ANNA'S HUMMINGBIRD IN ADULT MALE PLUMAGE FEEDS NESTLING

DALE PETERS CLYDE

261 Laurel Street
San Francisco, California 94118

Little is known concerning the role of male hummingbirds in nest building, incubation, and rearing of the young. Many ornithological writings state that males fail to engage in any of these activities. However, in Ecuador R. T. Moore (Wilson Bull. 59:21, 1947) collected a male Sparkling Violetear (*Colibri coruscans*) that had settled on the nest immediately after the incubating female had been flushed and collected. As I can find no reference to such behavior in North American species of hummingbirds, the following observations of feeding of young by an Anna's Hummingbird (*Calypte anna*) in adult male plumage seem worthy of attention.

My husband and I have a summer home located in Napa County, California, 3 mi. W of Oakville and situated at an elevation of 1100 ft in Douglas fir-oak-madrone forest. At the edge of the patio are two hummingbird feeders which are visited throughout most of the year by resident Anna's Hummingbirds. During the period of observation, the feeders were frequented by at least two birds in adult male plumage, two in adult female plumage, and several immatures.

On 6 June 1970 I discovered an Anna's nest 25–30 ft above the patio in the crotch of a branch of an oak (*Quercus wislizenii*). Using 10 × 40 and 7 × 35 binoculars, I observed the nest and birds sporadically from then until 22 June.

I was first able to see that there were two nestlings on 18 June when two beaks were raised for the food the female brought at intervals. During the following few days the activity of the young became more vigorous, until finally, at 17:00 on 21 June, one left the nest. I watched it flutter on short flights, exercise its wings, and utter a loud constant "peeping" until 19:30, when it took off strongly and disappeared for good. At no time after fledging was this young bird approached by either adult.

On 19 June I had become aware of an Anna's Hummingbird in adult male plumage perched about 12 inches from the nest. The bird's brilliant red crown and gorget were conspicuous. Since the bird was not collected, there remains the remote possibility that it was a female in full male plumage, or perhaps male hormonal drive decreased this late in the Anna's nesting period. In any event, it was a different bird from the one which fed the young throughout most of the nestling time. Mrs. Albert Vollmer, Mrs. Painter Douglass, my husband, and I intermittently noted this bird, on the same perch or within a few feet of it, from then until the first young fledged on 21 June. The tolerance of the female, which left the "male" undisturbed so near the nest, struck us as unusual behavior for a hummingbird.

During the 2.5 hr period between the initial flight and final disappearance of the first fledgling, we watched the male-plumaged bird visit the nest on four occasions, each time feeding the remaining nestling with the typical jabbing technique. I saw the "male" again feeding the nestling the next morning at 05:00, 05:45, and 07:00. There may have been other feedings later that I did not notice. At 11:30 we found the second fledgling, fully feathered, "peeping," but obviously weak and unable to fly, on the brick patio. (With human help it flew off on 26 June.)

The female hummingbird was last seen during the midafternoon of 21 June, shortly before the first young left the nest. Normally the female Anna's continues to feed the young for some time after they have left the nest (Kelly, Condor 57:351, 1955), and the fact that she did not suggests that she had been killed. Her absence might have induced the unusual behavior of the male-plumaged bird, as could have been the case with Moore's observation.

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INFLUENCE OF DISTURBANCES IN THE EARTH'S MAGNETIC FIELD ON RING-BILLED GULL ORIENTATION

WILLIAM E. SOUTHERN

Department of Biological Sciences
Northern Illinois University
DeKalb, Illinois 60115

During 1964 I used 60 juvenile Ring-billed Gulls (*Larus delawarensis*) from a colony near Rogers City, Presque Isle County, Michigan, in homing trials (Southern 1967, 1969). These birds were inexperienced in the sense that they had not previously flown beyond the limits of the colony, which is located on a peninsula extending into Lake Huron. The young gulls were considered to be desirable experimental subjects because they had not accumulated experiences associated with landmark recognition during migration and, as a result, their responses during homing trials could be more indicative of their ability to use other types of environmental cues, e.g., the sun. One of the most interesting observations made during these trials was that young Ring-billed Gulls seemed to possess a significant tendency to head ESE (mean angle, 112°) when released in unfamiliar territory. Such responses were often preceded by prolonged periods of circling or somewhat erratic flight. Selection of these headings was not correlated with direct visibility of solar cues (Southern 1969).

In an attempt during 1964 to investigate further the possible existence of an unlearned directional preference in this species, I conducted a series of orientation cage trials with 294 Ring-billed Gull chicks 2–20 days old. Results from these trials (1969) substantiated both the existence of a southeast preference (mean angle, 163°), and the persistence of the statistically significant tendency during clear, partly cloudy, and overcast skies (mean angles of 169°, 160°, and 160°, respectively).

Since the primary winter range for this population, as determined by band recoveries (Southern 1968), is located in the southeastern United States, this apparently unlearned directional preference is considered to be associated with the location of, and orientation toward, the winter range by young gulls. During 1964 an attempt was made to determine which, if any, environmental stimuli altered the birds' ability

TABLE 1. Statistical analysis of mean headings of Ring-billed Gull chicks tested during various intensities of magnetic disturbances.

Magnetic K-value	Lower limit (gamma[a])	n	%, total trials	Mean direction ϕ	Mean angular deviation S	Rayleigh statistic z
0	0	31	4.94	162.1	52.3	10.52*
1	5	105	16.74	154.5	49.1	42.05*
2	10	152	24.24	152.2	63.6	22.42*
3	20	147	23.44	158.8	70.0	9.49*
4	40	136	21.69	134.8	78.7	0.44
5	70	34	5.42	322.9	76.5	0.41
7	200	22	3.50	1.3	70.1	1.39

[a] 1 gamma = 0.00001 oersted.

[b] Asterisks indicate levels of z with $P \leq 0.05$; i.e., in these groups there was a significant tendency of individuals to cluster in the same heading; at other K-values the orientations of individuals did not depart significantly from randomness, although complete randomness (mean angular deviation of 90°) was not exhibited at any K-value.

to select a southeast course. Of the parameters considered (Southern 1969), only increasing intensities of disturbance in the earth's magnetic field showed statistically significant correlation with a reduction in southeast headings and a concurrent random dispersal pattern. Because of the many questions raised by these results, I conducted 386 additional orientation cage trials during 1968 and 1969 with young Ring-billed Gulls from the same colony. Of the test birds, 53 (7.79 per cent) failed to respond in the orientation cage and so the results from 333 trials have been combined with my 1964 data to provide a sample size of 627 for consideration in this paper. The experimental birds ranged in age from 2 to 20 days.

METHODS AND MATERIALS

The recent trials were conducted in an 8-ft-diameter orientation cage, whereas my earlier observations were made in a 30-ft-diameter structure. The opaque cage wall was constructed of 24-inch-high corrugated steel. A sheet of blue plastic served as the bottom and this was divided into 12 sectors, each representing 30°

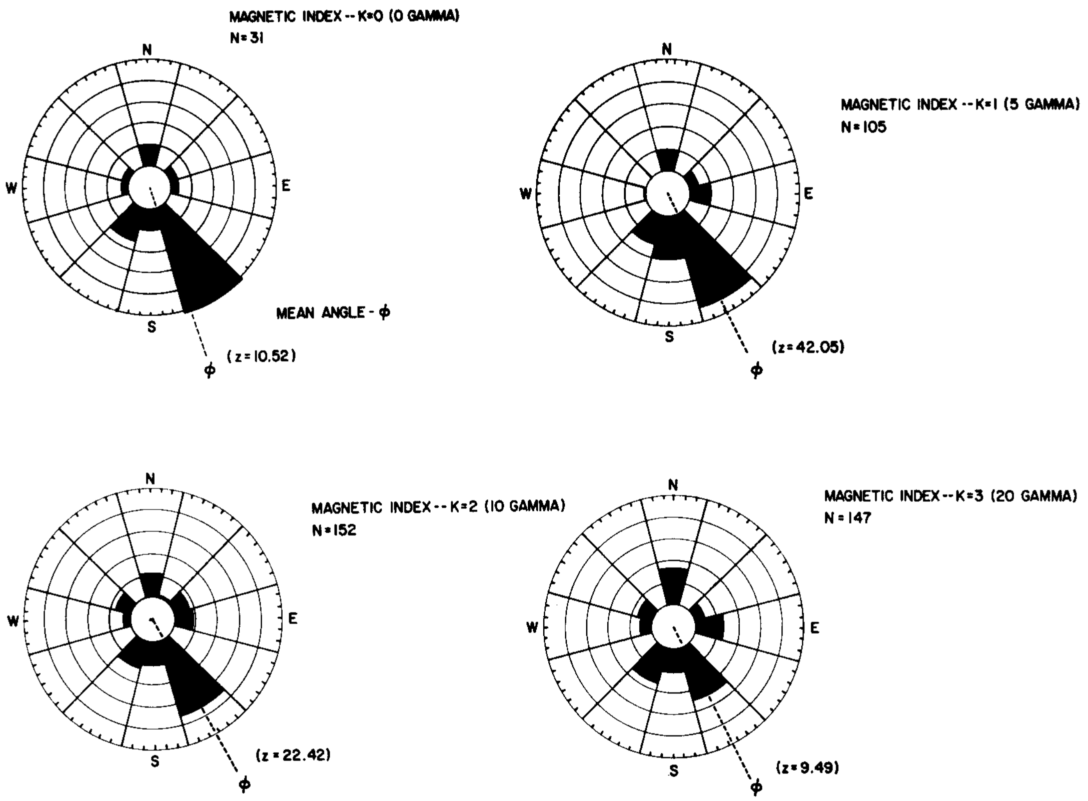

FIGURE 1. Directional responses of Ring-billed Gull chicks released in orientation cages during magnetic disturbances ranging between 0 and 3K. See text and table 1 for details. Each concentric circle = 10% of total responses; $P < 0.05$ when z exceeds 3.0

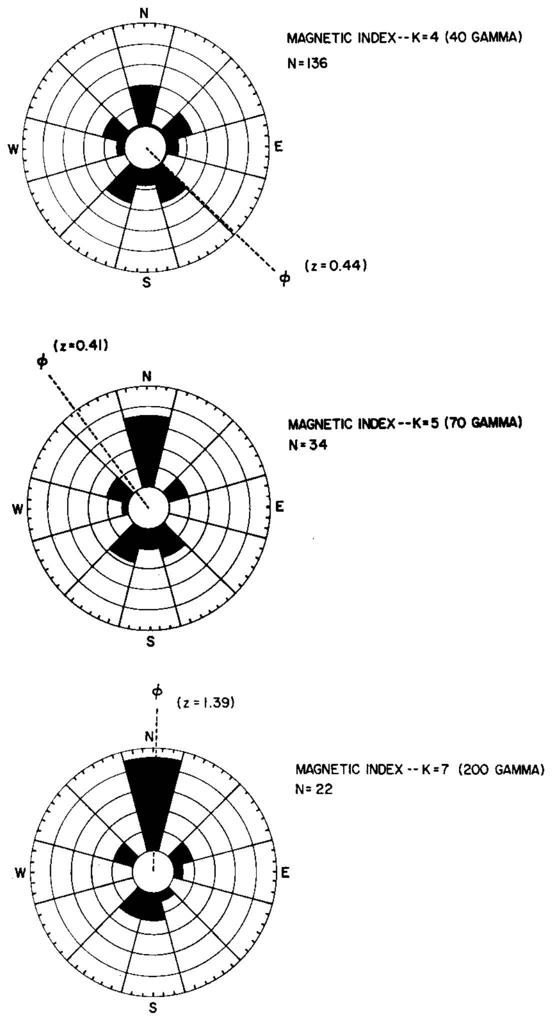

FIGURE 2. Directional responses of Ring-billed Gull chicks released in orientation cages during magnetic disturbances of 4, 5, and 7K (symbols as in fig. 1).

on a compass rose. The sectors were marked off with red plastic tape as were four increasingly larger concentric circles used to designate distance. The cage was set up on flat terrain about ¼ mile from the colony, with 0° on the cage floor corresponding with magnetic north. Groups of chicks were collected in the colony and transported to the cage site by automobile for the experiment. A test bird was placed beneath a 1-ft-cube holding container positioned in the center of the cage. The container was lifted by means of a rope and pulley arrangement operated by the observers after they were concealed behind blinds. A trial was terminated when either the test bird had reached the edge of the experimental chamber or 2 min had elapsed. Each individual chick was used in only one trial. Although chicks 2–10 days old were the best experimental subjects (they did not startle as readily), there was no significant difference between the responses of the various age classes and results from all trials have therefore been grouped for analysis in this paper. The movement pattern of the chicks was plotted on a printed replica of the cage floor, and time, sky conditions, and other pertinent information were also recorded. Data pertaining to the amount of magnetic disturbance were obtained from the Coast and Geodetic Survey's Fredericksburg, Virginia, Laboratory. The fluctuations are expressed as K-indices ranging from 0 through 9, with 5 representing moderate storm activity, 6 or 7 referring to moderately severe storms, and 8 or 9 indicating severe storm activity. The intensity of disturbance represented by these indices is measured in gamma (1 gamma = 0.00001 oersted) and the lower limit for each index is given in table 1. Data were sorted by K-indices and the mean angle and angular deviation were calculated for each group. The Rayleigh Test, a statistical test of randomness (Batschelet 1965), was then applied to the data as an indication of whether the data are significant. The program for this analysis was prepared by Dr. Jerrold Zar; the results are presented in table 1.

RESULTS

During the study period, K-values ranged between 0 and 7 (0–200 gamma) and the results were divided into seven analysis groups (no trials were conducted during K-6). Ring-billed Gull chicks used in trials conducted when the levels of magnetic disturbance ranged between 0 and 3-K showed a significant preference for southeast headings (fig. 1), whereas the data for birds tested during K-4, 5, and 7 lack a significant mean angle of departure and thus indicate random dispersal (fig. 2). This strongly suggests that the apparently unlearned mode of orientation used by young Ring-billed Gulls for selecting the direction of fall migration is disrupted by moderate to severe fluctuations in the earth's magnetic field.

If the birds are not actually obtaining directional information from the earth's magnetic field, it appears that the orientation method they are using is at least influenced by magnetic disturbances. This statement is, however, considered to be purely speculative at this time because of the nature of the tests that have been performed. We must now proceed to raise chicks in various degrees of isolation from the natural environmental stimuli that have been shown to influence orientation by species, and then subject these birds to trials in an artificial magnetic field that can be altered in accordance with levels represented by the respective K-values. Perhaps my results and the interesting work of Merkel and Wiltschko (1965) and Wiltschko (1968) pertaining to the responses of European Robins (*Erithacus rubecula*) to artificial magnetic fields will stimulate other investigators to begin inquiries in this area. The work of these investigators and that of Bellrose (1967a, b), coupled with Emlen's (1969) results on the development of orientation behavior in Indigo Buntings (*Passerina cyanea*), indicate the need for new approaches to research in avian orientation.

On the basis of my work with adult and young Ring-billed Gulls, it appears that there is initially a basic orientational response by fledgling gulls that is appropriate for directing them toward the winter range. This directional preference is apparent two days after hatching and may be present even earlier. It seems, therefore, that gulls from this particular population are genetically programmed to head southeast during fall migration, and that some environmental cues, perhaps those derived from the earth's magnetic field, enable them to select such a course. Experience gained during such migratory flights probably enhances the birds' ability to goal orient but it may also enable individuals to use additional methods of orientation. Adults may not, therefore, have to rely upon the availability of a single type of environmental cue.

This could account for the variations in homing results that have been obtained for adult Ring-billed Gulls (Southern 1967) and some other species. It is unlikely that the various methods are equally effective for individuals of one species or that various species would have comparable degrees of ability for performing each type of orientation. Investigators in this area must develop techniques for designing multidimensional models for the interpretation of orientation data since the solutions to our present questions appear to be many faceted and it is unlikely that satisfactory answers can be obtained by continuing to examine each variable as if it is independent of all others.

SUMMARY

Ring-billed Gull (*Larus delawarensis*) 2–20-day-old chicks from a population at Rogers City, Michigan, were used in 680 orientation-cage trials. The apparently innate ability of chicks to select a southeasterly heading, the appropriate bearing for reaching their winter range, was compared when trials were conducted under various intensities of magnetic disturbance (0–7K, which equals disturbances of 0–200 gamma). During minor disturbances (0–3K) a statistically significant proportion of the experimental birds selected southeasterly headings, but during higher intensity "storms" (4–7K) there was a breakdown in such preferences and no statistically significant mean direction was present for the data. Evidence to date suggests that the mode of orientation used by young Ring-billed Gulls for selecting the direction of fall migration is altered by fluctuations in the earth's magnetic field.

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CHLORINATED HYDROCARBON RESIDUES AND REPRODUCTIVE SUCCESS IN EASTERN NORTH AMERICAN MERLINS

STANLEY A. TEMPLE

Laboratory of Ornithology, and
Division of Biological Sciences
Cornell University
Ithaca, New York 14850

Many species of predatory birds have suffered severe declines in their population numbers since the introduction of chlorinated hydrocarbons into the environment (see Hickey 1969 for a review). Symptoms clearly correlated with these declines include abnormally late breeding, thinner eggshells and increased egg breakage, the resulting apparent reduction in clutch size, and increased embryonic mortality. The Merlin (*Falco columbarius*), being a bird-eating falcon, would seem to be highly vulnerable to these sublethal effects of pesticide poisoning. To assess the degree to which these manifestations of pesticide poisoning are affecting the Merlin populations in North America, their breeding biology was studied on the island of Newfoundland, Canada, during the 1969 nesting season.

METHODS

Observations were made at 20 Merlin nests in Newfoundland to evaluate reproductive performance. Five unhatched eggs from four different nests were collected, their shell thickness indexes calculated according to Ratcliffe (1967), and the DDE residues in the egg contents determined, using the analytical techniques described by Peakall (1970). In addition, subcutaneous fat biopsies from adult Merlins were collected, as described by Enderson and Berger (1968), and analyzed for DDE residues. Frequently taken prey species, as determined from prey remains at nests, were also examined for DDE residues. Pre-pesticide eggs (before 1947) from eastern Canada were obtained from museum egg collections and their shell thickness indexes calculated. Information on reproductive performance included with museum egg sets was also noted.

RESULTS AND DISCUSSION

Data on DDE residues in Merlins, their eggs, and their prey are given in table 1. Of 136 prey remains found

TABLE 1. Chlorinated hydrocarbon residues in Newfoundland Merlins, their eggs, and their prey.

Sample	No.	ppm-DDE[a] (oven dry wt. basis)
Merlins		
Breeding adults (fat)	3	267 (131–495)
Unhatched eggs	5	40.4 (28.5–52.1)
Prey species		
Gray Jay (brain)	2	0.24 (0.18–0.30)
Robin (brain)	1	3.17
Savanah Sparrow (brain)	2	2.10 (1.13–3.07)

[a] Mean, and range in parentheses.