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Effects of Dieldrin on the Social Interactions of Penned Pheasants and Chickens

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EFFECTS OF DIELDRIN ON THE SOCIAL INTERACTIONS OF PENNED PHEASANTS AND CHICKENS

BY

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EFFECTS OF DIELDRIN ON THE SOCIAL INTERACTIONS

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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.

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Abstract

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Studies to determine the effects of dieldrin on social hierarchy of pheasants and chickens were initiated in 1970. Social interactions were observed among groups of pheasant chicks, adult cock and hen pheasants and peck-order development among groups of young pheasants. To determine the effects of dieldrin on the pecking behavior of individual birds, pairs of pheasants and pairs of chickens were placed in a neutral cage. When patterns of dominance and subordination were consistent, dieldrin in capsules (4 mg to pheasants and 6 and 10 mg to chickens twice weekly) was given to one member of each pair and birds were observed for changes in pecking behavior. Toward the end of the study, one bird from each of the pheasant chick groups was given 4 mg of dieldrin twice a week.

Fights were observed among pheasant chicks at 3 weeks of age, and it was concluded that aggressive behavior and peck-order development began at this time. Only in smaller groups (two to five birds) could a rank be determined based on the total number of each individual's interactions. Groups of adult pheasants also displayed peck-orders, usually not linear.

Weight, previous dieldrin treatment, parental dieldrin treatment and ear tuft length had no effect on the peck-orders. There were no correlations between sex and rank in the pheasant chick groups.

Dominance-subordination patterns of pheasants and chickens were not affected by dieldrin administration. Although a few reversals of peck order occurred, none were statistically significant.

INTRODUCTION

Since World War II, man has continually increased the use of pesticides and herbicides to protect crops and to reduce disease carriers and pests. Included among pesticides are the chlorinated hydrocarbons, organic phosphates and carbamates. Of particular concern are the chlorinated hydrocarbons which, because of their stability, persist in the environment. This concern has led to research regarding the biological effects of pesticides. Both physiological and behavioral studies have been conducted.

Physiological studies include the detection of organochlorine residues in living tissue (Keith and Hunt 1966, Nauman 1969, Stickel 1968), the analysis of loss and magnification of the residues (Hickey et al. 1966, Lamb et al. 1967, Stickel 1968), observations of immediate mortality (Stickel 1968) and finally the detection of the effects of pesticides on reproduction, the immunological system, nutrition and body weight (Atkins and Linder 1967, Baxter et al. 1969, Stickel 1968).

Behavioral research has not been as extensive. Studies have included observations on population changes (Stickel 1968) and the detection of behavioral changes (Baxter et al. 1969, Sandler et al. 1968, Keith 1966, Khairy 1959, Warner et al. 1966, Nauman 1969 and Davis 1965). Davis (1965) reported that the discriminative learning ability of bobwhite quail (Colinus virginianus) was significantly poorer when the birds were fed as low as 20 ppm of DDT in their diets. In 1969, Baxter et al. found that ring-necked pheasant chicks

(Phasianus colchicus), having received dieldrin via the egg, had a different behavioral pattern from normal chicks when placed on a visual cliff. Similarly, Dahlgren et al. (1970) found that young pheasants were captured by hand more easily when both parents had received dieldrin followed by birds where hens only and finally cocks only had received dieldrin. On the other hand, Sandler et al. (1968) observed that dieldrin did not affect the detour behavior of sheep. To date, only one study has been concerned with the effects of pesticides on the social hierarchy of an animal species (Nauman 1969).

The effect of pesticides on the social order is important because all normal processes, including behavior, have definite survival values as a result of evolutionary adaptation. If sublethal applications of pesticides cause social changes, the survival of the species may be in danger.

The objectives of this study were (1) to determine if dieldrin, a chlorinated hydrocarbon, would alter the social interactions of penned ring-necked pheasants and chickens (Gallus domesticus) and (2) to learn more concerning the social hierarchy of penned pheasants. Pheasants were chosen for the study because of their economic and recreational interests to South Dakotans. Chickens were chosen for the study since they performed well under experimental conditions and because extensive literature is available on the peck-order of chickens.

LITERATURE REVIEW

Words such as "afraid," "frightened," "recognized," "resemblance," "acquainted," "friendships" and "memory" can be considered anthropomorphic. They are used, however, to describe the research of authors whose work is reviewed here. Because they are the words of the various authors, they have been included in certain points of the review.

Peck-Order of Chickens

In nature there is a tendency for some animal species to aggregate into groups or clusters (Allee 1931). This behavior has been observed among members of the gallinaceous birds such as the domestic chicken, wild turkeys (Meleagris gallopavo) and pheasants. Observing such aggregations of chickens, Schjelderup-Ebbe (1922) discovered that peck-order formed the basis of flock behavior. He found that a definite organization in the flocks was disclosed by the reaction of birds in contact situations. The bird highest in the social order may peck the other members of the group but is not pecked in return while the bird lowest in the order is pecked and does not peck in return (Schjelderup-Ebbe 1922, 1935, Masure and Allee 1934). Since this early work, the peck-order of chickens has been the object of numerous studies.

Aggressive behavior can be observed most frequently at the food site, nest boxes, water supply or dusting area (Guhl 1953). Pecks frequently are only in one direction and are usually aimed at the head (Guhl 1953). The form of the peck-order can vary. In flocks of 10 hens or less, straight linear hierarchies are common, but, with

more than 10 birds, triangular and square relationships can occur (Wood-Gush 1955). In a triangular situation, bird A may peck bird B who pecks bird C who is dominant to bird A. Flocks of hens and cocks have peck-orders (Guhl 1953) with the organization of the cocks usually more complex and less stable (Masure and Allee 1934). A mixed flock may have two peck-orders (Guhl 1953). Schjelderup-Ebbe (1935) reported that some flocks have despots.

Newborn chicks of the domestic chicken have no social organization but the peck-order starts to appear in the young males at about 8 weeks of age and appears at about 10 weeks in the females (Schjelderup-Ebbe 1935, Guhl 1953). Dominance in older birds has no correlation with the age at which a peck-order appears for the young (Schjelderup-Ebbe 1935). At first the conflicts seem to be play fights but later become more serious with a definite pattern of dominance-subordination emerging and becoming routine (Collias 1952). Birds developing despotism early have an advantage over those which develop this trait later.

Not all flocks start life together, but rather some birds are introduced to each other at older ages. In this case, each pair must work out their relationship. The formation of the social order has been discussed by Schjelderup-Ebbe (1935), Wood-Gush (1955) and Allee et al. (1939). There may be a fight between two birds with the winner having the right to peck the loser and the loser generally avoiding the winner. At times there may be more than one encounter with the loser challenging the winner again before the dominance relationship is finally established. Not all relationships are

determined by fighting. One bird may act as though afraid and the other automatically becomes dominant or both birds may appear frightened and the first bird to conquer its apparent fear becomes dominant. Once the peck-order is established, it may endure for a long time, especially in small flocks. On occasion there may be a definite revolt with revolts occurring most frequently in large flocks. The type of social order that is formed quickly and is maintained has been called a peck-right by Masure and Allee (1934). Among birds that form a less stable order after many contacts, such as pigeons, the social order has been termed peck-dominance.

Factors determining dominance and subordination have been discussed by Schjelderup-Ebbe (1935), Allee et al. (1939), Potter (1949), Collias (1952), Guhl (1953) and Wood-Gush (1955). Despotism is sex related. In chickens the adult male is dominant to the adult female; however, this is not always obvious. As long as sexual activity lasts, the cock will rarely peck the hen but this may change as the activity weakens. Adult cocks and hens will usually dominate juvenile birds. As a rule, age is not considered an important factor determining dominance but associated factors of skill and experience in winning and losing are considered important. The heavier bird will usually win an encounter if other factors are equal; however, this does not seem to explain triangular relationships. Collias (1943) statistically analyzed factors of significance in first contacts and found absence of molt, comb size (indicator of amount of male hormone present), social rank in the home flock and weight to be of importance in that order. Other factors affecting the peck-order include the

season of the year and sickness. Weak, sick birds have been killed by pecking from other members of the flock. Other circumstances could occur which might cause a dominant bird to lose position. A bird that has been injured or is weary from a previous fight would have less energy and probably lose a fight it normally would win. The location of an encounter seems important with birds having a better chance of victory on their own home territory. A bird in strange surroundings has an increased chance of winning if individuals it is associated with are present. On occasion, what would appear to be friendships seem to develop where neither bird will peck each other. Other factors include the past history of the bird, wildness, chance blows, differences in sensitivity to hormones, differences due to handling and errors in the researcher's judgment.

When a newcomer enters a flock of chickens, it is threatened or attacked by one or more of the inhabitants. On occasion the new bird will fight but more often than not it will become the lowest bird in the peck-order (Schjelderup-Ebbe 1935, Guhl 1953, Wood-Gush 1955). A group of new birds added to a flock will crowd together. Guhl and Allee (1944) experimented on shifting the members of a flock. They removed the dominant bird of the flock and placed it in isolation while introducing a new bird from isolation into the flock. The new bird became the low member of the peck-order and advanced in rank as other birds were removed and added. New arrivals became victors when the resident birds did not challenge the stranger. Collias (1943) mentioned that when two acquainted hens were both new in a flock, the more dominant hen helped its subordinate rise in the peck-order.

The changes of old age may be so gradual that they are not noticed allowing an old bird to be despot until its death (Schjelderup-Ebbe 1935). However if the changes are noticeable, younger birds may challenge the position of the older and weaker bird. The older bird never gives up without a fight however, and Schjelderup-Ebbe (1935) mentioned that the young may have been held back by force of habit.

Organization in a flock is more beneficial overall than lack of harmony. Dominant birds in the peck-order have priority to food, nests, roosts and have more freedom in the pen. Guhl and Allee (1944) found that organized flocks pecked less, ate more and had better body weight and more egg production than flocks that were constantly being reorganized. It has been found that dominant cocks mate with more hens and sire more chicks while cocks ranking low may be inhibited from mating even when the superior is absent (Guhl et al. 1945). Hens that are high in the peck-order either fail to invite the cocks to mate or crouch less frequently than hens in the middle or lower parts of the social order. Hens lower in the order mate oftener. Guhl (1950) pointed out that it does not necessarily follow that dominant hens would have fewer chicks.

Peck-orders are maintained because of recognition of the birds for each other using hints such as voice, color and facial characteristics (Collias 1952). Schjelderup-Ebbe (1935) found that a separation of more than 2 weeks would lead to one bird forgetting the other or else the dominance relation itself was forgotten. A young bird would remember its parent after separation for a week, but there seemed to be poor memory of the parent for its growing juvenile.

Birds that have been disguised are not recognized (Schjelderup-Ebbe 1922, Guhl 1953, and Wood-Gush 1955). Wood-Gush (1955) reported that changes of the comb, head or neck were more effective disguises than changes to the tail, wings, back or breast. Schjelderup-Ebbe (1935) observed pheasants which appeared to recognize each other after half a year.

Hale (1948), thinking that there was greater survival value in flocks having reduced social tensions, tried debeaking hens to reduce social tension. He found that the beak was no longer an efficient weapon but that the number of pecks actually increased. Thus debeaking did not change the formation of the peck-order.

It has been suggested that hormones may have partial physiological control over aggressive behavior. Allee et al. (1939) injected testosterone propionate into hens low in the peck-order and thereby induced revolts. Each adult that was treated rose in the social order with an injected individual eventually dominating each experimental flock. When Allee et al. (1940) injected thyroxin into hens from different social levels, they found no change in the rank of the birds unless the dose was large enough to produce a sudden and complete molt. Very large doses of thyroxin may cause a reduction in aggression and Allee and Collias (1940) reported the same effect from large doses of estradiol but only in a few cases. Their research indicates that slight changes in the endocrine system affects aggressiveness.

Studies have been conducted to find if there is a relationship between dominance and heredity. Fennell (1945) compared game cocks

to domestic cocks and found courage, aggressiveness and methods of attack to be hereditary with these characteristics more prominent in game cocks. Potter (1949) comparing different breeds in mixed flocks found that differences in social ranks held by different breeds were significant. The differences seemed to be associated with different hereditary backgrounds.

Peck-Order of Pheasants

Definite dominance hierarchies were observed by Collias and Taber (1951) among marked pheasants that regularly came to three feeding stations in a Wisconsin marsh. They observed these pheasants from February until April and found that both unisexual and mixed groups came to feed. The flocks were especially social during the winter but as spring progressed harems became established under a single cock. Food competition seemed to be the basis of the peck-orders that were established. Winter flocks were small consisting mostly of two or three birds. Males became more antagonistic as spring approached and the groups broke up as territories became established. The cocks that crowed and established territories near the food stations were the cocks highest in the peck-order. The social orders were consistent with very few reversals observed. Cocks were dominant over all the hens but did not peck the hens once the breeding season began. Hens also displayed organized social orders with one flock of 14 hens having at least 5 triangular relationships. Collias and Taber (1951) also observed that resident pheasants tended to dominate visitors. Older birds were generally dominant over younger birds but there were

no correlations of weight with dominance. Dominant wild pheasant cocks have higher breeding success and all aggressive birds have priority for food during food shortages, insuring survival.

Pesticide Peck-Order Research

Nauman (1969) studied the effect of pesticides on the social hierarchy of juvenile mallard ducks (Anas platyrhynchos). He subjected male mallards to diets containing 0, 2.5, 25 and 250 ppm DDT. He found that the peck-order rank and the number of interactions per observation period were not affected. This might be expected since Allee et al. (1940) reported that once peck-orders became established it was difficult to alter the order by varying biological factors.

The experimental method used by Nauman (1969) consisted of feeding the same level of DDT to all the mallards in one pen. A different experimental approach might show different results.

MATERIALS AND METHODS

Pheasant cocks, hens, and chicks and chicken hens were used to investigate the effect of dieldrin on social interactions. For convenience, pheasant cocks will be referred to as PC, pheasant hens as PH, pheasant chicks as PY and chickens as CH. Groups, such as the pheasant chicks, then are numbered PY-1, PY-2, PY-3, etc.

Pheasant Cocks

During March, six adults were observed as group PC-1. These birds, obtained from a previous experiment, had varying backgrounds prior to experiment. Two birds had not received previous dieldrin treatment, two had been given 4 mg of dieldrin once a week for 12 weeks and two had received 8 mg of dieldrin once a week for the same period.

Each bird was completely isolated from February 26 to March 3. On March 3, right ear tufts were measured, and the birds were weighed before being introduced to an outside pen (16 x 16 x 6 ft) made of chicken wire. Clear plastic covered the pen to protect birds during winter conditions. As weather conditions improved in spring, the plastic was removed. Waterers were placed in the pens and maintained throughout experimentation. Food consisted of kernel corn which was introduced prior to observation periods in order to stimulate pecking. Identification of individual birds in this group and all other birds in the study was by means of colored leg bands.

Group PC-1 was established to determine if a peck-order would develop in a group of six cocks and be influenced by previous dieldrin treatment, body weight or length of ear tufts. With few exceptions,

the group was observed for 30 minutes daily from March 3 until April 3. Observations were made by sitting quietly outside the pen and recording all pecks, threat gestures and chases. Information was recorded on a daily observation sheet (Appendix Fig. A).

Another approach to studying the effects of dieldrin on social interactions consisted of paired encounters such as done by Allee et al. (1939) and Potter (1949) with chickens. Where they took birds from flocks for the paired encounters, pheasants in this study were housed in individual cages.

Fourteen adult cock pheasants were obtained from a previous experiment for the paired encounters forming group PC-2. Ten of the birds had no previous dieldrin treatment while six had received 8 mg of dieldrin once a week for 12 weeks. The parental history of these cocks had been recorded for two generations (Table 1). Birds were housed in individual cages (Fig. 1) and isolated for a week prior to experimentation. At the end of the week, the weight of each bird and the length of the right ear tuft were measured (Table 1). From March 11 to 26, cocks were paired in all possible combinations with all other cocks in a neutral cage (Fig. 2). No bird was paired more than once a day. Pairs were observed and dominant-subordinate interactions were recorded (Appendix Fig. B). Although a few birds pecked other birds, this was the exception rather than the rule. Birds would frequently stand for one-half hour without any activity. Food deprivation did not stimulate pecking. It was therefore decided to force cocks into breeding condition by light stimulation.

Table 1. Pesticide history and physical parameters of paired cock pheasants, group PC-2.

Individual	Mg Dieldrin Received by Parents 1968-1969 Cocks/Hens	Previous Dieldrin Treatment mg	Weight g	Length of Ear Tufts mm
A	0-0/0-0	None	1452	20
C	0-0/0-0	None	1581	23
D	0-0/0-0	None	1534	20
E	0-0/0-0	None	1484	20
F	0-0/0-0	None	1764	23
L	6-6/6-6	None	1223	15
M	6-6/6-6	None	1492	20
N	6-6/6-6	None	1682	22
QQ	6-6/6-6	None	1319	18
V	0-6/0-0	8	1918	22
Z	0-6/0-0	8	1520	22
AA	0-6/0-0	8	1469	24
TT	6-6/0-0	8	1519	18
UU	0-0/6-6	8	1272	18

Figure 1. Individual cages used to hold pheasant cocks and chickens.

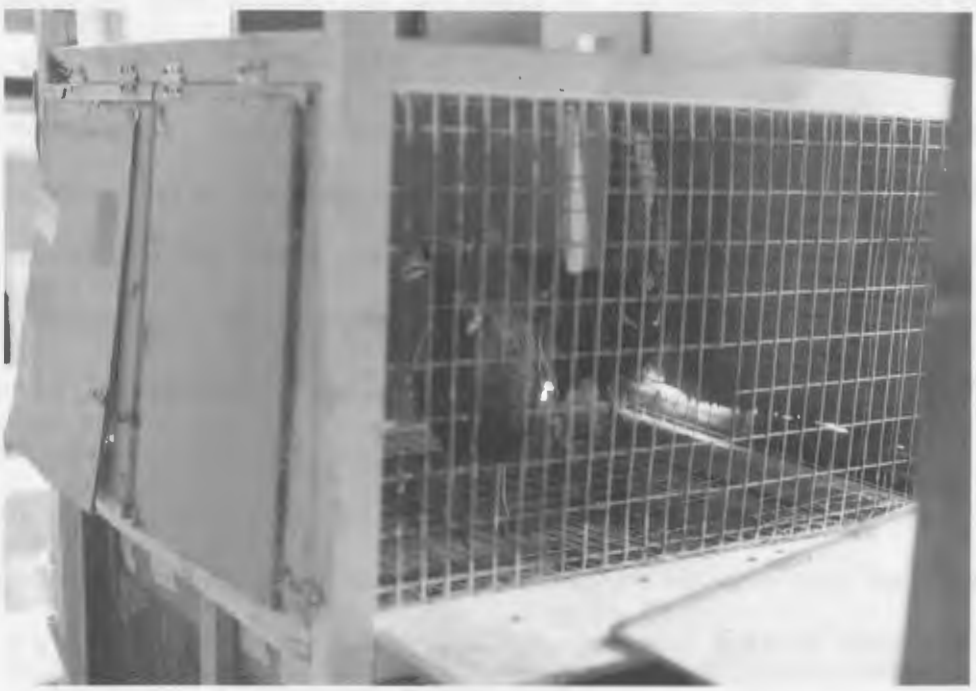

Figure 2. Neutral cage where paired encounters were observed.

The cock pheasants were kept isolated for 1 month while increasing the photoperiod to 15 hours. Hens were introduced to each cage for a short period daily. When in breeding condition, the cocks were again paired in all possible combinations, each cock paired only once a day. Observations continued from April 24 to May 17 and behavior was recorded. Six pairs with consistent behavior were chosen to receive dieldrin. One bird of each pair, picked randomly, was given 4 mg of dieldrin in #5 gelatin capsules (Fig. 3) two times a week for 2 weeks. The other bird received lactose in gelatin capsules. Throughout the study all control birds received lactose in this fashion when the experimental birds received dieldrin.

Fifteen cock pheasants in group PC-3 were paired from May 27 to June 6. Ten of these birds had not received dieldrin previously. The subgroups were divided on the basis of the amounts of dieldrin given to parents. The parents of the five controls never had dieldrin while the parents of one subgroup of experimental cocks had been given 6 mg of dieldrin at periods during their adult life. Each control bird was paired for three trials with one of the five experimental birds. Next the control birds were each paired with one of five other birds who had received 6 mg of dieldrin as had their parents. Behavior was recorded.

On June 1, after paired encounters were completed, the cock pheasants from group PC-2 were transferred to outside pens measuring 14 x 5 x 4.5 feet. These pens were considerably smaller than the pen of group PC-1. Three groups, PC-4, PC-5 and PC-6, were comprised initially of four cocks in each group. One or two hens were introduced

Figure 3. Method used to administer gelatin capsules containing dieldrin to all birds in the study.

Figure 4. Pens used for observations of pheasant chicks.

into each group and were alternated daily between groups. From June 1 to 16 behavioral observations were recorded daily for periods of 15 minutes.

On June 18, the cocks were rearranged into groups PC-7, PC-8 and PC-9. Group PC-7 was composed of the three dominant birds from groups PC-4, PC-5 and PC-6. Group PC-8 consisted of birds that had been in the middle of the social order of the original groups. Subordinate cocks from the original groups formed group PC-9. After 6 days of observations, original groups were reassembled and observed for 2 more weeks.

Pheasant Hens

Six adult pheasant hens were obtained from a previous experiment and formed into group PH-1. Prior to the time of group organization, two hens had received 4 mg of dieldrin and two had received 8 mg of dieldrin once a week for 12 weeks. The remaining two birds had been controls which had never received a pesticide. On March 2, after a week of individual isolation, the hens were weighed and placed in an outside pen measuring 16 x 16 x 6 feet. The pen was constructed of chicken wire and covered with clear plastic. Water was available at all times with kernel corn given at the beginning of each observation period. Thirty-minute daily observation periods extended from March 2 to April 3.

Pheasant Chicks

Small groups of pheasant chicks were observed to study the development of social order and pecking. Chicks were purchased from South

Dakota Pheasant Company, Canton, and kept in brooders for 12 days. On March 31 they were divided into one group of six birds and three groups of seven birds each, PY-1, PY-2, PY-3 and PY-4. The sexual composition of the groups was determined after secondary sex characteristics developed. Group PY-1 consisted of six males and two females, PY-2 of five males and three females and PY-4 of four males and five females. Birds were identified by colored leg bands with all birds in one group having the same color. One bird, for example, had one right leg band, another one left, another two on the right, etc.

Pens were constructed of chicken wire and measured 5 by 5 feet. Cardboard surrounded the bottom of the wire to prevent the small birds from escaping. The pens were on masonite that covered a cement floor. Heat lamps were operated constantly. Wood shavings were used to cover the floors to facilitate cleaning and provide additional warmth. Food consisted of commercial pheasant starter and later pheasant grower ration purchased from Zip Feed Mills, Sioux Falls, South Dakota. The chicks were observed daily for 10 minutes and all pecks were recorded.

On June 3, all chicks were randomly reassigned to smaller groups. Groups PY-5, PY-6, PY-7, PY-8, PY-9 and PY-12 consisted of four chicks, group PY-10 had three chicks, group PY-11 had two chicks and group PY-13 had five chicks. All birds were slightly over 10 weeks of age except for groups PY-12 and PY-13 that were 19 weeks old. The 19-week-old chicks were purchased from the same supplier for an earlier experiment which was discontinued. These smaller groups were caged in the original pens which had been subdivided into two equal parts. This provided an area of 2.5 by 5 feet for each group (Fig. 4). All

interactions were recorded from June 3 to 30. On June 30, birds were weighed and one bird from each group was chosen, depending upon social rank, to receive 4 mg of dieldrin in gelatin capsules. In four groups, PY-5, PY-7, PY-9 and PY-13, the most aggressive bird received the dieldrin while in PY-6, PY-8, PY-10 and PY-12, the least aggressive chick received the pesticide. Only in one group, PY-11, was the comparative aggressiveness of the bird receiving dieldrin unknown. These chicks received dieldrin twice a week for 1 month. If a death occurred a replacement was made. Interactions were noted until July 31. This particular experiment differed from Nauman's (1969) work on ducks in that all ducks in his groups received pesticides.

Chickens

It was found that chickens consistently pecked when in a contact situation. Therefore, three different groups of hens were housed under conditions similar to the pheasant pairs and paired encounters were observed in a neutral cage.

The first group, CH-1, consisted of eight yearling chickens which were paired in all possible combinations. Birds were paired with all others in three pretreatment encounters to insure that dominance existed with no change in daily behavior. The two most dominant and the two most subordinate hens were then given 6 mg of dieldrin in gelatin capsules two times a week. Treatment continued for 3 weeks until birds were paired with all others in three treatment encounters.

The second group of chickens, CH-2, consisted of 36 hens. Each bird was paired with only one other bird. The 18 pairs were observed

during eight pretreatment encounters. One bird, chosen randomly, from each pair then received 10 mg of dieldrin twice a week during the treatment period which lasted 26 days. This resulted in 13 pairings.

Composition of the final group of chickens, CH-3, consisted of 14 hens, each being paired with three other birds. Hens were not paired more than once a day. After three pretreatment encounters, seven birds were randomly chosen to receive 10 mg of dieldrin twice a week for the period it took to complete three treatment encounters.

RESULTS AND DISCUSSION

Pheasant Cocks

Data obtained from behavioral interactions, history of previous dieldrin treatment and physical parameters of pheasant cocks in group PC-1 are presented in Tables 2 and 3. Pecking occurred most frequently on the first day the group was placed together with few pecks occurring during following observation periods. Food deprivation did not seem to stimulate pecking.

The rank of each individual was not necessarily determined the first few days. For example, BB was obviously the dominant cock on the first day. Although he initially pecked RR, in succeeding days it became apparent that he was avoiding RR. Later RR was observed pecking BB only twice but was clearly dominant. This avoidance of one cock by another would account in part for the low frequency of pecks. On April 6, YY, a low ranking bird, began pecking all other cocks. This occurred following the separation of birds for 1 day.

The cocks of group PC-1 were ranked according to the total number of pecks each delivered and the number of birds they pecked. The changed behavior of YY was not considered. Individual rank appeared to have no relationship with weight, previous dieldrin treatment or length of ear tufts (Table 3). The absence of a correlation of weight with dominance agrees with the findings of Collias and Taber (1951). Perhaps the previous experience of each bird in group PC-1 was more important in the formation of a social order.

Table 2. Summary of daily pecks of birds in group PC-1.

Dominant	Subordinate	Date: March 3	4	5	6	7	8	9	10	12	15	16	17	18	19	20	21	24	26	April 6	Total No. of Pecks: Per Bird	All Birds
RR	BB																2				2	
	WW																		1		1	
	YY				1					3		1	3	1				1			10	
	GG									4		1	3								8	
	OO									1			1	1							3	24
BB	RR	2																			2	
	WW	1				1						2	1								5	
	YY	7												1							8	
	GG																				0	
	OO	3														1		1			5	20
WW	RR																				0	
	BB																				0	
	YY				2				1			1									4	
	GG				1																1	
	OO				5	1		1						1		2					10	15
YY	RR																			1	1	
	BB																			2	2	
	WW		1																	1	2	
	GG					1				1									3	3	8	
	OO		2						3												5	18
GG	RR																				0	
	BB																				0	
	WW				1																1	
	YY				3																3	
	OO	1			1																2	6
OO	All																				0	0
Totals		14	3	0	14	3	0	1	4	9	0	5	8	4	0	3	2	2	4	7	83	

Table 3. Peck-order of pheasant cocks (PC-1), individual weights, previous dieldrin treatment (once a week for 12 weeks) and length of ear tufts.

Individual	Rank	Weight g	Previous Dieldrin Treatment mg	Length of Ear Tufts mm
RR	1	1508	8	21
BB	2	1880	4	20
WW	3	1777	4	17
YY	4	1672	None	16
GG	5	1396	None	18
OO	6	1520	8	21

This preliminary experiment demonstrated that a peck-order could be observed in a small group of penned pheasant cocks. Although one bird was usually dominant to another, reversals did sometimes occur. With the changed behavior of YY, it would seem that over time the social order does not remain stable if the birds are temporarily separated. This does not support Schjelderup-Ebbe's (1935) conclusion that pheasants appeared to recognize each other after 6 months.

When most of the cocks of group PC-2 were in breeding condition, pairing began in a neutral cage. Because pecking did not occur consistently, interactions were classified. The classification used is a modification of that used by Balding (1967):

Type 1 - Two males fight; behavior includes crouching with breasts down and tail feathers up and spread, heads bobbing, pecking of floor and violent pecking of each other; one bird eventually wins and becomes dominant.

Type 2 - One male attacks the other male either immediately or in a short time; the attacking male puffs up his body feathers, spreads his tail feathers, crows and his wattles lengthen before pecking; the subordinate male either crouches or runs away.

Type 3 - One male makes a threatening gesture while the other crouches or runs away; no pecks are delivered.

Type 4 - One male crouches or runs to avoid being attacked by the other male when the other bird did not actually threaten or even see the first male.

Type 5 - One male has freedom of the cage and sometimes crows while the other male lies, sits or stands quietly.

Type 6 - Both males move around with neither appearing subordinate.

Type 7 - Both males lie, sit or stand quietly.

Type 8 - One male mounts the other with no pecking or fighting.

Pairing each male with all others from group PC-2 in two trials indicated that the type of social interactions were not consistent (Table 4). Bird A, for example, would be aggressive in one instance and during the next trial would more or less ignore the other male. A possible explanation of this inconsistent behavior is that pheasants may not need to establish their relationship every time they are introduced to each other in a paired situation. It is likewise possible that too much time lapsed between trials, thereby resulting in a loss of breeding condition and a lessening of aggression. When consistency of interaction types resulted, it occurred most frequently among the inactive, non-aggressive birds where neither dominant nor subordinate interactions were observed.

When the results shown in Table 4 are grouped for the types of birds (controls, controls with parents having had dieldrin and cocks who had dieldrin as did their parents), a percentage can be determined for the time the types were dominant, subordinate or neither (Table 5). Control cocks were dominant in 33 instances or 25.4 percent of the time while control birds whose parents had dieldrin were dominant in only four cases or 6.2 percent of the time. Cocks that received pesticides, as did their parents, were dominant 13 times or 14.4 percent.

Body weight and ear tuft length were not related to dominance. In 31 cases where a definite peck-order was evident, 14 heavier birds were dominant while 17 were subordinate and 12 birds with longer tufts were dominant while 16 were subordinate. Essentially no differences were detected in the type of interactions after dieldrin was given to

Table 4. Results of pairing cock pheasants (group PC-2) in trial one (T1) and trial two (T2) showing behavioral classification type (from 1 to 8) and dominant cock, if any. For example, 2A means that a type 2 interaction occurred with cock A being dominant while a 7 indicates that a type 7 interaction occurred with no cock being definitely dominant.

Bird	A		C		D		E		F		L		M		N		QQ		V		Z		AA		TT		UU	
	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2
A	-		2A	5	2A	5	5	4E	2F	3F	2A	5	2A	7	7	7	5	5	2A	5	7	5	2A	2A	7	7	2UU	3UU
C	2A	5	-		7	7	5	5	2F	2F	7	6	1C	5	7	7	7	5	5	5	7	7	2C	5	7	7	2UU	6
D	2A	5	7	7	-		7	5	3F	2F	7	2L	7	7	7	7	7	7	7	7	7	7	7	5	7	7	2UU	5
E	5	4E	5	5	7	5	-		2F	2F	5	5	4E	5	5	5	7	5	5	7	5	5	5	6	4E	5	2UU	2UU
F	2F	3F	2F	2F	3F	2F	2F	2F	-		2F	2F	2F	2F	2F	2F	2F	7	2F	2F	2F	2F	2F	2F	7	7	1UU	2UU
L	2A	5	7	6	7	2L	5	5	2F	2F	-		2M	5	7	7	7	2L	NP[a]		NP		NP		NP		NP	
M	2A	7	1C	5	7	7	4E	5	2F	2F	2M	5	-		7	2M	7	8	NP		NP		NP		NP		NP	
N	7	7	7	7	7	7	5	5	2F	2F	7	7	7	2M	-		7	7	NP		NP		NP		NP		NP	
QQ	5	5	7	5	7	7	7	5	2F	7	7	2L	7	8	7	7	-		NP		NP		NP		NP		NP	
V	2A	5	5	5	7	7	5	7	2F	2F	NP[a]		NP		NP		NP		-		7	7	7	7	7	7	2UU	7
Z	7	5	7	7	7	7	5	5	2F	2F	NP		NP		NP		NP		7	7	-		5	5	7	7	2UU	5
AA	2A	2A	2C	5	7	5	5	6	2F	2F	NP		NP		NP		NP		7	7	5	5	-		5	5	2UU	2UU
TT	7	7	7	7	7	7	4E	5	7	7	NP		NP		NP		NP		7	7	7	7	5	5	-		2UU	5
UU	2UU	3UU	2UU	6	2UU	5	2UU	2UU	1UU	2UU	NP		NP		NP		NP		2UU	7	2UU	5	2UU	2UU	2UU	5	-	

[a]Not paired.

Table 5. Percent dominance and subordination of PC-2 cocks with varying dieldrin backgrounds.

Parents Had Dieldrin	Previous Dieldrin Treatment mg	Birds	Percent		
			Dominant	Subordinate	Neither
No	None	A,C,D,E,F	25.4	15.4	59.2
Yes	None	L,M,N,QQ	6.2	21.9	71.9
Yes	8	V,Z,AA,TT, UU	14.4	17.8	67.8

to one bird in each of six pairs (Table 6). One change did occur, however. Bird A pecked AA in the pretreatment trials but during treatment ceased pecking. Actions of A still indicated, however, that it was the dominant cock.

Breeding records were kept for each cock of group PC-2 during the entire experiment. Under the existing experimental conditions of being caged separately and paired for only a few minutes daily, subordinate cocks did not stop breeding.

This experiment indicated that cock pheasants, unlike chickens, do not necessarily peck and establish dominance each time they are paired in a neutral cage. When interactions do occur, consistency from trial to trial cannot be expected. Body weight and ear tuft length did not affect the interactions and subordinate birds did not stop breeding. Dieldrin treatment had no effect on the type of interactions which resulted. It might be suggested that in another experiment, each male be paired with only one other male while in peak breeding condition to assure aggressiveness.

The behavioral interactions of paired cocks in group PC-3 were also classified with results given in Tables 7 and 8. Again, as with group PC-2, the types of interactions were not consistent. One complete reversal did occur between cocks 18 and 26. There is no indication from these data that control cocks or cocks with dieldrin histories tended to dominate. Groups were observed after the peak breeding season. It would be worth repeating while birds were in peak breeding condition and very aggressive.

Table 6. Behavioral classification of six pairs of cock pheasants from group PC-2 during the pretreatment and treatment periods.

Birds	Pretreatment		Treatment	
	Type	Dominant	Type	Dominant
A[a] and AA	2	A	5	A
F and C	2	F	2	F
E and L	5		5	
N and QQ	7		7	
Z and D	7		7	
V and TT	7		7	

[a]Birds underlined received 4 mg of dieldrin two times a week during treatment.

Table 7. Behavioral classification and dominant bird in three trials (T) of pheasant cock pairs (group PC-3), pairing 0-0 to 6-0 cocks.

0-0[a] Cocks		6-0[b] Cocks	Type of Interaction T1	T2	T3	Dominant Cock T1	T2	T3
18	to	25	2	2	2	18	18	18
19	to	22	2	2	2	22	22	22
20	to	24	2	2	2	20	20	20
16	to	23	6	2	6		16	
17	to	21	2	6	6	17		

[a]Parents without dieldrin treatment and received no dieldrin themselves.

[b]Male parent received 6 mg dieldrin but received no dieldrin themselves.

Table 8. Behavioral classification and dominant bird in three trials (T) of pheasant cock pairs (group PC-3), pairing 0-0 to 6-6 cocks.

0-0[a] Cocks		6-6[b] Cocks	Type of Interaction T1	T2	T3	Dominant Cock T1	T2	T3
16	to	28	2	7	7	28		
19	to	27	7	7	2			27
18	to	26	2	2	2	18	18	26
17	to	29	2	2	2	29	29	29
20	to	30	2	6	6	20		

[a]Parents without dieldrin treatment and received no dieldrin themselves.

[b]Both parents received 6 mg of dieldrin and received 6 mg of dieldrin once a week for 14 weeks themselves.

Observation of groups PC-4, PC-5 and PC-6, indicated that peck-orders did exist in small groups of penned pheasants during the summer months (Tables 9, 10 and 11). The introduction of one or more hens daily stimulated pecking. Few pecks occurred on days when the same hens were present as the day before. On occasion, straight linear hierarchies developed such as in group PC-4 (Table 9). At other times it was difficult to determine which of two birds should be ranked higher, as was the case for cocks E and AA in group PC-5 (Table 10). Previous dieldrin treatment in no way influenced the rank of the cocks. Bird M of group PC-4 was relatively inactive while being paired inside, but became very aggressive after being placed outside. This would suggest that birds may react differently in changed environments and at different times during the year.

When top ranking birds from groups PC-4, PC-5 and PC-6 were put together in group PC-7, a long fight ensued on the first day with M becoming dominant (Table 12), but fights did not take place on following days. Fights did not occur among the less aggressive birds which had been rearranged into PC-8 and PC-9 (Tables 13 and 14), however, birds were ranked based on their daily interactions. Cock L appeared to be the most aggressive bird of group PC-9, yet he never pecked once in his home group, PC-5, either before or after his experience in group PC-9. The aggressive birds of group PC-7 had the highest number of pecks. In two out of three cases, groups PC-7 and PC-8, birds which became dominant were in their home cages. Familiarity with surroundings could have influenced their becoming top ranking birds.

Table 9. Rank of individual birds and summary of interactions of birds in group PC-4 during first grouping from June 1 to 16 (13 days) and second grouping from June 26 to July 13 (12 days).

First Rank	Dominant Individual	First Grouping: Sub-ordinate	First Grouping: Total No. of Pecks Per Bird	First Grouping: Total No. of Pecks All Birds	Second Grouping: Total No. of Pecks Per Bird	Second Grouping: Total No. of Pecks All Birds	Second Rank
		SS	4		2		
1	M	C	15		8		1
		UU	10	29	0	10	
		M	0		0		
2	SS	C	5		0		3
		UU	1	6	0	0	
		M	0		0		
3	C	SS	0		2		2
		UU	2	2	0	2	
		M	0				
4	UU	SS	3				Dead
		C	0	3			

Table 10. Rank of individual birds and summary of interactions of birds in group PC-5 during first grouping from June 2 to 16 (12 days) and second grouping from June 26 to July 13 (12 days).

First Rank	Dominant Individual	First Grouping: Sub-ordinate	First Grouping: Total No. of Pecks Per Bird	First Grouping: Total No. of Pecks All Birds	Second Grouping: Total No. of Pecks Per Bird	Second Grouping: Total No. of Pecks All Birds	Second Rank
		E	3		4		
1	F[a]	AA	1		3		2
		L	4	8	4	11	
		F	1		10		
2	AA	E	3		4		1
		L	0	4	1	15	
		F	0		0		
3	E	AA	3		0		3
		L	4	7	1	1	
		F	0		0		
4	L[a]	E	0		0		4
		AA	0	0	0	0	

[a]Received 4 mg of dieldrin two times a week for 2 weeks prior to formation of group PC-5.

Table 11. Rank of individual birds and summary of interactions of birds in group PC-6 during first grouping from June 3 to 16 (11 days) and second grouping from June 26 to July 13 (12 days).

First Rank	Dominant Individual	First Grouping Sub-ordinate	First Grouping Total No. of Pecks Per Bird	First Grouping Total No. of Pecks All Birds	Second Grouping Total No. of Pecks Per Bird	Second Grouping Total No. of Pecks All Birds	Second Rank
		V	3		0		
1	A[a]	D	3		1		2
		Z	2	8	3	4	
		A	0				
2	V[a]	D	2				Dead
		Z	0	2			
		A	0		3		
3	D[a]	V	0		0		1
		Z	0	0	3	6	
		A	0		0		
3	Z	V	0		0		3
		D	0	0	0	0	

[a]Received 4 mg of dieldrin two times a week for 2 weeks prior to formation of group PC-6.

Table 12. Individual rank and summary of pecks of birds in group PC-7 for 6 days.

Rank	Dominant Individual	Subordinate Individual	Total No. of Pecks Per Bird	Total No. of Pecks All Birds
1	M	F	3	
		A	6	9
2	F	M	0	
		A	1	1
3	A	M	0	
		F	0	0

Table 13. Individual rank and summary of pecks of birds in group PC-8 for 6 days.

Rank	Dominant Individual	Subordinate Individual	Total No. of Pecks Per Bird	Total No. of Pecks All Birds
1	E	C	0	
		Z	1	
		V	3	4
2	C	E	0	
		Z	1	
		V	0	1
3	Z	E	0	
		C	0	
		V	0	0
-[a]	V	E	1	
		C	1	
		Z	0	2

[a]Indicates that V died after 2 days of observation.

Table 14. Individual rank and summary of pecks of birds in group PC-9 for 6 days.

Rank	Dominant Individual	Subordinate Individual	Total No. of Pecks Per Bird	Total No. of Pecks All Birds
1	L	AA	2	
		D	0	
		SS	1	3
2	AA	L	0	
		D	2	
		SS	0	2
3	D	L	0	
		AA	0	
		SS	2	2
4	SS	L	0	
		AA	0	
		D	0	0

Regrouping of original groups PC-4, PC-5 and PC-6 showed that identical peck-orders did not develop (Tables 9, 10 and 11) further illustrating the variability in pheasant social hierarchies. In group PC-4, for instance, M again became the top ranking cock but SS and C switched places with SS having the lower position. Neither SS nor C ranked high in previous groups PC-8 or PC-9 but SS was pecked more than C. The ranks of cocks in group PC-5 were also altered with the top two cocks, F and AA, changing places with AA becoming dominant. Possibly F's experience of becoming subordinate in group PC-7 influenced his reactions when returning to his home group. Finally, two cocks of group PC-6 shifted places. In this case the third ranking bird became dominant even though it was low in the peck-order of group PC-9. The changing of rank could be caused by a lack of recognition after a period of separation, intervening social experience and/or a change in individual aggressiveness over time.

On one occasion in group PC-6, a hen, which was introduced to stimulate pecking between cocks, was observed to peck a cock. This behavior was also observed in flocks of pheasants not included in the study. No fights were observed between adult hens and cocks, nor was pecking observed to occur consistently. Therefore it cannot be said that hens dominated cocks in certain instances. The fact that pecking did occur in this direction would suggest a possibility of some hens dominating cocks.

Pheasant Hens

The results of group PH-1 were similar to those of PC-1. The

peck-order of group PH-1 was not firmly established on the first day (Table 15). From the first to the third day, it appeared that G was the dominant hen. After that O seemed to be the dominant bird. However, on occasion, G did peck O. Possibly these two birds shared the dominant position or it may be conceivable that their rank alternated at times. Reversed pecks were more frequent among the hens suggesting a less stable peck-order. The hens were also more active generally, with a total of 134 pecks delivered by all birds over the entire observation period as compared to 83 pecks by the cocks of group PC-1. As with the cocks, prior dieldrin treatment and the weight of the hens did not influence the peck order (Table 16).

Pheasant Chicks

Pecking among pheasant chicks, groups PY-1, PY-2, PY-3 and PY-4, was evident on the first few days with the highest number of pecks, 46, on the second day (Table 17). None of the pecks during the initial 5 days indicated a social pattern. On the first day, a large percentage of pecks were delivered to the leg bands, with the incidence of this type of pecking decreasing until rarely observed. Chicks apparently ignored leg bands after they became familiar with them. Other frequent pecks were aimed at each other's beaks to attack or remove objects such as wood shavings or feces. Occasional pecks were directed to the body of another chick. This early behavior may be termed play fights as described by Collias (1952) for young chickens.

Table 15. Summary of daily pecks of birds in group PH-1.

Dominant	Subordinate	Date: March 2	3	4	5	6	7	8	9	10	11	12	15	16	17	18	19	20	21	24	26	April 3	Total No. of Pecks: Per Bird	All Birds
O	G								1	1	1	1		1	1						1		7	
	R					1	1		1	2	6	1		1							1		14	
	B	2	1	6	1		2	1	1	3		1	1		1		1			1	2		24	
	Y			1				3	3		1				2		1				1		12	
	W	1		1	1			2	5														10	67
G	O	5		1														1				1	8	
	R			3		2																	5	
	B	1		2			1			1		1											6	
	Y			6		1			2	1		1											11	
	W			2	2																		4	34
R	O														1				1				2	
	G															1							1	
	B			1	1		1										1						4	
	Y		1	1	2				1								1						6	
	W	3	1	3																			7	20
B	O		3																				3	
	G																						0	
	R																						0	
	Y					1	1			1													3	
	W																						0	6
Y	O					2	1																3	
	G																						0	
	R																				1		1	
	B													1							1		2	
	W																						0	6
W	B						1																1	1
Totals		12	6	27	7	7	8	6	14	9	8	5	1	3	5	1	4	1	1	1	7	1	134	

Table 16. Peck order of pheasant hens (PH-1), individual weights and previous dieldrin treatment (once a week for 12 weeks).

Individual	Rank	Weight g	Previous Dieldrin Treatment mg
O	1	751	None
G	2	620	8
R	3	480	None
B	4	805	4
Y	4	615	4
W	5	1,081	8

Table 17. Pecks per day, average pecks per day, and pecks per bird per day for pheasant chicks of groups PY-1, PY-2, PY-3, PY-4 and all groups totaled.

	No. of Pecks						No. of Pecks					
Day	PY-1	PY-2	PY-3	PY-4	All	Day	PY-1	PY-2	PY-3	PY-4	All
1	10	4	1	6	21	28	4	3	3	8	18
2	16	12	6	12	46	29	12	7	2	6	27
3	16	7	5	7	35	30	9	7	5	6	27
4	3	0	0	1	4	31	7	7	0	5	19
5	8	8	3	12	31	32	2	4	3	2	11
6	15	5	0	7	27	33	1	2	1	4	8
7	6	3	0	5	14	34	0	11	1	3	15
8	5	5	4	2	16	35	3	5	1	5	14
9	13	1	2	1	17	36	7	11	8	1	27
10	5	0	3	7	15	37	5	7	0	7	19
11	7	13	8	2	30	38	7	11	3	6	27
12	0	1	2	4	7	39	3	9	5	3	20
13	3	5	6	3	17	40	2	4	0	0	6
14	0	20	5	11	36	41	5	8	1	2	16
15	5	1	12	6	24	42	4	11	4	0	19
16	3	2	4	3	12	43	0	9	2	1	12
17	5	1	0	5	11	44	3	0	1	1	5
18	1	3	7	1	12	45	8	15	7	6	36
19	1	3	3	3	10	46	7	1	1	5	14
20	1	9	1	1	12	47	4	9	1	3	17
21	8	2	4	11	25	48	6	2	1	1	10
22	0	0	4	1	5	49	6	2	4	3	15
23	6	3	7	4	20	Total	257	273	169	225	924
24	0	0	2	2	4	Avg. Pecks					
25	11	8	10	5	34	Per Day	5.24	5.57	3.45	4.59	4.72
26	4	4	6	10	24	Pecks/Bird/Day	.66	.70	.43	.51	.57
27	0	8	10	15	33						

Chicks were 21 days of age on April 8, the sixth day of observation. On this day all pecking seemed more deliberate. In group PY-1 a fight took place between R, a female, and 2LR, a male. Behavior during the fight resembled the behavior described as a type 1 interaction for adult cocks. In addition to bobbing of the bodies, pecking of the floor and pecking each other, the birds spent a large percentage of the time in an upward stretched position, which appeared to be a threatening posture. Most other pecks delivered on this day appeared to be of a more threatening nature. Both males and females displayed increased aggressiveness. Observations of these groups indicated that both male and female chicks develop aggressiveness of a more serious nature at approximately 3 weeks of age.

Interactions were greatest and similar for groups PY-1, PY-2 and PY-4, while group PY-3 was comparatively inactive (Table 17). Sexual composition of each group was similar and therefore not responsible for the difference in aggressiveness. Average pecks per day for all groups was 4.72 with each chick pecking .57 times per day (Table 17). In any one day, the pecks which occurred were often delivered from one, two, or three birds, seldom more. Frequency of pecking during the first 25 days corresponded to the last 24 days. Thus birds were equally aggressive during the entire period even though days with zero interactions were noted.

The relationship of each chick to all its pen mates is recorded in Tables 18, 19, 20 and 21. Deciding if a social hierarchy existed among the chick groups was more difficult than with adult groups. Based upon the total number of dominant interactions for each chick,

Table 18. Total number of interactions for group PY-1 during 49 observation periods.

Dominant Bird	Subordinate									
	2R2L	2R	R	RL	L	2LR	2L[a]	2RL[a]	Total	D[b]
2R2L	-	12	7	17	14	14	8	3	75	1.53
2R	6	-	2	9	9	13	1	1	41	.84
R	3	9	-	4	3	14	1	5	39	.80
RL	16	3	2	-	4	11	0	0	36	.74
L	3	2	2	4	-	9	0	0	20	.41
2LR	2	1	4	5	2	-	2	1	17	.35
2L[a]	3	5	1	6	2	0	-	0	17	2.43
2RL[a]	1	1	1	3	2	1	3	-	12	.71
Total	34	33	19	48	36	62	15	10	257	
S[c]	.69	.67	.39	.98	.74	1.26	2.14	.59		

[a]Died during observations, 2L after 7 observation periods and 2RL after 17 periods.

[b]Total number of times dominant divided by number of observation periods.

[c]Total number of times subordinate divided by number of observation periods.

Table 19. Total number of interactions for group PY-2 during 49 observation periods.

Dominant Bird	Subordinate									
	2LR	2L	L	2R2L	2RL	RL	2R	R[a]	Total	D[b]
2LR	-	6	15	15	12	11	11	3	73	1.49
2L	6	-	11	17	2	8	4	5	53	1.08
L	6	7	-	11	7	4	4	1	40	.82
2R2L	8	5	3	-	3	2	7	0	28	.57
2RL	3	1	4	3	-	5	2	5	23	.47
RL	4	1	5	3	3	-	2	1	19	.39
2R	4	1	8	4	1	0	-	2	20	.41
R[a]	1	4	5	0	1	6	0	-	17	.57
Total	32	25	51	53	29	36	30	17	273	
S[c]	.65	.51	1.04	1.08	.59	.74	.61	.57		

[a]Died after 30 observation periods.

[b]Total number of times dominant divided by number of observation periods.

[c]Total number of times subordinate divided by number of observation periods.

Table 20. Total number of interactions for group PY-3 during 49 observation periods.

Dominant Bird	Subordinate									
	L	2R	R[a]	2RL	2L	RL	2LR	2R2L	Total	D[b]
L	-	4	10	11	4	11	7	5	52	1.06
2R	8	-	6	3	4	6	4	7	38	.78
R[a]	1	8	-	2	6	3	3	3	26	1.04
2RL	4	1	1	-	3	6	1	2	18	.37
2L	1	6	2	5	-	0	3	0	17	.35
RL	1	0	3	1	0	-	0	7	12	.24
2LR	0	1	0	0	0	0	-	3	4	.08
2R2L	0	0	0	1	1	0	0	-	2	.04
Total	15	20	22	23	18	26	18	27	169	
S[c]	.31	.41	.88	.47	.37	.53	.37	.55		

[a]Died after 25 observation periods.

[b]Total number of times dominant divided by number of observation periods.

[c]Total number of times subordinate divided by number of observation periods.

Table 21. Total number of interactions for group PY-4 during 49 observation periods.

Dominant Bird	Subordinate										
	2R2L	N	2RL[a]	2R	RL	L	R	2LR	2L[a]	Total	D[b]
2R2L	-	2	7	6	4	4	11	8	3	45	.92
N	2	-	8	2	9	5	5	2	3	36	.74
2RL[a]	4	3	-	8	6	4	1	4	2	32	.94
2R	2	4	4	-	2	5	1	4	8	30	.61
RL	8	2	3	1	-	6	0	1	0	21	.41
L	2	1	0	3	6	-	7	1	0	20	.41
R	1	2	0	1	4	5	-	1	3	17	.35
2LR	1	1	2	1	0	1	4	-	2	12	.24
2L[a]	1	0	2	0	1	0	5	3	-	12	.30
Total	21	15	26	22	32	30	34	24	21	225	
S[c]	.43	.31	.76	.45	.65	.61	.69	.49	.52		

[a]Died during observation, 2L after 40 observation periods and 2RL after 34 periods.

[b]Total number of times dominant divided by number of observation periods.

[c]Total number of times subordinate divided by number of observation periods.

it seemed that an organization did exist. In all groups there was a bird which was obviously more aggressive than the others such as birds 2R2L, 2LR, L and 2R2L in groups PY-1, PY-2, PY-3 and PY-4 respectively (Tables 18 through 21). This can be seen by looking at the total number of interactions for each bird or the interactions per day, listed under column D. The tables show a decreasing order of total dominant interactions for the remaining chicks with one or two chicks having a low number of pecks on their records. The position of some birds at the low end of the scale was caused by death previous to the time observations ended. In these cases, some of the birds were aggressive before death, but because of death had a low total number of interactions. Other birds at the low end of the scale were non-aggressive, subordinate birds.

A progressive increase in the number of times each bird was subordinate might be expected in each experiment (Tables 18 through 21). If the birds that died in group PY-1 are excluded from consideration, there is a progressive increase in the total number of times subordinate with bird 2LR being subordinate 62 instances or 1.26 times an observation period. In the other groups, however, birds which received the most pecks were not the least aggressive birds but were the more moderately aggressive. Chick 2R2L in group PY-2, for example, was pecked 53 times and RL of group PY-3 was pecked 26 times while the less aggressive birds were not pecked as frequently. An explanation for this phenomenon could be that subordinate birds try to avoid contact with the dominant birds and thereby are pecked less. Avoidance of particular birds by others was a common occurrence in all groups

Peck-orders which develop among groups of chicks, numbering from six to eight birds, are not as a rule straight linear hierarchies. Even though the chicks can be listed in an order of decreasing aggressiveness, reversed pecks are frequent and often numerous (Tables 18 through 21). In group PY-1, bird RL pecked 2R2L 16 times which was four more times than 2R2L pecked RL. It would appear that the relationship between these two chicks was not settled. In most instances of reversed pecks, it was not a case of one chick pecking for 25 days and the other chick becoming dominant the last 24 days, such as with 2R and 2L of group PY-3, but rather the chicks alternated pecking each other the entire observation period. Looking at reversals that occurred more than 5 times, 10 out of 11 were cases of alternate pecking. Enough reversed pecks occurred to indicate that the peck-orders were complicated and probably slightly unstable at this early age.

Data collected from smaller chick groups PY-5 through PY-13 are summarized in Tables 22 through 30. Birds in these groups, as with the larger groups, could be ranked according to aggressiveness. During pretreatment, two of the groups, PY-6 and PY-12, appeared to have linear hierarchies although in PY-12 there were no interactions between the two lowest ranked birds. Groups PY-5 and PY-9 indicated a tendency toward a straight line relationship although there were reversals between the middle two and last two birds of group PY-5 and an unsettled relationship between the two highest ranked chicks in group PY-9. The relationships of the remaining groups were somewhat unsettled with the peck-order of group PY-7 appearing to be non-linear. Two groups, PY-10 and PY-11, consisting of three and two

Table 22. Total number of interactions for pretreatment and treatment periods for group PY-5.

Dominant Bird	Subordinate											
	Pretreatment						Treatment					
	W[a]	2B[b]	B	R	Total	D[c]	W[a]	2B[b]	B	R	Total	D[d]
W[a]	-	8	9	8	25	1.19	-	4	1	14	19	1.73
2B[b]	0	-	9	9	18	0.86	7	-	3	29	39	1.62
B	2	4	-	11	17	0.81	0	1	-	1	2	0.67
R	1	5	8	-	14	0.67	0	14	0	-	14	0.58
Total	3	17	26	28	74		7	19	4	44	74	
S[e]	0.14	0.81	1.24	1.33			0.64	0.79	1.33	1.83		

[a]Received 4 mg of dieldrin twice a week during the first half of the treatment period until death.

[b]Received 4 mg of dieldrin twice a week during the second half of the treatment period after death of W.

[c]Total number of times dominant during pretreatment divided by number of observation periods (21).

[d]Total number of times dominant during treatment divided by number of observation periods (24) with the exception of B who was observed for only 3 periods and W who was observed for only 11 periods because of death.

[e]Total number of times subordinate divided by number of observation periods (21 during pretreatment and 24 during treatment) with B being observed for only 3 periods and W for only 11 periods during treatment.

Table 23. Total number of interactions for pretreatment and treatment periods for group PY-6.

Dominant Bird	Subordinate											
	Pretreatment						Treatment					
	W[b]	R	B	MG[a]	Total	D[c]	W[b]	R	B	MG[a]	Total	D[d]
W[b]	-	2	10	6	18	0.86	-	0	6	23	29	1.21
R	1	-	3	2	6	0.40	0	-	0	0	0	0.00
B	0	0	-	0	0	0.00	3	0	-	1	4	0.17
MG[a]	0	0	0	-	0	0.00	1	0	11	-	12	1.20
Total	1	2	13	8	24		4	0	17	24	45	
S[e]	0.05	0.13	0.62	0.38			0.17	0.00	0.71	2.40		

[a]Received 4 mg of dieldrin twice a week during the first half of the treatment period until death.

[b]Received 4 mg of dieldrin twice a week during the second half of the treatment period after the death of MG.

[c]Total number of times dominant during pretreatment divided by number of observation periods (21) with the exception of R who was observed for only 15 periods because of death.

[d]Total number of times dominant during treatment divided by number of observation periods (24) with the exception of MG who was observed for only 10 periods because of death and R who died before treatment started.

[e]Total number of times subordinate divided by number of observation periods (21 during pretreatment and 24 during treatment) with the exception of R and MG as mentioned above.

Table 24. Total number of interactions for pretreatment and treatment periods for group PY-7.

Dominant Bird	Subordinate: Pretreatment R[a]	W	B	MG	Total	D[b]	Subordinate: Treatment R[a]	W	B	MG	Total	D[c]
R[a]	-	3	13	1	17	0.81	-	13	41	4	58	2.42
W	2	-	6	1	9	0.43	1	-	3	0	4	0.17
B	3	4	-	1	8	0.38	4	1	-	10	15	0.63
MG	0	4	0	-	4	0.19	0	0	8	-	8	0.67
Total	5	11	19	3	38		5	14	52	14	85	
S[d]	0.24	0.52	0.91	0.14			0.21	0.58	2.17	1.17		

[a]Received 4 mg of dieldrin twice a week during the treatment period.

[b]Total number of times dominant during pretreatment divided by number of observation periods (21).

[c]Total number of times dominant during treatment divided by number of observation periods (24) with the exception of MG who was observed for only 12 periods because of death.

[d]Total number of times subordinate divided by number of observation periods (21 during pretreatment and 24 during treatment) with the exception of MG as mentioned above.

Table 25. Total number of interactions for pretreatment and treatment periods for group PY-8.

Dominant Bird	Subordinate											
	Pretreatment						Treatment					
	MG	R	B[b]	W[a]	Total	D[c]	MG	R	B[b]	W[a]	Total	D[d]
MG	-	20	2	11	33	1.57	-	7	3	0	10	0.42
R	6	-	4	2	12	0.57	2	-	0	0	2	0.08
B[b]	0	2	-	0	2	0.10	4	19	-	4	27	1.12
W[a]	0	1	0	-	1	0.05	0	0	0	-	0	0.00
Total	6	23	6	13	48		6	26	3	4	39	
S[e]	0.28	1.10	0.28	0.62			0.25	1.08	0.12	0.44		

[a]Received 4 mg of dieldrin twice a week during the first third of the treatment period until death.

[b]Received 4 mg of dieldrin twice a week during the last two-thirds of the treatment period after the death of W.

[c]Total number of times dominant during pretreatment divided by number of observation periods (21).

[d]Total number of times dominant during treatment divided by number of observation periods (24) with the exception of W who was observed for only 9 periods because of death.

[e]Total number of times subordinate divided by number of observation periods (21 during pretreatment and 24 during treatment) with the exception of W as mentioned above.

Table 26. Total number of interactions for pretreatment and treatment periods for group PY-9.

Dominant Bird	Subordinate											
	Pretreatment						Treatment					
	B[a]	W[b]	MG	R	Total	D[c]	B[a]	W[b]	MG	R	Total	D[d]
B[a]	-	7	9	18	34	1.62	-	1	0	8	9	1.00
W[b]	5	-	2	6	13	0.62	6	-	0	8	14	0.58
MG	0	0	-	1	1	0.05	0	0	-	0	0	0.00
R	0	0	0	-	0	0.00	5	0	0	-	5	0.21
Total	5	7	11	25	48		11	1	0	16	28	
S[e]	0.24	0.33	0.58	1.19			1.22	0.04	0.00	0.67		

[a]Received 4 mg of dieldrin twice a week during the first half of the treatment period until death.

[b]Received 4 mg of dieldrin twice a week during the second half of the treatment period after the death of B.

[c]Total number of times dominant during pretreatment divided by number of observation periods (21) with the exception of MG who was observed for only 19 periods because of death.

[d]Total number of times dominant during treatment divided by number of observation periods (24) with the exception of B who was observed for only 9 periods because of death and MG who died before treatment started.

[e]Total number of times subordinate divided by number of observation periods (21 during pretreatment and 24 during treatment) with the exceptions of MG and B as mentioned above.

Table 27. Total number of interactions for pretreatment and treatment periods for group PY-10.

Dominant Bird	Subordinate									
	Pretreatment					Treatment				
	R	B	MG[a]	Total	D[b]	R	B	MG[a]	Total	D[c]
R	-	3	2	5	0.24	-	1	0	1	0.14
B	2	-	1	3	0.14	5	-	2	7	0.64
MG[a]	2	0	-	2	0.09	10	2	-	12	1.09
Total	4	3	3	10		15	3	2	20	
S[d]	0.19	0.14	0.14			2.14	0.27	0.18		

[a]Received 4 mg of dieldrin twice a week during the treatment period.

[b]Total number of times dominant during pretreatment divided by number of observation periods (21).

[c]Total number of times dominant during treatment divided by number of observation periods (11) with the exception of R who was observed for only 7 periods because of death.

[d]Total number of times subordinate divided by number of observation periods (21 during pretreatment and 11 during treatment) with the exception of R as mentioned above.

Table 28. Total number of interactions for pretreatment and treatment periods for group PY-11.

Dominant Bird	Subordinate							
	Pretreatment				Treatment			
	R[a]	B	Total	D[b]	R[a]	B	Total	D[b]
R[a]	-	3	3	0.14	-	2	2	0.22
B	1	-	1	0.05	0	-	0	0.00
Total	1	3	4		0	2	2	
S[d]	0.05	0.14			0.00	0.22		

[a]Received 4 mg of dieldrin twice a week during the treatment period.

[b]Total number of times dominant during pretreatment divided by number of observation periods (21).

[c]Total number of times dominant during treatment divided by number of observation periods (9).

[d]Total number of times subordinate divided by number of observation periods (21 during pretreatment and 9 during treatment).

Table 29. Total number of interactions for pretreatment and treatment periods for group PY-12.

Dominant Bird	Subordinate											
	Pretreatment						Treatment					
	GR	Y	W	B[a]	Total	D[b]	GR	Y	W	B[a]	Total	D[c]
GR	-	6	8	2	16	0.76	-	4	7	0	11	0.45
Y	2	-	6	6	14	0.67	7	-	7	14	28	1.17
W	0	1	-	0	1	0.05	0	0	-	5	5	0.21
B[a]	0	0	0	-	0	0.00	0	2	6	-	8	0.33
Total	2	7	14	8	31		7	6	20	19	52	
S[d]	0.10	0.33	0.67	0.38			0.29	0.25	0.83	0.79		

[a]Received 4 mg of dieldrin twice a week during the treatment period.

[b]Total number of times dominant during pretreatment divided by number of observation periods (21).

[c]Total number of times dominant during treatment divided by number of observation periods (24).

[d]Total number of times subordinate divided by number of observation periods (21 during pretreatment and 24 during treatment).

Table 30. Total number of interactions for pretreatment and treatment periods for group PY-13.

Dominant Bird	Subordinate												
	Pretreatment							Treatment					
	G[a]	WB	BR	R	WR	Total	D[b]	G[a]	WB	BR	R	WR	Total	D[c]
G[a]	-	8	4	0	1	13	1.86	-	13	3	0	0	16	0.67
WB	9	-	2	0	1	12	1.71	12	-	3	2	0	17	0.71
BR	8	2	-	1	0	11	1.57	7	5	-	5	1	18	0.75
R	0	0	0	-	1	1	0.14	0	0	0	-	0	0	0.00
WR	0	0	0	0	-	0	0.00	0	0	3	0	-	3	0.12
Total	17	10	6	1	3	37		19	18	9	7	1	54	
S[d]	2.42	1.43	0.86	0.14	0.43			0.79	0.75	0.38	0.29	0.04		

[a]Received 4 mg of dieldrin twice a week during the treatment period.

[b]Total number of times dominant during pretreatment divided by number of observation periods (7).

[c]Total number of times dominant during treatment divided by number of observation periods (24).

[d]Total number of times subordinate divided by number of observation periods (7 during pretreatment and 24 during treatment).

chicks respectively, had few interactions which made it difficult to assess distinct organizational arrengement. Within group PY-13, three aggressive and two non-aggressive birds were observed with no social order being obvious. These groups demonstrated that a variety of social arrangements are present in small groups of chicks from linear hierarchies to non-linear hierarchies to groups with unsettled relationships and finally to groups of non-aggressive chicks with so few interactions that organization cannot be determined.

A relationship existed between the aggressive chicks of the smaller groups and the aggressive chicks of the previous larger groups. One third of the most aggressive birds had likewise been the most aggressive birds in previous groups while one third had been second most aggressive and one sixth had been third. Only one of the birds had previously held a low ranking position. Of the four most aggressive birds of groups PY-1, PY-2, PY-3 and PY-4, all were either most or second most aggressive bird in their new groups.

Neither the weight of the chicks nor the sex affected aggressiveness. The heaviest bird was dominant in some groups and subordinate in others. In the six groups made up of both sexes, the most aggressive bird in three groups was a female and a male in the remaining groups.

The mean number of times each chick was dominant and subordinate per 10-minute observation period was determined during pretreatment and treatment periods. Dominant interactions ranged from 0 to 2.42 with a mean of .62 pecks per bird per observation. The number of times a bird was subordinate ranged from 0 to 2.42 or an average of .63 per

observation. These results show young penned pheasants to be much less active than penned juvenile male mallards. Nauman (1969) found mallards to be dominant 5.21 times per 5-minute observation period and subordinate 7.55 times.

Death occurred during treatment. Two birds, W of group PY-5 and B of PY-9, were dominant birds which received dieldrin. Both of these birds retained their aggression until the day before death. Out of nine birds which died, five were chicks which had received dieldrin.

During treatment, changes in aggression occurred in eight of the nine chick groups (Tables 22 through 30). The most obvious change was in group PY-10 where all birds switched ranks (Table 27). The top two chicks of group PY-5 appeared to change position while in other groups the middle two or bottom two birds changed position. Contingency tables and chi-square tests were employed as a statistical method to find if the changes in aggression were significantly different for birds receiving and not receiving dieldrin. The results showed no significant changes ($P > 0.05$).

Chickens

Dominant interactions of the eight chickens in group CH-1 were consistent during the entire pretreatment period (Table 31). When birds were paired, the relationships were normally settled immediately with either a fight between the two birds or one bird immediately pecking the other. The relationship was settled each time any two chickens were paired. Occasionally a period of time, approximately one to five minutes, lapsed before pecking occurred. One reversal resulted during

Table 31. Summary of the dominant interactions of eight chickens, group CH-1, in three pretreatment series.

Bird	Number Pecked	Birds Pecked						
S	7	BW	R	B	Y	RB	W	GW
BW	6		R	B	Y	RB	W	GW
R	5			B	Y	RB	W	GW
B	4				Y	RB	W	GW
Y	2						W	GW
RB	2				Y			GW
W	2					RB		GW
GW	0							

Table 32. Summary of the dominant interactions of eight chickens, group CH-1, in three treatment series.

Bird	Number Pecked	Birds Pecked						
S[a]	7	BW	R	B	Y	RB	W	GW
BW[a]	6		R	B	Y	RB	W	GW
R	5			B	Y	RB	W	GW
B	4				Y	RB	W	GW
Y	2						W	GW
RB	3				Y		W	GW
W[a]	1							GW
GW[a]	0							

[a]Birds that received 6 mg of dieldrin two times a week for 3 weeks.

the treatment series of group CH-1 (Table 32). Bird W which was previously dominant to RB became subordinate after receiving dieldrin.

Pairing a chicken with only one other chicken for a number of days, as was done with group CH-2, did not lead to consistent dominance (Table 33). Eight of the 18 pairs of chickens alternated pecking with neither bird of the pair being defeated or victorious. Of the nine pairs having a dominant chicken, one reversal occurred during the treatment period. Bird FF which was subordinate during pretreatment began pecking the day she started receiving dieldrin going from a mean of 0 pecks to 3.75 pecks per observation period.

When the chickens of group CH-3 were each paired with three other birds, a dominant bird was again evident in each encounter. Comparing the behavior in the three groups of chickens, it would appear that to have consistent dominant-subordinate interactions, pairings must occur with more than just one other chicken for each bird. Absolutely no reversals occurred during the treatment phase of this group (Table 34). Dominant hens all remained consistently dominant.

Since only two reversals occurred in all three chicken groups, the reversals were probably only coincidental. Two reversals do not constitute enough evidence to conclude that dieldrin affects peck-orders. Although stability is the rule (Schjelderup-Ebbe 1935) among birds in constant association, reversals might be occasionally expected. This might especially be true when birds are housed separately and paired with each other every few days. It is interesting, however, that both reversals involved subordinate birds becoming dominant after receiving dieldrin.

Table 33. Dominant bird of 18 pairs of chickens, group CH-2, during eight pretreatment encounters and 13 treatment encounters.

Bird to Bird[a]		Pretreatment	Treatment
A	B	-[b]	-
D	C	C	C
E	F	-	-
G	H	H	H
J	I	J	J
L	K	L	L
N	M	-	-
P	O	O	O
Q	R	R	R
S	T	S	S
V	U	-	-
W	X	X	-
Y	Z	-	-
AA	BB	AA	AA
CC	DD	-	-
EE	FF	EE	FF
HH	GG	-	-
II	JJ	-	-

[a]Birds in this column received 10 mg of dieldrin twice a week during the treatment period which lasted 26 days.

[b]The - indicates birds which alternated in pecking each other during the observation period.

Table 34. Dominance among chickens during 3 pretreatment encounters (P) and 3 treatment encounters (T) of 14 birds each paired with three other birds (group CH-3).

Bird	A[a]		E		G		J[a]		P		Q[a]		S[a]		V		W		Y[a]		AA		CC[a]		EE[a]		II	
	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T
A[a]			E	E	G	G	J	J	-[b]		-		-		-		-		-		-		-		-		-	
E	E	E			G	G	E	E	-		-		-		-		-		-		-		-		-		-	
G	G	G	G	G			-		-		-		-		G	G	-		-		-		-		-		-	
J[a]	J	J	E	E	-				J	J	-		-		-		-		-		-		-		-		-	
P	-[b]		-		-		J	J			-		S	S	-		-		-		-		CC	CC	-		-	
Q[a]	-		-		-		-		-				S	S	V	V	W	W	-		-		-		-		-	
S[a]	-		-		-		-		S	S	S	S			S	S	-		-		-		-		-		-	
V	-		-		G	G	-		-		V	V	S	S			-		-		-		-		-		-	
W	-		-		-		-		-		W	W	-		-				W	W	AA	AA	-		-		-	
Y[a]	-		-		-		-		-		-		-		-		W	W			AA	AA	-		EE	EE	-	
AA	-		-		-		-		-		-		-		-		AA	AA	AA	AA			-		-		AA	AA
CC[a]	-		-		-		-		CC	CC	-		-		-		-		-		-				CC	CC	CC	CC
EE[a]	-		-		-		-		-		-		-		-		-		EE	EE	-		CC	CC			EE	EE
II	-		-		-		-		-		-		-		-		-		-		AA	AA	CC	CC	EE	EE		

[a]Received 10 mg of dieldrin twice a week during the treatment period.
[b]Not paired.

SUMMARY AND CONCLUSIONS

Aggressive behavior developed among penned pheasant chicks approximately 3 weeks of age and led to the gradual establishment of a social order. Groups of chicks consisting of six to eight birds from 3 weeks to 11 weeks of age appeared to have unstable social orders with many reversals of peck-order occurring. Definite peck-orders were not obvious in these large groups. Each group did, however, have both aggressive chicks which pecked frequently and non-aggressive birds which pecked infrequently or not at all. When chicks 11 to 18 weeks of age were placed in groups of 2 to 5, a variety of social arrangements were displayed from straight linear hierarchies and non-linear hierarchies to groups with unsettled relationships and groups with no interactions. Sex and weight had no influence on the rank of the chicks.

Peck-orders were observed in groups of adult pheasant hens and cocks. The highest frequency of pecking occurred the first day or two in these groups as well as in the chick groups. Pecks occurred on following days but with less frequency. Rank, however, was not necessarily determined the first day. Generally the peck-orders were non-linear. After a period of separation, the rank of an individual occasionally changed, the change being most common among individuals at the lower end of the peck-order. Sometimes a low ranking bird became dominant.

Reversed pecks occurred, especially among the very young chicks and pheasant hens, which suggests instability. Also, in all groups,

the birds receiving the most pecks were generally those near the middle of the peck-order. This was a result of the lowest ranking birds avoiding the dominant birds. When hens were shifted daily among cock groups, pecking appeared to be stimulated.

Although some chicks changed ranks during dieldrin treatment, no changes were significant. The resulting peck-orders in groups were not affected by weight, previous dieldrin treatment, parental dieldrin treatment or, in the case of males, length of ear tufts. The rank of paired cock pheasants had no relation to weight or ear tuft length and was not altered by dieldrin application. Experiments with paired chickens showed similar results, that dieldrin application did not alter the dominance-subordination pattern.

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APPENDIX

Appendix Figure A. Example of a daily observation sheet used for recording group behavior, showing the number of times each pheasant was dominant and the birds they dominated.

Date March 6 Time 9:25 to 9:55 a.m. Group PC-1

Dominant Bird	Subordinate Bird																
YY																	
GG			YY	OO	YY	YY	WW										
WW			OO	GG	YY	OO	OO	OO	YY	OO							
BB																	
OO																	
RR			YY														

Appendix Figure B. Example of a daily observation sheet used for recording the behavior of paired birds. The number of times each pheasant was dominant is recorded.

Date April 24 Birds Cock Pairs

Dominant Bird	Subordinate Bird																
A		L	L	L	L												
L																	
C		a		M	M	M	M	M									
M																	
D																	
N																	
E		P	P	P	P												
P																	
F		QQ	QQ	QQ	QQ	QQ	QQ										
QQ																	
V																	
Z																	
AA																	

[a]Fight