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# Behavioral Interactions in a Fixed Aggregation of Bobwhites

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# BEHAVIORAL INTERACTIONS IN A FIXED AGGREGATION OF BOBWHITES

by

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## INTRODUCTION

Many observations have been made on the behavior in the field of the bobwhite (Colinus virginianus) and of other gallinaceous birds. Stoddard (1950) has described in some detail various aspects of bobwhite behavior. Stokes (1963) conducted a laboratory study on the agonistic and sexual behavior of the chukar partridge. No behavioral studies, to the writer's knowledge, however, have been conducted on bobwhites under controlled environmental conditions. The birds used in the present study were housed in individual cages and were arranged in an artificially fixed aggregation (Fig. 1). The birds were maintained in this condition through the experimental period and for a length of 13 months prior to it (Robinson, 1963a; 1963b). The writer's study dealt with (1) pacing and resting behavior, (2) leadership tendencies, and (3) the behavior of individuals which had been shifted from their fixed position in the aggregation to a new position. Data on pacing and resting behavior and on leadership tendencies were gathered under both breeding and non-breeding conditions. Data on the behavior of birds which had been moved to a new position, however, were obtained only when the birds were in breeding condition.

## METHODS

An experimental population constituted of 20 adult bobwhites, 11 males and 9 females, was purchased from a commercial game breeder in Holland, Michigan, on March 14, 1962. The birds were placed in a controlled environment laboratory on the same day they were purchased. Each bird was housed in an individual cage, 11½ x 8½ x 7½ inches,

which was constructed of ½-inch mesh hardware cloth. The cages were then spaced 3-4 inches apart on metal racks so that, in most cases, males alternated with females.

In the laboratory a temperature of $73^0$F. ($\pm 3^0$) and a relative humidity of 52 to 60 per cent were maintained throughout the experimental period. The light source was a bank of fluorescent tubes which provided 500 foot-candles of illumination. This intensity is reported to be below the upper tolerance limit for bobwhites (Robinson, 1957; 1963b:8).

During the summer of 1962 and winter of 1962-63, the birds were used in studies concerning egg production (Robinson, 1963a) and illumination preferenda (Robinson, 1963b). During this period half of the birds were handled daily, during the mid-day hours, in order that weights and cloacal temperatures might be measured. The birds were provided with an adequate supply of water, grit, and food. The commercial feed preparation which was used had a gross assay of 20 per cent crude protein, 2.5 per cent crude fat, and 6 per cent crude fiber. Two birds, one male and one female, died during the course of these studies.

In the present study the arrangement of the birds (Fig. 1), and the daily routine described above were maintained. Each of the 18 birds was considered in one of six possible categories. The categories were defined on the basis of (1) the presence or absence of a bird on either side of the individual under consideration, and (2) the sex of the bird(s) on either side of the individual. The categories, based on these arrangements, were as follows:

no bird-MALE-female
no bird-FEMALE-male
no bird-MALE-male
male-MALE-female
female-MALE-female
male-FEMALE-male

The birds were observed, while in their cages, from behind a cardboard wall 10 feet in front of the cages. Observations were conducted between the hours of 10:00 a.m. and 2:00 p.m., which were the mid-day hours of the artificial illumination period. After entering the room, the writer waited for a period of 15 minutes, hidden from the birds' view, before beginning observations. This procedure was followed so that the birds might resume their usual activities. During each observation period almost every bird was observed, individually, for 10 minutes. The directions in which each bird faced while resting and pacing were recorded.

Two series of observations were made. In one series the photoperiod was maintained at 9 hours, thus keeping the birds in non-breeding condition. Upon completion of this series of observations the photoperiod was immediately raised to 15 hours (Robinson, 1963a:216). After 18 days, the first "ah-bob-white" call was heard. At this time the birds were assumed to be in breeding condition, and the second series of observations was begun. When the birds were destroyed on June 27, 1963, the gonads were measured and their appearance recorded (Tables 1-2). The results of the two series of observations were then analyzed statistically.

Another aspect of this study tested the possibility of leadership among the birds in the experimental population. At the end of each observation period a clipboard was dropped from a height of 40 inches

onto a cement floor, thus producing a loud noise. The birds would immediately crouch and become motionless, as is characteristic of bobwhites when frightened in the field (Stoddard, 1950:57,58). The first bird to begin moving about following the period of immobility was noted and recorded in each case. Thus, it was hoped to determine whether or not one particular bird seemed to "lead" the others in recovering from the fright reaction.

It has been mentioned previously that the birds were arranged in an artificially fixed aggregation (Fig. 1). The birds were maintained in this arrangement for a period of over 15 months. After the birds had come into breeding condition, various individuals were moved from their fixed position to a new position on the rack. The reactions of the bird to its new neighbors and their reactions to the newcomer were recorded. After a 5-minute observation period, the bird was returned to its original position. After a period of 30 minutes, the procedure was repeated using a different bird. A total of 18 such observations was made.

## RESULTS AND DISCUSSION

The results of the two series of observations on pacing and resting behavior of bobwhites are listed in Tables 3 to 10. Each bird that was situated between two other birds was considered to have a choice of pacing and resting, along the sides of the cage, toward either one bird or the other. In those situations in which a bird was at the end of a row of cages, however, the choice was between an

adjacent bird and a blank space. In either situation any significant deviation from random pacing and resting was considered to be meaningful in terms of the individual's response to the adjacent bird. In the tables the deviations from randomness are noted. The 0.05 level of probability is used for t-score values, and the 0.01 level is used for chi square values.

Occasionally, some of the birds directed their pacing and resting behavior toward either the front or back of the cages. The meaning of these actions in terms of an individual's response to an adjacent bird is difficult to assess. These responses may or may not be identical to those directed toward the sides of a cage. These data, therefore, have not been included in the tables. In Tables 3 to 8 data are presented for those cases in which a bird was situated between an adjacent bird and a blank space. In those situations where an individual had a choice of pacing toward either a bird of the opposite sex or toward a blank space (Tables 3 to 6), its activity was directed toward the bird of opposite sex. When an individual was between a blank space and a bird of the same sex (Tables 7-8), however, the number of cage lengths traversed on either side did not differ significantly. These statements apply to both long and short photoperiods.

Field observations show that bobwhites of the opposite sex form pairs when breeding condition is attained (Stoddard, 1950:19). The data on pacing behavior during breeding condition (Tables 3 and 5) are in accord with this field evidence. In the two cases in which a male was between a blank space and another male, one male paced exclusively toward the adjacent male, while the other male paced toward both the

blank space and the adjacent male (Table 7). Further evidence must be obtained, therefore, before any conclusions can be drawn.

It would seem likely that males which were adjacent to one another would become antagonistic toward each other when breeding condition was reached (Stoddard, 1950:17; Stanford, 1952:9). No antagonistic behavior, however, was observed. If male bobwhites do set up peck-orders, as Genelly (1955:270,276) postulates for California quail, dominance-submissive relationships may have been established already; thus, agressive behavior might be infrequent.

Observations in the field also show that bobwhites are gregarious during the non-breeding season (Stoddard, 1950:44). It would appear, therefore, that a bird would choose to pace toward an adjacent bird rather than toward a blank space. This was found to be true when the adjacent bird was of the opposite sex (Tables 3 and 5), but when the adjacent bird was of the same sex the results were inconclusive (Table 7; see discussion above).

The resting behavior of individuals situated between an adjacent bird and a blank space is recorded in Tables 4, 6, and 8. Tables 4 and 8 show that a male bird in this situation rested toward the adjacent bird, without respect to sex or photoperiod. Female birds which were situated between a male and a blank space, however, tended to rest toward the blank space during both long and short photoperiods (Table 6).

Tables 9 and 10 present data on males which were situated between a female on one side and a male on the other. It is interesting to note that males paced and rested more frequently toward the females

under both breeding and non-breeding conditions. It is reasonable that males in breeding condition would direct their behavior toward a female, however, it might seem that males would show equal interest in both males and females under non-breeding conditions. Howard and Emlen (1942) state that in intra-covey fighting among valley quail, the fighting was between members of the same sex. This may indicate that valley quail are able to recognize sex differences at all times of the year. If this is true for bobwhites, the males in non-breeding condition may be directing their behavior toward a female or away from another male. Further experiments would be necessary to determine which might be the case.

The last two categories include males or females which were situated between two birds, both of the same but opposite sex. The pacing and resting behavior of non-breeding birds in this situation seemed variable; 5 out of 10 directed their pacing behavior toward one bird and their resting behavior toward the other. The majority of birds in breeding condition (7 or 10), however, seemed to direct their pacing and resting behavior toward the same individual. More observations should be made, however, before any conclusions are stated.

The second aspect of the study dealt with the possibility of leadership among the birds in the experimental population. The term "leader" was applied to an individual when it was the first bird to move after a loud noise was made. The results are recorded in Table 11. When the birds were in non-breeding condition, No. 8, a 3-year old female, was most frequently the first bird to move. Other birds, however, were occasional "leaders". In some cases several birds were observed

to move simultaneously. When the birds came into breeding condition, No. 15, a 2-year old male, was the first bird to move in the majority of cases. Stoddard (1950:57,58) discusses the "freezing" reaction of bobwhites and states that after the birds have remained motionless for a period of time, "suddenly all will relax and resume activity, apparently at a signal of reassurance from some member of the group". In the writer's study no calls were heard when an individual first began to move. It appeared that most of the birds began moving about only after one or several birds began moving actively. Sumner (1935:207), in his life history study of California quail, states that leadership among these birds seems to be determined by chance, with neither sex predominating. He goes on to say that "one or more 'leaders' may move off nearly simultaneously in different directions". Fischel's work with leadership in chickens (Masure and Allee, 1934:325) indicates that group leadership may change quite frequently, and that no one individual retains leadership over a long period of time. My data indicate that although one particular individual may assume a role of leadership in many cases, leadership is not limited to a single individual and is not limited to birds of one sex or age. Moynihan and Hall (1954:36) state that the absence of a constant individual "leader" in spice finches may be due to the lack of a definite dominance hierarchy. Studies on peck-order in bobwhites and the relationship of dominance to "leadership" must first be undertaken before any statement to this effect can be made about bobwhites.

The third aspect of the study dealt with the shifting of some cages from their original position on the rack to a new position. At this time all of the birds were in breeding condition. It is interesting that when a male bird was shifted to a new position, it often displayed in a manner similar to that described by Stoddard (1950:17,18) and Stanford (1952:11). The display was usually a frontal one with the body feathers fluffed and the wings extended. The tips of the primary feathers rarely touched the bottom of the cage. The bird's beak would occasionally be open when the display was being given. This display was given toward both males and females. When the male was returned to its original position, however, it did not display toward its original neighbor. Since this display was presented to both males and females, it may have a function similar to the invitatory display that Tinbergen observed in his study of the snow bunting (Armstrong, 1947:133,134). Tinbergen found that males gave the invitatory display toward birds of either sex. The bird receiving the display then reacted in a manner such that its sex was identified to the displaying male. Domm and Davis (1948:29) also found this to be true of domestic fowl. It is also possible that the display given by male bobwhites is simply a form of hostile behavior (Moynihan, 1955), without so specific a function as that of sex recognition. When a male bobwhite gave this display, the bird receiving the display, whether male or female, either crouched and became motionless for a short period of time or simply ignored the displaying bird and continued its usual activities. More observations must be made before any conclusions can be reached.

Since the male bobwhite did not display upon return to his original position, it may be that he was able to recognize the individuals which had been next to him for the previous 15 months. Armstrong (1947:132) stated that individual birds may recognize one another by deportment, head features, or voice. Among those birds which seem to be able to recognize individuals are ring doves, terns, pintails, robins, Galapagos finches, mute swans, and jackdaws. The possibility that the response was based on recognition of a familiar physical environment cannot, of course, be ruled out.

One female bird was observed to display, however, this display differed from that given by the male. The display was given only toward a strange female. The displaying female would fluff her feathers slightly, open her beak, and then lunge at the side of the cage toward the strange female. The displaying female would also bob up and down along the side of the cage during the display. These displays were of longer duration than those given by the males and may represent a form of agonistic behavior. The reactions of the females to whom the display was directed varied. One female continued to pace while the other female was displaying, whereas, other females rested and occasionally paced during the display. Stokes (1961, 1963) points out that in chukar partridges females are usually highly tolerant of one another, but that there are exceptions.

Another interesting point was that when males were shifted to a new position, they often began giving the covey call. In the field this call is given by both sexes and is used to call scattered birds back together (Stoddard, 1950:105). Once the shifted bird began

calling, many other males also began calling. When females were shifted, however, they were not observed to give this call. Stokes (1961:114,115) observed that when two male chukar partridges met aggressively, bursts of rally calls or covey calls were uttered. Other males often joined the calling. In the case of bobwhites, whether or not the call represented a form of agonistic behavior would require further investigation. Since a male that was shifted to a new position gave the covey call regardless of the sex of its new neighbors, it may well be that he was simply calling to his original neighbors. The joining in of the other males may be a case of defining their own position or possibly simply a case of social facilitation (Tinbergen, 1953:54).

In many cases in which a bird was moved to a new position, either the shifted bird or its new neighbors crouched and became quiet for varying periods of time. More often it was a female that became quiet; nevertheless, this behavior was observed among some males. According to Stokes (1961, 1963) the phenomenon of crouching and becoming quiet in the presence of a strange bird is a sign of submissive behavior, at least in the chukar partridge.

## SUMMARY AND CONCLUSIONS

A laboratory study of the behavior of bobwhites, under controlled environmental conditions, was conducted in the spring of 1963. Thirteen months prior to the experimental period, 20 birds were placed in metal cages and spaced 3-4 inches apart on metal racks, such that

in most cases males alternated with females. The pacing and resting behavior of 18 surviving birds with respect to their surroundings were observed from behind a cardboard wall located 10 feet in front of the cages.

It may be said that, in general, the pacing and resting behavior of the birds in non-breeding condition demonstrates the gregarious nature of bobwhites during this season. Data also indicate that there may be dominance-submissive relationships among these birds. Evidence is presented which indicates that bobwhites may be able to recognize sexual differences at all times of the year. In addition, whereas an individual in non-breeding condition may rest toward one bird and pace toward another, a bird in breeding condition more frequently directs its behavior toward a single bird.

The possibility of leadership among bobwhites was tested by noting the first birds to move about after a loud noise had been made. It must be concluded that although one bird may "lead" more often than others in recovering from the fright reaction, leadership changes often and is not limited to birds of one sex or age.

The final aspect of the study dealt with the reactions of the birds after various individuals had been moved from their original position on the metal rack to a new position. Males that had been moved displayed frequently toward their new neighbors (either male or female). This may be an invitatory display which incites other birds to identify themselves by engaging in certain behavioral activity. Inasmuch as males did not display after being returned to their

original position, they may be able to recognize their original neighbors. One female bird was observed to display toward strange females. The display was different from that given by the males. The display of the female may represent some form of agonistic behavior.

Males, when placed in new surroundings, frequently uttered the covey call. The purpose of this call may be either to call the male's original neighbors back to him, or it may represent a form of agonistic behavior. No. females were observed to give this call.

In many cases in which a bird was moved to a new position, either the shifted bird or its new neighbors crouched and became quiet. This phenomenon was performed more frequently by females and may indicate submissive behavior.

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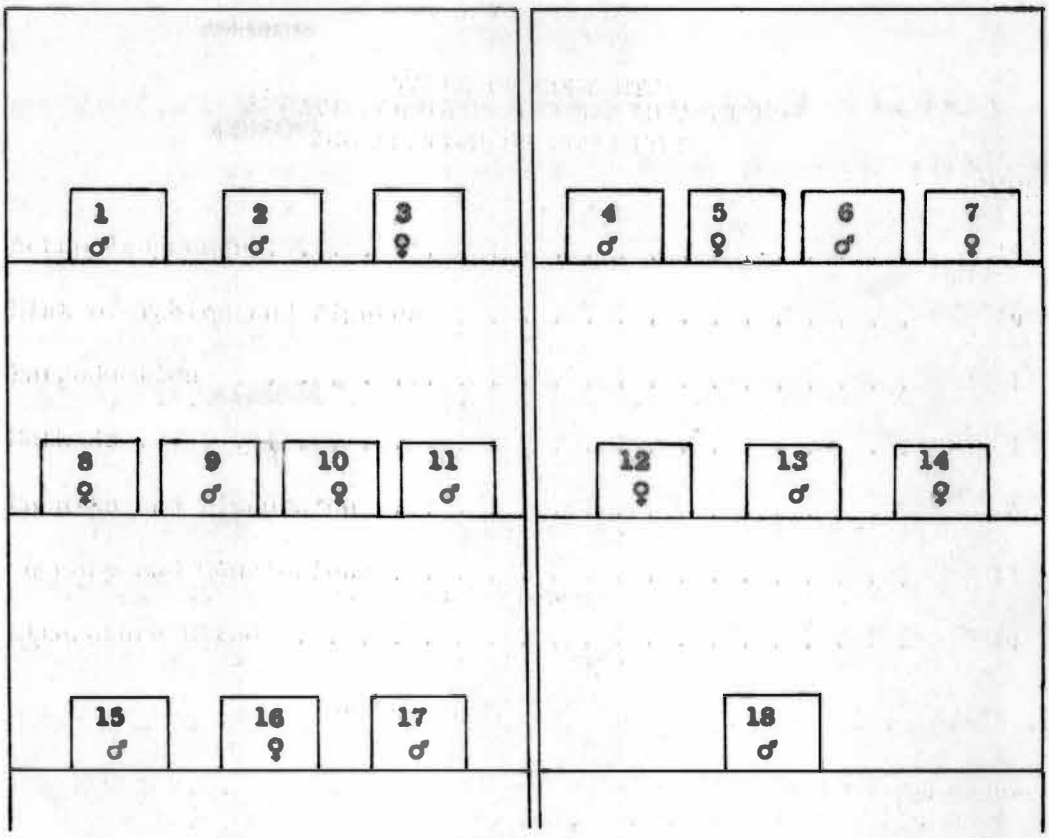


**Figure 1.** Arrangement of birds in fixed aggregation. Numbers are identification numerals assigned to each individual; sexes are shown by the appropriate symbols. Scale: 18 in. = 1 in.

Table 1. Reproductive condition of males at end of experimental period based on measurements of excised gonads immediately following death.

| Male (Ident. No.) | Condition | Lt. Testis (mm.) | Rt. Testis (mm.) |
|---|---|---|---|
| 1 | breeding | 14 x 11 | 12 x 9 |
| 2 | " | 19 x 10 | 15 x 12 |
| 4 | " | 17 x 11 | 16 x 11 |
| 6 | " | 17 x 10 | 17 x 10 |
| 11 | " | 17 x 11 | 16 x 12 |
| 13 | " | 16 x 11 | 14 x 10 |
| 15 | " | 18 x 12 | 15 x 12 |
| 17 | " | 18 x 11 | 15 x 11 |

Table 2. Reproductive condition of females at end of experimental period based on measurements and observations of excised gonads and accessory structures immediately following death.

| Female (Ident. No.) | Condition |
|---|---|
| 3 | breeding - 1 partially shelled egg in oviduct |
| 5 | " - largest follicle 6 mm. in diameter |
| 7 | " - 2 shelled eggs in oviduct |
| 8 | " - 1 unshelled egg in oviduct |
| 10 | " - largest follicle 14 mm. in diameter |
| 12 | " - 1 shelled egg in oviduct |
| 14 | " - largest follicle 16 mm. in diameter |
| 16 | " - 1 unshelled egg in oviduct |

Table 3. Arrangement: No bird-MALE-female. Number of cage lengths traversed by a male bird in non-breeding condition (14 observations) and breeding condition (14 observations) with respect to its surroundings.

| Reproductive Condition | Toward no bird | Toward female | t-score | Significant difference |
|---|---|---|---|---|
| non-breeding | 0 | 2680 | 11.19 | yes |
| breeding | 0 | 1689 | 9.17 | yes |

Table 4. Arrangement: No bird-MALE-female. Approximate number of minutes that a male bird rested in non-breeding condition (6 observations) and breeding condition (15 observations) with respect to its surroundings.

| Reproductive Condition | Toward no bird | Toward female | $chi^2$ | Significant difference |
|---|---|---|---|---|
| non-breeding | 3.0 | 37.5 | 29.38 | yes |
| breeding | 0.5 | 30.3 | 28.84 | yes |

Table 5. Arrangement: No bird-FEMALE-male. Number of cage lengths traversed by a female bird in non-breeding condition (13 observations) and breeding condition (13 observations) with respect to its surroundings.

| Reproductive Condition | Toward no bird | Toward male | t-score | Significant difference |
|---|---|---|---|---|
| non-breeding | 3 | 3193 | 4.91 | yes |
| breeding | 0 | 3548 | 8.95 | yes |

Table 6. Arrangement: No bird-FEMALE-male. Approximate number of minutes that a female bird rested in non-breeding condition (23 observations) and breeding condition (27 observations) with respect to its surroundings.

| Reproductive Condition | Toward no bird | Toward male | $chi^2$ | Significant difference |
|---|---|---|---|---|
| non-breeding | 103.9 | 15.7 | 64.04 | yes |
| breeding | 94.5 | 52.0 | 12.32 | yes |

Table 7. Arrangement: No bird-MALE-male. Number of cage lengths traversed by a male bird in non-breeding condition (8 observations) and breeding condition (13 observations) with respect to its surroundings.

| Reproductive Condition | Toward no bird | Toward male | t-score | Significant difference |
|---|---|---|---|---|
| non-breeding | 66 | 754 | 2.07 | no |
| breeding | 148 | 707 | 1.79 | no |

Table 8. Arrangement: No bird-MALE-male. Approximate number of minutes that a male bird rested in non-breeding condition (23 observations) and breeding condition (34 observations) with respect to its surroundings.

| Reproductive Condition | Toward no bird | Toward male | $chi^2$ | Significant difference |
|---|---|---|---|---|
| non-breeding | 31.0 | 86.8 | 26.44 | yes |
| breeding | 50.9 | 163.7 | 59.30 | yes |

Table 9. Arrangement: male-MALE-female. Number of cage lengths traversed by a male bird in non-breeding condition (6 observations) and breeding condition (11 observations) with respect to its surroundings.

| Reproductive Condition | Toward male | Toward female | t-score | Significant difference |
|---|---|---|---|---|
| non-breeding | 7 | 1271 | 2.80 | yes |
| breeding | 109 | 906 | 2.39 | yes |

Table 10. Arrangement: male-MALE-female. Approximate number of minutes that a male bird rested in non-breeding condition (24 observations) and breeding condition (36 observations) with respect to its surroundings.

| Reproductive Condition | Toward male | Toward female | $chi^2$ | Significant difference |
|---|---|---|---|---|
| non-breeding | 23.0 | 122.7 | 68.22 | yes |
| breeding | 38.7 | 214.6 | 122.16 | yes |

Table 11. Ranking of individual bird on basis of number of times each bird was first to move after a loud noise was made. The numbers in parentheses indicate the number of observations in which several birds were observed to move simultaneously. The age and sex of each bird is also indicated.

| Non-breeding condition | | | | | Breeding condition | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Ident. No. | Age | Sex | No. of obs. | | Ident. No. | Age | Sex | No. of obs. | |
| 8 | 3 yr. | ♀ | 5 | | 15 | 2 yr. | ♂ | 7 | |
| 16 | 2 yr. | ♀ | 2 | (3) | 8 | 3 yr. | ♀ | 2 | (10) |
| 11 | 2 yr. | ♂ | 1 | | 9 | 2 yr. | ♂ | 1 | |
| 13 | 2 yr. | ♂ | 1 | | 14 | 2 yr. | ♀ | 1 | |
| | | | | | 16 | 2 yr. | ♀ | 1 | |