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REGULATION OF PHEASANT DENSITY THROUGH NEST ABANDONMENT IN SOUTH-CENTRAL NEBRASKA

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INTRODUCTION

In a five-year study of the ring-necked pheasant (Phasianus colchicus) in south-central Nebraska, Linder, Lyon and Agee (1960) proposed that "the quality of nesting environment determines the number of nests which will be successful in a given year; this regulates total production which in turn determines the following year's breeding population." These conclusions were based upon the following findings:

1. A close correlation existed between the number of chicks produced and the number of hens the following spring. Because of this relationship it was concluded that mortality through fall, winter and early spring was relatively constant from year to year and adjustment to a higher or lower population level occurred during the nesting season.

2. The study area was in a region of intensive agriculture and nesting occurred in a relatively restricted acreage. Nearly 90 percent of the chicks were produced in two cover types: (1) roadside, in which early production took place and (2) wheat, where most late nesting occurred.

3. A considerable amount of renesting occurred indicating previous failures. As the total number of hens in the spring population increased, the average number of nests established per hen also increased indicating a higher rate of failure. It was suggested that in years of higher populations there was a greater incidence of voluntary abandonments.

4. The number of chicks produced was not a function of the number of hens currently in the breeding population; rather, the nesting environment appeared to govern the number of nests which was successful each year.

Since environmental factors apparently inhibited further hatching after a particular number of chicks was produced, a hypothesis was proposed (Linder and Agee, 1963) which seemed to explain the mechanism of population adjustment as it occurred in the population under study. The hypothesis was expressed in three parts, as follows:

A. The number of young produced was controlled by nest abandonment during incubation.

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B. The stimulus for abandonment was furnished by association with chicks hatched by other hens. These associations occurred most readily when nesting cover was sparse and afforded minimum concealment.

C. This tended to establish an upper limit upon the number of broods which could be hatched and brooded in a particular unit of cover, regardless of the number of breeding hens present.

Operation of the hypothesis would depend upon the existence of a behavioral pattern whereby a hen would abandon her nest upon stimulus from chicks hatched by another hen. It would further require that areas occupied by nesting hens and by broods overlap sufficiently to provide opportunity for contacts and that family ties be sufficiently flexible to permit associations between unrelated hens and chicks. It was along these lines that work was performed to test this hypothesis.

LITERATURE REVIEW

Since relatively little has been published on the physiological and behavioral aspects of nesting wild galliforms, it was necessary to rely largely on literature dealing with birds of other orders.

There is agreement among endocrinologists that the biological changes related to the reproduction cycle are brought about by hormones (Eisner, 1960) and several authors have shown that the hormones are triggered by environmental factors. Hence the reproduction cycle in birds depends on internal changes set in motion by external factors operating through the endocrine system (Hinde and Warren, 1959).

Work done on several species lends support to the suggestion that young chicks normally prompt the hen's advancement from care of the eggs to care of the young.

Tinbergen (1953) discussing parental behavior in birds, stated that the external stimuli are provided by the young and that, in some birds, there are indications that the stimulus is given by chicks while still in the egg. Most probably the parents react to the calls which can be heard before hatching.

That young can provide stimulus has also been shown in other species, including jewel fish, (Hemichromis bimaculatus) (Noble, Kumpf and Billing, 1938), other cichlid fishes (Greenberg, 1963), and bobwhites (Colinus virginianus)(Anon, 1922). In the latter species, adoption of incubator-hatched young by foster parents was readily brought about by confining them together. Responses were also noted by Vilks (1958) working with passerine birds. He commented that if two different stimuli were acting on the nesting bird simultaneously during the nesting period, the bird responded to the stimulus of the phase which had not yet started. He believed the patterns were characteristic for the whole order and perhaps for all birds.

Emlen (1941), working with the tricolor redwing (Agelaius tricolor), concluded that following the initiation of incubation, behavior was largely controlled by external situations associated with the nest. By introducing strange young into nests he was able to cause incubating females to advance prematurely out of the incubation phase. It is reasonable to expect that the same phenomenon might occur in pheasants, and cause nest abandonment.

From brood observations reported in literature it appears that familial ties in the pheasant are not firm. Mixing of broods is evidently frequent in the wild and many chicks are observed without hens. This indicates that unattended chicks as well as those accompanied by hens were available to provide external stimuli. Hiatt and Fisher (1947) reported that large numbers of broods were not attended by hens, and that such broods increased during the summer from 14 percent in June to 35 percent in October. Wagner (1957) reported that in Wisconsin a similar progressive increase in broods without hens was observed. Stokes (1954) observed that in a population with a density of over 30 birds per acre, chicks frequently wandered about with no adult hen in sight. He also reported that in high density populations, two or more broods frequently intermingled. Kozicky (1951) believed unsuccessful hens were associated with pheasant broods in Iowa. Hiatt and Fisher (op. cit.) also found broods were sometimes attended by more than one hen.

While literature generally supports the hypothesis, specific evidence is scant. For this reason data gathered on established study areas in southern Nebraska since 1954 were scanned and experiments with external stimuli were initiated to check further the credibility of the hypothesis.

DESCRIPTION OF AREAS

Studies reported here were conducted on three areas in south-central Nebraska. Two of the areas, near Harvard and Clay Center in Clay County, were used to evaluate use of cover for nesting and rearing. The third area, the Sacramento-Wilcox Game Management Area (referred herein as the Sacramento Area) in Phelps County, was used for evaluation of use of cover for rearing and experiments with external stimuli.

Clay County is a region of gently undulating uplands slightly modified by stream erosion. Soil types in this area are largely silt loams with soil pH values ranging from 5.4 to 8.3 (Roberts and Gemmel, 1927).

The climate of Clay County is characterized by long, moderately hot summers and cold, dry winters. Mean monthly temperatures range from 25 degrees Fahrenheit in January to 79 degrees in July. Mean annual precipitation is 22 inches, of which 43 percent falls during May, June and July (Weather Bureau, U.S. Dept. of Commerce, 1955-62). The average growing season is 155 days (Roberts and Gemmell, op. cit.).

Using 1958 as a typical year, nearly all of the land of the Clay County study areas was intensively cultivated or grazed. Of the total acreage, row crops (corn and grain sorghum) occupied about 41 percent; winter wheat, 22 percent; pasture, 8 percent; and alfalfa, 4 percent. The remainder was winter barley, oats, sweet clover and native hay.

Roadsides, fencerows and odd areas occupied about three percent of the total acreage. Odd areas were comprised largely of farmsteads and railroad right-of-ways which had been abandoned and had reverted to mixed grasses and forbs.

Deep-well irrigation was practiced on the study areas. Irrigated crops were corn, grain sorghum, alfalfa, and wheat. Corn and sorghum comprised more than 90 percent of the total acres irrigated (Linder et al., 1960).

Studies on the Clay County areas were carried out to estimate use of cover for nesting under undisturbed conditions. For the study of induced nest abandonment the state-owned Sacramento Area was selected because of the high density of nesting pheasants. The latter is a tract of about 2,300 acres located in south-central Nebraska with soils of loessial origin. It consists of a broad, shallow basin (lagoon) surrounded by an uncultivated perimeter which extends to cultivated uplands irrigated by deep-wells. During the study water areas of the lagoon varied with amount of precipitation. Portions of the perimeter which were subjected to intermittent flooding were vegetated primarily by smartweed (Polygonum spp.),sunflower (Helianthus spp.), and sedges (Carex spp.). An area consisting principally of western wheatgrass (Agropyron smithii) and smooth brome (Bromus inermus) lay between the high water line of the lagoon and the uplands cultivated to corn, grain sorghum and wheat.

PROCEDURES AND RESULTS

Distribution of nests:

Various habitat types were studied on seven sections of the Harvard Area to determine if hens nested in cover used by chicks (Linder, et al., 1960). Each type was sampled to determine the extent of nesting and the rate of nest success (Stokes, 1954). Production from each cover type was calculated.

Six vegetation types which comprised available nesting cover were: wheat, pasture, alfalfa, roadsides, odd areas and fencerows. Approximately 87 percent of the chicks were produced in nests located in wheat and roadsides. While 25 percent of the nests occurred in alfalfa, mowing destroyed nearly all of them. Pastures, fencerows and odd areas held 12 percent of the nests and only 6 percent of the chicks were produced in these types because of the restricted acreage and/or poor quality cover that existed there.

Roadsides were used extensively for early nesting cover. Only four percent of the acreage of nesting cover was in roadsides, but 21 percent of the nests occurred in that type and 29 percent of the chicks were produced there. Predation and abandonment were observed as the main factors in nest failure. Mammals destroyed 39 percent of the nests; abandonment accounted for 19 percent. The high rate of destruction by mammals probably reflected the use of this cover type for travel lanes and hunting areas. Nest abandonment occurred early in the season and may have represented a normal occurrence (Buss, et. al., 1951). It should be pointed out that a study such as this cannot identify accurately all cases of abandonment. As mentioned by Stokes (1954) and Kimball et. al. (1956), nests destroyed by predators and farming operations include those previously abandoned by the hen.

There was an increase in chick production in roadsides with increase in density of vegetation canopy, but, the number of nests established did not increase. This suggested that canopy density had a greater influence upon success of nests than it did upon their establishment (Linder, 1964). While the greater concealment afforded by the denser canopy may have reduced the efficiency of predators, it also diminished the chance contacts between incubating hens and young. A relationship between density of roadside cover and production of chicks in widely scattered areas of Nebraska was also reported by Wiegers and Agee (1962).

Wheat was an important cover type for late nesting. More than 41 percent of all nests were in wheat and about 58 percent of all chicks produced were hatched there. Although there was a large acreage of wheat (65 percent of the nesting cover) nest densities were low. Predation and farming operations were the main causes of nest destruction. Abandonment occurred in 16 percent of all nests established in that type.

There was a comparable increase or decrease in numbers of nests established in wheat and roadside each year. However, when chick production was high in roadside, production was low in wheat and vice versa.

Distribution of broods:

Studies on cover usage by chicks were conducted. Vegetative types important for nesting were sampled at different times of the day by flushing and counting chicks. Cover used for roosting was sampled by walking each land parcel in the morning before the birds left the roosting areas. Additional information on roosting was obtained by searching transects at night with the use of flood lights (Smith, 1954). Counts showed that wheat and roadside were used extensively by young birds throughout the day. For roosting, wheat and lagoon areas were the most important with lagoon land assuming greater importance in dry years.

Contacts between unrelated hens and chicks would occur most frequently if the brood and the maternal hen did not display strong family bonds. Records were kept of broods sighted on the Clay County Areas from 1955 through 1962. Counts conformed to the methods described by Bennett and Hendrickson (1938). For each brood observed data on the number of young present, their estimated ages and the number of hens were recorded. During the study, 5,947 young birds were observed. Of these, 23 percent were not with hens. It was also noted that 40 percent of 873 hens were not accompanied by young. In other studies, large numbers of hens without chicks were observed (MacMullan, 1960; Mohler, 1959).

Observations were made of 120 groups of chicks six weeks of age or younger. Ten of these with a single age group of chicks were accompanied by more than one hen. In 23 observations single hens were accompanied by more than one age group of young.

Induction of Nest Abandonment by External Stimuli:

During the nesting seasons of 1961 and 1963, experiments were conducted on the Sacramento Area to determine if incubating wild hens could be induced to abandon their nests through stimuli furnished by chicks.

During the three years, 794 pheasant nests were found during June, July and early August by searching in the most favorable appearing nesting cover. Of these nests, 588 had been destroyed and 106 contained hatched eggs. Closer observation of the remaining 100 nests showed that 64 had been abandoned. The other 36 nests were used to test the response of hens to (1) the sound of chicks; (2) the sight and sound of chicks; and (3) full association with chicks.

In each of the experiments hens were subjected to chicks which were hatched in incubators or to chicks captured in the field and presumed to be imprinted to a hen (Lorenz, 1937).

Recording thermometers were used at many of the nests to furnish information on the hens' presence or absence.

Effects of sound:

To determine the effect of sound of chicks upon an incubating hen, a wire mesh pen 4 feet in diameter and 1½ feet high was concealed in the vegetation 6 to 8 feet from the nest. Two or three chicks were confined in the pen to ascertain if their peeping would induce the hen to abandon the nest. Chicks were left out day and night with food and water maintained in the pen. Under such conditions, the chicks were very active and their peeping was audible over distances of more than 50 feet. It is believed that chicks emitted only the distress call (Hess, 1959), hence the hens' responses to other calls were not tested.

Five hens were subjected to this treatment (Table 1). None of them abandoned or displayed any observable reaction to the sound of the chicks. At all five nests, chicks were in the pens at the time the eggs hatched and the hens left with their broods. At two nests the hens were subject to calling chicks throughout the incubation period.

Effects of sight and sound:

To determine the effect which the sight and sound of young might have on hens, chicks were confined in enclosed wire cages, 2 feet square and 1½ feet high. Each cage was mounted on stakes above the vegetation within 4 feet of the nest and in view of the hen. Cages containing chicks were erected beside nine nesting hens. Cages without chicks were placed by seven nests as controls. These were checked with the same regularity as cages with chicks, including maintenance of a food and water supply.

From field observations it was evident that sight and sound altered the behavior of the incubating hens. For example, one experimental hen was observed beneath the cage, evidently looking at the chicks inside. Another hen walked from the nest when disturbed instead of flying (incubating hens almost invariably fly from the nest when disturbed). The hens at two nests were undisturbed when the sites were checked for four and five days respectively before young were introduced. However, these hens flushed with care-of-the-young behavior when checked.

Of the nine nests near cages with chicks, four were abandoned, four were destroyed and one was successful (Table 1). All seven hens in control situations completed incubation and left with their chicks.

Association with chicks:

To determine the effect of full association with chicks, a wire pen about 14 feet in diameter and 1 foot high was placed around the nesting hen. This type of pen was sufficient to confine small chicks but represented only a slight obstacle to the hen. No experimentation was begun until after the hen had left and returned to the encircled nest at least once, suggesting that she did not abandon the nest because of the pen. In 11 pens two to four young pheasants were held to determine their effect on the hen. Hens in four additional pens served as controls and were subjected to the same activity except that chicks were not placed within the pens.

TABLE 1. FATES OF NESTS WHERE HENS WERE SUBJECTED TO ASSOCIATION WITH CHICKS

	Experiment	Control
Treatment: sound of chicks		
Total nests	5	0
Number hatched	5	-
Number destroyed	0	-
Number abandoned	0	-
Treatment: sight and sound of chicks		
Total nests	9	7
Number hatched	1	7
Number destroyed	4	0
Number abandoned	4	0
Treatment: full association with chicks		
Total nests	11	4
Number hatched	0	4
Number destroyed	2	0
Number abandoned	9	0

At the 11 pens in which chicks were placed, nine hens abandoned their nests and two nests were destroyed by mammals. At three of these the hens were observed with the chicks and evidently were devoting major attention to them. Two of the hens showed apparently divided attentions between the chicks and nest. They were observed with the chicks and on the nest alternately. They undoubtedly would have left the nest if the chicks could have escaped from the pen, as they were observed outside of the pen calling to the chicks. One of the hens was on the nest with the chicks at the last observation. Chicks in the pen with still another nesting hen were hatched in an incubator and placed in the pen when one and two days old. Nevertheless, they were with the hen on the nest shortly after they were introduced. Later the hen was calling from outside of the pen. When the pen was raised permitting the chicks to escape, they responded by going to the hen. The hen did not return to the nest.

In this experiment, action of chicks hatched in an incubator was different from activity of chicks captured in the wild. Incubator-hatched chicks commonly remained near the perimeter of the pen, continually attempting to escape. In many instances it is doubtful that these chicks made their presence known to the hen except through their calls. However, captured wild chicks (presumably imprinted) usually penetrated the vegetation immediately upon release into the pen and were soon in the vicinity of the hen.

All control hens completed incubation and left their nests with their chicks (Table 1). These four nests were encircled by pens a total of 37 days.

DISCUSSION AND CONCLUSIONS

A hypothesis is proposed that nest abandonment may occur when an incubating hen is subjected to the presence of chicks hatched by other hens and that this abandonment can serve to regulate population density.

Advancement in the reproductive sequence is dependent upon external factors acting through the endocrine system. When a nesting hen is physiologically interrupted or rendered out-of-phase in the nesting sequence, nest failure results. Previous studies have shown that females of other species can be induced to advance prematurely from care of the eggs to care of the young. Experiments reported here showed a similar response by incubating pheasant hens, including altered behavior and abandonment of the nest. The extent of this response reflected the degree of association with the young. A pronounced change occurred when the hen could come in physical contact with the chicks: Nine of 11 hens so treated abandoned their nests. Three were observed dividing their attentions between their eggs and the introduced young before abandoning.

Wheat and roadsides were the cover types of primary importance in reproduction. Roadsides were important for early nesting because of residual vegetation; however, production of chicks in roadsides was not constant but appeared to increase as the density of the vegetation increased. As mentioned previously, this could be explained by assuming that better concealment decreased contacts between hens and chicks, thus, the denser cover permitted a larger number of chicks to be produced before interactions occurred. In this way, variations in the quality of the habitat influenced the level of production.

Cover in wheat was sparse early in the spring and nesting did not occur until the vegetation offered concealment. Production here seemed to be influenced by earlier production in roadsides. This became more meaningful after it was found that wheat was important for rearing of young. Hens, which had earlier produced chicks in roadsides, moved their broods into the wheatfields for rearing. These chicks may have encountered incubating hens causing them to abandon their nests. That associations between unrelated chicks and hens occurred in the wild was demonstrated. During the experimentation, it was apparent that a hen exposed to chicks showed reduced attentiveness toward the nest. This was also observed in the wild.

In 1961, brood studies showed the progress of the hatch was relatively late, and few chicks were present in the nesting cover. Hens were reluctant to flush from their nests and only 1 of the 7 flushed failed to return. Loss of nests to predators was also very low.

However, in 1963, hatching was unusually early and relatively large numbers of chicks were present in the nesting cover. Hens flushed from their nests very readily, often while the investigator was a considerable distance away. Eighteen hens responded in this way but only three of them returned to their nests. Predators destroyed a much larger proportion of the observed nests than in 1961.

These observations, together with the experimental evidence, inferred the reduced attentiveness was expressed not only in a higher rate of abandonment, but also in a greater vulnerability of the nest to predators.

This study has provided information that the level of the population of pheasants might be controlled by nest failure prompted by the activities of chicks. It was shown that behavioral mechanisms necessary for its operation exist. However, the demonstration that such nest abandonment actually occurs in nature and at a rate sufficient to control a population remains a subject for future study.

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