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RECOGNITION CHARACTERISTICS IN COVEY DIALECTS OF BOBWHITE QUAIL

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ABSTRACT.—Fifty Bobwhite quail (*Colinus virginianus*) were randomly divided into two equal-size coveys at six weeks of age. At 12 weeks the separation ("hoy-poo") call was recorded from birds in both coveys. Duration and frequency characters were measured and subjected to discriminant analysis. This analysis indicated that each covey could be segregated mainly on the difference in duration between the "hoy" and "poo" parts of the call. Another duration character and one frequency character also contributed to segregation of the call types of the two coveys. The differences in the separation call that occurred between coveys most likely resulted from within-covey learning, where those birds associated with each other developed similarities in their calls in the form of an accent or covey dialect.

The Bobwhite (*Colinus virginianus*) is one of the most vocally communicative species of galliforms, having more than 20 documented calls with variations on these calls (Stokes 1967). This large vocabulary is used in all social situations. One of the more easily heard and recognized of the calls is the separation call, phonetically described as "hoy poo." This call is given when birds have become separated and are attempting to reassemble the covey (Stokes 1967).

Bailey (1978) found that Bobwhites within a covey could be individually identified by differences in the frequency of the "hoy" portion of the separation calls. He suggested that individuals within a covey recognized the individual-specific frequency of each bird in the covey and that this recognition would serve to maintain the integrity of a covey.

Dialects of the "hoy" portion of the separation call have been demonstrated among populations in widely separated locations in the United States (Goldstein 1978). Wild-living Bobwhites are attracted to separation calls of birds having their own population dialect, showing recognition of regional dialect, but not necessarily discrimination among individual birds. Calls differ among populations in duration of notes, duration between parts of the call and in frequencies of the notes (Goldstein 1974).

Combinations of variations in both frequency and duration could provide a large number of recognizable covey accents or dialects. The purpose of our study was to quantitatively examine the separation call of the Bobwhite in order to determine whether individual- or covey-specific characteristics are the more useful for maintaining covey integrity and to establish which characters of the call could be used for identification of a covey.

MATERIALS AND METHODS

Fifty Bobwhite quail, one day old, were obtained from a commercial game farm. The quail were brooded in a battery brooder until six weeks old. Birds were then divided randomly into two 25-bird coveys and individually marked with numbered, color-coded leg bands for individual and covey identification. We then moved the birds to the field and held each covey in a recall pen ($2 \times 1 \times .75$ m). The pens were about 200 m apart. Each pen was freely supplied with water and pelleted pheasant grower ration.

We began recording the separation call of the quail when the birds were 12 weeks old, the age when the adult form of the call is established (Kochenderfer 1971). Recordings were made each morning about an hour after sunrise and in late afternoon during the last hour before sunset. For each recording session, we took three birds from one covey and placed them in old-field cover about 25 m apart and 25 to 50 m from their home pens. Up to five repetitions of the "hoy poo" were recorded from each bird and each bird was recorded in one session only. All birds in Covey 1 were recorded before those in Covey 2. All recording was completed in two weeks.

Calls were recorded on a Uher 4000 Report-L tape recorder using a Uher M534 unidirectional microphone mounted in a parabola (d = 45 cm). Microphone-to-bird distance was approximately equal on all recorded calls and

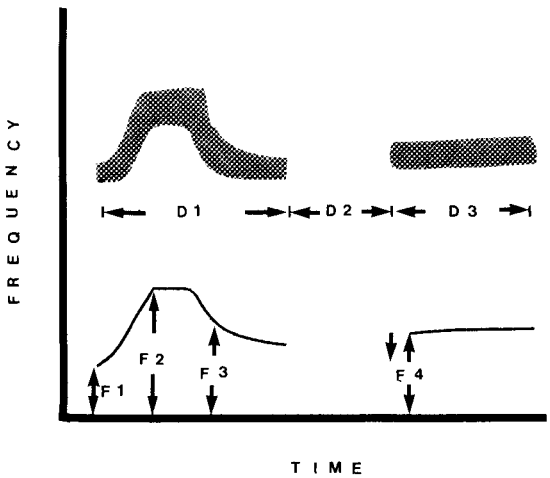

FIGURE 1. Schematic of idealized sonograph of "hoy poo" call with durations D1, D2, D3, measured on wide band and frequencies F1, F2, F3, F4 measured on narrow band.

recording was at the same decibel level for each call.

Recordings were played directly into a Kay Elemetrics Vibralyzer 7030A at the same decibel level as recorded in the field. Only recordings of nine birds in each covey had sufficient quality for complete analysis of all characteristics. A broad-band and a narrow-band sonogram was produced for one complete "hoy poo," selected on the basis of quality, for each bird. Characters measured on each sound spectrogram of each call were similar to those used by Goldstein (1978). Frequency characteristics were measured on narrow bands and temporal characteristics were measured on broad bands. Frequencies were measured from baseline, on the fundamental tone; durations were measured between preselected points (Fig. 1). All measurements were made in millimeters.

Seven characters (four frequency characters and three duration characters) were measurable on all birds. These measurements were subjected to a one-way ANOVA and stepwise discriminant analysis (Dixon and Brown 1979).

RESULTS

Temporal characters were more important than frequency characters in discriminating between the separation calls of coveys of Bobwhites. All measured durations in the "hoy poo" call were more different between coveys than within a covey. The duration of the "hoy" portion of the call was significantly longer in Covey 1. Duration between the "hoy" and "poo" portions was significantly greater in Covey 2 and was the largest difference of all measured characteristics. Duration of the "poo" portion of the call was significantly greater in Covey 1 (Table 1).

Frequency measured at F3 (Fig. 1) was significantly greater in Covey 2 (Table 1). No other frequency measurements showed any significant differences between coveys.

Multiple discriminant analysis of all characters measured showed that only characters D2 and D3 (Fig. 1) were important as identifying characters separating these coveys. The standardized discriminant functions were −1.00 for D2 and 0.784 for D3, indicating that D2 was the single most important discriminating character for these two coveys. Both these characters combined accounted for 100% of the variation in the analysis.

The F-ratio for character F3 was greater than that for character D, which would indicate a greater discriminating value for character F3 (Table 1). However, in step 1 of discriminate analysis the highest F-ratio is removed and all F-ratios are then recalculated on the basis of the remaining characters, consequently changing F-ratios. This recalculation resulted in an increased F-ratio for character D3 of 9.21 and a lowered F-ratio for F3 of 3.86, making D2 the most important variable and D3 the next most important variable.

TABLE 1. Means*, standard deviations and one-way analysis of variance** of "hoy-poo" characters*** of Bobwhite quail measured from sonograms.

Character	Covey 1 $\bar{x}$	($n = 9$) SD	Covey 2 $\bar{x}$	($n = 9$) SD	F-ratio	Probability
F1	16.4	3.2	15.9	3.3	0.09	0.77
F2	21.8	4.3	25.0	3.0	3.41	0.08
F3	12.3	3.6	16.9	3.3	7.82	0.013
F4	15.3	1.9	18.2	4.8	2.79	0.11
D1	38.9	10.0	29.4	5.6	6.13	0.025
D2	13.3	6.1	29.9	8.8	21.48	0.003
D3	23.8	4.6	19.1	3.0	6.58	0.02

* Measured in mm (1 mm = 0.007 s).
** Degrees of freedom = 1:16.
*** F1, F2, F3—frequency characteristics at onset, highest point and drop off point of "hoy" portion of call. F4—frequency characteristic of onset of "poo" portion of call. D1—duration of "hoy." D2—duration between "hoy" and "poo." D3—duration of "poo."

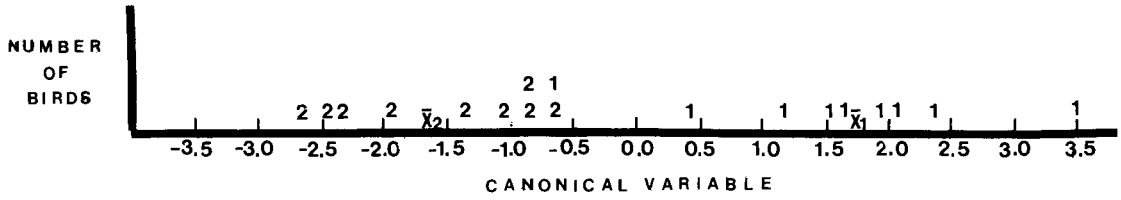

FIGURE 2. Birds in each covey plotted on canonical variable: $\bar{x}$ = mean of each covey; 1 = bird belonging to Covey 1; 2 = bird belonging to Covey 2.

The classification procedure showed that 100% of Covey 2 and 89% of Covey 1 would be correctly classified using these two characters. Overall, correct classification would be 94% for both coveys. The 11% incorrect classification within Covey 1 was due to one bird, who showed some duration characteristics more like birds in Covey 2 than birds in its own covey (Fig. 2).

DISCUSSION

Differences between the two coveys, in the parameters used in this study, cannot be attributed to genotypic variability in the quail because all birds came from one common stock and they were randomly assigned to one covey or the other. These measured differences more likely resulted from a learning process in which associated birds develop similarities in their calls in the form of an accent or localized dialect specific to that covey. Each member of a given covey then need not be a phonetician but need only recognize the characteristic or complex of characteristics specific to its own covey. It must be able to produce the calls resembling the mean accent of its own covey in order to communicate with and rejoin its own covey when separated from it. Recognition of each nearby individual covey should not be necessary, just recognition and response to the bird's own covey.

Young Bobwhites in the wild might learn the separation calls from either or both parents. Both parents brood chicks and both sexes give the separation calls (Stoddard 1931). But whether the male or the female contributes more or whether they contribute equally is not known.

The role of learning in song (call) production in passerine birds is well established (Nottebohm 1972, Lemon 1975). However, Konishi (1963) and Nottebohm and Nottebohm (1971) believed that learning plays no role in the development of vocalization in gallinaceous birds. Lemon (1975) suggested that the apparent innateness of calls in the gallinaceous birds might reflect a simpler neuromuscular mechanism in call production than in passerines so learning might produce only subtle changes in call structure.

Individual recognition on the basis of frequency differences in the "hoy" portion of the separation call (Bailey 1978) might be an important characteristic within the covey group. Thus, in order to maintain covey integrity, the number of differences any quail would need to know would equal the total number of birds in the covey. Frequency or pitch of a call also varies with the intensity with which it is given (Bailey 1978). Intensity with which a call is given varies with distance of separation of the birds in a wild situation, so separation distances would act to alter frequency, making individual recognition more difficult.

Our results suggest that each covey has a unique separation call, its uniqueness achieved more through changes in temporal than frequency characters. Each differing temporal component would act as a generalized "password" (Feekes 1977) for covey identification. Bobwhites in the field more probably discriminate between covey-specific passwords and identify with their own covey password than with individual birds. Covey affiliation breaks down in fall and winter when individuals frequently interchange among coveys (Agee 1957, Yoho and Dimmick 1972). The separation call might serve slightly different purposes and in different social relationships in the family covey in summer as compared with the mixed covey in fall and winter. Its function of reassembling birds would nevertheless be the same in both types of coveys.

Our birds were not tested directly for responses to temporal differences in the separation calls. Goldstein (1974) tested responses of wild quail uttering the "bob-white" (sexual soliciting) call in Nebraska by playing tapes of the "hoy" portion of the call, which varied both in frequency and duration from that of Nebraska quail. These birds approached all calls regardless of frequency or duration, but they varied in intensity of responses, closeness of approach and number of birds responding. Wild Nebraska birds approached "hoy" calls of higher frequency than their own typical call.

These same birds also approached calls having a 1 s pause between "hoy" calls, typical for Nebraska birds, more than to "hoy" calls having a 0.5 s pause, characteristic of Massachusetts quail.

We did not measure the interval between successive "hoy" calls because the total "hoy poo" call was used; thus, our data are not directly comparable to Goldstein's (1974). However, the difference in means of pause between the "hoy" and "poo" portions (character D2) in the coveys tested in our study was 0.14 s. This difference is considerably less than the 1 s minimum that Goldstein (1974) found necessary for a differential response in wild Nebraska Bobwhites.

Some passerine birds have been shown to have very fine temporal discrimination (Pumphrey 1961). Bullfinches (*Pyrrhula pyrrhula*) are capable of discriminating between double and single click notes differing in duration by as little as .002 s (Wilkinson and Howse 1975). Temporal discrimination has been found to be important in sequence calls produced by Bullfinches isolated from a group (Wilkinson and Howse 1975). Similarly, temporal characteristics are used in the assembly calls of Common Crows (*Corvus brachyrhynchos*; Richards and Thompson 1978). Temporal discrimination ability in Bobwhite is not well known. But if the capabilities of these quail are similar to those of the Bullfinch, the mean difference in duration between the "hoy" and "poo" of .14 s found in our study would be well within their range of temporal discrimination ability.

Although frequency was not an important variable in statistically separating coveys in our study, frequency character F3 was significantly different in the two coveys. Doubtless the functions of frequency and temporal characters are not so simple and clear cut in the wild, as shown in our work. We lack precise understanding of how Bobwhites interpret these frequency and temporal characters. Both frequency and duration, and combinations of them might be involved in individual and covey recognition in these quail.

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LITERATURE CITED

AGEE, C. P. 1957. The fall shuffle in central Missouri Bobwhites. J. Wildl. Manage. 21:329–335.

BAILEY, K. 1978. The structure and variation of the separation call of the Bobwhite quail (*Colinus virginianus* Odontophorinae). Anim. Behav. 26:296–303.

DIXON, W. J., AND M. B. BROWN [EDS.]. 1979. Biomedical computer programs P-Series. Univ. of California Press, Berkeley.

FEEKES, F. 1977. Colony-specific song in *Cacicus cela* (Icteridae: Aves): the pass-word hypothesis. Ardea 65:197–202.

GOLDSTEIN, R. B. 1974. Some physiological and zoogeographic parameters in the vocal acoustics of new world quail. Ph.D. diss., Univ. of Nebraska, Lincoln.

GOLDSTEIN, R. B. 1978. Geographic variation in the "hoy" call of the Bobwhite. Auk 95:85–94.

KOCHENDERFER, C. 1971. The ontogeny of vocalizations in the Bobwhite quail. M.Sci. thesis, Univ. of Nebraska, Lincoln.

KONISHI, M. 1963. The role of auditory feedback in the vocal behaviour of the domestic fowl. Z. Tierpsychol. 20:304–367.

LEMON, R. D. 1975. How birds develop song dialects. Condor 77:385–406.

NOTTEBOHM, F. 1972. The origins of vocal learning. Am. Nat. 106:116–140.

NOTTEBOHM, F., AND M. E. NOTTEBOHM. 1971. Vocalizations and breeding behaviour of surgically deafened Ring Doves (*Streptopelia risoria*). Anim. Behav. 19:311–327.

PUMPHREY, R. J. 1961. Sensory organs: hearing, p. 69–86. *In* A. J. Marshall. [ed.], Biology and comparative physiology of birds. Vol. 2. Academic Press, New York.

RICHARDS, D. B., AND N. S. THOMPSON. 1978. Critical properties of the assembly call of the common American crow. Behaviour 64:184–203.

STODDARD, H. L. 1931. The Bobwhite quail: its habits, preservation and increase. Charles Scribner's Sons, New York.

STOKES, A. W. 1967. Behavior of the Bobwhite, *Colinus virginianus*. Auk 84:1–33.

WILKINSON, R., AND P. E. HOWSE. 1975. Variation in the temporal characteristics of the vocalizations of Bullfinches, *Pyrrhula pyrrhula*. Z. Tierpsychol. 38: 200–211.

YOHO, N. S., AND R. W. DIMMICK. 1972. Habitat utilization by Bobwhite quail during winter, p. 90–99. Proc. First National Bobwhite Quail Symp. Oklahoma State Univ., Stillwater.

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