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GEOGRAPHIC VARIATION IN SOCIAL STRUCTURE AND BEHAVIOR OF *APHELOCOMA ULTRAMARINA*¹

STUART D. STRAHL² AND JERRAM L. BROWN

Department of Biological Sciences, State University of New York, Albany, NY 12222

Key words: Communal breeding; group size; social organization; geographic variation; vocalization; *Corvidae*; jay; Chisos Mountains; Texas.

The study of geographic variation in social structure may reveal flexibility of social behavior in a species and suggest correlations with environmental factors. Geographic variation in social structure has not been established previously for *Aphelocoma ultramarina* (Gray-breasted or Mexican Jay). In this paper we report observations on group size and composition from a population of *A. u. couchii* inhabiting the Chisos Mountains of Texas and compare them to published results for *A. u. arizonae* gathered using similar methods in the Chiricahua Mountains of Arizona (Brown and Brown 1985). In addition, we describe a vocalization found in one population but not the other.

The field work was done in the Chisos Mountains by Brown on 26 to 29 July 1970, and by Strahl on 6 to 13 June 1981. These jays live in all-purpose, group territories that are essentially mutually exclusive. To count the members of a group we induced them to fly across an opening in the forest by playing their calls with a tape recorder. These calls included the common flock calls as well as the *Rattle* call described below. Systematic counts of group size were not made in 1970. Of the 26 groups counted in 1981, half were counted

on two to six occasions at least a day apart; the remainder, on only one day. We used the highest of the available counts for each group. Since the groups counted only once were not significantly different in average size from those counted more often (*t*-test, $P > 0.05$), we combined data for all 26 groups. The mean group size was 4.5 birds (± 1.14 SD; omitting birds of the year). We observed six groups of three, eight of four, five of five, and seven of six.

For *A. u. arizonae* Brown and Brown (1985) reported group sizes in May and June 1976, from five to 13, averaging 8.7 (± 2.3 SD, $n = 33$). In a smaller number of flocks ($n = 6, 7$) mean group size varied from 6.7 to 17.5 for the period 1969 to 1983. Mean group size was significantly higher in *A. u. arizonae* in 1976 than in *A. u. couchii* in 1981 (Mann-Whitney *U*-test, $P < 0.001$).

The composition of groups (specifically the number of breeding females per group) was probably also different in the two populations. The *Rattle* call is given only by breeding females of the Steller's Jay, *Cyanocitta stelleri*, and the Scrub Jay, *A. coerulescens* (Brown 1964, and pers. observ. of banded Scrub Jays in California). Therefore, we used the number of birds giving *Rattles* in response to a stimulus *Rattle* in each group to estimate the number of females in groups of *A. u. couchii*. *Rattles* were given in response to the stimulus in 22 of the 26 groups. In no group was more than one bird observed to *Rattle*. In one case a bird that had been incubating left her nest to *Rattle* at the tape, thus confirming her sex, since only females incubate in this species (pers. observ.).

A second type of evidence consistent with the hypothesis of one breeding female per group in *A. u. couchii* arises from our observations on the number of

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² Present address: Universidad Simon Bolivar, Division de Ciencias Biologicas, Dto. Biologia de Organismos, Apartado 80659, Caracas 108, Venezuela.

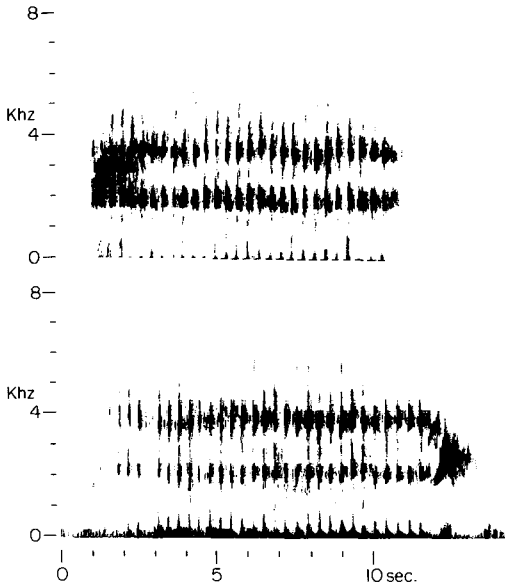


FIGURE 1. *Rattle* calls recorded from *Aphelocoma ultramarina couchii* in the Chisos Mountains, Texas, July 1970, one with (below) and one without (above) a terminal flourish.

juveniles in each group in 1981. Juveniles were seen in six of the groups. The maximum in a group was four, which corresponds to a single clutch of a single female. The counts of juveniles in other units in 1981 were 1, 1, 2, 2, and 2+. Although these data are not sufficient to totally reject the hypothesis that more than one female breeds in each unit, they do strongly suggest that most social units of *A. u. couchii* have only one breeding female. In contrast, in most groups of *A. u. arizonae* from two to four females attempted to nest each year and in six groups observed from 1971 to 1982 at least two females per group bred successfully in some groups in 10 of the 12 years (Brown 1963, 1972, 1986). In brief, singular breeding typifies the Texas population; and plural breeding, the Arizona population.

These data force us to reconsider our view of sociality in *A. ultramarina*. Previous authors have viewed this species as differing from *A. c. coerulescens* in Florida by having larger group sizes and plural breeding (Brown 1974, Woolfenden and Fitzpatrick 1984). It appears, however, that the Chisos Mountain population resembles *A. c. coerulescens* more than *A. u. arizonae* in this respect. In *A. c. coerulescens* groups ranged from two to six, averaged 3.0, and were singular breeding.

In one of its vocalizations, the *Rattle*, *A. u. couchii* also resembles *A. coerulescens* more than *A. u. arizonae*. The *Rattle* is a common vocalization in jays and other corvids. It is characteristic of female *A. coerulescens* (pers. observ. of color-banded birds in California) and *C. stelleri* (see sonogram in Brown 1964). We heard it from most groups of *A. u. couchii*, but in

19 years of extensive field work with *A. u. arizonae* we have never heard anything like it, even in response to playbacks of the *Rattle* of *A. u. couchii*. Two examples of *Rattles* of *A. u. couchii* are shown in Figure 1. Unlike the *Rattles* we have heard from a variety of other species of jays, some from *A. u. couchii* have a terminal "flourish." The figure shows a *Rattle* with such a flourish (below) and one without it (above). The terminal flourish was encountered at several locations in the Chisos Mountains by Brown in 1970 and Ligon (pers. comm.) but was not noted by Strahl in 1981.

The fact that female *A. u. couchii* responded to playbacks of *Rattles* by giving *Rattles* suggests that females use the call as a threat against other females. In a study of color-banded *C. stelleri* Brown (1964) found this to be the common pattern. Therefore, we hypothesize that the absence of *Rattles* in a plural breeding population may enable two or more females to breed in the same territory without fighting. Alternatively the absence of *Rattles* may simply reflect a lower level of intolerance of each other by females. In either case, one might predict that other plural breeding populations or species of jays would also lack the *Rattle*.

Reports of group sizes of *A. u. couchii* in the early literature differ greatly from ours. Van Tyne (1929) reported them "already in flocks of twenty-five, or more of old and young" in June. Brandt (1940:70) found "scattered groups numbering up to a dozen birds" in the breeding season. Wauer (1973) reported that "flocks of 5 to 18 are common." These authors may have subconsciously emphasized maximum aggregations casually encountered in the course of field work devoted to faunal studies. Such groups would most likely result from the coming together of two or three social units with their young at a territorial border. In the only other study done by observers who were aware of the likelihood of communal breeding, Ligon and Husar (1974) in May and June observed the following group sizes: 2, 2, 3, 3, 3, 4, exclusive of juveniles. These counts done in 1972 and 1973 agree reasonably well with our counts done in 1970 and 1981, considering the possibility of yearly variation.

It is tempting to regard the typical group sizes of *A. ultramarina* in Texas and Arizona as responses to local environmental conditions. To Brown but not Strahl, climate and richness of vegetation appear more favorable in the various Arizona populations than in the Chisos Mountains, suggesting weakly that the difference in unit size might be purely environmental; however, differences in vocalization, egg color, plumage and ontogeny of bill color (summarized in Brown 1963 and amended by Ligon and Husar 1974) suggest that genetic differences may also be involved.

In summary, we document that sizes of social units in *A. ultramarina* average smaller in *A. u. couchii* than in *A. u. arizonae* and that *A. u. couchii* is typically singular-breeding, in contrast to *A. u. arizonae*, which is plural breeding. The presence of the *Rattle* call, illustrated here for the first time, in *A. u. couchii* but not *A. u. arizonae* may be related to these differences in social organization.

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METABOLIC, WATER AND THERMAL RELATIONS OF THE CHILEAN TINAMOU¹

PHILIP C. WITHERS,² RICHARD B. FORBES, AND MICHAEL S. HEDRICK³
Department of Biology, Portland State University, Portland, OR 97207

Key words: Tinamou; water loss; metabolism; temperature; phylogeny.

We present here some basic aspects of the thermal and metabolic physiology of the Chilean Tinamou (*Nothoprocta perdicaria*). Tinamous (Tinamidae) are quail-like ground birds widely distributed throughout the neotropics from Mexico to Patagonia. The taxonomic status of tinamou is controversial, but Cracraft (1981) includes Tinamidae in Palaeognathiformes. Hence, tinamous are suspected to be closely related to the ratites, although they are carinate and therefore may be more closely related to other birds than to ratites. The metabolic physiology of tinamou is thus of particular interest because ratites have been shown to have considerably lower basal metabolic rates than do carinates (Calder and Dawson 1978, Withers 1983).

Four Chilean Tinamous (mean mass $458 \pm SE 8$ g) were obtained from the Washington State Department of Fisheries and Wildlife in June 1980. They were maintained outdoors under natural photoperiod and ambient temperature throughout the year. The experiments reported here were conducted in late November and in December of 1980 and 1982. A standard flow-through respirometry system in a constant temperature cabinet was used for the measurement of oxygen consumption rate ($\dot{V}O_2$: ml $O_2 \cdot g^{-1} \cdot hr^{-1}$) and evaporative water loss (EWL: mg $H_2O \cdot g^{-1} \cdot hr^{-1}$) at ambient temperatures (T_a : °C) from -10 to +30. All experiments were conducted during the light portion of the ambient photoperiod (10:00 to 16:00). The flow rate of dry air (dew point < -5°C) was regulated with a Gilson mass flow controller and meter. Excurrent air was monitored for O_2 content to $\pm 0.01\%$ with a Servomax 570A paramagnetic O_2 analyzer calibrated with dry, CO_2 -free nitrogen (0% O_2) and room air (20.94% O_2). Incurrent and excurrent air was monitored for water vapor content to $\pm 0.05^\circ C$ dewpoint with an EG&G Dew-All hygrometer (NBS traceable hygrometer calibration). The percent O_2 and dewpoint were continuously recorded with a dual channel Honeywell stripchart recorder. Dewpoint was converted to absolute humidity (STP) using the equations of Parrish and Putnam (1977). The $\dot{V}O_2$ (STPD) and EWL were calculated using the equations of Withers (1977). EWL was not measured at

¹ Received 19 May 1986. Final acceptance 6 October 1986.

² Present address: Department of Zoology, University of Western Australia, Nedlands, W.A. 6009, Australia.

³ Present address: Department of Zoology, University of British Columbia, Vancouver, B.C. V6T 2A9, Canada.