and he often observed mixed age-groups of chicks in broods. Because of the weak family bond, orphan chicks or chicks with a hen might serve as stimuli for a hen to abandon her clutch.

Full association of chicks and hens in this study came only during actual adoption experiments. Though my results are difficult to relate to the wild, about 50 percent of the experimental hens did in fact adopt chicks. This indicates that wild hen pheasants might adopt chicks and abandon their clutch depending upon the conditions prevailing at that particular time. However, it is not known how often the necessary stimuli occur among wild nesting hens.

The phase of the reproductive cycle seemed to have no effect on chick adoption. In 1969, 7 (10 percent) of the 65 hens tested for adoption laid no eggs. Absence of egg laying had no effect on adoption as 4 of 7 non-laying hens adopted chicks; this is a higher percentage of adoption than found among all hens. Only 3 (4 percent) of the 76 hens laid no eggs in 1970, and 2 of these 3 hens adopted chicks.

3. Hens killing chicks.

Hens which killed chicks by pecking usually killed them early in the adoption experiment, and almost immediately upon retrieval. Twenty-five (38 percent) of 65 hens tested for chick adoption in 1969 killed chicks (Table 1). In the 1970 study, only 22 (26 percent) of 76 hens tested for chick adoption killed chicks (Table 2). Crispens (letter

to R. E. Thill, Aug. 28, 1968) stated that approximately 30 percent of the pheasants tested in his adoption study employing prolactin killed chicks.

4. Hens adopting and killing chicks.

In the 1969 study, only 4 (6 percent) of 65 hens adopted and killed chicks (Table 1). In 1970, 11 (14 percent) of 76 hens displayed this behavior (Table 2). Hens in this classification usually killed one or more of the initial chicks which were introduced and usually only weakly adopted the other chicks.

5. Hens neither adopting nor killing chicks.

In 1969, 12 (18 percent) of 65 hens tested for chick adoption neither adopted nor killed chicks (Table 1). In 1970, 8 (11 percent) of 76 hens displayed this behavior (Table 2). Hens in this classification disregarded chicks or accidentally killed chicks by stepping or sitting on them. These hens were easily disturbed even though they built nests and laid eggs.

Effects of Dieldrin

The level of dieldrin administered to adult hens in both years of the study was sublethal. In 1969, 11 dieldrin-treated hens adopted chicks as compared to 13 controls (Table 1). However, the number of dieldrin hens killing chicks was nearly twice that of controls. Sixteen dieldrin-treated hens killed chicks as compared to nine controls. Chi-square analysis showed no significant difference ($P > 0.05$) in

adoption or any of the criteria tested.

Chi-square analysis of the effect of dieldrin on hens in the 1970 study also showed no significant differences ($P > 0.05$) in any of the criteria tested. Twenty-one dieldrin-treated hens adopted chicks as compared to 16 controls (Table 2). Nine dieldrin-treated hens killed chicks as compared to 11 controls. In the 1970 study, more dieldrin-treated hens (21) adopted chicks than controls (16) and fewer dieldrin-treated hens (9) killed chicks than controls (11).

Effects of Chick Stimuli

In 1969, differences in duration of chick stimuli were tested by providing 8, 15, and 22 days of stimuli to one-third of each of the four groups of hens. Nine hens adopted chicks in both the 8- and 15-day subgroups and 6 hens adopted chicks in the 22-day subgroup (Table 1). Eleven hens killed chicks in the 15-day subgroup and 10 hens killed chicks in the 22-day subgroup. However, only 4 hens killed chicks in the 8-day subgroup. Chi-square analysis revealed no significant difference ($P > 0.05$) between treatments.

In 1969, Groups I and III received sound stimuli from chicks used to provide sight-and-sound stimuli to Groups II and IV. Sound stimuli results (Groups I and III) were similar to those from sight-and-sound stimuli (Groups II and IV). Eleven hens in the sound-stimuli groups adopted chicks as compared with 13 hens in the sight-and-sound stimuli groups (Table 1). Fifteen hens receiving sound stimuli killed chicks as compared to 10 hens receiving sight-and-sound stimuli. Chi-square

analysis of these data showed no significant difference ($P > 0.05$) between the two treatments for any of the criteria tested. Linder (1964:30) in his field studies in Nebraska stated that "In no instance did a hen abandon or was there any reaction noted to the sound of chicks."

In the 1970 study, sight-and-sound chick stimuli were provided over a 9-day period for Groups II and IV and no chick stimuli were provided for hen Groups I and III. Eighteen hens from Groups II and IV adopted chicks and 9 hens in these groups killed chicks (Table 2). Nineteen hens from Groups I and III adopted chicks and 11 hens in these groups killed chicks. Chi-square analysis showed no significant difference ($P > 0.05$) between treatments for any of the criteria tested. Linder (1964:39) stated that "From field observations there is evidence that sight and sound may offer sufficient stimuli to alter behavior of the incubating hen." However, sight-and-sound chick stimuli under the conditions of the 1970 study showed no effect on the adoptive behavior of the hens.

CONCLUSIONS

From one-third to one-half of the pheasant hens tested for adoptive behavior under penned conditions adopted and brooded orphan chicks. From one-fourth to one-third of the hens tested killed chicks by pecking. Some hens both adopted and killed chicks (6 to 14 percent), while others neither adopted nor killed chicks (10 to 18 percent).

The significance of this study is in demonstrating that non-incubating pheasant hens under penned conditions will adopt orphan chicks. Although results may not be directly applicable to the wild, it seems reasonable to believe wild hens might also adopt chicks and abandon their clutches under certain conditions, and that this might conceivably operate as a form of population regulation as hypothesized by Linder and Agee (1965).

Chi-square analyses showed that chick stimuli consisting of combinations of sight and sound had no significant effect ($P > 0.05$) on adoptive behavior. Under the condition of this study sublethal doses of dieldrin had no observable effect on chick adoption. Hens receiving dieldrin in this study received it only over a 3-week period and were given unlimited food and water. In contrast wild hens would receive insecticides over a long period of time, and the stress involved in winter survival and spring reproduction might conceivably bring about some change in behavior.

Any further studies on chick adoption by pheasant hens should be conducted under penned-field conditions. If insecticides or stimuli are tested, they should be tested under field conditions in a manner as closely approximating wild conditions as possible.

LITERATURE CITED

- Atkins, T. D. and R. L. Linder. 1967. Effects of dieldrin on reproduction of penned hen pheasants. J. Wildl. Mgmt. 31(4): 746-753.
- Azevedo, J. A., Jr., E. G. Hunt, and L. A. Woods, Jr. 1965. Physiological effects of DDT on pheasants. Calif. Fish and Game. 51(4):276-293.
- Baxter, W. L., R. L. Linder, and R. B. Dahlgren. 1969. Dieldrin effects in two generations of penned hen pheasants. J. Wildl. Mgmt. 33(1):96-102.
- Breitenbach, R. P. and R. K. Meyer. 1959. Pituitary prolactin levels in laying, incubating and brooding pheasants (Phasianus colchicus). Proc. Soc. Exp. Biol. and Med. 101:16-19.
- Burrows, W. H. and T. C. Byerly. 1938. The effect of certain groups of environmental factors upon the expression of broodiness. Poultry Sci. 17:324-330.
- Crispens, C. G. Jr. 1956. Prolactin: An evaluation of its use in ring-necked pheasant propagation. J. Wildl. Mgmt. 20(4):453-455.
- Dahlgren, R. B. 1970. Effects of polychlorinated biphenyls on reproduction of penned pheasants. Paper presented at Fifteenth Annual Conf., Central Mtn. Plains Sec., The Wildl. Soc., Pingree Park, Colorado. (Abstract, in press.)
- Dahlgren, R. B., R. L. Linder, and K. K. Ortman. 1970. Dieldrin effects on susceptibility of penned pheasants to hand capture. J. Wildl. Mgmt. 34(4):957-959.
- DeWitt, J. B. 1956. Chronic toxicity to quail and pheasants of some chlorinated insecticides. J. Agr. and Food Chem. 4(10):863-866.
- Genelley, R. E., and R. L. Rudd. 1956. Chronic toxicity of DDT, toxaphene, and dieldrin to ring-necked pheasants. Calif. Fish and Game. 42:5-14.
- Goodale, H. D. 1916. Notes of the behavior of capon when brooding chicks. J. Animal Behav. 6:319-324.

- James, D. and K. B. Davis, Jr. 1965. The effect of sublethal amounts of DDT on the discrimination ability of the bobwhite, Colinus virginianus (Linnaeus). American Zoologist. 5(2):229. (Abstract)
- Lamb, D. W., R. L. Linder, and Y. A. Greichus. 1967. Dieldrin residues in eggs and fat of penned pheasant hens. J. Wildl. Mgmt. 31(1):24-27.
- Linder, R. L. 1964. Regulation of pheasant density through nest abandonment in south-central Nebraska. Ph. D. Thesis. Univ. of Nebraska, Lincoln. 106 p.
- Linder, R. L. and C. P. Agee. 1965. Regulation of pheasant density through nest abandonment in south-central Nebraska. Trans. N. A. Wildl. and Nat. Res. Conf. 30:411-422.
- McEwen, L. C., and R. L. Brown. 1966. Acute toxicity of dieldrin and malathion to wild sharp-tailed grouse. J. Wildl. Mgmt. 30(3): 604-611.
- Nelson, M. M. 1963. The relationship of the hormone prolactin to incubation and care of young in pheasants. Minn. P-R Job Comp. Report, Project W-11-R-22. 13 p.
- Ramsay, A. O. 1953. Variations in the development of broodiness in the fowl. Behav. 5:51-57.
- Stanford, J. A. 1952. An evaluation of the adoption method of bobwhite quail propagation. Trans. N. A. Wildl. Conf. 17: 330-337.
- Van Gelder, G. A., B. E. Sandler, W. B. Buck, J. B. Maland, and C. G. Karas. 1969. Behavioral and electrophysiological effects of dieldrin in sheep. Industrial Med. 38(3)64-67.