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GENERAL NOTES

Dwarf Jay *(Aphelocoma nana)* ¾ X. Watercolor by George Miksch Sutton.

HABITAT AND HABITS OF THE DWARF JAY, *APHELOCOMA NANA*

John William Hardy

In a paper discussing behavior, habitat, and relationships of jays of the genus *Cyanolyca* (which I now regard as a subgenus of *Aphelocoma*, Hardy, 1969:371, as here used), I briefly described (Hardy, 1964:8–11) the vegetation inhabited by Mexican species of this group. I referred (p. 10) to the habitat of the Dwarf Jay (*A. nana*) as . . . "humid pine-oak forests. . . . from nearly pure stands of oak, containing only scattered pines (*Pinus*) and an understory of subdominant broad-leaved trees, to forests of nearly equal pine and oak representation, scattered fir (*Abies religiosa*), and abundant epiphytic growth."

From 1 March to 21 April 1965, 24 April to 4 May 1966, and 6 to 16 May 1967, I studied these habitats and also the habits and niche characteristics of the Dwarf Jay on Cerro San Felipe, 3 to 5 km NW of La Cumbre and about 30 km NE of the city of Oaxaca, state of Oaxaca, Mexico, long. 96° 60′ W, lat. 17° 20′ E. The results are the subject of the present paper.

METHODS

Analysis of Vegetation.—I used quadrats each 100 sq. meters in area, in analyzing the forest. Square quadrats were employed in the more mature, open, sparsely wooded communities, as belts of one to two meters width fail in such a habitat to record positional relationships and even occurrence of widely spaced, very large trees. Quadrats 50 × 2 m were used in densely vegetated stands containing more prominent second and first story trees, rather uniformly spaced under sparse mature trees, usually forming a much broken third story or canopy. Seven forest locations were studied. Five areas (Hillside quadrats 1, 3, 4, of 1965; 1, 2, of 1966) were in nesting habitat of Dwarf Jays and either contained active nests or were near nests (quadrat 4). Hillside quadrat 2, 1965 was on an exposed slope in foraging habitat not known or thought to contain Dwarf Jay nests. Hillside quadrat 5 was in open mature pine forest seldom visited by Dwarf Jays, but a vegetational community interspersed intimately with jay habitat communities. Two deep canyon (=barranca) quadrats were in climax *Meliosma* forest regularly visited by jays in wide-ranging foraging activities in afternoon hours. Communities consisting of scattered groups of large firs with a dense understory of small oaks were not analyzed, although these were foraged in by jays moving between upland nesting and foraging areas and barrancas.

In the field analysis, I delimited with a rope an area to be censused. Trees within were then mapped as to position, species, diameter at breast height (DBH, diameter at a height of 1.35 m), and crown position. The main foliage cluster of a tree, or its crown, was thus designated as contributing either to the forest canopy (third level), subcanopy (second-layer), sapling (first level), or shrub-seedling (ground cover level). The shrub-seedling level was sparse in most communities, and I adjudged it to be insignificant in the ecology of jay habitat. I ignored it except for tree species found to be constituents of one of the other levels.

I estimated degree of slope, exposure, and elevation, and collected epiphytic growth, leaf, twig, and fruit specimens for later identification.

Study of Jays.—My assistants and I located and observed activities at nests from within blinds and also without blinds. Nest contents were checked periodically using a mirror mounted on a long pole. We took notes on time spent foraging by the birds in different vegetation and at different levels in the forest. Recordings of vocalizations were made using sound equipment described by Hardy and Dickerman (1965:110). I observed feeding habits and preserved stomach contents. Specimens of jays were collected, to determine change and status of reproductive condition of apparently nesting jays not specifically under study and of apparently non-breeding, flocking individuals. Abandoned nests and eggs were preserved. A general collection of birds, mammals, and plants was made. Rainfall was measured using a standard rainfall gauge situated in the open. A hygrothermograph recorded temperature and humidity during this period near ground level in the forest.

VEGETATION AND THE JAY NICHE

The mountain forests of Oaxaca in which the Dwarf Jay lives have suffered greatly from deforestation, small farm agriculture, and other pressures of human activity. Where disturbance has been especially severe, the basic character of the vegetation is so completely altered that only remnant components of the original avifauna not including the jay persist. Dwarf Jays, in fact, seem to exist only where most of the forest is of climax tree species. The birds are not restricted to the undisturbed areas, however, frequently being common in second growth climax, so long as the climax species of trees predominate, and tracts of mature climax forest are nearby. Oaks (*Quercus* spp.), pines, and fir are the dominant trees in the jay habitat (Tables 1 to 3). These occur in various associations and faciations. On the drier slopes, either southern or western exposure or near the crests of ridges above 6000 feet elevation (Tables 1 and 2), a *Q. rugosa*—*Q. laurina* association prevails (Fig. 1), with fir and pine as scattered components of the layers below the canopy. *Q. rugosa* is a heavy rugged tree with broad, rough, and coriaceous leaves. *Q. laurina* is a "willow oak" type of tree with small, slender, thin leaves. Firs in this association are small and scattered, pines are rare and various in size, and other tree species are usually represented by isolated individuals of various size or absent. Hillside quadrats 1 to 4, 1965 (Table 1) are of this association. An active Dwarf Jay nest was in or near each of these quadrats except quadrat 2. All except quadrat 2 were in second growth woodland. Of the three associations in which Dwarf Jays consistently occurred, they were sparsest in this one, according to my observations. Following is a brief description of the character of the vegetation in each quadrat area, to supplement quantitative data in the tables.

FIG. 1. Woodland communities of Cerro San Felipe, Oaxaca, in the Dwarf Jay study area. A. Dense second-growth climax humid oak woods near site of nest 1, 1965 (see Table 1, quadrat 1). B. Mature humid oak climax forest from near site of nest 3, 1965; camp in lower background (see Table 2, quadrat 4).

Hillside quadrat 1, 1965. Exposure NW, slope 45 degrees. Canopy sparse, 12–23 m high, secondary level dense, between 6 and 11 m high. First story, fairly dense merging with second story, 1.5 to 6 m. Heavy leaf litter, but little ground vegetation of herbaceous type. Heavy epiphytic growth of usnea, moss, lichens, and ferns. Large trees as evidenced by stumps have been cut. One of these, an oak, had been 850 mm in diameter. Several others nearly that size also present.

Hillside quadrat 2, 1965. Exposure WNW, slope 45 degrees. Similar to number one, but subcanopy more open, probably too open to be suitable for Dwarf Jay nesting.

Hillside quadrat 3, 1965. Exposure SE, slope variable, 30–45 degrees. Irregularly disturbed woodland, about 270 m across clearing from 1 and 2. More mature trees of the dominant species than in preceding quadrats. Canopy trees 23 to 38 m in height. Drier ground aspect with considerable litter of pine needles. Greater variety of tree species in understories.

Hillside quadrat 4, 1965. Exposure E, slope 60 degrees. Few stumps of large trees, so that canopy is the crown of the secondary layer, which is so dense (approximately 50 per cent closure) that ground level is deeply shaded. Very sparse ground cover; leaf litter mostly pine needles.

Jays were so sparsely distributed in the preceding four quadrat areas that each of four pairs discovered nesting in such communities were, so far as I could detect, completely free of other jays wandering into their areas, boundary disputes, or even the voices of other individual jays.

Jays seemed to be more abundant in oak-fir-pine associations as exemplified by quadrats 1 and 2, 1966 (Table 2), taken on northeast and east exposures and slopes of 10 to 20 degrees at approximately 2800 m elevation. As an indication of the greater density of birds, an observer could frequently hear other jays calling as he watched activities at nests near these

TABLE 1

VEGETATIONAL COMPOSITION OF QUADRATS 1–5, 1965 OF THE DWARF JAY STUDY AREA*

Tree Species	No.	(%)	Per cent trees in veg. levels 3	2	1	Gr.	Total DBH	B.A. / Ha.	%B.A.
(Hillside Quadrat 1, 50 × 2 m)									
Quercus rugosa	9	(21)	75	33	12	—	1095	78.5	28.0
Q. laurina	30	(69)	25	67	>81	50	1686	201.0	71.0
Abies religiosa	2	(5)	—	—	> 8	—	15	0.02	Trace
Arbutus xalapensis	2	(5)	—	—	—	50	160	2.0	>1.0
(Hillside Quadrat 2, 10 m^2)									
Quercus rugosa	5	(29)	40	—	20	40	970	62.8	22.0
Q. laurina	10	(59)	30	50	—	20	1710	219.0	77.0
Arbutus xalapensis	2	(12)	—	50	—	50	155	2.0	1.0
(Hillside Quadrat 3, 10 m^2)									
Quercus rugosa	14	(27)	14	7	64	7	2057	314.0	68.0
Q. laurina	11	(22)	9	27	64	—	770	50.0	>11.0
Arbutus xalapensis	1	(0.5)	—	100	—	—	260	4.0	0.86
Litsea galacescens	11	(22)	—	27	73	—	385	12.5	2.8
Pinus tenuifolia	8	(16)	—	75	25	—	950	78.5	17.0
Jatropha sp., *Montanoa arborescens*, *Abies religiosa*	6	(3)	—	33	50	17	295	1.04	>0.003
(Hillside Quadrat 4, 10 m^2)									
Quercus rugosa	7	(26)	—	57	29	14	590	28.3	5.6
Q. laurina	11	(41)	18	73	9	—	2140	452.0	89.4
Pinus sp.	3	(11)	33	—	33	33	460	15.7	3.1
Abies religiosa	3	(11)	33	—	33	33	305	6.3	1.2
Unidentified tree	3	(0.1)	—	33	67	—	225	3.1	0.06
(Open Pine Stand Hillside Quadrat 5, 10 m^2)									
Quercus rugosa	4	(21)	—	100	—	—	635	28.3	4.0
Q. laurina	5	(26)	40	60	—	—	910	62.8	8.8
Pinus sp.	5	(26)	100	—	—	—	2830	615.4	86.7
Abies religiosa	1	(6)	—	100	—	—	140	1.5	2.1
Buddleia cordata	1	(6)	—	100	—	—	160	1.8	2.5
Litsea glaucescens and Unidentified	3	(17)	—	100	—	—	40	0.1	0.0001

* Column headings for this table and tables 2 and 3: No. = number of individuals; (%) = total per cent composition; % trees in veg. levels 3, 2, 1, Gr. = per cent of total number of individuals represented in canopy, second, first, and ground levels; Total DBH = total diameter breast height; $\frac{\text{B.A.}}{\text{Ha.}}$ = basal area per hectare; % B.A. = per cent basal area.

FIG. 2. Woodland communities of Cerro San Felipe, Oaxaca, in the Dwarf Jay study area. A. Mature humid oak-pine-fir climax forest near site of nest 2, 1966 (see Table 3, quadrat 1). B. Vertical view of open canopy of mature open pine forest, south facing slope near area shown in A. above (see Table 4).

quadrats. Also, by walking no more than 90 m from the nest site, an observer could find other jays foraging. Some of these seemed to be nonbreeding birds traveling in small flocks (4 or 5 birds), but others occurred regularly in certain nearby places singly or in pairs, and probably were established breeders.

These two quadrats in contrast to the first four described had fir as one of the dominants, represented among the canopy constituents and prominent in the secondary layer. The exposure and slope resulted in poor drainage. cooler temperature and more shade, and, in quadrat 1, 1966, more herbaceous ground growth (Fig. 2A). *Quercus aáata* is a large heavy bodied tree like *Q. rugosa*, but apparently is restricted to mesic poorly drained areas. It has broad leaves of medium thickness, that are dark, green and waxy in texture.

Following are brief descriptions of these two quadrats to supplement quantitative data in Table 2.

Hillside quadrat 1, 1966. Exposure NE, 10 degree slope, Canopy 30 to 45 m in height. Well developed secondary layer at 6 to 12 m. Little ground level vegetation, with total screening effect of two canopies estimated at 70 per cent.

Hillside quadrat 2, 1966. Canopy sparse (evidence of larger trees having been removed), and dense secondary layer of 6 to 12 m in height. Weak first story 3 to 6 m in height with many small dead fir and oak. Effective closure from light at ground level 30 to 40 per cent.

TABLE 2

VEGETATIONAL COMPOSITION OF QUADRATS 1 AND 2, 1966 OF THE DWARF JAY STUDY AREA.

			Per cent trees in veg. levels					B.A.	
Tree Species	No.	(%)	3	2	1	Gr.	Total DBH	Ha.	%B.A.
			(Hillside Quadrat 1, 10 m^2)						
Quercus aáata	3	(27)	100	—	—	—	1750	226.0	68.0
Q. laurina	1	(9)	—	100	—	—	260	5.3	1.6
Litsea glaucesceus	2	(18)	—	100	—	—	400	12.5	3.7
Pinus sp.	1	(9)	—	100	—	—	320	8.2	2.5
Abies religiosa	4	(36)	50	25	25	—	1005	81.8	24.5
			(Hillside Quadrat 2, 10 m^2)						
Abies religiosa	28	(68)	—	71	29	—	2270	452.2	66.0
Quercus rugosa	9	(22)	33	33	22	11	1680	221.6	32.0
Quercus laurina	2	(5)	—	100	—	—	265	5.0	7.3
Litsea glaucescens, Arbutus? or *Arctostaphylos*	2	(5)	—	100	—	—	165	0.38	0.0004

Tables 1 (part) and 3 give data for quadrats not utilized for nesting by Dwarf Jays. The open pine forest (Fig. 2B) of quadrat 5, 1965, was within observation distance of our camp. This habitat is rarely entered by Dwarf Jays. On only one occasion did I see a Dwarf Jay cross this woodland, forage briefly and enter denser woodland adjacent to it. Barranca quadrats 1 and 2 were situated at the upper reaches of the subtropical barranca vegetation zone. This is so different in character that there was an almost complete difference in avifauna. In early April Dwarf Jays were occasionally seen foraging in afternoon hours in the uppermost parts of this zone. In 1966 and 1967, after nest-building was completed, no jays were seen at any time in such habitat. It is certain that they do not breed in it.

Following is a brief description of each of these three quadrats to supplement quantitative data in Tables 1 and 3.

Hillside quadrat 5, 1965. Exposure S, 45 degree slope. Open pine forest, with oaks distinctly subdominant and sparse. Canopy at 30 to 38 m in height and totally pine with less than 25 per cent closure. No secondary canopy; oaks slender and without crown structure. Carpet of pine needles, 10 per cent cover by sapling and herbaceous or shrub growth and bracken fern (*Pteridium*).

Barranca quadrats 1 and 2. These two quadrats were similar in general appearance, with fewer large trees in 2. Both were of westward exposure, on 45 degree slopes, and had similar layering. The third story canopy was at a height of 22 to 30 m (with one tree reaching approximately 38 m), the second story was at 10 to 15 m, and the first story at 1 to 3 m. Canopy closure was between 70 and 85 per cent, deeply shad-

TABLE 3

VEGETATIONAL COMPOSITION OF BARRANCA QUADRATS, 1965 NEAR DWARF JAY STUDY AREA.

Tree Species	No.	(%)	Per cent trees in veg. levels				Total DBH	B.A.	
			3	2	1	Gr.		Ha.	%B.A.
			(Barranca Quadrat 1, 10 m^2)						
Meliosma dentata	10	(100)	30	70	—	—	3455	907.5	100
			(Barranca Quadrat 2, 10 m^2)						
Meliosma dentata	11	(58)	91	9	—	—	2160	314	95.1
Litsea glaucescens var. *subsolitaria*	5	(26)	—	100	—	—	422	13.6	4.1
Compositae or ?	3	(16)	—	100	—	—	187	2.5	0.8

ing much of the subcanopy woodland to the exclusion of a well defined second layer or dense growth in the first and ground layers.

Other Bird Species

The following list is of species I regularly observed and judged to be common to abundant in the study area oak-pine-fir forest and thus, like the plants, characterizing the jay habitat. No systematic attempt was made to census the avifauna of the entire area. Several other bird species, such as *Xiphocolaptcs promeropirhynchus*, perhaps just as characteristic of the area but irregularly seen and apparently uncommon, are omitted here, as are several species, such as *Catharus frantzii*, common nearby in the subtropical vegetation of the deep ravines, away from Dwarf Jay habitat. Specimens of all these species were collected and deposited in the collection of the Moore Laboratory of Zoology at Occidental College.

Dendrortyx macroura, Columba fasciata, Caprimulgus vociferus, Hylocharis leucotis, Lampornis clemenciae, Trogon mexicanus, Lepidocolaptes affinis, Empidonax difficilis, Mitrephancs phacocercus, Cyanocitta stelleri, Campylorhynchus megaloptcrus, Troglodytes brunneicollis, Henicorhina leucophrys, Melanotis caerulescens, Turdus migratorius, Turdus assimilis, Turdus infuscatus, Myadestes obscurus, Catharus occidentalis, Ptilogonys cinereus, Myioborus miniatus, Ergaticus ruber, Vermivora superciliosa, Pipilo ocai, Atlapetes pileatus, A. brunneinucha.

The Forage Niche and Foraging Behavior

A necessary constituent of Dwarf Jay breeding habitat is a prominent sub-canopy layer of forest vegetation. Such a layer is composed of the

TABLE 4
PER CENT OF TIME SPENT (BIRD-MINUTES) FEEDING BY DWARF JAYS IN DIFFERENT LEVELS AND ZONES OF VEGETATION

	Ground	Ground level vegetation shrub, low	First story waist to head high	Second story Trunk	Second story Foliage	Third story Sub-canopy	Third story Canopy	Totals
				105	196.6	32	36	
			[——15——	——]*	+	+		
				[——143——	——]*	[——70——	——]*	
Bird min	4.1				444.6		138	586.7
Per cent of total time	0.7	Traee	2.6		75.7		23.5	

* Bracketed times indicate foraging activities spanning two or more zones in a manner precluding designation of time spent in one.

crowns of trees having a DBH of approximately 50 to 200 mm mingled upwardly with the lower branches of taller trees to form a subcanopy area beneath the primary canopy. The latter is sufficiently open (less than 50 per cent closure) to allow the development of a strong second layer. The third layer and fourth or seedling-shrub layer seem to be of little importance to the jays. In all jay habitats analyzed on Cerro San Felipe these layers are very weakly developed and were rarely visited by the birds in foraging, usually as they chased a flying insect that had dropped from above. Dwarf Jays occasionally enter the subcanopy but unlike Steller's Jays (*Cyanocitta stelleri*) that inhabit the same forests, Dwarf Jays do not often forage at these upper levels. When they do, it is usually not in nesting habitat but as they forage across relatively open areas of forest lacking lower vegetational layers.

Over 80 per cent of the foraging time of Dwarf Jays is spent from the bottom of the primary canopy to the top of the first layer of trees. Census of time spent feeding in the various layers and zones was made irregularly through the 1965–66 years of the study, and the results are summarized in Table 4. Observations in 1967 were consistent with indications of these data.

Within the layer chosen for foraging, Dwarf Jays look for insect prey in and around epiphytes, including bromeliads, ferns, and lichens. In this aspect of their feeding, they are quite titmouse-like, hanging upside down from small branches, hovering beneath a limb and suddenly clutching it to peck something, and in general making an assiduous investigation of

TABLE 5

STOMACH CONTENTS OF FOUR SPECIMENS OF DWARF JAY FROM CERRO SAN FELIPE, OAXACA

	Coleoptera	Diptera	Hymenoptera	Insect larvae, eggs	Plant fiber
RTM A–37 ♂ ad., testes 3 × 5 mm, no molt. 7 July 1963.	Includes weevils (Curculioninae)	Tipulids*	Wasps	Unident.	—
RTM A–51 ♀ ad., ovary gran., molting. 7 July 1963.	Weevils (90 per cent)	1 Tipulid 1 short-wing fly	—	—	—
RTM A–46 ♂ ad., testis 2 × 3 mm, molting. 6 July 1963.	Bark beetles (Scolytidae ?) Weevils	—	—	3 whitish larvae	—
RTM A–168 ♂ ad., testes 3 × 5 mm, no molt. 16 April 1965.	50 Bark Beetles (Scolytidae and 1 Meladryidae ?)	1 Tipulid	—	1 egg 2 larvae	trace

* Where no numerical designation occurs, contents consisted of a complex admixture of fragments.

all crevices that might hold food. They break open plant galls to get larvae from within. These two activities, in about equal proportions, comprise most of their feeding methods. Less frequently observed foraging behavior includes searching for food beneath the peeling bark fragments of the trunks and larger limbs of trees, and chasing slow flying insects. Most jays are known to eat acorns. The Dwarf Jay lives in oak forests that produce small acorns of appropriate size for this small jay, but acorns have yet to be confirmed as a diet item.

Table 5 shows the results of analysis of the contents of four Dwarf Jay stomachs and suggests the largely insectivorous nature of the diet.

Weather

The climate of high elevations (2400–3000 m) of Cerro San Felipe is cool-temperate. There is a rainy season from June through October or

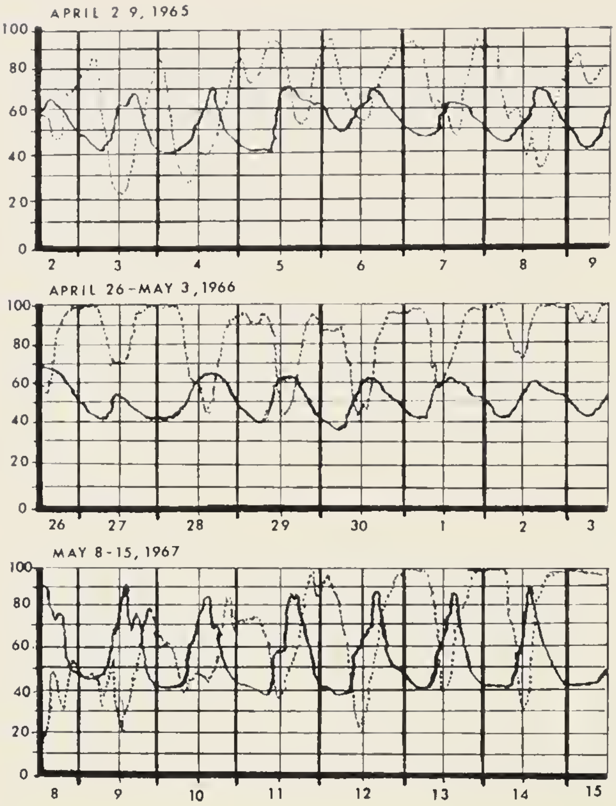

Fig. 3. Temperature and relative humidity records for three selected weeks, Cerro San Felipe, Oaxaca. Adapted from hygrothermographic charts, these records were made at ground level in shade in Dwarf Jay habitat. Dotted lines equal relative humidity, solid lines equal temperature in Fahrenheit degrees. Dark vertical graph lines designate midnight, light vertical lines, noon.

November and a dry season from then until late May. The rare precipitation of the dry season may be in the form of snow flurries. Light frosts occasionally occur. I have no experience in the area in the period from mid-July to late March. but Mr. Boone Hallberg, a botanist resident at nearby Ixtlan de Juarez, provided the foregoing generalizations. My experience in the area almost spans the breeding season period of the Dwarf Jay, from late March to mid-May. Figure 3 shows the fluctuations in temperature (F) and relative humidity in three periods, one from each of the three successive years of this study. Figure 4 summarizes facts on cloud cover and precipitation for the periods of study. Comparing information in these two figures the following generalization about the weather in the breeding season can be made. Early April has typical dry season weather. Days are cool and consistently clear with only scattered high cumulus clouds. Temperatures range from the low 40's at night to the high 60's F in the daytime, with daily mean in the 54 to 57 range. Relative humidity fluctuates greatly, falling to the 40's or lower around noon depending on wind

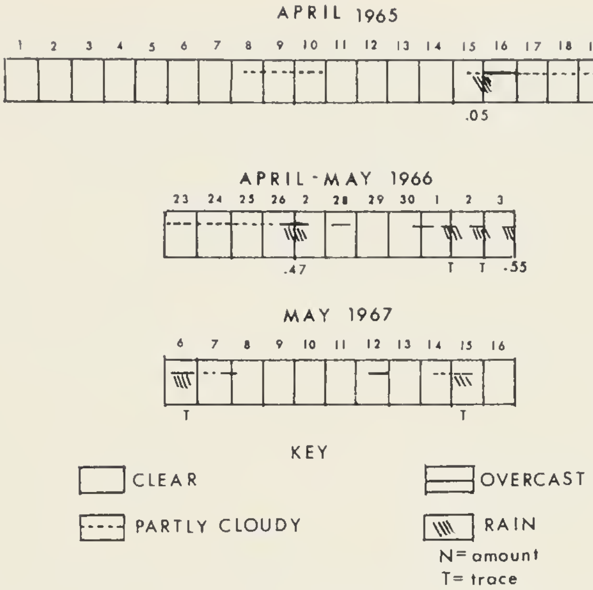

FIG. 4. Weather conditions in the three study periods on Cerro San Felipe, Oaxaca. Rainfall in inches.

and rising sharply thereafter as the sun disappears behind the high ridges and peaks to the west, reaching the 80's and 90's around midnight.

The year 1966 was an unusually wet year with the first indications of the onset of the rainy season appearing by late April. Because of the greater prevalence of overcast days and precipitation, temperatures averaged even lower than in 1965 (daily mean approximately 54) and ranged from 36 to 66 from 26 April to 3 May. Humidity was higher, never fell below 40, rose daily to the 90's and averaged in the low 70's.

The year 1967 was a "normal" year; a few days were overcast and rainy or misty and frequent partly cloudy conditions existed. Temperatures ranged from 38 to 91, with a daily mean of from 60 to 64.

The regularity of fluctuations, the consistent inverse correlation of temperature and humidity, the persistence of daily humid periods, even in the dry season, and the virtual lack of freezing weather are certainly in contrast to conditions of a cool temperate climate at higher latitudes. These climatological factors are the basis for the prevalence of a tropical aspect to the forest, the existence of evergreen broad-leaved trees, rank epiphytic growth of bromeliads and orchids, and representation in the avifauna of such distinctly tropical avian genera as *Smaragdolanius*, *Diglossa*, and *Trogon*.

THE REPRODUCTIVE CYCLE

Onset

In the non-breeding season, Dwarf Jays move about and forage in loose aggregations of four to perhaps ten individuals, which are in turn part of multispecies flocks. Within such groups, the onset of the reproductive period becomes evident in the pairing of individuals, the separation of the jays from the other species, and courtship feeding. On 4 and 5 April 1965, I observed small groups of Dwarf Jays in the study area. On 5 April at 07:15 at the edge of a second growth oak woodland, I encountered two birds actively feeding on larvae in oak galls. These they removed from the backs of oak leaves, and hammered open in typical corvid fashion. In a period of approximately ten minntes, courtship feeding occurred once. The presumed female was sitting quietly in a low tree about ten feet from the ground. The presumed male approached, and fed the female quickly without displaying. Nor did the female display. Moments later a third jay appeared nearby and the presumed male of the pair and this new bird engaged in very active hopping about in what I interpreted as a display of territoriality. The display culminated with the interloper being quietly pursued back into the forest. Ten minutes later two jays again approached the foraging pair from the point of the interloper's retreat and the four birds foraged in the area for 45 minutes before moving away. In midafternoon I encountered four jays feeding in the second story of a deep ravine (near barranca quadrats 1 and 2). No courtship feeding was observed but I saw one attack another, apparently in an attempt to drive it away. The attack involved erect posturing, tail spreading, and active pursuit among the branches. Such encounters as this I interpret as the first evidences of territorial aggression, soon to be followed by complete separation of the aggregations into pairs, holding exclusive territories.

I soon discovered a regular pattern of movements and activities that the Dwarf Jays were following in this period. In early morning hours the birds were in small groups or pairs in the breeding habitat—the oak-pine-fir woodland and forest. Occasionally pairs engaged in courtship feeding and visiting the area of the nest tree and site. Nest building occurred for a few minutes before the birds returned to foraging and courtship feeding. By late morning the birds moved away from the nest area and by noon had vacated the hillside oak-pine-fir habitat completely for the deep ravines in which they remained until late evening. I noted their return to the hillside forests on several occasions near our camp, situated on the brink of a large ravine. The birds called frequently, moving in the lose aggregations past us from tree to tree and on up into the areas above the camp, not pausing to feed or rest as was characteristic of them in their foraging periods. This pattern of behavior prevailed until eggs were laid.

Nest building

Nest building apparently begins in March; on 4 April I discovered a nearly completed Dwarf Jay nest 20 feet up in the crown of a scraggly oak

(*Q. rugosa*), in quadrat 1 (Table 1). At 09:40 the pair was foraging and calling softly. Suddenly one bird, the presumed female, stripped a strand of usnea from a branch and flew silently away along the hillside, to the nest tree. She entered the crown of the tree and quickly emerged, having deposited the material. Again she flew out of sight only to return in two minutes with more of the material. Calling quietly she went directly to the nest. Again she quickly departed out of sight, at 10:00. I watched at the nest site until 11:00 but saw no further activity. Apparently I had witnessed the end of the morning's nestbuilding activities.

Nest 1 was the only one on which I was able to gather any information on activities associated with nest building and this only in the closing stage. My assistant Ray Jillson spent 3.5 and 2-hour periods respectively during the mornings of 5 and 6 April observing this nest. The density of the foliage made it impossible to see if birds arriving at the nest were bringing nest material. Moreover, arrivals and departures were overlooked several times because of poor visibility and the secretive nature of the birds. Jillson's observations do provide some idea of the frequency of coming and going at the nest and the coordination of the pair's activities. One bird, presumably the female, seemed to be attended by the other bird. I have concluded from these and other observations that activities at the nest, include nest sitting, cup-shaping, and courtship feeding. The presumed male sometimes visited the other bird at the nest and otherwise stayed nearby in a tree or foraged in the surrounding woodland, ready to accompany its mate. From 07:00 to 10:30 (210 min.) on 5 April, the nest was definitely vacant for 11 periods of 50 (the first 50), 22, 3, 1, 7, 7, 4, 10, 12, 1, and 1 min. Both birds were at the nest together for 6 periods of 3, 5, 1, 1, 1, and 1 min. One bird was at the nest 16 periods of 3, 5, 1, 2, 1, 3, 4, 1, 1, 3, 5, 11, 1, 2, 1, and 1 min. Both birds were in trees near the nest for two periods of 14 and 1 min. All of these periods were given to the nearest minute, except all periods of 30 sec. to 1 minute are listed as 1 min. Seven minutes remain unaccounted for.

The frequent visits to the nest, and interaction between members of the pair near and at the nest, recall the activities of Blue Jays (*Cyanocitta cristata*) and Mexican Jays (*Aphelocoma ultramarina*) prior to egglaying (Hardy, 1961: 27, 35 to 36). The nests in all these species seem to serve as centers for sexually attentive activities presumably related to synchronization of the states of the participating adults. Although we did not observe copulation in the Dwarf Jay, this should be the time of its occurrence. Following observations on 5 and 6 April, there was less activity observed at nest 1, until the time of the actual egg-laying.

TABLE 6

NESTS OF DWARF JAYS

Nest	Date found	Tree species	Status	Height in Meters	Place in tree	Vegetation layer	Contents
#1	4 Apr. '65	*Q. rugosa*	late construction	6	crown	2	12 Apr., 1 egg 13 Apr., 2 eggs
#2	7 Apr. '65	*Q. rugosa*	late construction	4.5	subcrown	2	12 Apr., 2 eggs
#3	13 Apr. '65	*Q. laurina*	?	15	crown	2	15 Apr., 2 eggs
#4	16 Apr. '65	*Q. laurina*	2 eggs ?	4.5	end of low branch 30 ft. tree	2	21 Apr., 2 eggs
#5	21 Apr. '65	*Q. laurina*	3 eggs	6	crown	2	21 Apr., 2 eggs
#1	24 Apr. '66	*Q. laurina*	3 eggs ?	3	crown	low 2	4 May, 3 eggs
#2	24 Apr. '66	*Q. aáata*	incubation ?	10.5	end of branch	2	4 May, incubation
#3	27 Apr. '66	*Q. rugosa*	incubation ?	10.5	end of branch	2	4 May, incubation
#1	7 May '67	*Q. rugosa*	3 hatchlings	4.5	subcrown	2	16 May, young
#2	10 May '67	*Q. laurina*	young (age?)	6	subcrown	2	16 May, young

Fig. 5. Two nests of the Dwarf Jay, removed from original sites. A. Nest 3, 1965, showing cup. B. Side view of Nest 1, 1965, showing bulky moss construction.

Egg-laying

On 12 April I found jays in the vicinity of nest 1, in late afternoon; the first egg was also in the nest. The birds gave harsh rasping cries and fluttered about in the nest tree as I checked the contents. Nest 2 checked the same day had two eggs. On 13 April each nest contained two eggs in late afternoon. No additional eggs were laid in either; these were complete clutches, and each female began regular incubation from this time onward. Table 6 provides data on nests and eggs discovered in the three years of study. Data are not sufficient to allow determination of clutch size variation. However, complete two- and three-egg clutches were found, and no indication of larger clutches was obtained. The nests were exclusively in oaks, and were either in the crown of a second story tree, or at the end of a branch in the same layer.

Description of Nests and Eggs

The nest and eggs of the Dwarf Jay have apparently not been previously described. The following description of them is based upon three nests (Moore Laboratory N–564, 565, 566) and eggs contained in 566. This is nest 2 of the present paper (see Table 6). Nest 564 (no. 3): outside depth 18 cm, outside diameter 19 cm. Nest cup 7 cm wide, 7.5 cm deep. Nest 565 (no. 1): outside depth 14 cm; outside diameter 16 cm, cup width 6 cm, depth 7 cm. Nest 566: outside depth 20 cm, width 19 cm; cup width 8 cm, depth 7 cm. Composition except for lining of the three nests is essentially the same. Each is a bulky but compact mass of mosses and lichens, with a few (20–30) twigs 5 to 15 cm long and 2 to 5 mm in diameter in the mass, largely around the top where they give strength to the form of the rim and cup. Nests 564 and 566 are lined completely with pine needles, while 565 is lined with fine rootlets, a few strands of grass and a few pine needles. Each of these nests was constructed in the fork of a tree, and size may be governed by the necessity to fill the complete space to attain strength. The outside size of the nests is large in comparison to the size of the birds that build them and they are strong for the nest of a jay. Figure 5 shows top and side views of typical Dwarf Jay nests. The size of the nest plus the deep cup may afford additional protection for the eggs and young in the cool climate of the nesting season. The sturdiness of the nest is attested to by the fact that abandoned ones remain intact for long periods. I found one nest in 1966 that looked absolutely fresh in 1967 except for accumulated leaves in the cup. Old nests of jays. as well as of other birds (such as the similar nests of *Catharus* thrushes) are eventually taken over by ferns and other epiphytes that thrive in the foothold provided by the accumulated matter of the nests. The many seemingly fresh nests, only a very few of which contain eggs or young, may serve as a buffer to predation by snakes, and birds, visiting all nests with the expectation of finding prey.

Eggs.—One egg that I collected measures 25.9 × 18.2 mm. In shape it is precisely between oval and subelliptical following Preston's classification (1953:166). The ground color is a pale, dull greenish blue, and this is finely and uniformly speckled and splotched with grayish olive and dark olive, heaviest at the large end.

Discussion.—Lack (1948:26–27) and Skutch (1949) point out the fact that tropical latitude birds whose temperate latitude relatives normally have four and five or more egg clutches characteristically have smaller clutches. Blue and Steller's Jays, and Mexican and Scrub (*A. coerulescens*) Jays regularly have four- or five-egg clutches (Bent, 1946). The range of the Dwarf Jay is in tropical latitudes and seemingly the bird's clutch size of two or three eggs is adjusted to the more nearly uniform tropical aspects of its breeding climate, rather than to its generally cool temperature. The small clutch size may be correlated with short day length, which Frith (1957) points out is an environmental factor that all birds of middle latitudes face.

Incubation

Roles of the sexes.—It is characteristic of corvids that only the female incubates (Kendeigh, 1952:243). According to my experience with several species (Hardy, 1961) the female is fed at or near the nest by the male and also leaves the nest at varying intervals to feed, preen, and defecate. At such times she is often accompanied by her mate, the nest being left unguarded. Table 7 summarizes diurnal incubation rhythms and associated behavior during incubation in the Dwarf Jay from approximately 35 hours of observations at nine nests. Since there was never any indication that more than one individual of a pair sat on the nest, I conclude that the Dwarf Jay is a typical corvid of the asocial solitary type. The assumed male's behavior was as described above; there was no indication of helpers at the nest, or indeed of any other Dwarf Jays but members of the pair in the vicinity of the nest.

Incubation period.—No single nest was studied from egg-laying through hatching; therefore the exact incubation period of the Dwarf Jay remains unknown. The data at hand, however, do suggest that the period is around 20 days, if we assume that synchrony of activities prevailed in the population under study and the onset of reproductive activity coincided in the three years of study. Both assumptions are strongly indicated by the data and observations.

Incubation behavior.—The lack of previous records of Dwarf Jay nests suggested that the species' nesting habits and nest situation might be so secretive that the nest would be difficult to discover and observe. The jays can be silent for long periods and are difficult to follow as they forage and move through the forest. If an observer does locate a foraging Dwarf Jay in the nesting season particularly after the time of egg-laying, and then keeps persistent watch on the bird it will eventually go to its nest. Moreover, it will behave no more secretively near the nest than at any other

TABLE 7

SUMMARY OF DATA ON INCUBATION AND ASSOCIATED ACTIVITIES AT SIX NESTS OF THE DWARF JAY, 13–20 APRIL 1965 AND 24 APRIL–3 MAY 1966

No. Observation Days	15	
AM Observation Time	340	2122 min
PM Observation Time	1782	
No. Observation Periods	22	
Mean Length Observation Period	96	
Time Female On Nest	1846	(87)*
Time Female Off Nest	276	(13)
Time Male Fed Female At Nest	22	approx. 1/hr
Time Male Fed Female Off Nest	10	

* Numbers in parentheses are percentages.

place. Dwarf Jays, in fact, seemingly ignore a human observer who remains quiet and inactive, even when the watcher is within 8 to 10 m of the nest.

An adult upon approaching the nest usually lands in a nearby tree, then flies to the nest tree, landing below or to the side as it flies to the nest and occasionally calls at the nest. Upon the approach of the male to the nest while the female incubates, the female may leave the nest to meet him or await his arrival. In either case she typically crouches low and extends the wings slightly and flutters them, at the same time giving a begging call—a juvenile-like whining sound. The male then promptly feeds its mate.

The male may forage for several minutes in nearby trees immediately prior to and following visits to the nest. Otherwise he forages out of sight of the observer near the nest, but within a distance that makes him audible and the calls of the female at the nest audible to him. When she leaves the nest in the absence of the male, she usually joins him or is joined by him. She occasionally calls upon leaving the nest and is answered by the male. Rarely does she forage near the nest site, except shortly before returning to the nest. The habit of the birds leaving the vicinity of the nest to forage probably aids in preventing predators from discovering the nest by the obvious activities of the adults near it.

Typically, the female incubates quietly, only occasionally shifting her position. The small bird sits so low in the cup that only the bill and end of tail are visible from slightly below nest surface level. This fact also may be one of the functions of the large nest-to-bird ratio and reduce the obviousness of the bird to a predator.

Length of periods on and off the nest.—There was no indication of a change in the incubation habits from early to late incubation. Sitting periods of the females are irregular throughout, varying from a few minutes to over two hours. The maximum time of a sitting period is not known, since the longest ones I recorded either were commenced prior to or persisted after observation time. If all the complete time periods in my observations are averaged (omitting the periods for which either the end or beginning was not witnessed), the mean length of sitting period for the female is 24 minutes (range 2 to 77). If all periods are averaged, the mean is 32 (range 2 to 120). It is perhaps advisable, considering the paucity of the data, to state merely that sitting times vary irregularly, tending to greater length and without interruption by the male to feed the female in afternoon hours.

There is a tendency for the earliest period off the nest in the morning to be longer than subsequent ones. Thirty-five off-periods, omitting incompletely watched ones, totaled 265 min and averaged 7.5 min, while 16 opening-off periods (observation periods which began with no adult at the nest), even those probably not the female's first off-period of the day average 10 min.

Apparently the male's visits to the nest are governed solely by the female's presence. Whether he feeds her on or off the nest depends upon her behavior at his approach. He never goes to the nest if she is not there in this phase of the cycle.

Intolerance of birds to physical disturbance of nest.—On several occasions I examined the contents of Dwarf Jay nests in the absence of adults apparently without disturbing activities. On two occasions, at nest 1 and 3, 1965, I sought to ascertain nest contents and was discovered in the act by the adults. They were vociferous, giving harsh rasping calls which I otherwise never heard, and flitted about within a few feet of me. Neither pair were ever seen at their nests again. In each case the full clutch of two eggs had been laid. They were not incubated after the disturbance and were collected (nest 1) and disappeared probably due to predation (nest 3) within three days.

If birds typically reacted in this way to nest disturbance, few life history studies could be conducted. The reaction of the Dwarf Jays suggests that either predators are few or that when disturbance does occur it almost always is by a predator that robs the nest, removing any purpose for the birds to return to it.

Although snakes and large arboreal lizards are either rare or nonexistent in the habitat of these jays. Steller's Jays and Barred Wrens (*Campylorhynchus megalopterus*) probably are potential nest predators. Yet Dwarf Jays would seem capable of defending against either of these species, neither of which is likely to approach in the presence of the nest owners. Squirrels were uncommon in the study area; I never saw one in the secondary layer where the jays' nests were situated. I have no information on the possibility of nocturnal predators.

Care of the Young

In 1966 the study terminated before young were hatched in any nest under observation. In 1967, the first of two nests discovered contained three hatchlings on 6 May, when it was found. Located within the territorial area of nest 1, 1966, it was 60 m up the ravine slope from the barranca creek, 4.5 m up in the crown of an oak (*Q. rugosa*).

I estimated that when found the young were approximately 3 to 4 days of age. They seemed virtually naked but could not be examined at close range due to the inaccessible position of the nest and my fear of disturbing activities of the adults. The eyes were bulbous and closed. The mouth lining was pinkish yellow. Observations were begun at this nest and occurred from 8 to 16 May.

Table 8 summarizes the timing and frequency of brooding and feeding, at one nest regularly observed. A single observation period at a second nest is included, but observations were not regularly made at the second nest because it was so situated that accurate account of events there could not be kept. The data suggest the following: both male and female feed the young with equal frequency; only the female broods; brooding, except in late evening and nocturnal hours diminishes after the first week of nestling life, while feeding trips by the adults increase in frequency from two to four an hour to about double that frequency. Fecal sacs are usually removed from the vicinity of the nest and are rarely eaten at the nest. The basic character of brooding and feeding of young is similar to that in the north temperate Scrub Jay (Amadon. 1944:14–15) and the Blue Jay (Hardy, 1961:64–68).

The service of the adults as in Blue and Scrub Jays was not coordinated. Occasionally they arrive at the nest to feed simultaneously. but their arrivals and departures were not alternated or synchronized. This is undoubtedly due to the fact that in jays. the female does practically all the brooding and her cycles of feeding and brooding are independently coordinated with

TABLE 8

CARE AND FEEDING OF NESTLINGS BY DWARF JAYS

Date (Nest)	Time beginning	Total time (min.)	Brooding (min.)	♀ feeds young	♂ feeds young	Adult feeds young	♂ feeds ♀ who feeds young	Removes fecal sac (eats)
8 May (#1)	16:30	60	25 $\underline{1}$*	1	1			
9 May (#1)	08:20	120	9 15 sec 44	3	5	1		1
11 May (#2)	07:00	120	$\overline{65}$ $\underline{20}$			1?		
11 May (#1)	10:20	120	$\overline{5}$ 18 1	3	2		1	(1)
12 May (#1)	08:30	60				5		1
13 May (#1)	17:00	30	adults forage near nest					
14 May	10:00	120		1	1	12		3
14 May (#1)	17:00	60	32	2 attempts, young refuse				
16 May (#1)	07:00	60	30 sec 35		1	1	1	1
Total		750	25:45	8	10	20	2	7
Frequency				0.64/hr	0.80/hr	1.60/hr	0.16/hr	0.56/hr
				3.2 hr				

* Bar over numeral indicates activity was in progress as observation began; bar under numeral indicates activity continued beyond termination of observation.

each other and do not depend on the male brooding or guarding the nest. After bringing food the male seldom stays at the nest for more then a few seconds. The female did not follow or beg from her mate and was rarely fed by him.

It proved impossible to arrange study of the reproductive cycle of the Dwarf Jay when and after the young leave the nest. Thus, the number of days the young spend in the nest and the nature and time of their care by the adults in the fledgling stage remains unknown. In the Moore Laboratory of Zoology there are four juvenal specimens. Two, apparently just out of the nest are stubby-tailed, collected by Toro Aviles, on Mt. Totontepec, Oaxaca (some 75 airline km east of Cerro San Felipe) on 12 and 18 April 1942. These specimens had led me to expect that my scheduled times of study would allow me to observe the young leaving the nest. Either nesting time is regularly earlier on Totontepec, the year 1942 was an early year, or Aviles' dates are incorrect. Lamb collected one full-grown juvenile on 5 July 1942 near the border between Puebla and Veracruz, at the top of Acultzingo grade (La Puerta) about 35 miles SW of Orizaba, Veracruz, and his notes suggest no evidence of this young being cared for by adults, which he also collected.

I spent the period 4 to 8 July 1963 in the study area on Cerro San Felipe studying Dwarf Jays. Based on observations in the other years of study, this would have been at a time when the young had been out of the nest for about six weeks. At no time did I observe any indication that any Dwarf Jays were still dependent on others for food. Flocks of from 5 to 10 birds were watched on three days as they roamed the woodlands foraging in company with other species, especially the wren *Campylorhynchus megalopterus.* Short (1961:341–343) has written of the multispecies flocks in which this wren and the jay are prominent constituents on Cerro San Felipe.

Breeding activity of the jays had ceased before early July. Three individuals collected and now in the spirit collection of the Moore Laboratory had just begun the prebasic molt. In a female (A–37) with a minute granular ovary, the third primaries were new quills with 1 cm brushes. The second primaries were soft but fully grown. Molt of under and upper tail coverts was in progress, and scattered wing coverts and body feathers were also molting. Another female (A–51) was like A–37 and in addition was replacing the innermost rectrices, which were sheathed. A male with left testis 3 × 2 mm was molting first and second primaries, upper and lower coverts of remiges and rectrices.

No molt data were taken for two specimens preserved as skeletons. One, a male, had testes 8 × 5 mm and a female, with skull incompletely ossified and the bill lining white (an indication of first year age) had a very small granular ovary.

Lamb's two adult specimens from La Puerta, Veracruz, mentioned above, were completing the molt of the 5th and 6th primaries.

Except for the fact that the Dwarf Jays observed from 5 to 8 July on Cerro San Felipe were in small loose flocks, I could detect no basic behavioral differences between them and breeding birds in their movements, calls, or foraging habits.

I find no evidence in the literature to indicate that the Dwarf Jay migrates or otherwise displaces itself from its nesting grounds, in the non-breeding season.

Timing of the Breeding Season of Dwarf Jays

As previously emphasized, although this jay is representative of an avifauna of largely tropical affinities, it is nonetheless an inhabitant of a cool temperate climate. Its breeding season begins well in advance of the rainy season and the young are on the wing, probably largely independent of adult care by the onset of the rains. Pitelka (1958:45–49) studied breeding, age, molt, and food abundance of Steller's Jay in the Queen Charlotte Islands, coastal British Columbia. He suggests that in that species molt, rather than breeding, was critically timed to the season of maximum food abundance. In the Dwarf Jay habitat, maximum abundance of food probably occurs in the first months of the rainy season, July through September, suggesting that this species may be similarly adapted.

VOCALIZATIONS

I have previously discussed the vocal character of the Dwarf Jay (Hardy, 1964:3–6), with special reference to the species' taxonomic affinities. As pointed out then, the Dwarf Jay has one of the smallest basic repertoires known among jays. There is one species-specific call, variations in delivery of which appear in different contexts. This call, a doubly flexed, shrill, nasal, *shreéup* (Fig. 6A) may be given singly, in multiples of two or three, rapidly almost run together, and with bill either open or closed. In these ways only is variety obtained. A short, soft closed-billed utterance of this call serves as a contact-conversational note between two adults close to each other. An open-billed singly uttered version serves as a contact note when the birds are farther apart and out of each others sight. Rapid multiple versions serve both as high intensity activity notes among foraging individuals in a loose flock, probably correlated with flock movement and cohesion, and in excited reference to a predator, human being, or comparable stimulus evoking suspicion or examination.

Besides the *shreéup* there are generalized begging notes, rapidly uttered, that are not species-specific. These are given by the female toward the male in solicitation of food. Another generalized and rarely heard call is the harsh rasp (Fig. 6B) that is given in intense "fear" and "rage." The adults gave it when they found us examining their nest.

The limited character of the Dwarf Jay vocal repertoire may be a function of the simple social structure of the species, especially during the nesting season. It is also correlated with the simplicity of sexual display (so far as known involving only courtship feeding). These behavioral

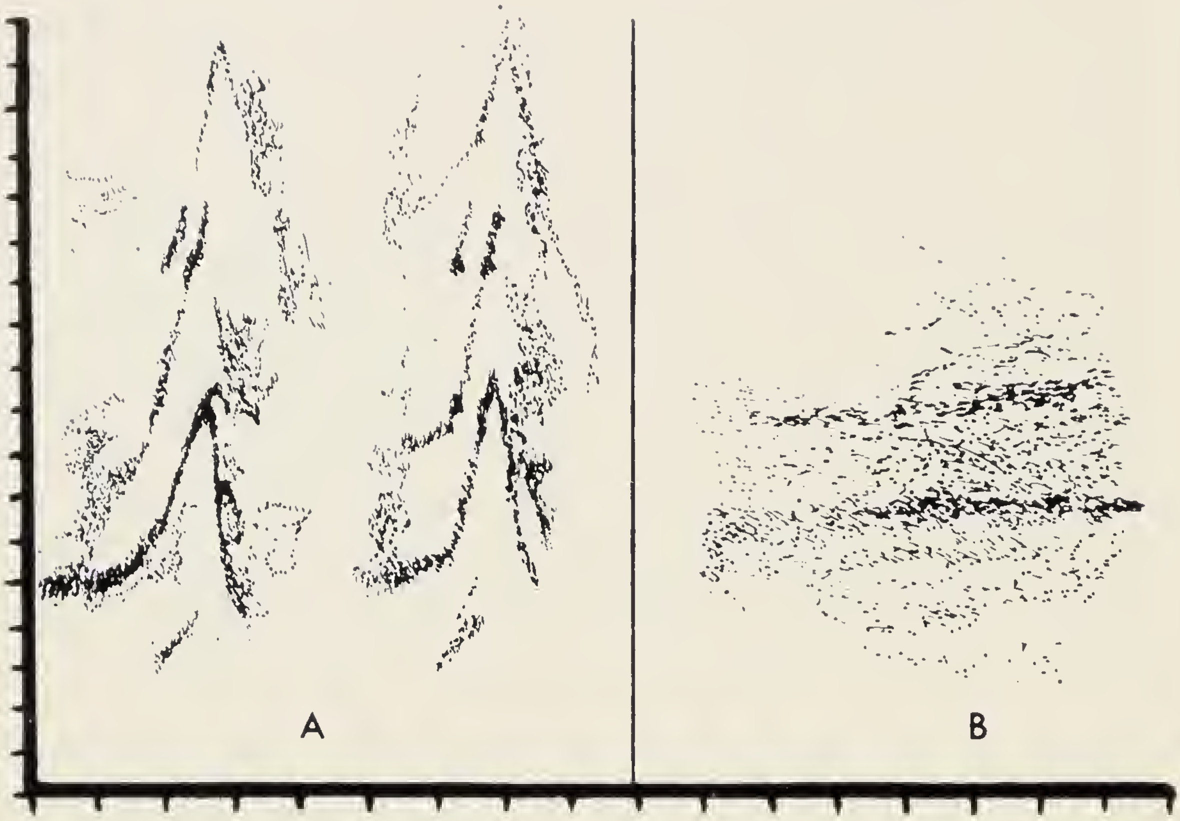

Fig. 6. Ink drawings of sonagrams of two Dwarf Jay calls. Narrow band pass filter. Frequency is measured on the vertical axis at 500 cycle intervals to 10 Khz. Time is measured on the horizontal axis at 0.2 sec. intervals. Both recordings from Moore Laboratory Master Tape 13, 12 April 1965, nest 1, Cerro San Felipe, Oaxaca, by J. W. Hardy. A. Two doubly inflected alarm calls (*shreéup*!). B. Harsh rasp given in "fear" or "rage."

characteristics eliminate the necessity of a complex vocabulary with distinctive components that can result from completely distinct types of operation of the syringeal apparatus. The few variations of vocal sound in this species seem to be handled by variations on a single basic syringeal operation that produces the *shreéup* plus differences superimposed by the strength of air flow and the opening or closing of the mouth cavity.

PREDATORS

Dwarf Jays, while intently foraging in the top of the second story of trees, form excellent targets for cruising Sharp-shinned Hawks (*Accipiter striatus*). This species seemingly preys on the jay. In 1965, while I was observing nest 3 near our camp, one of these small hawks, apparently a male darted and almost seized the male jay as he hopped about in the canopy of the nest tree. The jay called twice and fled. The hawk perched nearby and then quickly flew away. At nest 2 on 19 April 1965 when there had been two eggs in the nest for a week, I spent two hours on watch in the afternoon. No jay appeared at the nest. At 15:40 a Sharp-shinned Hawk caught a small bird immediately down the ravine from my observation position (as evidenced by the sudden flurry of small birds and anxious calling). Moments later the hawk flew by and I believe it was carrying a Dwarf Jay. It appeared a few minutes later, flying by without prey.

In 1967 near nest 1, I also observed a Sharp-shinned Hawk dart past the nest area, causing a flurry of birds including the jays. The hawk this time did not attack a specific bird.

SUMMARY

In 1963, 1965, 1966, and 1967, I studied aspects of the life history and ecology of the Dwarf Jay (*Aphelocoma nana*) in the montane forests of Cerro San Felipe, Oaxaca, Mexico. This jay is an inhabitant of humid oak-pine-fir forests on the mountain between about 2500 and 2900 meters elevation. Its occurrence is closely correlated with the existence of and largely confined to a secondary layer of trees below the canopy. The bird seldom ventures to shrubs and the ground vegetation or to the high canopy of the forest. It rarely enters pure pine forests, also present in the study area. It is sedentary. In foraging, the Dwarf Jay attacks plant galls and gleans arthropods from epiphytic growth. It is adept at exploring small branches and their epiphytes in a titmouse-like fashion. Occasionally it takes medium-sized flying insects. In the non-breeding season it frequently travels in small bands of less than a dozen birds associated with other species, such as the wren *Campylorhynchus megalopterus*.

The Dwarf Jay is an asocial species in the nesting season, pairs occupying exclusive areas away from other breeding individuals of the species. Although widespread in the chosen habitat, the Dwarf Jay population studied was of low density. This may have resulted in the lack of frequent territorial behavior, but the exclusive occupance of areas by pairs and occasional encounters early in nesting indicate that the species is territorial.

Nesting began in late March. At that time small groups of jays in which pairs were engaged in courtship feeding were seen. Both members of a pair are attendant in nest construction, both probably contributing to nest building. I found nests nearly completed in the first week in April. Nests are placed in the crowns of second story oaks or near the end of a branch. They ranged in height from 3 to 15 m. Nests are large in relationship to the size of the jays themselves. Construction is of twigs, mosses, and pine needles and the finished nest is compact and sturdy. In the time of nest building, the birds desert the nest area in afternoon hours to forage in deep ravines. They build in morning hours. Egg-laying commenced on 12 April in 1965. Complete clutches were composed of two or three eggs, which are pale-greenish-blue, marked with olive. Incubation is seemingly by the female only. She is attended by her mate, sometimes fed at or near the nest, and usually accompanied by him in her time off the nest. She incubates in periods ranging from 2 minutes to longer than 2 hours. The longer periods occur in afternoon hours. The incubation period was not precisely determined but is apparently 20 days or longer as in other New World jays. Hatching occurs in late April or early May. At the one nest studied in detail in the nestling stage, both male and female fed the young and only the female brooded. The fledgling stage was not observed, but observations made in early July, 1965, indicate that young

are completely independent by this time, and the jays already are in the non-breeding bands with wrens and other resident species.

The vocal repertoire of the Dwarf Jay is extremely simple, consisting largely of variations on the production of a single basic component, the *shreéup* call. At times of extreme anger or fright the birds emit a harsh rasping call.

The Sharp-shinned Hawk is seemingly a predator of the Dwarf Jay.

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VARIATION IN PLASMA PROTEINS OF SUBOSCINE BIRDS

J. Alan Feduccia

Information obtained from biochemical data has now been used extensively to aid in uncovering the evolutionary relationships of animals. Because many biochemical characters can be shown to be conservative (vary little within taxonomic groups) they are thought to be very good indicators of relationships (see Sibley, 1960, and Zuckerkandl and Pauling, 1965).

Most of the studies of electrophoretic patterns of avian blood serum and plasma proteins (Brandt, Clegg, and Andrew, 1951; Common, McKinley, and Maw, 1953; Wall and Schlumberger, 1957; Sibley and Johnsgard, 1959; and Sibley and Hendrickson, 1970) have led to the almost universal conclusion that although there is a basic and conservative overall pattern, there is so much variation due to sex, age, health, polymorphisms, and unknown factors as to render the information of little value in uncovering the evolutionary relationships of birds.

As most of the studies to date have utilized filter paper, cellulose acetate, or starch gel electrophoresis, it is of interest here to consider the electrophoretic patterns of avian plasma proteins in suboscine birds as delimited by the more refined acrylamide gel electrophoresis. It should be pointed out here that the patterns obtained from both plasma and serum (without clotting factors) are very similar and Wall and Schlumberger (1957) reported, ". . . no essential differences were discernible between the electrophoretic patterns of serum and plasma from the same birds."

MATERIALS AND METHODS

Owing to the difficulty in obtaining live material of suboscine birds, the birds were shot and the blood extracted from cuts in either the wing or the neck. The blood was placed in a culture tube containing a tablet of potassium oxalate dissolved in 2.0 ml of a 1.0 per cent saline solution. The tubes were then placed on ice. Red blood cells were precipitated by centrifugation and the supernatant liquid used in the electrophoretic analysis. Disc electrophoresis similar to that described by Davis (1964), and Ornstein (1964), was used. This technique has been used previously for avian material by Desborough and Irwin (1966). A tris-glycine buffer at pH 8.5 with bromphenol blue added as a marker was utilized. Ten tubes with acrylamide gel were run simultaneously in a cold room at a constant 50° F, with each tube conducting 5 ma. The current was terminated when the brom-phenol blue front had migrated 32 mm (approximately 30 minutes time). The gels were then removed from the tubes and stained for total protein by 0.2 per cent Amido Black in a 5:5:1 solution of water, methanol, and acetic acid for 30 minutes. The gels were then destained in an 8 per cent acetic acid solution and stored in a solution of the same composition. One tube of human plasma obtained from the author was included in each electrophoretic run

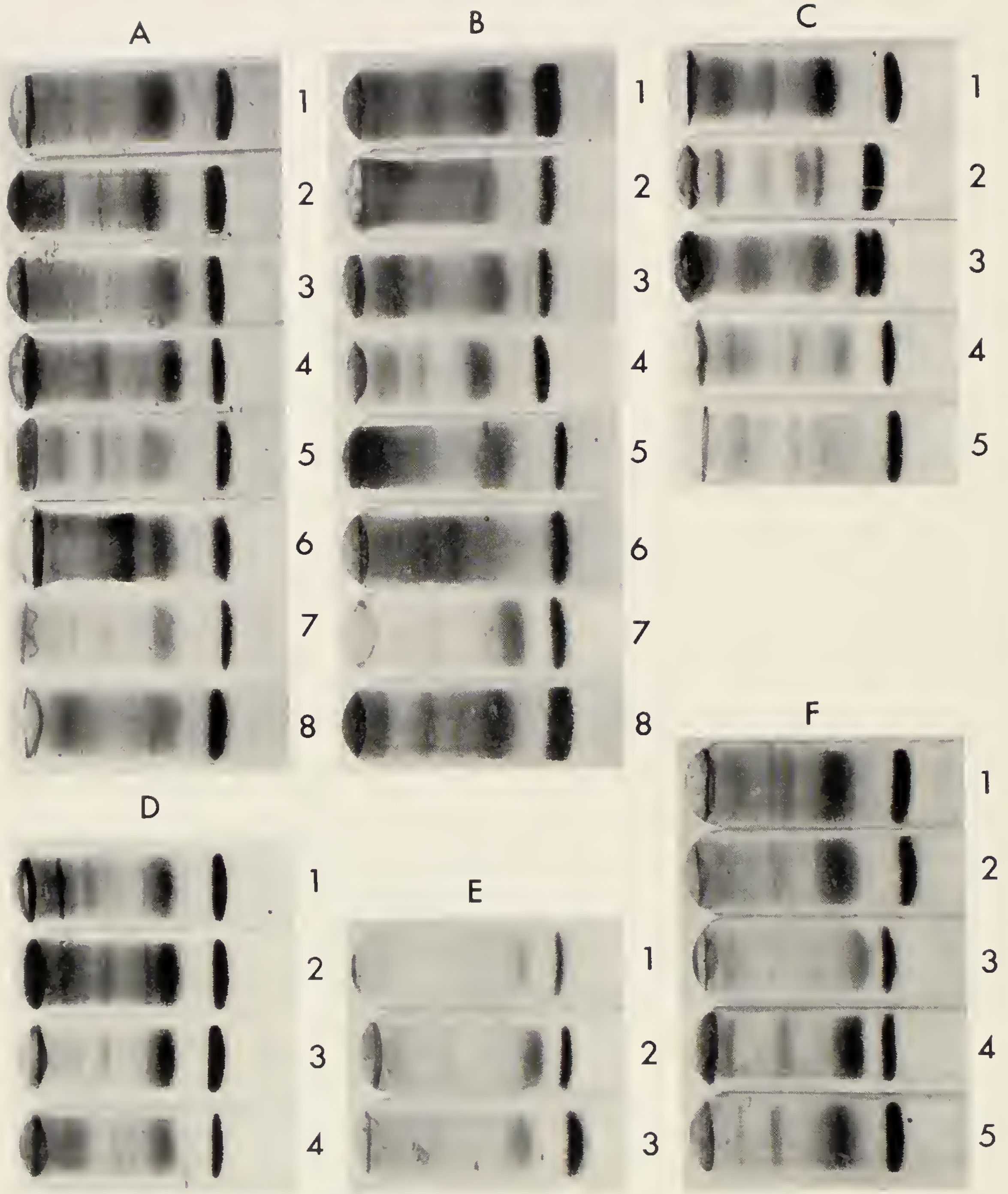

FIG. 1. Acrylamide gel electrophoresis patterns of plasma proteins of: (A) Furnariidae: 1. *Pseudocolaptes lawrencii*, 2. *Hyloctistes subulatus*, 3. *Automolus ochrolaemus*, 4. *Thripadectes rufobrunneus*, 5. *Xenops minutus*, 6. *Cranioleuca erythrops*, 7. *Synallaxis albescens*, 8. *Margarornis rubiginosus*; (B) Dendrocolaptidae: 1. *Dendrocincla anabatina*, 2. *Glyphorhynchus spirurus*, 3. *Deconychura longicauda*, 4. *Sittasomus griseicapillus*, 5. *Xiphorhynchus erythropygius*, 6. *Campylorhamphus pusillus*, 7. *Lepidocolaptes souleyetii*, 8. *Dendrocolaptes certhia*; (C) Formicariidae: 1. *Microrhopias quixensis*, 2. *Taraba major*, 3. *Grallaria perspicillata*, 4. *Thamnophilus doliatus*, 5. *Thamnophilus bridgesi*; (D) Cotingindae: 1. *Querula purpurata*, 2. *Lipaugus unirufus*, 3. *Rhytipterna holerythra*, 4. *Pachyramphus polychopterus*; (E) Pipridae: 1. *Pipra mentalis*, 2. *Manacus candei*, 3. *Chiroxiphia linearis*; (F) Tyrannidae: 1. *Myiarchus* sp., 2. *Contopus* sp., 3. *Myiozetetes similis*, 4. *Pipromorpha oleaginea*, 5. *Onychorhynchus mexicanus*.

as a test for consistency. During the study approximately 100 bird specimens representing a broad spectrum of the suboscines were examined. All individuals were run several times.

Identification of the serum and plasma proteins in birds is based primarily on comparisons with human serum electrophoretic patterns (see Davis, 1964; Clarke, 1964; and Sibley and Hendrickson, 1970). The fastest migrating and most prominent band is the serum albumin. The other more prominent bands are alpha-, beta-, and gamma-globulins, which include a great variety of different proteins.

RESULTS AND DISCUSSION

The comparisons made indicate a high degree of variation among individuals and closely related species, often more than between distantly related forms. This variation is probably due to such factors as age, sex, health, and unknown factors. However, once the small variations are not considered there appears to be a basic pattern for the major components, the serum albumin and major globulin band (closest to the albumin), throughout suboscine birds. These results confirm Sibley's and Hendrickson's results from electrophoretic patterns of plasma proteins that, ". . . once we eliminate the taxonomically non-significant variation from the patterns, we find that they are remarkably similar in all birds." "The variation superimposed upon this basic pattern mainly reflects the physiological functions of the plasma proteins and is consonant with the known or suspected roles which these substances play in the life of the organism."

However, there are several points of interest in Figure 1. The position of the first two major bands, the serum albumin and globulin, is very constant, and although some variation is exhibited by the gels, this is likely due to individual variation. There was a pre-albumin band in some species, but not in others. Of interest in Figure 1 is the double band of serum albumin found in *Grallaria.* I found serum albumin to be polymorphic in both *Thamnophilus bridgesi,* and in *Xiphorhynchus lachrymosus.* The double band in *Grallaria* therefore seems to be of little importance.

Although difficulty in interpretation is encountered due to the almost endless variation in the smaller bands, it is of interest to consider the patterns obtained from the family Cotingidae, a family which has been thought to be quite heterogeneous. Here, the four forms examined, *Querula, Lipaugus, Rhytipterna,* and *Pachyramphus,* although they represent diverse morphological types, have plasma electrophoretic patterns which are almost identical (Fig. 1).

In summary, the results of this study confirm previous studies of serum and plasma proteins in birds. There is a basic pattern which is similar in all birds, superimposed on a great variety of taxonomically meaningless variation. Where patterns do seem to indicate relationships (as in the Cotingidae), one is hesitant to advocate the validity of the data owing to the otherwise great variation.

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PUBLICATION NOTES AND NOTICES

Bird Songs of the Mountain Lake Sanctuary. Tape recorded by Dan Gibson and W. W. H. Gunn. Mountain Lake Sanctuary, Lake Wales, Florida, 1970: 7 inch stereo 33⅓ r.p.m. recording. $1.50. Order from Mountain Lake Gift Shop, Box 832, Lake Wales, Florida 33853.

Recordings of songs and calls of 20 species of birds with a running commentary, plus a selection played on the Singing Tower carillon. A souvenir of the Sanctuary. —P.S.

SOCIAL ORGANIZATION OF THE BLUE-BACKED MANAKIN

D. W. Snow

The manakins of the genus *Chiroxiphia* are peculiar in that pairs of males (or in *C. caudata* several males) perform a coordinated courtship dance in which each bird appears to play an equal part. The displays take place on low perches in the undergrowth of secondary forest, and the evidence indicates that the main perches are traditional, though other perches are also occasionally used. In *C. pareola, C. lanceolata,* and *C. linearis,* the two displaying males jump up alternately. In the Blue-backed Manakin (*C. pareola*), which has been studied in most detail, each jump is accompanied by a nasal twanging call, so that the two birds jumping alternately produce a rhythmic twanging. If a female lands on the perch, they face her and continue the dance; the jumping bird flutters backwards in the air while the perched bird hitches itself forwards on the perch and jumps up as the other lands, with the result that the two birds form a revolving "cartwheel." The joint dance appears to be an advertising display, whose function is to attract females to the site. Copulation, however, is preceded by a different display in which only one male takes part. In addition to the joint dance, males also call jointly, sitting side by side or on adjacent perches and uttering long series of ringing notes in almost exact unison.

These displays and calls were described in an earlier paper from observations made in Tobago (Snow, 1963*b*). It was found that, at the main display site studied, there was a dominant male which called up other males, using a special "summoning" call; the summoned bird would approach, also calling, and the two birds would then break into a bout of calling in unison from the trees above the display perch. This would regularly be followed by the joint dance on the perch itself. But the most interesting question of the organization of the males was left unanswered. Two possibilities were suggested: (1) that each display perch is "owned" by a dominant male, which is joined by subordinate males that have no display perches of their own; or (2) that each display perch is "owned" by a male, which is joined by neighboring perch-owners for bouts of joint display and in its turn joins its neighbors, as appears to be the case in *Pipra aureola* (Snow. 1963*a*). Gilliard (1959), however, had earlier suggested, also from observations made in Tobago, that a group of perches is the common property of a group of males, and he found evidence of a social hierarchy within the group which he studied.

In 1961 I attempted to decide the question by color-ringing, but without success, as the season was too far advanced and the two birds which were caught did not reappear. Early in 1970 another opportunity presented itself. From 16 January to 6 April I was camping beside a creek in the foothills of the Kanuku Mountains in southern Guyana, very close to a group of Blue-backed Manakins which occupied a patch of secondary forest just across the creek from the camp clearing. The study was not as successful as was hoped, as display was never at a very high level and for some periods fell off inexplicably, though the breeding season should have been at hand with the onset of the wet season in April or May (no Blue-backed Manakin nests have yet been reported from Guyana). The observations that were made, however, were sufficient to show that the social organization was much as Gilliard suggested for his Tobago birds.

Preliminary observations, soon after our arrival at the camp, showed that at least four display perches were being used, about 30-40 m apart. As in Tobago, the display sites were in thick patches of undergrowth, especially where there was a tangle of woody lianas close to the ground, the horizontal or nearly horizontal portions of the lianas forming the actual perches. Mist-nets were set at three of the display sites, the fourth being on unsuitable terrain, and five male manakins were trapped and color-ringed between 25 January and 16 February: one fully adult male, two subadults which might well have been taken for adults in the field (adult plumage, with greenish wash on the black body plumage and greenish fringes to the wing and tail feathers), and two more immature males with red caps but otherwise mainly juvenile plumage. Two of these were trapped at one perch, two at another, and one at the third perch.

After a gap of three weeks, during which display was very slack, as judged by the lack of calling to be heard from the camp, activity seemed to increase a little and a series of watches was carried out between 10 March and 2 April, totalling 22 hours. The details of the display movements and calls were, as far as could be determined, identical with those of the Tobago birds, and the following account deals only with the social organization.

In addition to the five birds that had been caught, of which three were seen between 10 March and 2 April, one unringed fully adult bird was regularly present and there may have been another. No unringed immature or subadult birds were seen. Thus there were certainly six, and perhaps seven, males associated with the display perches during the period of the study. Of the four display sites in use in January, one (at which one male had been trapped) was never seen to be used during the later observation period. The others were all used, as was a fifth site which consisted of a rather diffuse cluster of perches. All these display sites were within an area of about 100 × 50 m, and from a central position it was easy to hear whether display was taking place at any of them. No dancing displays were recorded anywhere else in the vicinity outside this area, but occasionally a pair of males would call in unison in the forest on the camp side of the creek.

The most active bird in the group turned out, unfortunately, to be the unringed adult male. This bird spent a considerable amount of its time in the trees above one of the central display sites, uttering "summoning" calls, until it eventually gave up or moved off or, on several occasions during observation periods, was joined by another male. With the unringed adult giving the lead, the pair would then break into a bout of calling in unison and might later fly down to one of the display perches and begin to dance. If the pair were disturbed at one display perch they sometimes flew almost directly to another and continued their display. The unringed adult (presumed to be the same bird on each occasion from its behavior and the perches from which it called) certainly went to three of the perches that were in use and probably went to the fourth. On all occasions when the relations between it and another bird could be observed it was dominant, in the sense that it called up the other bird and initiated any movement from one display site to another or from a high perch down to one of the low display perches.

The two younger males that were seen most frequently also both went to three of the four display perches that were in use, either when called up by the adult male or of their own accord if they were alone. The third ringed bird was seen on only one day, when it was engaged in prolonged calling in unison with the unringed adult near the central display perch. No joint displays were seen involving two subordinate males, apparently because each of them tended to associate with the dominant bird if he was about. Probably there was a hierarchy within the group, based primarily on age, the older subordinate birds being able to displace the younger ones as display-partners of the dominant male. Occasionally three or more birds were present at the same time, and the rather fragmentary observations that were made on these occasions suggested that, although males are attracted to other males which are calling or displaying, properly coordinated joint displays are possible only between two males, as the earlier study (Snow 1963*b*) had also indicated. If a newcomer comes close and is persistent, the display breaks up and the birds revert to uttering the initial "summoning" calls.

On no occasion were two pairs of males recorded calling or displaying at different display sites at the same time. Nor did I ever see a solitary male remain at a display site when display was going on at a neighboring site. In other words the negative evidence, as well as the positive, all indicated that there was a single group of males ranging over the whole display area, with no private ownership of any of the display perches.

The display area in Guyana and the main area watched in Tobago by Gilliard and myself were both in rather small patches of habitat suitable for manakins surrounded by less suitable areas. In more extensive habitats it must often be impossible for one male to be dominant over all the display sites, and in such places it may be that a number of dominant males divide up the area among themselves. Thus in extensive forest on Pigeon Peak in Tobago we found that pairs of males might display simultaneously at neighboring perches, but we were unable to make detailed observations. In such areas the relations between males may well be more complex than in the smaller restricted areas that have so far been studied.

SUMMARY

In the Blue-backed Manakin (*Chiroxiphia pareola*) pairs of males perform joint displays on species perches low in forest undergrowth. The organization of a group of males in southern Guyana was investigated by color-banding. Contrary to the suggestions made as a result of study of the same species in Tobago, but in agreement with Gilliard's earlier observations, it was found that the group of display perches was the common property of the whole group of males.

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A STUDY OF HENSLOW'S SPARROW IN MICHIGAN

Jerome D. Robins

As with many birds of secretive habits and irregular distribution, the Henslow's Sparrow (*Passerherbulus henslowii*) is insufficiently known. Our knowledge of this species is best summarized by Graber (1968), which is based on her observations and those of Hyde (1939) and Sutton (1959*a*, *b*). The present study focused on the population structure and nesting biology in 1966 at Kalamazoo, in southwestern Michigan.

METHODS

The study area is a 30-acre brome grass-alfalfa-red clover hayfield marked off into a grid by stakes set at 100-foot intervals (described in detail by Brewer et al., 1969). Censuses of singing males were made on 65 different days between the first of May and mid-September. During each census the locations of birds were marked on maps which reproduced the grid as well as the outstanding vegetational features.

Territories were mapped using only the singing locations recorded for the various males. No additional types of territorial defense were observed and human disturbance caused the birds to go out of their territories. Male G was chased continually for 45 minutes to determine how far he would go from his territory of 2.4 acres (as previously determined by mapping song posts). The resultant area was 5.9 acres with the greatest linear distance away from his territory being 780 feet. Singing locations were connected by straight lines to form polygons which correspond to the "utilized territories" of Odum and Kuenzler (1955). (The areas of the polygons were determined by use of a planimeter.)

Observations of nine nests were made from blinds placed on the ground five feet from the nests. Since records of attentiveness and inattentiveness were not random (they began and ended with the beginning or ending of an attentive or inattentive period) and because unequal numbers of sessions and recesses were collected, percentage attentiveness was calculated by use of Skutch's (1960:8) formula:

$$\begin{array}{l}\text{Percentage}\\ \text{attentiveness}\end{array} = \frac{\text{Mean attentive period}}{\text{Mean attentive period} + \text{Mean inattentive period}} \times 100.$$

Fourteen males, 10 females, 18 nestlings and 2 juveniles were banded and individually marked with celluloid leg bands.

BREEDING SEASON HABITAT

The habitat requirements of Henslow's Sparrow seem to include or, at least, be related to the following features: (1) an intermediate moisture range; very wet or dry areas are avoided; (2) vegetation dominated by herbaceous plants particularly grasses or sedges which is dense or, at least, with frequent dense patches. At Kalamazoo, territories were smaller and more numerous on the north portion which had the densest vegetation; (3) presence of litter; and (4) singing perches. Over most of the season at Kalamazoo, the birds sang just below the top of the general vegetational cover. Invading woody plants and grid stakes provided perches above this level but they were used only infrequently. During the initial part of the breeding season, however, clumps of dead vegetation standing above the new grass were often used as singing perches.

ESTABLISHMENT AND MAINTENANCE OF TERRITORIES

Males initiated their primary song upon arrival and ceased singing about mid-September. First arrival occurred on 22 April in 1966 and 30 April in 1967. The latest observation in 1966 was on 16 October, but the last identification of a marked individual was on 17 September.

Sutton (1959*b*) stated that territorial defense included frequent chasing by the males. During extensive observations at Kalamazoo I saw no such incidents. Territorial disputes between adjacent males were limited to "formal songfests." "Singing" and "song" are here used to refer to the vocalization given by the male represented as *tsi-lick* by Peterson (1947:231). There was no tendency for adjacent males to come to their nearest borders for a duel. In cases where one male moved near the border of its territory and that of a nearby male, the latter usually continued singing at the same location, even if on the opposite side of its territory. The average distance between simultaneously singing males on adjacent territories was 216 feet ($N = 107$). With these observations as a basis, territories are here considered to be any area within which a given male sang.

Four continuous day-long song counts were made in an attempt to determine the amount of time males devoted to singing at various stages of the breeding cycle (Table 1). All the songs of three males in nearby territories were included in each song count. The first two song counts (10 May and 26 May) represent periods when the birds were in the earliest stages of the breeding cycle. The greatest amount of time devoted to singing was in the early morning and early evening. Initiation of steady singing occurred about one-half hour before sunrise and most birds stopped singing about one-half hour after sunset. The increase in singing which occurred from early to late May may have been influenced by the increase in the total number of birds present as well as by behavior related to the nesting cycle itself. Almost no singing was observed between 21:00 and 04:00. On 26 May continual song by all three males under study ended by 20:38. Male E, however, began singing at a rate of eight to nine songs per minute at 21:45 and continued beyond 23:00 when I left. This was the only time a Henslow's Sparrow was heard singing regularly after nightfall between the first of May and mid-September (over 55 observations). The lack of nighttime singing was surprising in that several observers have heard this species sing during the night (see Graber, 1968).

TABLE 1

MEAN NUMBER OF SONGS PER HOUR FOR THREE MALE HENSLOW'S SPARROWS AT FOUR PERIODS DURING THE BREEDING SEASON

The individuals and the total number of songs for each were: 10 May (D:67, E:1960, F:1322); 26 May (E:2103, H:2214, J:1546); 18 July (I:500, J:2099, S:4962); and 15 August (H:746, J:1679, R:223).

Hour	10 May	26 May	18 July	15 August
00:00	4	–*	–	–
01:00	3	–	–	–
02:00	3	–	–	–
03:00	2	2	2	–
04:00	100	312	204	–
05:00	438	517	370	307
06:00	156	40	255	175
07:00	76	38	252	38
08:00	57	75	181	56
09:00	11	147	148	0
10:00	41	67	14	13
11:00	1	5	40	50
12:00	0	25	34	0
13:00	0	–	29	1
14:00	1	–	93	7
15:00	1	–	57	0
16:00	1	56	106	15
17:00	1	185	137	1
18:00	1	161	223	0
19:00	75	71	201	195
20:00	138	63	174	24
21:00	2	35	–	–
22:00	4	152	–	–
23:00	1	–	–	–
Total	1117	1951	2520	882
Sunrise	05:25	05:10	05:20	05:48
Sunset	19:50	20:08	20:14	19:41

* A dash means no observation was made.

The time devoted to singing by the three males was highly variable during July and August (223 to 4962 songs per day). This variation appears to be related to the stage of the nesting cycle. For example, on 17 July male S established himself on portions of three existing territories in an area occupied by five singing males. He was included in the song count on 18 July. In his apparent attempt to establish a territory, male S sang more than twice as many songs as I had previously recorded (4962), and sang during all hours from 03:00 to 21:00. Nest building was in progress in the territory of male J.

who sang about as many songs (2099) as other males at the same stage earlier in the year. Male S was not observed after 20 July.

During the nestling period daytime singing was limited to intervals of only two or three minutes. These sessions immediately followed about half of the feedings of nestlings made by the males. In the early morning and evening the males also sang for periods of one to ten minutes which were not associated with feeding the nestlings.

TERRITORIES AND POPULATION SIZE

Over the course of the breeding season, shifting of territories, disappearance of singing males, and establishment of males new to the area were common occurrences. Ten males had only one territory which appeared to remain stable during their stay on the area, two males had two successive territories, two males had three territories, and four males had four territories. The greatest shift of territories on the study area was made by male E. After setting up his first territory he moved 625 feet south. Later, he moved 65 feet further south, and finally northeast 605 feet. These territories lasted for 28–30 days, 32–34 days, 22–23 days, and 34–35 days respectively. Young were fledged in the second and fourth territories.

For the most part, territories were distinct units separated from others on all sides by buffer zones where neither male sang. Over the summer the average distance between adjacent territories was inversely related to the number of territories present, ranging from 47 feet in July when the population was the highest, to 431 feet in September when the population was the lowest (Table 2). Territory size for all territories through the year averaged 0.8 acres ($N = 36$). On the northern half of the area where the vegetation was the tallest and most dense, territory size averaged 0.7 acres whereas on the southern half the average was 1.1 acres. The average size of a territory was smallest at the beginning of the year and gradually increased through the summer (Table 2). This pattern, however, was not true of all individuals.

Only six territories were defended on the area during the first half of May. This number gradually increased to a maximum of 15 territories during the first half of July and then gradually decreased to three territories in the first half of September (Table 2). Thereafter no territories were defended by song, but Henslow's Sparrows were present in the area until 16 October. During the first half of July when the population was the most dense, the number of breeding birds per 100 acres was 59.3 on the north half and 42.9 on the south half of the study area. The mean number of breeding birds per 100 acres from records in the literature was 23 (Robins, 1967). The majority of the 27 studies reported figures below the mean. If buffer zones

TABLE 2

HENSLOW'S SPARROW TERRITORIES ON 30 ACRES OF SUITABLE HAYFIELD HABITAT AT KALAMAZOO, MICHIGAN

Each territory was present eight or more days during the half-month intervals.

Period	Number of territories	Males per 100 acres	Mean territory size in acres	Mean distance between adjacent territories (feet)
May 1–15	6	20.0	0.7	221
May 16–30	9	30.0	0.9	69
June 1–16	10	33.3	0.9	83
June 17–30	12	40.0	0.9	77
July 1–16	15	50.0	0.8	47
July 17–30	13	43.3	0.9	55
Aug. 1–15	10	33.3	1.0	75
Aug. 16–30	8	26.7	1.1	82
Sept. 1–17	3	10.0	1.6	431

between territories are not essential, the area could support a population more than double that observed in 1966.

RELATIONS WITH OTHER ANIMALS

Avian breeding associates.—The grassland portion of the study area had an estimated 37.4 breeding males of all bird species in 1966 (R. Brewer, pers. comm.). The seven species present and the number of males were: Henslow's Sparrow, 15; Red-winged Blackbird (*Agelaius phoeniceus*), 7.2; Short-billed Marsh Wren (*Cistothorus platensis*), 6; Eastern Meadowlark (*Sturnella magna*), 4.5; Bobolink (*Dolichonyx oryzivorus*), 4.0; Savannah Sparrow, (*Passerculus sandwichensis*), 0.5; and Grasshopper Sparrow (*Ammodramus savannarum*), 0.2. Henslow's Sparrows comprised 40 per cent of the total number of males present. Inasmuch as the Red-winged Blackbird, Eastern Meadowlark, and Bobolink are polygynous they would have, in comparison with Henslow's Sparrows, larger populations and more nests than are indicated by the number of males.

Male Bobolinks and Red-winged Blackbirds occasionally chased singing Henslow's Sparrows, and adults flying to and from the nest during the nestling stage. Such incidents appeared to occur only when a blackbird or Bobolink by chance happened to fly over a singing male or cross the path of a flying Henslow's Sparrow. Attacks were limited to dips in flight to within a few feet of the grass into which the Henslow's Sparrows immediately disappeared. On several occasions when Short-billed Marsh Wrens began singing, a neighboring Henslow's Sparrow male flew near the wren and began singing. One morning a pair of Henslow's Sparrows attacked a Short-billed Marsh Wren. Several times a male Henslow's Sparrow pursued a Grasshopper Sparrow flying across his territory. The reverse was observed on several occasions in an abandoned field near Augusta, Michigan.

Enemies.—One nest discovered near Augusta, Michigan contained two Brown-headed Cowbird (*Molothrus ater*) eggs and two Henslow's Sparrow eggs. All hatched, but on the sixth day of the nestling period the two sparrow nestlings were found dead two and three feet from the nest. Both appeared to have died shortly before discovery. The two sparrows weighed 5.3 and 6.5 grams and were much smaller than individuals of the same age weighed by Hyde (9 gm; 1939).

Because of the continuous cover of the vegetation and secretive habits of Henslow's Sparrow, I feel the most important enemies were probably mammals or snakes living wholly or partially within the concealing grasses. The only species actually observed preying upon a Henslow's Sparrow was the thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*). While observing the young leave nest 7 on 25 July I saw a ground squirrel pick up one young bird still in the nest and carry it off through the grass. The victim's three nestmates had departed only a few minutes before. Because they are diurnal ground squirrels may be important predators of ground-nesting birds.

THE NEST

The open, cup-shaped nests were constructed of the common grasses on the area. Large, broad brome grass (*Bromus inermis*) leaves comprised an outer layer of the nest; the interior was lined with small, fine bluegrass (*Poa compressa* and *P. pratensis*) stems. No green vegetation was present in the nests. The grasses comprising the nests were loosely woven together and as the nestlings grew, the nest expanded. A new nest was constructed for each nesting attempt.

Although the study area appeared to have a continuous cover, clumps of grasses were discernible upon parting the vegetation. All of the nests found were at the base of these clumps resting upon the litter. They were about one inch above ground and not fastened to the standing vegetation, but merely placed among the stems. Only one of the 10 nests discovered was similar to the roofed nests described as typical by Hyde (1939).

EGG LAYING AND NESTING SUCCESS

The most common clutch sizes of Henslow's Sparrow are four or five eggs. At Kalamazoo six nests contained five eggs, three contained four eggs or young, and one nest contained only two young birds. One nest found near Augusta, Michigan, contained two sparrow eggs and two cowbird eggs. When found, the 11 nests contained 40 eggs and six young. One or more young were fledged from six nests and 17 young fledged from all nests. Only at nest 3 did all young fledge. Oddly enough, this was the only nest at which the male did not participate in the care of the young.

The laying season appears to extend from late May to late August. Assuming the incubation period to be 11 days, as Hyde (1939) suggested, the date of completion of 3 nests was calculated as being between 25 and 27 May, or about one month after the first birds arrived. On 25 August a recently fledged bird (six fecal sacs were found next to it) was discovered and banded. Two young about three or four days old disappeared from another nest (nest 10) on 19 August.

Several males defended territories for more than two months. From these observations and the length of time eggs or young were in the nest, it would seem that some birds may raise more than two broods in one season. Two, however, may be the most common number.

INCUBATION AND BROODING BEHAVIOR

During 59 hours of observation at two nests in the second half of the incubation period only females were seen to incubate. Males were not observed near the nests at this time. Incubation attentiveness was about 70 per cent prior to hatching of the first egg. Fifty-two attentive periods had a mean length of about 44 minutes (SD = 16.7), and 55 inattentive periods had a mean length of 19 minutes (SD = 9.5). Attentiveness was also recorded during 4.2 hours between hatching of the first and last (fifth) egg. The percentage time the eggs were covered during the hatching period declined only slightly from pre-hatching levels, but there was a considerable, and statistically significant (*t* test, $p < 0.001$), decline in the length of both attentive (43.8 versus 11.7) and inattentive (18.8 versus 7.1) periods.

During almost 130 hours of observation of individually marked birds at six nests only the females brooded. Frequently, however, the males remained standing on the rim of the nest or close by for several minutes after feeding the young. Brooding attendance generally decreased as the nestlings aged, but the number of days of the nestling period on which the young were brooded varied from nest to nest. Daytime brooding was terminated by the third day at nest 6, by the fifth day at nest 3 and by the fourth or fifth day at nest 5. At nests 8 and 9 daytime brooding was observed through the second half of the nestling period, even on the day when the young fledged. Only at nests 8 and 9 were eggs present during the whole nestling period.

NEST SANITATION

No eggshells were found in or near the nests. Six young in three nests hatched in my presence and all of the six eggshells were eaten by the females. Unhatched eggs were left in two nests. Both parents disposed of fecal sacs.

TABLE 3

INITIATION AND ENDING OF REGULAR SONG FOR MALE HENSLOW'S SPARROWS
Individuals are the same as in Table 1, except that occasional outbursts of isolated songs during the night were ignored.

	10 May	26 May	18 July	15 August
Morning				
Initiation of song (minutes before sunrise)	42	39	54	28
Temperature (°C)	–9	18	19	19
Cloud cover (per cent)	0	85	10	90
Evening				
Ending of song (minutes after sunset)	26	25	13	25
Temperature (°C)	1	10	20	17
Cloud cover (per cent)	75	20	100	0

A high percentage of fecal sacs was eaten during the first days of the nestling period. Thereafter, the percentage of those carried away gradually increased. Production of fecal sacs by the young was maintained for over 2.5 hours after fledging at nest 7. Near nest 11 a recently fledged bird was discovered crouching near six fecal sacs. At nest 7 the adults carried fecal sacs away whenever they were produced, even when the young were outside of the nest.

BEHAVIOR OF PARENTS AFTER LOSS OF YOUNG

On the evening of the third day of the nestling period the female at nest 6 began overnight "brooding" at 14 minutes past sunset. Four young were present. Observations were discontinued 11 minutes later with the female still on the nest. The next morning I entered the blind at 04:30, 43 minutes before sunrise. The female stood on the rim of the nest at 04:53 and probed into the nest for about 30 seconds. All of the nestlings were gone. Then the male arrived with food and the female flew off. The male remained at the nest for three minutes apparently searching for the young which had disappeared overnight. At 04:58 the female returned with food but soon ate it and began "brooding." After four minutes of sitting she stood on the rim of the nest and began probing in the bottom of the nest. Between 05:00 and 06:00 the female alternately "brooded" and probed into the nest five times and she made two foraging trips. The male brought food to the nest only once during that hour.

At 06:18 a Short-billed Marsh Wren flew to a point about five yards

TABLE 4
ENDING AND BEGINNING OF OVERNIGHT ROOSTING ON THE NEST BY NINE FEMALES

	Days when roosting ended before sunrise	Days when roosting ended after sunrise	Days when roosting began before sunset	Days when roosting began after sunset
Number of observations	15	7	4	22
Mean per cent cloud cover	28	61	80	29
Mean temperature (Centigrade)	12	15	18	16

northwest of the nest. Immediately, the sparrows from nest 6 chased it. In the next six minutes the marsh wren flew up from the grass three times and on each occasion both sparrows chased it. One of the sparrows made physical contact with the wren on two of these occasions before the wren retreated into the vegetation.

DAILY CYCLE

The daily duration of song of the males was calculated for four days through the breeding season beginning with their first regular singing in the morning and ending with their last regular singing in the evening. Duration of song was directly related to total day length, lasting approximately one hour longer than the period from sunrise to sunset. The time of initiation of song was latest on those days with the highest percentage of cloud cover (Table 3). The time of ending of song was fairly constant in relation to sunset. The earliest ending of song occurred on 18 July when there was a continuous cloud cover.

The average time of initiation of overnight roosting on the nest by females was 12 minutes past sunset and the average departure time in the morning was 5 minutes past sunrise. Late morning and early evening roosting by females was directly related to higher temperatures and high cloud cover percentages (Table 4). The small difference in temperature and the large difference in cloud cover suggests that cloud cover was more important in regulating the beginning and ending of a female's day as appeared to be the case for singing by males.

SUMMARY

In Michigan Henslow's Sparrow breeds in areas characterized by (1) herbaceous cover (usually grasses or sedges), (2) the presence of litter, (3) an intermediate range of moisture, and possibly (4) the presence of singing perches in the spring.

Territories appeared to be established and maintained exclusively by song. Many

territories (any area defended by song) were surrounded by areas where no males sang. During the height of the breeding season 58 per cent of the suitable habitat remained unoccupied. The average size of all singing territories was 0.8 acres. Territory size and density of the vegetation were inversely related. The maximum population was 50 singing males per 100 acres during the first half of July.

Nests were built of dead grasses, and were placed in the center of clumps of vegetation. Thirty-seven per cent of the eggs and young discovered fledged. Incubation and brooding were performed entirely by the female. Incubation attentiveness was 70 per cent. Attentiveness decreased during the nestling period; brooding behavior was maintained after the fifth day only in those nests that contained unhatched eggs.

Daily duration of song by the males was directly related to, but one hour longer than, the period from sunrise to sunset. In general, incubating and brooding females first left the nest before sunrise and began overnight roosting on the nest after sunset. Cloud cover appeared to be important in influencing the beginning and ending of the active day for both males and females.

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NOTES ON VARIOUS RAILS IN MEXICO

Robert W. Dickerman

While carrying out field studies on the Song Sparrows (*Melospiza melodia*) of the Mexican Plateau from 1956 to 1958 (Dickerman, 1963), I collected other marsh birds, with special efforts spent on the elusive rails. During that period some work was done in the coastal marshes. These studies were expanded during 1961–1966 while I was living in Mexico, coordinating a research and training program in arbovirus ecology. A number of the records obtained have already been published, as cited beyond. While comparing my specimens with previously collected museum series, I encountered a few additional unrecorded or erroneously reported specimens. Specimens were collected by myself unless otherwise noted, and are deposited at the University of Minnesota and Cornell University (Ithaca).

Rallus longirostris elegans.—The Mexican Check-List, (Friedmann et al., 1950), listed three records of the nominate form of the "King" Rail for Mexico. Two of these were based on specimens from Guanajuato in the Moore Laboratory of Zoology, Occidental College; these prove to be referable to *R. l. tenuirostris.* The third record is based on a female (wing chord 154 mm) in the American Museum of Natural History, collected at Tlacotalpan, Veracruz, 19 January 1901; this specimen was correctly identified as *elegans.*

On 28 July 1969 I collected a male "King" Rail 2 miles west of Tecolutla, Veracruz. Although in heavy first prebasic molt with the still unmolted black rump feathers of the juvenal plumage, it has fully-grown wings (chord 161 mm) and partially enlarged testes measuring 14 × 6 and 12 × 4 mm. In plummage and molt it is similar to a series of young *elegans* collected at Tivoli, Texas, in August and September. In the American Museum of Natural History collection there is a male *elegans* in first prebasic molt from Brownsville, Texas collected 1 October 1912, whose outer primaries are sheathed basally. These two specimens may indicate that the *R. l. elegans* nests farther south than is currently recognized.

I believe all of the large "Ka-Ka-Ka" calling rails (the "King" Rails [*Rallus elegans*] and the "Clapper" Rails [*R. longirostris*]) of North America and their representative populations extending into the West Indies and South America should be combined into a single species, *Rallus longirostris* Boddaert. The species differences based on the morphologically distinctive and largely ecologically separated populations of the northeastern United States break down as one examines specimens from throughout the range of the entire complex. Interbreeding between "Clapper" and "King" Rails produces viable eggs, a mated pair has been observed with a brood, and intergrades have been identified (Meanley, 1969). Unfortunately there is no good joint common name; (it is doubtful that "Ka-Ka Rail" would be acceptable).

It is recommended that a hyphenated name King-Clapper Rail be used for the species. The current common names could be used in quotes to designate a freshwater (or richly colored) "King" Rail form or to designate a saltwater marsh (gray) "Clapper" Rail form, if these should prove useful concepts for a given study.

Rallus longirostris tenuirostris.—A number of specimens collected between 1961 and 1965 amplify the range of this subspecies as reviewed by Warner and Dickerman (1959). An asterisk denotes new state records; localities are quoted from specimen labels.

*Nayarit:	1 mile S of Compostela, 3 adult males, 1 adult female.
Michoacan:	1 mile W Jacona, 1 adult male.
Jalisco:	2 mile NNE Lagos de Moreno = Laguna San Juan Bautista, 1 adult male.
Mexico:	San Pedro Techuchulco (=headwaters Rio Lerma), 1 adult male, 1 adult female, 4 natal.
	Laguna Zumpango, 1 adult female, 1 immature female.
*Guerrero:	Laguna de Tuxpan, 1 adult male.
Tlaxcala:	Laguna Rosario, 1 adult male.
*Puebla:	Laguna San Felipe (= 10 Km NE Izucar de Matamoros), 2 adult males, 2 adult females.

Rallus longirostris nayaritensis.—Two subspecies of "Clapper" Rails have been described from the mainland Pacific coast of western Mexico: *R. l. rhizophorae*, which ranges from Guaymas (Kino Bay), Sonora (van Rossem, 1945) south to the northern border of Sinaloa (Ridgway and Friedmann, 1941), and *R. l. nayaritensis*, known only from an unsexed, immature bird collected at San Blas, Nayarit. The two were considered similar in the relative darkness of coloration of the upper parts, with the type of *nayaritensis* being more olivaceous, possibly due to its fresher plumage. The chief difference between the two was that the type of *nayaritensis* had the avellaneous area restricted to an ill-defined pectoral band with a pale neck, lower breast and abdomen. However it is obvious from the description that this pattern may be due to the worn condition or "make" of the type.

In the collection of the Moore Laboratory of Zoology there are two unrecorded specimens of *nayaritensis*, a female collected by Chester B.

TABLE 1

	Males		Females	
	Wing	ex. culmen	Wing	ex. culmen
R. l. rhizophorae (from Ridgway and Friedmann, 1941)	147–155.5 (151.8)	56–60.5 (59)	139.5–148 (142.6)	53–57.5 (55.2)
R. l. nayaritensis	156	60.6	141	59.3
R. l. rhizophorae	151–163 (n = 3)	58.4–63.1 (n = 3)	135–145	53.5–56.8

Lamb from Estero Mescales, 5 miles north of Teacapan, Sinaloa, and a male from Castillo, 11 kilometers E. of Mazatlan, Sinaloa, 13 March 1935 and 17 February 1934, respectively. The localities are about 130 and 210 kilometers northwest of San Blas. These two specimens are more olivaceous dorsally, and have richer underparts and darker flanks than the small series of *rhizophorae* at hand. Dr. Robert T. Orr kindly compared them with the type of *nayaritensis* in the collection of the California Academy of Science. He found them to be very similar to the type, with the Teacapan bird a little darker on the top of the head and slightly richer in coloration on the back (pers. comm.). Their measurements, the first available for adult *nayaritensis*, are presented in Table 1.

Rallus longirostris rhizophorae. Six rather worn specimens (two collected by Lamb) in the Moore Laboratory from "Isla las Tunas," Sinaloa are closest to *rhizophorae*, and extend its range about 175 km southeastwards. Measurements for five specimens are presented in Table 1. "Isla las Tunas" does not appear on the American Geographical Society 1:100,000 map. It is a small island between Isla Mero and Isla Altamura, about 44 kilometers SSW of Guanuchil, Sinaloa. Dr. L. C. Binford kindly made the critical color comparisons.

On 20 April 1962, an adult male "Clapper" Rail (along with a *R. l. tenuirostris*) was collected at Laguna San Felipe, Puebla. This is the first record of a normally coastal salt marsh subspecies from the interior of Mexico. This specimen is in color very close to *rhizophorae* from the coast of Sonora. Its measurements (exposed culmen 60.1 mm), (wing chord 155 mm) fall within those of *rhizophorae* (Table 1).

Rallus longirostris pallidus.—On January 1965 Allan R. Phillips, Kenneth C. Parkes, and I collected two females at Rio Lagartos, Yucatan, which apparently represent the second and third specimens from the type locality of this subspecies (Paynter, 1955). They weighed 237.3 and 301 g, with "moderate fat" and "much fat" respectively. The latter, apparently an adult with ova up to 4 mm in diameter, had soft parts as follows: *bill*—dull orange brightest at base to horn at tip, dark horn on culmen, *legs*—dull orange, duller than bill, *iris*—medium brown.

Rallus limicola friedmanni.—An adult Virginia Rail collected at the water works on the south side of San Cristobal de las Casas, Chiapas, 25 January 1966, is the second record for the state, (Dickerman, 1966).

Rallus maculatus insolitus.—An adult male in rather worn plumage, collected 8 May 1962 at Laguna San Felipe, Puebla represents the first record for the species in the interior of Mexico (Dickerman and Warner, 1961.) It weighed 186.7 g, was in general body molt, and was rather fat. When shot, it was sitting in the sun at the edge of dense cattails.

Additional specimens from Tecolutla, Veracruz, the northernmost locality from which the species is known (Dickerman and Warner, 1961), are two adult males collected on 13 and 15 August 1969. They had little fat and weighed 207.8 and 219 g, and their gonads measured about 9.5 × 6 and 9 × 5, and 10 × 6 and 6 × 4 mm, respectively. Both were in light general body molt. One to five Spotted Rails were seen and up to 6–7 others were heard calling on each visit to the marsh 2 miles west of Tecolutla 26 July, 13, 15, and 20 August. On 13 and 15 August I was accompanied by Fredrich Schueler. We concurred that the call note sounded like the repeated notes of the American Bittern with the increasing tempo of a Ruffed Grouse, becoming less loud towards the end of the call. The grunts or chuffings are so low in pitch that at times one has the impression he feels them prior to hearing them. The birds appeared to have calling stations—at least on those two mornings we heard two birds from virtually the same sites, and one of these was heard again on the 20th. Calling diminished rapidly after sunrise, possibly due to the advanced stage of the season and molt period, and we were unable to pin a bird down sufficiently to locate an exact calling post. All calling birds were located away from tall cattail in areas of flooded pasture or sedges, where there were occasional bushes. One specimen collected was "squeaked" back into view after running into the edge of a solid stand of cattail. For a discussion of the plumage and generic status of this species, see Dickerman and Parkes (1969).

Porzana flaviventer woodi.—The Yellow-breasted Rail was first reported in Mexico from Tecolutla, Veracruz by Dickerman and Warner (1961). Three individuals were seen flushed in a marsh 2 miles west of Tecolutla 13 August 1969 (one was collected), and five or six were flushed from the same marsh on 20 August 1969. An additional record from Veracruz is a male that was found as it fluttered to the ground, about 20:00, under a street light in the rural village of Dos Amates (north of Catcmaco), 2 May 1964. The specimen was prepared by A. Ramircz V. and had testes measuring about 2.5 mm.

With the assistance of Sostenes Romero R. four specimens were collected 19 April 1963, 13 and 14 March 1964, and 10 September 1965 at El Arenal on the northeast side of Laguna Tres Palos, about 19 miles east of Acapulco, Guerrero. These represent the first record for the species on the west coast of Mexico. The September bird was a male with testes measuring 10 × 5 mm. Late in the evening of 22 January 1966, accompanied by Juan Nava S., I saw 4 Yellow-breasted Rails at the Laguna Lagartos, Chiapas (Mexico-Guatemala border). On the morning of 24 January we returned to the lake and Nava collected an adult male with testes measuring 8 × 3.5 and two females with ovaries slightly enlarged. Two males weighed 24.1 and 26.5 g, three females 20.5, 24.0 and 25.4 g. All specimens had little to moderate fat.

Porzana carolina.—An early arrival date for the Sora on mainland Mexico is an immature collected at Tecolutla, Veracruz on 13 August 1969. Friedmann et al. (1950) and Paynter (1955) cite 12 August as the earliest date for the Yucatan Peninsula.

Laterallus jamaicensis cf. *jamaicensis.*—On 15 March 1963, I collected a female in worn plumage, and general body molt at Laguna Media Luna, 10 kilometers SW of Rio Verde, San Luis Potosi. The first Mexican specimen identified as the eastern subspecies was a male collected 2 June 1958 at Tecolutla, Veracruz, (Dickerman and Warner, 1961). Russell (1966) reported that the measurement of the width of the bill at base plus the width of bill at nostrils when divided by two and plotted against total culmen length, separated two specimens from British Honduras with short stout bills from series of *L. j. jamaicensis* and *L. j. coturniculus.* He found no color characters by which to distinguish the British Honduras birds and considered described color differences between *jamaicensis* and *coturniculus* to be only average differences at best.

I agree with Russell that color characters cannot be utilized in separating the two forms due to the paucity even of comparable old material, not to mention specimens taken in the last three decades!

Apparently due to differences in techniques, my culmen measurements were shorter than those of Russell and comparisons of that measurement could not be made with his tables. The wing measurement of the Veracruz male (68 mm) is 2 mm under the minimum for the eastern form but the wing tips are abraded. Its tarsus at 21.7 mm is near the lower limit for *jamaicensis* males. The wing and tarsal measurements of the female from San Luis Potosi, 70 and 22.4, are larger than those presented by

Russell for *coturniculus* but the wing is 0.5 mm shorter than the minimal for *jamaicensis.* On the basis of geography and these measurements I am tentatively identifying these two specimens as *jamaicensis.*

Coturnicops noveboracensis goldmani.—The Yellow Rail was previously known from Mexico only by the unique type of this subspecies collected by E. A. Goldman, 11 July 1904 (Friedmann et al., 1950). Late in the morning of 7 September 1961, on my way back across the wet meadow that borders the cattail marsh at San Pedro Techuchulco at the headwaters of the Rio Lerma, I decided to collect some of the abundant *Microtus* seen running from bunchgrass to bunchgrass. Firing at an animal that stopped just out of sight behind a clump of grass, I was amazed to pick up a flightless juvenile Yellow Rail. Since that time, four adults and an additional juvenile have been collected with the assistance of Juan Nava S. (See Hardy and Dickerman [1965] for photos and description of the habitat). An additional partial skeleton of an adult Yellow Rail, apparently the remains of a predator's meal, was found by Nava 22 July 1964.

These specimens have permitted a re-evaluation of the characters used in describing the subspecies. The type of *goldmani* was, although unrecognized as such, the earliest collected juvenile of the species! Nelson (1904), Ridgway and Friedmann (1941), and Deignan (1961) all cited the specimen as an "Adult? male"! Actually its remiges are all still sheathed. Comparing the four new adults with series of recently taken northern birds, *C. n. goldmani* is recognizable by its generally darker, more blackish crown and paler, less richly colored nape region with blacker, less brownish mid-feather stripes. The four adults have measurements at or near the upper limits given by Ridgway and Friedmann (1941) for 54 males and 44 females of *novaboracensis.* Three male *goldmani* measure: wing chord 90.5, 92, and 93 mm; tarsus 26.0, 26.8, and 28.0 mm as compared to northern males: wing chord 73–93 mm (86.7); tarsus 21–27.5 mm (23.7). The single female *goldmani* measures: wing chord 87 mm; tarsus 24 mm compared to northern females: wing chord 75–89 mm (84.2); tarsus 20–26 mm (22.7).

The three juveniles (including the type) fit Roberts' (1932) description of the juvenal plumage *contra* Ridgway and Friedmann (1941: 174). All are lightly spotted on the crown. They lack the white spotting on the cheeks and malar areas and upper flanks as in two short-billed specimens which are presumed immatures of the nominate form (MMNH 17616 and LSU 19180). However a male with a hard skull and fully developed bill (USNM 17812) also has white on the head. The mid-dorsal region of all three *goldmani* juveniles is streaked. The Mexican birds have white barring on either side of the streaked area. Unfortunately, a detailed study of the plumages of the Yellow Rail must await the collection of more known juveniles and molting birds of the nominate population. Specimens illustrating the first prebasic molt have not been found in any museum series to date.

Amaurolimnas concolor.—Friedmann et al., (1950) listed Tutla, Oaxaca as the only Mexican locality for this species. Additional Oaxaca specimens are three adult males (AMNH) collected near Sarabia 15 July 1962 and 2 and 12 August 1964, from the collection of William Shaldach. Recently, Andrle (1967) cited a specimen in my collection from Sontecomapan, Veracruz. Additional Veracruz specimens are from El Mirador (three adult males) and Rancho Caracol (one adult male, two adult females, and two immatures); both localities are about 30 miles WSW of Tezonapa. The El Mirador specimens were collected for me by Abraham Ramirez V. and the Caracol specimens in the R. T. Moore collection were taken in August 1948 by Chester Lamb. The latter are labelled "30 miles S. of Tezonapa." For unknown reasons Moore did not include the records of the Caracol specimens in the 1951 Mexican Check-List. A specimen in the U.S. National Museum, collected 24 April 1943 by W. A. Weber at La Venta, Tabasco, is the first record from that state. Its soft part colors (*iris*—orange vermilion; *bill*—grass-green; *ridge and top of upper mandible*—dusky; *feet*—vermilion) resemble those presented by Slud (1964) and differ from the duller colors described by Wetmore (1965). The specimen described by Wetmore was collected in February (pers. comm.) as opposed to April in the case of the Tabasco specimen; this difference may indicate a brightening of colors into the breeding season.

Porphyrula martinica.—On 12 August 1957, I collected an adult male Purple Gallinule with partially enlarged gonads at Laguna Zumpango, State of Mexico. A second specimen was collected at the same locality 17 June 1965, and the species was found to be relatively common on several trips to the lake in 1965 and the spring of 1966, and it possibly breeds there. Apparently this is the first report of the species in the Valley of Mexico since Salvin and Godman (1903).

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EFFECTS OF THE ARRIVAL OF A NEW SPECIES UPON HABITAT UTILIZATION BY TWO FOREST THRUSHES IN MAINE

Douglass H. Morse

When the geographic range of a species expands strikingly over a short period of time, the student of populations is presented with an unusual opportunity. Such changes in status may bring new pairs of species into contact and provide insight into the roles of organism and environment in determining how potentially available habitats will be utilized by a complement of species.

Recent changes in the range of the Wood Thrush (*Hylocichla mustelina*) made such a study feasible. Since 1890 this species has become an addition to the breeding avifauna in many parts of the northeastern United States and adjacent Canada (Weaver *in* Bent, 1949). Before 1950 it was an uncommon summer resident in Maine (Palmer, 1949), the area considered in this study, but since that time it has become common through much of the state during the breeding season, judging from personal observations and from reports on file in the Portland Society of Natural History.

Preliminary information indicated that in certain cases Wood Thrushes had set up territories in areas frequented in earlier years by Hermit Thrushes (*H. guttata*) and Veeries (*H. fuscescens*). This study represents an attempt to supplement these observations and to determine what effects, if any, this incursion has had upon other forest thrushes in Maine.

METHODS

In 1965 I selected several habitats in two rather similar geographical localities of Maine and censused the three species of thrushes. In one locality Wood Thrushes were common and potentially in close contact with the other two species, and in the other one Wood Thrushes were uncommon. Most of the habitats utilized by the three species occurred in both localities, though their prevalence differed greatly in a few cases. Regularly singing birds were counted in relatively homogeneous habitats of the types listed in Tables 1 and 2. These habitats censused were sufficiently large (several hectares in size) that birds consistently singing there might be assigned to them with a high degree of probability. No attempt was made to census large areas exhaustively; rather the technique utilized was to record individuals encountered singing. In this way it was possible to obtain a representative ratio of the species of thrushes from each habitat, as far as the availability of the habitat and time made this possible. Censuses were conducted during early and mid-June, when all three species were singing regularly.

The first area, in Lisbon and Webster, Androscoggin Co., Maine, was selected within the range where Wood Thrushes now are common summer residents. I have recorded them in this region regularly since 1952, and they have been common summer residents there since 1955.

The second area is a narrow strip of land not extending over two km from the ocean, running from the villages of Broad Cove (Bremen Twp.) to Round Pond (Bristol Twp.), Lincoln County, a distance of about 10 km. This study area lies approximately 70 km east of the first one. In 1965 Wood Thrushes were uncommon nesters in coastal Lincoln County, though they appeared to be increasing in numbers. Not until 1962 did I encounter apparent breeding birds in this area. Though Wood Thrushes in 1965 were not common in the area censused, they were conspicuously more common five km inland from the sea. A brief survey suggested that their numbers there approximated those in the Lisbon-Webster study area. Since it appeared that this species was continuing to increase in the coastal strip, an additional census was made there in 1967. At this time the areas studied in 1965 were resurveyed as closely as possible. However, due to extensive logging several of them had changed markedly, and consequently other similar areas were substituted where possible.

Hermit Thrushes and Veeries nest commonly in both localities censused. The only other species of this genus breeding in either of the areas is the Swainson's Thrush (*H. ustulata*), which frequents thick spruce forests immediately along the shore and on the islands in the Bremen-Bristol area. Though found in mixed coniferous-deciduous areas in some parts of its range (Knight, 1908; Palmer, 1949; Dilger, 1956*a*), Swainson's Thrushes nesting in this coastal strip showed little suggestion of such a selection. They were at no time found in contact with Wood Thrushes during the breeding season and hence are not considered further.

RESULTS

Overlap between species.—In the Lisbon-Webster area the Wood Thrush occupies regularly as wide a variety of potentially available habitats as does the Hermit Thrush and a wider set than the Veery (Table 1). On the average Wood Thrushes occupy both coniferous and deciduous areas that are moister than those used by Hermit Thrushes and drier than those used by Veeries. Hermit Thrushes in the study areas were most typically found in dry to mesic coniferous and deciduous forests, particularly in dry pine-oak situations. Veeries were most characteristic of damp deciduous forests. These areas are comparable to those in which the species were found by Dilger (1956*a*).

Considerable overlap of certain pairs of species was noted in the Lisbon-Webster region (Table 1), which in each case involved the Wood Thrush and another species. Hermit Thrushes and Veeries did not occupy any habitat in nearly equal numbers. Only in the mixed coniferous-deciduous forests with red maple and/or alder and mixed deciduous forests with red maple and/or alder were both Hermit Thrushes and Veeries regularly found. Even these data should not be interpreted to indicate that they utilized the two habitats similarly, since these habitats encompass a wider variety of conditions than most of the others in Tables 1 and 2. Within

TABLE 1

NESTING HABITATS OF THRUSHES IN LISBON-WEBSTER IN 1965

Habitat	Hermit Thrush	Wood Thrush	Veery
Red oak (*Quercus rubra*)	11	0	0
Red oak-white pine (*Pinus strobus*)	7	0	0
Cutover coniferous forest	6	0	0
Mixed coniferous forest	3	2	0
Old white pine (9 m or over)	9	1	0
Young white pine (under 9 m)	9	4	0
Mixed coniferous-deciduous forest with no red maple (*Acer rubrum*) or alder (*Alnus rugosa*)	8	4	0
Mixed coniferous-deciduous forest with red maple and/or alder	10	6	3
Young white pine-alder	1	7	1
Mixed deciduous forest with no red maple or alder	8	3	0
Mixed deciduous forest with red maple and/or alder	10	3	3
Red maple	0	13	8
Alder-red maple	0	5	4
Alder	0	0	15
TOTAL	82	48	34

the two habitats under consideration a tendency usually appeared for the three species to sort out, with Hermit Thrushes in the driest situations, Wood Thrushes in the most mesic, and Veeries in the wettest. No overlap was noted in the driest habitats between Hermit Thrushes and Wood Thrushes (red oak and dry oak-pine) or in the wettest habitat between Veeries and Wood Thrushes (alders). Thus, the Hermit Thrush and Veery enjoyed exclusive use of certain areas. Wood Thrushes were not found in any habitats to the exclusion of the two other species, though they did occupy young white pine-alder areas nearly to the exclusion of the other species.

Data upon Hermit Thrushes and Veeries from the Bremen-Bristol area in 1965 and 1967 reveal relatively few differences in the areas utilized by Hermit Thrushes and Veeries (Table 2). What overlap occurred between the two species was again in the mixed coniferous-deciduous forest with red maple and/or alder and in the mixed deciduous forest with red maple and/or alder. Again the species appeared largely to utilize different parts of the two last-mentioned habitats. The increase in numbers of the Wood Thrush in the Bremen-Bristol area is perhaps significant, however. Num-

TABLE 2

NESTING HABITATS OF THRUSHES IN BREMEN-BRISTOL IN 1965, 1967*

Habitat	Hermit Thrush	Wood Thrush	Veery
Red oak	9,9	0,0	2,0
Red oak-white pine	26,8	0,0	1,0
Red spruce (*Picea rubens*)	6,11	0,0	0,0
Cutover coniferous forest	6,8	0,1	0,0
Old white pine (9 m and over)	8,9	2,2	0,0
Young white pine (under 9 m)	3,2	0,2	0,0
Mixed coniferous-deciduous forest with no red maple or alder	3,9	0,0	1,1
Mixed coniferous-deciduous forest with red maple and/or alder	19,19	1,3	5,10
Mixed deciduous forest with no red maple or alder	14,5	0,0	0,1
Mixed deciduous forest with red maple and/or alder	4,5	0,1	8,7
Red maple	0,0	1,0	26,15
Alder-red maple	0,0	1,2	6,3
Alder	0,0	0,1	9,9
TOTAL	98,85	5,12	58,46

* Figures preceding commas refer to data from 1965; those following commas refer to 1967.

bers of Wood Thrushes were still too low in 1967 to reveal in great detail particular affinities of this species to any specific habitats, but those in which this species was noted correspond with those from the Lisbon-Webster census, suggesting that this species is colonizing areas that on the average are more mesic than those utilized either by Hermit Thrushes or Veeries.

The method used in gathering data does not permit a direct comparison with Dilger's (1956*a*) measurements of overlap in habitats of the species concerned. However, indices of overlap (R_o) from information theory were calculated (Table 3) for the data from Lisbon-Webster and Bremen-Bristol in 1967 (Tables 1 and 2), using the equation of Horn (1966):

$$R_o = \frac{\Sigma\,(x_i + y_i)\log(x_i + y_i) - \Sigma\,x_i \log x_i - \Sigma\,y_i \log y_i}{(X + Y)\log(X + Y) - X \log X - Y \log Y}$$

Here X and Y equal the total number of observations in the samples of habitats X and Y, respectively; x_i and y_i equal the proportion of observations made in the i^{th} habitat category in samples X and Y, respectively. These figures indicate, as Tables 1 and 2 themselves suggest, that overlap between Wood Thrushes and Hermit Thrushes and between Wood Thrushes

TABLE 3

INDICES OF OVERLAP IN NESTING HABITATS BETWEEN PAIRS OF SPECIES*

	Lisbon-Webster, 1965		Bremen-Bristol, 1967	
	Wood Thrush	Hermit Thrush	Wood Thrush	Hermit Thrush
Hermit Thrush	0.52		0.62	
Veery	0.60	0.22	0.56	0.36

* N's as in Tables 1 and 2.

and Veeries is considerably greater than between Hermit Thrushes and Veeries. Due to the small number of data on the Wood Thrush from Bremen-Bristol in 1965, a set of indices was not calculated. Because of the greatly varying sample sizes in certain habitats in the two geographic areas, it is difficult to compare directly the indices from the two localities. However, the index of overlap between Hermit Thrushes and Veeries is substantially larger in the Bremen-Bristol area, where Wood Thrushes are not common, than in the Lisbon-Webster area.

Interspecific interactions.—Since the habitats utilized by Wood Thrushes overlap broadly those of Hermit Thrushes and Veeries, considerable efforts were made to learn the basis by which the ownership of territories was determined. It soon became apparent that relatively little direct hostile interaction occurred between the Wood Thrush and the other two species. During the period when censuses were made for Tables 1 and 2 individuals were restricted to territories that upon the basis of their songs and movements appeared largely exclusive of the other species.

On 27 May 1967 the first apparent hostile interaction between a Wood Thrush and a congener was observed, with a male Wood Thrush chasing briefly a male Hermit Thrush that was singing about 25 m from it in a mixed coniferous-deciduous forest. The early date plus the absence of encounters later in the season suggested that they occurred largely at the time that Wood Thrushes arrived and set up territories, and that such early encounters might act as a major factor in demarcating territories through the season. Such a situation was noted in formation of largely exclusive territories by Yellow and Chestnut-sided Warblers (*Dendroica petechia* and *D. pensylvanica*) (Morse, 1966). As a result in 1967, 1968, and 1969 attempts were made to observe interactions in the Bremen-Bristol area in late May and early June, the time of arrival of the Wood Thrush in this region.

On 1 June 1968 two interactions between Wood Thrushes and Veeries were noted. The first took place in a wet deciduous forest along the edge of a stream. Two Catbirds (*Dumetella carolinensis*) were engaged in a protracted hostile encounter, and during the process a number of other birds were attracted to the area, including a male Wood Thrush and a male Veery. Shortly the Wood Thrush flew in the immediate direction of the Veery, which then retreated. The Wood Thrush sang for five minutes in this location, approximately 5 m up in a small red maple tree. After being supplanted the Veery moved approximately 75 m to the west and sang for this period of time about 15 m up in a large red maple. Then the Wood Thrush flew into the tree where the Veery was situated, and the Veery immediately ceased singing, but called several times and then flew about 100 m to the northwest, where it continued singing.

On the same day a male Wood Thrush was singing regularly in a moist mixed coniferous-deciduous forest, about 10 m up in a white pine. From here it flew about 75 m and attacked a Veery that was foraging nearby at ground level in a small open area. The Wood Thrush then sang in a small deciduous sapling immediately above where the Veery had been.

On 3 June a Veery was singing on the edge of a white pine forest and a moist deciduous area with low woody vegetation, consisting mostly of alders and willows (*Salix* sp.). A Wood Thrush, which had been singing in various perches in the pine forest at some distance (over 100 m) flew either into the pine where the Veery was singing or into the adjacent tree, and sang for two minutes. At the time that the Wood Thrush landed, the Veery flew out into the deciduous area and continued singing from there. After singing the Wood Thrush moved back into the midst of the pine forest and away from the Veery. Within 30 seconds the Veery returned to its previous position on the edge of the two habitats and commenced to sing.

On 28 May 1969 a Wood Thrush was noted singing in the driest part of a large alder thicket. A Veery then began calling about 30 m away in the wettest part of this thicket. Within 30 sec the Wood Thrush flew directly at the Veery, which immediately retreated from the area and became silent. The Wood Thrush sang in this location for two to three minutes before returning to its previous singing area. After approximately 30 minutes this Veery had moved south along a small stream about 50 m into an area adjacent to where another Wood Thrush was singing. This bird attacked the Veery and chased it repeatedly through the alders for over 45 sec, including several long flights. At one point the two birds nearly hit me as the Veery flew through this dense growth about one m above the ground, closely followed by the Wood Thrush.

Later visits to all of the areas where these encounters were noted indicated that overlap in territorial areas between species was extremely limited or nonexistent. These observations agree with the impressions of interspecific territoriality gained while making the observations reported in Tables 1 and 2. In spite of the extensive observations made on thrushes after early June upon no occasion were interspecific hostile encounters noted. Though these species are difficult to observe, the moderate number of observations made in the period of a week in late May and early June suggest that any such encounters after that time are considerably less frequent. At no time did I observe similar interactions between Hermit Thrushes and Veeries, though it was not possible to observe these species at the time of their arrival on the breeding grounds.

Territories held by different species in different years.—As indicated earlier this study was initiated because of the discovery that in two cases Wood Thrushes utilized essentially the same territories that were used the previous year by a Hermit Thrush and Veery, respectively. In 1956 in Webster a Wood Thrush used an elm (*Ulmus americana*) swamp and surrounding red maple cover that in 1955 had been the territory of a Veery.

Veeries did not nest there in 1956. Both the elms and maples in this territory averaged 15–20 m in height, and parts of the swamp remained damp through most of the summer. Since that year Wood Thrushes have utilized this plot regularly. In 1956 a pair of Wood Thrushes used a clump of white pines about 5 m in height on the edge of an old field undergoing succession, an area used by Hermit Thrushes in the previous year.

Accumulation of such data depends upon careful year-to-year censusing and mapping of territories, which had been performed for other purposes in the observations reported directly above. In 1967, two pairs of Wood Thrushes in Bremen occupied areas in young white pines that each overlapped approximately one-half of a Hermit Thrush territory of 1965. In no case was nearly direct correspondence of territories noted, as in the two cases in Webster. However, the apparent strong tendencies toward interspecific territoriality might result in such situations.

DISCUSSION

The apparent low frequency of hostile interactions among the different species during most of the season suggests that if separation of them is not entirely by habitat selection, it is performed quite rapidly by interactions at the beginning of the season. Separation of Hermit Thrushes and Veeries may be realized largely by habitat selection at this time, but separation of Wood Thrushes from Hermit Thrushes and Veeries apparently is not effected principally by this method. The Wood Thrush is significantly larger than the other two species (Dilger, 1956*a*) and appears to be socially dominant over the two smaller species. Colquhoun (1942) found a direct correlation between size of species and dominance in a closely-related group of European titmice in Europe. If a similar situation obtains here, judging from the absence of data from later in the season initial encounters may suffice to establish territorial boundaries, even though Hermit Thrushes and Veeries have established territories by the time that Wood Thrushes appear. The somewhat greater level of overlap between Hermit Thrushes and Veeries where Wood Thrushes are uncommon (Bremen-Bristol) suggests the possibility that limited interactions may occur between these two species; however, none were noted. The lower overlap between Hermit Thrushes and Veeries where Wood Thrushes were common in Lisbon-Webster probably was caused by the Wood Thrushes occupying habitats that were marginally mesic to the former two species.

Though Dilger (1956*b*) performed experiments on species recognition in five species of *Hylocichla,* he included no information upon interspecific encounters under natural conditions. The experiments are of interest to this paper, however, since any one of the five species would attack a model of any of the five species placed in its territory if this model were silent. When vocalizations from a speaker accompanied the model, there was no response to it or it was reduced markedly in all but conspecifics. Clearly the major discriminatory cue presented in the experiments was the vocalizations. Among the three species with which we are presently concerned, occasional Wood Thrushes in Dilger's experiments showed a low intensity response to Hermit Thrush songs, but none showed a response to "hostile" (Dilger, 1956*b*) calls of Hermit Thrushes. No response was shown by Wood Thrushes to either songs or "hostile" calls of Veeries.

These experiments suggest that these species are not inevitably oblivious to each other. Judging from these data a silent bird may stand a strong chance of being attacked if it enters the territory of another individual of the same or another species. The models were not tested for motion or bodily carriage, and it is possible that differences of this sort could modify the effect. Since males are not constantly singing, and females do not apparently sing, there appears to be a chance that intruders would inadvertently be treated as conspecifics, even though the probability of such a response doubtlessly would be lower than for conspecifics. In four of the five interactions noted between Wood Thrushes and Veeries, the Veery initially was not singing or uttering a "hostile" vocalization.

If overt encounters are limited, one might anticipate that vocal responses would be of importance in maintaining such relationships, at least after initial encounters. This matter was not investigated, but the presence of some interspecific responses to playbacks in Dilger's work suggests the possibility of such vocal communication. Several species of closely related wood warblers respond markedly to vocalizations of congeners (Morse, 1966, 1967).

The range extension of the Wood Thrush is a phenomenon that could potentially lower the population size of the other two species within the area concerned. However, since certain habitats do not appear to be exploited regularly by the Wood Thrush, both the Hermit Thrush and the Veery retain virtual or absolute environmental refugia, and one would predict their continuing presence in an area in which both wet lowland forest and dry upland forest exist as recognizable entities.

SUMMARY

Studies were carried out in Maine to investigate the nature of interactions existing among species of breeding thrushes following the recent addition of Wood Thrushes to the breeding fauna. Wood Thrushes (*Hylocichla mustelina*) regularly encounter two other species of forest thrushes, Hermit Thrushes (*H. guttata*) and Veeries (*H. fuscescens*). Territories of Hermit Thrushes are in mesic to dry habitats, those of

Veeries are distinctly moist ones, and those of Wood Thrushes are in areas intermediate to these two. Only limited overlap occurs between Hermit Thrushes and Veeries, and they may presently sort out largely by habitat selection. Considerable overlap in habitats utilized occurs between Wood Thrushes and both Hermit Thrushes and Veeries. Wood Thrushes maintain interspecific territories, and the boundaries appear to be demarcated by encounters with Hermit Thrushes and Veeries as soon as the socially dominant Wood Thrushes arrive on their breeding grounds in the spring. Overt encounters between Wood Thrushes and the other two species after a week are either markedly reduced in frequency or nonexistent. The presence of Wood Thrushes potentially lowers the population sizes of Hermit Thrushes and Veeries, but the latter two species nest in certain habitats that are seldom if ever exploited by the Wood Thrush. Thus, in localities containing wet, mesic, and dry forests one would predict coexistence of the three species.

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THE OCCURRENCE OF BILL-SWEEPING IN THE TERRESTRIAL FORAGING OF BIRDS

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Broad taxonomic surveys of particular behavioral traits provide an important background for systematic decisions as well as interpretations on the evolution of behavior. I here review one kind of behavior, discuss aspects of its evolution, and assess its potential as a taxonomic character. In seeking food hidden on the ground some avian species often use characteristic lateral sweeps of the bill to move aside twigs, leaves, dry soil, or snow. In view of its descriptive appropriateness the term "bill-sweeping" has been chosen to designate this foraging behavior. Kilham (1968) used the same term for similar movements used by nuthatches (*Sitta*) on a trunk or branch apparently to create spurious olfactory trails which may serve to mislead squirrels seeking nuthatch nests.

My observations have been made over several years in the field, at a feeding station, and in aviaries. Although the ornithological literature is too voluminous to search exhaustively for records of bill-sweeping, an extensive literature search has been made with examination of studies on hundreds of species. I have listed a citation for each genus for which I have found a record of sweeping but have not attempted to cite every published comment on the subject. Much remains to be learned about bill-sweeping, and I hope that this first review of the subject will also indicate areas needing further investigation. The present report is an extension of an earlier study on bill-wiping which involves similar movements (Clark, 1970*b*).

Bill-sweeping ordinarily results in the movement of a conspicuous quantity of material on a substrate and is thus unlike typical bill-wiping. The sideward motions of the bill used by some aquatic foragers (e.g., *Platalea*) also resembles sweeping but are not reviewed here. In addition, the common cases in which items are lifted between the mandibles and then dropped without a consistent and detectable lateral movement of the bill are also excluded from detailed consideration. At a feeding station I have seen such raising and dropping of items without sweeping by *Cyanocitta cristata, Parus atricapillus, P. bicolor, Sitta carolinensis, Quiscalus quiscula, Molothrus ater, Spinus pinus, S. tristis, Junco hyemalis, Spizella arborea,* and *Passerella iliaca.*

RECORDS OF BILL-SWEEPING

Species reported to bill-sweep are listed in Table 1. Variable features in sweeping include 1) the substrate, 2) the conspicuousness of the sweeps, and 3) the way in which the mandibles are used.

TABLE 1

RECORDS OF BILL-SWEEPING IN FORAGING

Taxa	Source of Data
Tinamidae	
Crypturellus boucardi	Lancaster, 1964*a*
Nothoprocta cinerascens	Lancaster, 1964*b*
Pteroclidae	
Pterocles orientalis	This study
Columbidae	
Columba livia	Johnston, 1960
Zenaidura macroura	″ ″
Geopelia cuneata	″ ″ ; this study
Scardafella inca	″ ″
Columbigallina passerina	″ ″
Momotidae	
Momotus momota	Skutch, 1964
Upupidae	
Upupa epops	Skead, 1950
Furnariidae	
Automolus ochrolaemus	Skutch, 1969
Sclerurus albigularis	Slud, 1964
S. guatemalensis	Skutch, 1969
Formicariidae	
Myrmeciza exsul	Skutch, 1969
Formicarius analis	Skutch, 1945
Gymnopithys bicolor	″ ″ ; Willis, 1967
Grallaria perspicillata	Skutch, 1969
Corvidae	
Cyanocitta cristata	This study
C. stelleri	Brown, 1963, 1964
Aphelocoma coerulescens	″ ″
A. ultramarina	″ ″
Pica pica	Linsdale, 1937
Sittidae	
Sitta carolinensis	This study
Timaliidae	
Eupetes leucostictus	Rand and Gilliard, 1968
Garrulax rufogularis	Harrison, 1962
Troglodytidae	
Campylorhynchus griseus	Selander, 1964
Mimidae	
Dumetella carolinensis	Allen cited by Gross in Bent, 1948
Melanotis hypoleucus	Skutch, 1950
Toxostoma rufum	Engels, 1940; Klopfer and Hailman, 1967: 184; this study
T. curvirostre	Engels, 1940

Table 1 Continued

Taxa	Source of Data
T. redivivum	″ ″
Cinclocerthia ruficauda	Zusi, 1969
Turdidae	
Catharus sp.	Dilger, 1956
Hylocichla mustelina	Dilger, 1956; this study
Turdus merula	Snow, 1958; this study
T. albicollis (= *T. assimilis*)	Skutch, 1960
T. migratorius	This study
Parulidac	
Seiurus noveboracensis	Schwartz, 1964
S. motacilla	Slud, 1964
Ploceidae	
Passer domesticus	This study
Lagonosticta rubricata	Goodwin, 1964
Uraeginthus sp.	Goodwin, 1965
Icteridae	
Quiscalus quiscula	This study
Thraupidae	
Rhodinocichla rosea	Skutch, 1962
Fringillidae	
Atlapetes brunneinucha	Slud, 1964; Skutch, 1967
A. torquatus	Skutch, 1954

Birds may sweep in vegetational litter, dry soil, or snow. The kinds of substrates on which sweeping occurs obviously depend on the habitats utilized by particular species. Pigeons commonly sweep in dry soil (cf. Johnston, 1960), and perhaps sandgrouse do also, for at a zoo I observed both a pigeon *Geopelia cuneata* and a sandgrouse *Pterocles orientalis* engaged in a similar type of bill-sweeping at their shared food bowl. Apparently neither pigeons nor sandgrouse have been reported to sweep in leaf litter. Among other species listed in Table 1, jays (*Cyanocitta*, *Aphelocoma*; Brown, 1963), timaliids (*Garrulax;* Harrison, 1962), thrashers (*Toxostoma;* Engels, 1940), and estrildines (e.g., *Lagonosticta;* Goodwin, 1964) sweep in soil.

The majority of the species of Table 1 reportedly sweep in vegetational litter, and I have seen this activity engaged in by *Cyanocitta cristata*, *Toxostoma rufum*, *Hylocichla mustelina*, *Turdus merula*, *T. migratorius*, and *Quiscalus quiscula*. Certain species of jays (Brown, 1963), timaliids (Harrison, 1962). and thrashers (Bent, 1948: Engels, 1940) are sufficiently versatile to sweep in vegetational litter as well as dry soil. *Cyanocitta cristata* and *Passer domesticus* were seen during this study to sweep in snow.

Most species that I have observed sweeping do so conspicuously. However, the ploceid *Passer domesticus* makes relatively inconspicuous lateral movements which were most readily detected when birds sought food beneath a thin layer of powdery snow. Their movements produced momentary small clouds of flying snow near their heads, whereas the foraging of nearby emberizines, *Junco hyemalis* and *Spizella arborea,* had no such effect.

Whether swept items are lifted between the mandibles or are simply pushed aside is often difficult to determine in the field. Although more data are desirable, it appears that use of only one or both of these methods may be a species-specific trait. Gross (after Allen in Bent, 1948: 333) reports that both methods are used by the Catbird (*Dumetella carolinensis*) as does Bent (1948: 364) for the Brown Thrasher (*Toxostoma rufum*). In London, England, I observed European Blackbirds (*Turdus merula*) using both methods (see also Snow, 1958: 28). Bicolored Antbirds (*Gymnopithys bicolor;* Willis, 1967), Tremblers (*Cinclocerthia ruficauda;* Zusi, 1969), and Northern Waterthrushes (*Seiurus noveboracensis*; Schwartz, 1964) lift pieces between the mandibles during sweeping, but apparently do not simply push items aside. In addition, I have seen a White-breasted Nuthatch (*Sitta carolinensis*) grasp leaves between the mandibles and lift them aside to uncover sunflower seeds at a feeding platform, but I have not observed sweeping by "pushing aside" in this species. By contrast, Skutch (1969: 276) reports that the furnariid *Sclerurus guatemalensis* flicks aside leaves with a closed bill; this genus has not been reported to lift items between the mandibles during sweeping.

European Blackbirds (Snow, 1958: 28) and Wood Thrushes (*Hylocichla mustelina;* Dilger, 1956; Klopfer and Hailman, 1967: 184) may scratch with a foot as well as bill-sweep in clearing the substrate. These are the only records known to me of species using both of these techniques in foraging.

In a few additional cases, bill-sweeping is not directly involved in foraging. Brown (1963) reports the use of digging (sweeping) motions in the burying of hoarded food by the Mexican Jay (*Aphelocoma ultramarina*) and also (Brown, 1964) comments on "digging" as a displacement activity of both this species and the Steller's Jay (*Cyanocitta stelleri*).

American Goldfinches (*Spinus tristis*) often make sideward sweeps with the bill in a pile of seeds (Coutlee, 1963; this study). The function of this activity is unknown, but conceivably these movements might serve to uncover food in dry soil, although such behavior has apparently never been recorded.

Many species apparently do not sweep. I have been able to make extended observations on the following species and have never observed bill-sweeping: *Charadrius melodus, Pluvialis dominica, Sterna hirundo, Parus atricapillus, Agelaius phoeniceus, Molothrus ater, Richmondena cardinalis, Hesperiphona vespertina, Pipilo erythrophthalmus, Junco hyemalis, Spizella arborea, S. passerina, S. pusilla, Zonotrichia albicollis,* and *Melospiza melodia.* In addition, Dunham (1966) implies that the Rose-breasted Grosbeak (*Pheucticus ludovicianus*) does not sweep.

DISCUSSION

In many of the species known to sweep, this behavior occurs only under restricted conditions. For example, in the Robin (*Turdus migratorius*), I have observed that sweeping is unlikely to occur if food can be found without sweeping. Skutch (1969: 237) reports that the antbird *Myrmeciza exsul* flicks leaves aside apparently only when in pursuit of fleeing prey. Sweeping may thus be highly restricted and, although characteristic of a species, may not be a preeminent kind of behavior.

Sweeping can be relatively readily seen only for birds that forage regularly on the ground. Thus it is difficult to estimate the potentiality for sweeping in the numerous species that are primarily arboreal. Although sweeping is commonly an adaptation for terrestrial feeding, it is not necessarily confined to extensively terrestrial species as exemplified by its occurrence in the White-breasted Nuthatch, a specialized arboreal species. Sweeping in the foraging of nuthatches might possibly be correlated with the regular use of similar movements in apparent nest defense (Kilham, 1968).

Among species known to sweep there is an impressive diversity in size and shape of bills. Apparently no morphological adaptations for sweeping have thus far been described. Specializations in bill structure have ordinarily been discussed in relation to commonly used feeding methods, and little attention has been given to possible morphological correlates of less frequent kinds of feeding behavior.

If the apparently widely scattered taxonomic distribution of sweeping reflects the general situation, considerable evolutionary convergence has occurred through either independent origins or losses of the trait. An extreme interpretation would be that bill-sweeping occurred in the common ancestors of extant birds and has subsequently been lost in many lineages. At the opposite extreme would be an hypothesis that the present distribution can be explained entirely by independent origins. Direct evidence on the evolutionary history of sweeping is not available, but presumably such a simple behavioral trait as sweeping might be evolutionarily gained or lost more readily than a more complex kind of behavior. The most conservative hypothesis appears to be that the present taxonomic distribution is a result of both repeated origins and independent losses.

Sweeping for food has presumably evolved from other kinds of behavior. For example, a feeding bird might with its bill accidentally push aside some of the ground cover and thereby obtain additional food; given a genetic basis for this tendency, selection might favor the gradual evolution of sweeping as a regular method of foraging. Alternatively, the accidental uncovering of food through bill-wiping on the ground might be a first stage in an evolutionary series leading to sweeping. As bill-wiping occurs widely among birds (Clark, 1970*b*), its potential as an evolutionary source for sweeping is great. Indeed, the bill-wiping characteristic for so many species may be a kind of preadaptation for sweeping. In another possibility, the lifting and dropping of unpalatable items without sweeping movements, as apparently occurs in many birds, might develop a lateral component and evolutionarily give rise to sweeping. The first two suggested possibilities might potentially account for sweeping without lifting, and the third would be a conceivable origin for sweeping that involves holding objects between the mandibles. Other possibilities can be envisioned, and in no case is the evolutionary origin of bill-sweeping clearly indicated.

Bill-sweeping may have limited value as a taxonomic character in view of its probable history of repeated evolutionary origins and losses. Although bill-sweeping is presumably generally homologous within a genus (e. g., *Turdus*) or between closely related genera (c. g., *Turdus* and *Hylocichla*), the sweeping of birds in different orders is probably not homologous. The question of possible homologies between remotely related genera or between families remains open.

Despite the care that must be exercised in applying bill-sweeping as a taxonomic character, there are three specific cases in which sweeping is possibly relevant to taxonomic decisions. (1) The question as to whether sandgrouse are more closely related to pigeons or plovers has recently been extensively debated (cf. Maclean, 1967; Stegmann, 1969; George, 1969). My finding of sweeping in sandgrouse and pigeons, in contrast to the lack of this behavior in plovers, is at least suggestive. (2) The sweeping of *Rhodinocichla rosea* is one of a number of features suggesting its possible affinities with the Mimidae (Skutch, 1962), but other, apparently evolutionarily more conservative, characters indicate a relationship with the Thraupidae (Eisenmann, 1962). (3) The bill-sweeping of the brush-finches (*Atlapetes*) is of interest in view of the problem of the relationship of this genus to the towhees (*Pipilo;* Parkes, 1957). *Pipilo erythrophthalmus*, in apparent contrast to *Atlapetes*, scratches with both feet in foraging and does not bill-sweep (Clark, 1970*a*; this study). This foraging difference, if characteristic of each genus, would lend support to the idea that similarities in appearance of adults in certain species of *Pipilo* and *Atlapetes* are a result of evolutionary convergence.

SUMMARY

Records of the use of sideward bill movements in terrestrial feeding are summarized and analyzed for more than 45 species of birds. Variable features in sweeping include the nature of the substrate, conspicuousness of the movements, and the method of use of the mandibles; at least some of these aspects appear to be species-specific. The scattered taxonomic distribution of bill-sweeping indicates that considerable evolutionary convergence has occurred, but bill-sweeping may in some cases be used along with other evidence as indicative of phylogenetic relationships.

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LIFE HISTORY OF THE BROAD-BILLED MOTMOT, WITH NOTES ON THE RUFOUS MOTMOT

Alexander F. Skutch

In earlier papers (1945, 1947, 1964) I gave accounts of the habits of three species of motmots that inhabit more or less open country, or cool woodland on high mountains. The present paper deals with two species of the wet lowland forest. The nests of these two motmots that we chiefly studied were in sight of each other on the "La Selva" nature preserve, which lies along the left bank of the Río Puerto Viejo just above its confluence with the Río Sarapiquí, a tributary of the Río San Juan in the Caribbean lowlands of northern Costa Rica. They were watched during two visits to this locality, from April to June in 1967 and from March to early June in the following year. The heavy forest of this very rainy region, with its tall, epiphyte-burdened trees, its undergrowth dominated by low palms, and its exceptionally rich avifauna, has been well described by Slud (1960).

BROAD-BILLED MOTMOT (*Electron platyrhynchum*)

One of the smaller members of its family, the Broad-billed Motmot is about 12 inches long. The foreparts of its short body, including the head, neck, and chest, are mainly cinnamon-rufous, with a large black patch on either side, covering the cheeks and auricular region, another black patch in the center of the foreneck, and greenish blue on the chin and upper throat. The posterior parts of the body, including the back and rump, breast and abdomen, are green, more olivaceous above, more bluish below. The wings are green, tinged with blue on the primaries. The two central feathers of the strongly graduated tail, much longer than the others, are racquet-shaped; each has a roundish terminal disc connected with the basal portion by a stalk-like length of naked shaft. The ends of the discs are dull black; the remainder of the tail is bluish green basally and greenish blue toward the end. The bill, black with a light tip, is broad and flat, with finely serrated cutting edges. The upper mandible has a low ridge or keel along the center. The eyes and feet are dark. The sexes are alike.

The color pattern of the Broad-billed Motmot is almost identical with that of the much larger Rufous Motmot (*Baryphthengus ruficapillus*), the chief differences being the absence of blue on the chin of the latter (which is cinnamon-rufous like the chest) and the smaller patch of black on the bigger bird's foreneck. The bill of the Rufous Motmot is much narrower than that of the Broad-billed Motmot, and it lacks a pronounced keel. Although these differences are quite evident at close range, at a distance, in the absence of a standard of size, one sometimes hesitates to decide to which species the motmot belongs—until, perhaps, the great difference in voice reveals its identity. Over much of their range, these two species, representatives of quite distinct genera, live in the same forests, and their astonishing similarity in coloration raises an interesting evolutionary problem.

The Broad-billed Motmot ranges through humid forests from eastern Honduras to the upper Amazon Valley in Ecuador, Perú, and Brazil. In Central America it occurs chiefly on the Caribbean side, but it crosses to the Pacific side in northwestern Costa Rica. An inhabitant of warm lowlands, in Central America it is rarely found above 3,000 feet. Except when attending its nests, it generally perches alone well above the ground in forest trees. Often it swings its tail, pendulum-like, from side to side, in a typical motmot gesture.

FOOD

This small motmot subsists largely on insects and their larvae, with an admixture of spiders, centipedes, small frogs, and lizards. Among insects, cicadas supply a substantial part of the motmot's food in the season of their abundance. Large butterflies and dragonflies are occasionally captured. I have never seen this motmot eat fruit, and in many hours of watching at three nests, none was given to the nestlings. The Turquoise-browed (*Eumomota superciliosa*) and the Blue-throated Green (*Aspatha gularis*) Motmots likewise eat little or no fruit, but the larger Rufous and Blue-diademed Motmots (*Momotus momota*) include much fruit in their varied diet. The latter may be attracted to feeding shelves by bananas.

Like other motmots, Broad-bills forage in a manner that avoids wasted movement. They perch quietly, scrutinizing their surroundings, until they spy some suitable item, which they then snatch from a leaf, a twig, a trunk, or the air by means of a sudden swift dart. Without alighting at the moment of seizure. they carry the object to some convenient perch, against which, if it be large, they beat it noisily while holding it firmly in their broad, serrated bills. Sometimes, from a low lookout, they fly downward to capture some small creature in the ground cover. Occasionally they join the crowd of birds that gather to catch fugitives from the army ants, a habit which they share with Blue-diademed and Rufous Motmots.

VOICE

For a small family, the motmots produce a surprising variety of sounds. At one extreme we have the clear, musical piping of the Blue-throated Green Motmot, at the other, the deep, lusterless, bass notes of the present species. The call of the Broad-billed Motmot is a loud, harsh croak, quite lacking in timbre, a wooden *cwaa cwaa* that carries far. In April and May, at La Selva, this was sometimes the very first call of a diurnal bird that we heard at daybreak, shattering the stillness of the dusky forest as early as a quarter to five. Soon the hoarse croaks sounded on all sides, proving that this motmot was more abundant than occasional meetings with it would suggest. Presently the softer, hollow-sounding notes of the Rufous Motmot would join the dawn chorus, which in tropical forest is rarely so full and stirring as in the cleared lands where more thrushes, finches, and other first-class songsters reside. Except on certain days in March and April when Broad-billed Motmots seemed to be courting, or perhaps disputing over territories, their full croak was rarely heard after sunrise.

In addition to the drawn-out *cwaa,* the motmots sometimes utter similar but shorter notes in rapid succession, *ca ca ca ca ca ca.* Rarely I have heard from them a low rattle or clicking, *k-e-e-e-e.* A parent motmot hesitating to take food into its burrow while I stood near continued to repeat a sharp *keck keck keck.* Low, throaty notes indicate excitement or distrust.

The voices of fledglings, of which we shall have more to say later, are amazingly different from those of the adults. The former utter soft, mellow notes of a sort rather frequent among birds; sometimes they might be mistaken for those of the Black-throated Trogon (*Trogon rufus*), at other times for those of the Chestnut-backed Antbird (*Myrmeciza exsul*), both of which live in the same forests. Possibly the ancestors of present-day Broad-billed Motmots had soft voices that were confusingly similar to those of some of their avian neighbors, but through the ages natural selection favored those individuals whose notes were more distinctive, until today these motmots have far-carrying calls that can hardly be confused with any other sound in the forests where they dwell.

DENUDATION OF THE SHAFTS OF THE CENTRAL RECTRICES

It is well known that when the central tail feathers of racquet-tailed motmots first grow out, their vanes are continuous to their tips, although they are commonly constricted in the subterminal region where the shafts will finally be denuded. I have long wished to follow the process of racquet formation; but this is difficult to observe in free birds, while in captives one cannot be certain that it takes its normal course. The nearest I ever came to following the course of racquet formation was on Barro Colorado Island many years ago, when I was there with Frank M. Chapman. One evening in late December, 1930, just as we were finishing supper, a Broad-billed Motmot perched on the petiole of a papaya tree close beside the main building and startled us with his loud *cwaa cwaa.* For the next three weeks, this bird, whom we took to be a male, entered the clear-

Fig. 1. Broad-billed Motmot, photographed on Barro Colorado Island after sunset on 5 January 1931. The longer central tail feather has already been trimmed.

ing from the surrounding forest almost every evening after sunset, to continue to feed when it was growing too dark in the woodland. Sometimes he was accompanied by another motmot, easily distinguished by the condition of its tail, who was apparently his mate. They had certain favorite low perches on which they rested while they looked for insects, which they caught on aerial sallies, or flew down into the grass to secure. Their eyesight was truly amazing; in the gathering dusk. they could detect and capture a small insect amid the grass 20 feet away. Often they did not return into the forest until it became too dark for us to see them clearly.

These motmots were far from shy. By setting our heavy, ground-glass-plate cameras on tripods and focusing them on the birds' habitual perches. with a thread attached to the trigger so that we could trip it from a distance, we obtained a series of photographs showing the progress of denudation of the central tail feathers. The motmots rested so quietly in one spot that a three-second exposure in the fading light often revealed no movement.

At the beginning of January, the motmot who was our most regular visitor had central tail feathers of unequal length (Fig. 1). The left was the longer of the two and appeared to be fully grown, but the shaft behind the terminal racquet had been denuded for only a short distance. The right central rectrix was about an inch shorter and had not been trimmed at all. By 7 January the full-grown left central rectrix appeared to have the shaft denuded for the usual distance. But when I last saw this bird, on 20 January, the right central rectrix, now nearly as long as the left, showed no sign of denudation.

On another Broad-bill that I saw about this time, the condition of the central tail feathers was just the reverse; the right one was longer, with the subterminal portion of the shaft denuded, whereas the left feather reached only a little way beyond the base of the racquet of the other and had uninterrupted vanes. In mid-January other Broad-bills had their tails completely trimmed, while on yet others the two central rectrices were apparently fully grown with no trace of denudation. From these observations, we may conclude that in this species the process of racquet-formation does not begin until, or some time after, the central tail feathers have stopped growing. On the other hand, in the Turquoise-browed Motmot, which has a much greater length of naked shaft, this is denuded of vanes while the central rectrices are no longer than the lateral ones and far from attaining their full length. In neither species have I actually witnessed the removal of the vanes.

COURTSHIP

On Barro Colorado Island, one morning in mid-January, I followed the calls of Broad-bills until I came in view of two of them resting, about six feet apart, on a branch somewhat below mid-height of the forest, apparently engaged in courtship. At short intervals, each uttered a deep *cwaa cwaa,* sometimes simultaneously, sometimes one following or answering the other, but neither obviously acting as leader. As they continued this monotonous conversation, they sat serenely still, as is their fashion. From time to time, one darted out to pluck an insect from a neighboring branch or twig and carry it to a different perch, after which they resumed their courtship, if such it was, in altered positions. Once the motmot with unequal central tail feathers, whom I took to be the male, snatched a beetle from a large limb and was knocking it resoundingly against his perch, when the other flew straight toward him, as though to claim the insect. But the male, far from gallantly presenting the food to the female, as I have seen the Turquoise-browed Motmot do, churlishly withheld it. Appearing to become angry, he repeated several times a loud *ca-a-wak, ca-a-wak* and switched his

Fig. 2. Nest site of the Broad-billed Motmot in a high bluff above the Río Puerto Viejo in the Caribbean lowlands of northern Costa Rica. The mouths of two burrows, occupied in successive years, are visible. Finca La Selva, May, 1968.

tail vehemently upward, while the other motmot, rebuffed, flew to another perch. Presently the monotonous *cwaa*-ing was resumed; but after about an hour the responses of the supposed female became less and less ready, until she ceased to reply, and soon thereafter departed. Thereupon, the male's calls became weaker, until he tired of uttering them unanswered and continued to perch in silence, motionless except for an occasional plunge after a passing insect. A stolid courtship, surely, but in keeping with the motmot's impassive nature!

NEST AND EGGS

At La Selva on 14 May 1967, I discovered my first burrow of the Broad-billed Motmot. In a high, wooded bluff rising steeply above the Río Puerto Viejo was a small bay or recess, about 20 yards across, evidently formed by a landslip long before, but now overgrown with ferns, palms, saplings, and small trees. At the head of this natural amphitheatre was the vertical bank of earth in which the burrow had been dug. It was screened by trees and vines from the broad expanse of the river, and behind was a great tract of heavy forest (Fig. 2). The exposed entrance to the burrow was 3½ feet below the top of the bank. The tunnel curved to the right, so that I could not see to the end when I threw in the beam of a flashlight; but the motmot in charge of the eggs moved outward far enough to reveal its head and shoulders and stayed there gazing into the light. Since I could not examine the eggs without an excavation so extensive that it would have jeopardized the nest, I did not attempt to do so. When we left La Selva on 11 June, the parents were feeding nestlings in this burrow.

When next I visited this embayment of the bluff on 12 March of the following year, there was a new burrow about four yards from the old one, on a level with it. Although still unoccupied, parallel furrows along its bottom, made by the motmots' short legs as they shuffled in and out, showed that it had been recently entered. There was no pile of freshly dug earth below its mouth to show that it was newly excavated; perhaps, like Blue-diademed Motmots, Broad-bills dig in September or October the burrows in which they will nest in the following March or April. This new burrow ran straight into the bank, but the enlargement at its inner end was offset slightly to the left. Looking in at the front, I needed a mirror to see all of the eggs that were later laid, but much of the sitting bird was visible with no other aid than a flashlight. This burrow was 33 inches long. Near its mouth, it was 3 inches wide by 2⅞ inches high.

The third burrow was, like the first two, in the nearly vertical wall of a recess or indentation in a high bank above a stream, in this instance a small tributary of the Río Puerto Viejo. The landslide that had left this nick in the bank had also occurred years before, and it was now overgrown with vegetation. Several large clumps of plume-like fern fronds grew on the bank above the mouth of the burrow, which was 39 inches long and quite straight, so that a light was all that I needed to see what it contained. The bore of this tunnel was also wider than high, 3¼ inches in horizontal diameter by 2¼ in height.

The first burrow held an unknown number of eggs which hatched on 31 May 1967. Allowing three weeks for incubation (the period carefully determined for the Blue-throated Green Motmot), they were laid about 10 May. During the week following my first visit to the second burrow on 12 March of the following year, a twig set in its mouth showed that it was seldom entered, and no bird slept in it. Then followed three very rainy weeks, during which the bank became too soft and slippery to be safely climbed. When, after two dry days, I revisited the burrow on 13 April, it contained three eggs, their pure white shells already slightly soiled from contact with the earthen floor of the unlined nest chamber. As in other motmots, no soft material had been carried in to form a bed for them. These eggs hatched on 29 April, and accordingly had been laid about 8 April. The third nest was more advanced: it contained two nestlings with sprouting pinfeathers when discovered on 30 April 1968. The eggs from which they hatched had been laid at the beginning of the month.

According to the few available records, in the Sarapiquí lowlands of northern Costa Rica Broad-billed Motmots dig, in vertical earthen banks partly screened by vegetation, straight or sometimes crooked burrows from 33 to 39 inches long. They do not use the same burrow in successive years. They lay, in April or early May, two or three white, unmarked eggs.

INCUBATION

Of the parents who attended the first burrow in 1967. one had an intact but somewhat worn tail, but the other, who passed the nights in the nest, had lost both racquets. In the following year, the motmots at the new burrow close by, evidently the same pair, showed the same differences: one had two good racquets, but the other, who slept in the burrow, had none; indeed, by the time the nestlings flew, it had only a short stub of a tail. Apparently the long hours it spent in the burrow in earth soaked by daily rains were deleterious to the tail feathers. To distinguish these motmots in our records, we called one "Racquets" and the other "Discless." probably the latter, who regularly attended the eggs and nestlings by night, was the female; but this is not certain, for in a number of cuckoos, woodpeckers, puffbirds, and other birds, the male takes charge of the nest through the night.

At the third nest, also, one parent had two whole racquets while the other had none, although its tail was otherwise in good shape, by no means so worn as that of Discless. I found this burrow too late to learn which parent occupied it by night, but the more frequent calling of the one with both racquets suggested that this was the male.

In sharp contrast to Blue-diademed Motmots, which when nesting in cultivated districts are sometimes so wary that they can hardly be watched even from a blind, these forest-dwelling Broad-bills were all amazingly fearless in our presence. Often they would enter their burrows while we stood at the edge of the bank directly above the doorway, our feet not two yards from their heads. Once, while I was looking into a burrow, a parent arriving with food almost bumped into me, then alighted so near that I came within an inch of touching it. Although their tolerance of an observer varied somewhat with the individual motmot and with time, in some cases decreasing if they had not been watched for a week or so, they would soon become reconciled to our presence. Sitting unconcealed only three or four yards from their burrows, we could watch these motmots carry on all their usual activities.

Both sexes incubate, as in other motmots. To learn the pattern of incubation, we watched directly at the critical times of the change-overs, and set a little stick upright in the mouth of the burrow to indicate whether any bird had passed in or out during the long hours when no movement was expected. The least touch by a passing motmot would push over this small sentinel. The ease with which the two partners could be distinguished by their tails greatly facilitated our study. In 1968, when the burrow was straight, we could look in and see who was present, without disturbing the birds.

These motmots followed the same simple schedule as the Blue-diademed Motmots (Skutch, 1964). There were only two change-overs in each 24-hour period, at dawn and in the middle of the day. Discless incubated from around noon until the following dawn; Racquets, throughout the morning. Discless usually flew silently from the burrow before 05:00, when the loud calls of Broad-bills were sounding through the forest but the light of the approaching day was still so dim that I could hardly see her go. Sometimes I was apprised of her departure only by the swaying of the dusky foliage in front of the tunnel. The earliest hour at which I recorded her exit was before 04:40; the latest, 05:14. The eggs then remained unattended until Racquets arrived 16 to 45 minutes later, before sunrise, at times varying from 05:15 to 05:46.

After sitting for from five and three quarters to eight and three quarters hours, Racquets left the burrow at hours ranging from before 11:00 to 14:03; but on most days he emerged between 11:45 and 13:30. Sometimes he deserted the eggs before his relief arrived, and once they remained unattended for more than 130 minutes; but often he stayed at his post until his partner came. Sometimes, hearing her low croaking notes as she alighted on a slender leaning palm stem in front of the burrow, he would fly out before she entered, but on other days she entered first and he emerged a minute later.

The stick set in the mouth of the burrow after Discless went on duty nearly always remained upright until nightfall, and this was true even on the day when she entered before 11:15. But on 16 April, when Discless was found on the eggs at 12:10, she was absent at 17:10. A minute later she reentered while I stood above the burrow. This was the only time when the sentinel indicated a departure from the usual routine of one entry and one exit by each partner every 24 hours.

The foregoing paragraphs summarize observations made on 26 days at the nests of this pair in 1967 and 1968. Only minor differences were noticed in the two years. In 1967, when these birds incubated in May, the morning departure of Discless and the arrival of Racquets tended to be earlier than in the following year, when they incubated in April and day dawned somewhat later.

When I looked into the straight burrow in 1968, I nearly always found the motmots sitting on their eggs with head inward and tail projecting straight outward into the entrance tunnel. Only in this orientation could they incubate without bending the tail against the wall of the chamber—at least in the case of Racquets, whose central rectrices were whole. Years earlier, I had found Turquoise-browed Motmots sitting on their eggs with their tails outward.

THE NESTLINGS

Development.—In the straight burrow where I could see the three eggs and nestlings, they hatched on 29 April 1968, and the empty shells promptly vanished. The newborn motmots were blind, pink, and devoid of down. The nestlings could already stand and move around, keeping their abdomen above the ground and supporting their weight on their heels which, as in other motmots, were doubtless protected by smooth callous pads, although I did not notice this detail in these nestlings beyond my reach. When they were a week old, their pinfeathers were pushing through the skin, which had become a darker pink. At nine days, some of the contour feathers were escaping from the ends of their long sheaths; and when 11 days old the motmots were partly feathered.

I still had not seen them with open eyes, but perhaps they closed them in the beam of the flashlight with which I viewed them. While I was looking into the burrow two days later, however, a parent arrived with food and called, whereupon one of the 13-day-old nestlings, after pushing another aside, ran down the tunnel toward the entrance, with open eyes. I stood aside, so that it could not see me, and the nestling came about two thirds of the way to the burrow's mouth. When I looked in again, necessarily with the light, it ran backward to join its nest-mates at the inner end. At 15 days, the young were taking their meals at the burrow's mouth, making it unnecessary for their parents to enter. When 16 days old, the nestlings were nearly covered with plumage. Nevertheless, they remained safely in their burrow for another eight or nine days.

When the 13-day-old nestlings heard the voice of an approaching parent, they trilled softly, and the parent answered with a throaty rattle. Thereafter, the young motmots became increasingly noisy; their trills, which grew louder and clearer, were often given even when no parent was near. On their last day in the nest, the choruses of trills were punctuated by loud, full, almost soprano notes such as I had never before heard from a Broad-billed Motmot.

Brooding.—On 1 June 1967, when the nestlings in the first burrow were a day or two old, Racquets entered the nest with food at 05:20 (about the time he did so while he incubated) and remained brooding for 138 minutes. After an interval of 22 minutes, Discless entered to feed and brood, and was still inside when I left 80 minutes later. On 5 June we watched from 05:25 until noon. Racquets fed the nestlings, but Discless was not seen. Unless she remained in the burrow all this time—which is unlikely—the five-day-old nestlings were not brooded on this wet morning. On the following afternoon, from 13:30 until 18:00, the naked nestlings were certainly not brooded, for both parents were bringing food and neither remained in the nest longer than was necessary to deliver it.

A pair of Blue-diademed Motmots did not brood their week-old nestlings in the course of a morning. Even nocturnal brooding was discontinued when the nestlings were about five days old. Evidently nestling motmots remain sufficiently warm in their deep burrows without a parental coverlet, and the early cessation of brooding reduces the risk that some predatory animal, blocking the only avenue of escape, will capture a parent along with its young.

Feeding.—The newly hatched nestlings were given small insects so thoroughly mashed that it was hardly possible to recognize their kind. But when only five or six days old the young motmots received objects as large as cicadas, that had doubtless been prepared by some beating against a branch but were only slightly mutilated. Thereafter, cicadas, which were abundant in the forest at this season, became a prominent item in the nestlings' diet. In a total of 19 hours of watching from 5 to 10 June 1967, when the nestlings in burrow 1, of unknown number, were five to ten days of age, they were fed 43 times, one object on each parental visit. These 43 meals included 20 cicadas, two green mantises, 15 other insects, one spider, one tiny frog, one small lizard, and three unrecognized objects.

On 23 May 1968, when the three nestlings in burrow 2 were about 24 days old, we watched throughout the day. The first feeding came at 05:10 and the last at 17:55. In this interval of 12¾ hours, 54 meals were taken to the burrow. These included 16 cicadas, four beetles, three caterpillars, two grasshoppers, one butterfly, one walking-stick insect, and two centipedes. Most of the remaining meals consisted of insects of undetermined kinds. The cicadas were brought chiefly during the middle of the day, when they were most active and noisy. Between 09:00 and 14:00, they accounted for half of the nestlings' meals. On this day, one young motmot left the burrow at 14:03, and thenceforth we could not see how often it was fed. During the nine hours when all three nestlings were within, they were fed 42 times, or at the rate of 1.6 meals per nestling per hour.

While watching these motmots carry cicadas to their nests, I was struck by the similarity of their broad, heavy bills to those of the Boat-billed Flycatchers (*Megarhynchus pitangua*), which also feed largely on cicadas in their season. Such bills appear well fitted to deal with these large, hard-bodied insects. However, White-fronted Nunbirds (*Monasa morphoeus*), whose bills have a quite different shape, also take many cicadas. And although in both years the motmots we called Racquets and Discless gave many cicadas to their young, the same was not true of other pairs of Broadbills. On 30 April and 1 May 1968, I spent nine hours watching nest 3, which then contained two blind nestlings with sprouting pinfeathers. They were fed 39 times, or at the rate of 2.2 times per nestling per hour. Their meals included at least 31 insects, of which 1 was a dragonfly, 1 a damsel fly, 1 a butterfly, 1 a beetle, and 3 were larvae. There were 2 spiders and 6 unrecognized items, but no cicada. Nine meals were brought between 07:00 and 08:00; eight between 10:00 and 11:00.

At this nest, the parent with a complete tail brought food 25 times and the other, whose discs were lacking, 14 times. At nest 1 in 1967, we saw Racquets bring food 25 times and Discless 18 times; but if we exclude the morning of 5 June, when Racquets brought food seven times and Discless was not seen, each parent fed the nestlings 18 times while we watched. During the first nine hours of 23 May 1968, Racquets brought food 19 times, Discless 23 times, to the three nestlings who were about to leave. The two sexes take nearly equal shares in feeding the young.

Arriving with food for their nestlings, the parent motmots usually alighted on a branch in front of the burrow and uttered low, throaty notes while twitching their tails sideways, as is their habit. Sometimes they beat against their perch the insect they held conspicuously in their bill, nearly always with wings still attached; but as a rule such preparation as the food received was done before they came into view. After more or less delay, with perhaps an advance to an intermediate perch, the parent darted into the burrow. Soon it shot out headfirst and flew away. When the nestlings were eight or nine days old, however, the parents began to emerge tail-first, after a visit lasting only a few seconds. Evidently the nestlings were now advancing part of the way up the tunnel to take their food, making it superfluous for the parents to go inward as far as the chamber, where alone they could comfortably turn around. During the second half of the nestling period, the young motmots trilled and purred when the parents came to feed them. On their last day or so in the burrow, they stood visibly in its mouth to take their meals, which they did the moment a parent alighted in front of them, to leave an instant later. Now the adults did not enter the burrow at all.

Sanitation.—The parents were not seen to carry any waste from the burrow. After they ceased to go in far enough to turn around when delivering meals, they probably never entered the brood chamber for the purpose of cleaning it. Soon the filthy floor swarmed with white maggots, which doubtless helped to break down the waste matter. Even before they were feathered, the nestlings, standing on their heels, could hold their bodies out of contact with the ground, so that at last they emerged with clean, fresh plumage.

Departure.—The first arrival of the stubby-tailed parent Discless with food for the feathered nestlings in burrow 2, in the dim light at 05:10 on 23 May, set off a chorus of loud, clear trills and duller churrs, mixed with which were full but soft, mellow notes such as I had never before heard from a Broad-billed Motmot. For the next hour the trilling and churring in the burrow continued with little interruption, finally to die away as the nestlings' hunger was satisfied. Throughout the day, the approach of a parent with food usually released a fresh outburst of churring, purring, or trilling, which varied in intensity and duration with the young motmots' appetite. As we could see when one stood in the burrow's mouth, their throats swelled out strongly as they produced these sounds.

The full mellow notes, heard increasingly as the day advanced, were most surprising. Usually they were delivered in pairs, sometimes three together. Even those of the same pair might differ in pitch and tone, so that sometimes they reminded me of the Chestnut-backed Antbird's rather plaintive whistles, sometimes of the Black-throated Trogon's subdued *cow cow cow.* We were to hear much of these soft notes from young who had left the burrow.

As the hours passed, the nestlings delayed more and more in the entrance, looking out, after taking food from their parents. After receiving a cicada at 14:03, the young motmot who had been resting in the doorway with its foreparts exposed suddenly took wing. It covered about 60 feet on a slightly descending course, to alight in the thick crotch of a riverside tree. The parent who had just fed it escorted it closely on its first flight. Resting in the fork, the fledgling preened its fresh plumage, which resembled that of the adults, except that its tail was very short, and it lacked the black patches on face and foreneck. Another nestling promptly stationed itself in the burrow's mouth.

After three more meals had been delivered to the young in the burrow, another took wing, at 15:45, two minutes after it was fed. It appeared to leave spontaneously rather than in obedience to parental urging. Flying obliquely upward for about 20 feet, it tried to alight on the tip of a palm frond, but finding itself unable to cling there, it reversed its course and came to rest on the ground at the edge of the bank, just above its burrow. After remaining here for a quarter of an hour, it flew back into the forest beyond view.

The nestling still in the burrow continued from time to time to give the mellow call, and often it was answered by the one who emerged first. During the last hour of the day it received six meals, all from Racquets. Discless, who alone had been present when the first young departed, was evidently giving all her attention to the fledglings in the open, and we saw little of her.

After the departure of the second fledgling, the parents apparently divided the brood between them, as do numerous other birds. Next morning Racquets started to feed the nestling in the burrow at 05:20. By 06:30 this young motmot had received five winged insects and one larva. When the seventh meal was offered, the nestling, satiated, refused it. For ten minutes Racquets continued to hold this insect, instead of taking it to one of the fledglings whose trogon-like calls sounded plainly among the neighboring trees. Finally, Racquets swallowed what he had been holding and flew away. By 07:00, when I left, Discless had not been seen. Evidently she was wholly occupied with the two fledglings who had flown on the preceding afternoon.

By noon of that day the last young motmot had flown, leaving a dying cicada in the tunnel. The young had remained in the burrow for 24 or 25 days, an exceptionally short nestling period for a motmot. Turquoise-browed Motmots remain in the nest for 28 or more days; Blue-throated Green Motmots for 29 to 31 days; Blue-diademed Motmots for 29 to 32 days, and exceptionally as much as 38 days. During the day after the young Broad-bills first flew, their mellow calls sounded at intervals from the forest behind the burrow; but they perched so inconspicuously amid the foliage that I succeeded in glimpsing only one, who swung its short tail from side to side, just as the adults do with their long tails. It was alert, and flew off as I approached. After two or three days in the open, the young motmots became much quieter, and I rarely heard the soft calls which revealed that they were still nearby.

The stick that I set upright in the burrow's mouth after the last young Broad-bill flew bore testimony that it was not entered during the following week. As far as I know, none of the lowland motmots uses its burrow as a dormitory. But in the cool highlands, Blue-throated Green Motmots, who sleep in pairs in burrows throughout the year, may return at nightfall to that from which their brood has just flown, leaving their fledglings to roost outside on cold, rainy nights.

RUFOUS MOTMOT (*Baryphthengus ruficapillus*)

The Central American race of this largest of the motmots attains a length of 17 to 20 inches and is sometimes known as the Great Rufous Motmot. Well over half its length, however, is accounted for by its long, racquet-tipped tail. Its head, neck all around, and most of the under parts are bright cinnamon-rufous or tawny-ochraceous, with a black band extending across the face from the lores to the ears and a small black patch in the center of the chest. The remaining upper plumage, the lower abdomen and under tail coverts, and the wings are green of varying shades, which on the primaries merges into greenish blue and violet-blue. The bluish green at the base of the tail gives way to greenish blue toward the end, and the central feathers are tipped with black. The rather narrow, coarsely serrated bill is black, and the eyes and feet are dark. Although northern forms with racquet-shaped central rectrices are now held to be conspecific with southern forms that have continuous webs on these feathers (and other important differences), they were formerly classified in distinct genera (*Urospatha* for the northern races, *Baryphthengus* for the southern)! [1] The surprising similarity in coloration of the Rufous and Broad-billed Motmots was discussed in our account of the latter.

The Rufous Motmot ranges from Nicaragua and Costa Rica (where it is confined to the Caribbean side) to southern Brazil, but it is absent from Venezuela and the Guianas in northeastern South America. Although in southern Brazil the species has been found nesting as high as 3,800 feet (Mitchell, 1957:116), in Central America it rarely occurs higher than 2,500 feet. Here, at the northern end of its range, its home is in the tall, wet, lowland forests, from which it may come forth into adjoining shady plantations, such as those of cacao and bananas, to hunt for food. In the forest it seems generally to remain high, where when silent it escapes detection, but it sometimes forages in the undergrowth, and may even pick food from the ground, especially when accompanying army ants. Mostly it is found alone or in pairs; but at La Selva, where this motmot was abundant, 13 gathered, before sunrise on a morning in late April, in a fringe of forest between the house and the river. They were highly excited, moved around and called much, but were not seen to fight. One held in its bill something green that was apparently a fragment of leaf, reminding me of the similar puzzling habit of the Blue-diademed Motmot in its courtship gatherings (Skutch, 1964:323–324). One of these 13 Rufous Motmots

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[1] Since this account was written, Wetmore (1968:448) has supported the specific distinctness of northern and southern forms. If considered distinct, the northern species should be called *Baryphthengus martii*.

lacked racquets on its tail. To see so many of these handsome birds together was a rare and memorable experience.

In the southern part of its range in Brazil, where it lacks racquets, the Rufous Motmot is not so closely restricted to the heavy forest as in the north, but it appears to be adapting itself to man and the changes he makes in the environment, as the Blue-diademed Motmot has done in Costa Rica and elsewhere. Mitchell (1957:115–117) found it nesting in a wooded part of the Parque da Cidade, Rio de Janeiro; and at a hotel on Mt. Itatiaia she "came upon a pair dust-bathing like a couple of old hens under a carport" which was "certainly not in deep woods."

FOOD

The Rufous Motmots' diet is varied, including large quantities of both vegetable and animal foods. On Barro Colorado Island, Chapman (1929: 47–48) watched them eating the yellow, plum-sized fruits of the nutmeg tree (*Virola panamensis*), which they plucked while fluttering on wing—although, as he remarked, there seemed to be no reason why these birds with fairly strong feet and bill should not gather the fruit while perching near it. At La Selva, I watched a Rufous Motmot devour, while perching, a number of the little orange fruits of a small palm. To their nestlings they carried fruits of various kinds, and also white objects that appeared to be seeds of *Inga* or *Protium*, enclosed in soft, sweetish, white coats. They eat many insects which they catch in the usual way of motmots, perching motionless until they sight their victim, then seizing it at the end of a sudden, swift sally. When foraging with army ants, as they frequently do, these motmots commonly perch somewhat more than head-high and pluck fugitive insects and other small creatures chiefly from foliage and trunks, but occasionally they descend briefly to the ground to capture them. Once, in a cacao plantation, I saw a motmot pick a large, pale red, cylindrical milliped from among fallen leaves. Still standing on the ground, the bird beat its prey until it broke, and swallowed it piecemeal. According to Wetmore (1968:446) this motmot eats caterpillars, wasps, spiders, lizards, small fish, small crabs, and large scorpions, as well as fruits.

VOICE

In the wet Caribbean forests of southern Central America, the hollow hooting of the Rufous Motmots is one of the characteristic dawn sounds. Until they have been traced to their source—which may take long—the deep, soft, scarcely birdlike notes create an atmosphere of unfathomable mystery. It is easy to imagine that the ghosts of the vanished aborigines are calling to each other through the dripping woodland. The notes come in pairs or triplets—*hoo hoo,* or *hoo hoo hoo*—or sometimes four or more together. There are strong contrasts in pitch. One morning I heard three low *hoo*'s followed by three higher ones, then three distinctly lower. This series of nine notes was repeated several times; but in the feeble dawn light I could not learn whether a single motmot was hooting or a male and female were calling antiphonally, with voices contrasting in pitch. On another morning, while standing near a nest in the earliest dawn, I listened to two motmots, on opposite sides of me, calling alternately with phrases of two notes. I took this to be a mated pair answering each other: *hoo hoo —hoo hoo—hoo hoo. . .* If so, there was little difference in the voices of the two sexes. But soon a third motmot, farther to my left, joined in with similar notes and complicated the situation, so that I could reach no definite conclusion.

NESTING

While I watched the nest of the Broad-billed Motmots on the wooded bluff above the Río Puerto Viejo at La Selva, a pair of Rufous Motmots carrying food betrayed the location of a nest which otherwise I never should have found. About 50 feet from the Broad-bills' burrow was a small opening in the canopy made by the fall of a tree. Amid the clutter of trunks and branches below this opening was a cave-like den or burrow, that seemed to have been made by some middle-sized mammal. This cavity in the steeply sloping ground was roughly semicircular, about a yard wide and high; but the entrance was too narrow to admit my shoulders, and access to it was impeded by a large log lying in front. Illumination of the den by a flashlight beam failed to disclose just where the nest was. Probably the nestlings rested at the end of a long tunnel which the motmots had dug, beginning in the side of the little cave. Blue-diademed Motmots often choose a similar situation for their burrows, making them exceedingly difficult to find.

Early in the morning of 16 May, these Rufous Motmots were carrying fruits and white arillate seeds into the cave, but later in the day they brought chiefly well-mangled insects and other small invertebrates, always one at a time. held in the tip of their serrated bills. To enter the den, they alighted on the mound of excavated earth in front and hopped down the declivity until they had vanished underground. Soon they came hopping up the mound, from the top of which they took wing. These motmots and the Broad-bills nesting nearby never seemed to pay any attention to each other.

On the morning of 20 May, a Rufous Motmot carried a white seed into the den, only to emerge after a short interval still holding it. Then the bird swallowed the seed and flew away. Perhaps the young had just flown, but I could not find them in the vicinity. Could they have succumbed—possibly drowned—during the heavy rains two days earlier?

My suspicion that some mishap had befallen the nestlings was strengthened when, on 6 June, the parents were discovered preparing to nest again in the same den, for motmots are not known to rear two broods in a season. The two sexes alternated in the task of digging a new tunnel from the side of the den or lengthening the old one—I could not learn which. Arriving with clean bills, they perched side by side on a low horizontal branch in front of the cave, into which presently one vanished. While it was underground, the mate on the branch tirelessly repeated a low *coot* at measured intervals. After a quarter of an hour, the digger reappeared, its black bill caked with brown earth. While they rested close together between spells of work, both kept up this sound, as I could assure myself by watching their throats swell slightly as each note was uttered, with closed bill. The muddy-billed bird returned for a shorter spell of work. After it emerged, the partner with a clean bill went underground, to reappear seven minutes later with its bill muddy, too. Then the first motmot went in for another turn at digging. While waiting in front of the den, the motmots preened their lovely plumage with their clay-encrusted bills, which to me seemed a stupid thing to do. After about 40 minutes, one of the pair flew away, and its mate soon followed. Neither would work unless the other were nearby.

These motmots worked at various times from the late morning to the early afternoon. As they descended into the cave from the mound of excavated earth in front, they kicked the loose earth backward with alternate strokes of their feet, just as motmots do when they enter a burrow that they are digging. Doubtless they continued this activity after they passed from view, thus gradually shifting outward the earth that they removed from their tunnel, and preventing the cave from filling up. Sometimes, too, a motmot emerged from a spell of work with a lump of clay in its bill, to drop it after perching. Probably only a minor portion of the excavated earth was removed in this second manner.

We did not remain at La Selva to learn the outcome of this second nesting of the Rufous Motmots in 1967; but in May of the following year, they were again incubating somewhere in the side of the same den in the bluff above the Río Puerto Viejo. Again they were close neighbors of the Broad-billed Motmots; but whereas in the former year their eggs hatched more than two weeks earlier than those of the Broad-bills, this year they hatched a whole month later. A few observations indicated that the incubation pattern of the Rufous Motmots was the same as that of the Blue-diademed and Broad-billed Motmots. One partner left the burrow at daybreak and the other entered soon after, to remain until the middle of the day. There was a change-over in the early afternoon. Apparently the parent then entering remained uninterruptedly until the following dawn; but since the gaping mouth of the cave gave doubtful value to the use of little sticks to indicate whether a bird had passed in or out, we did not prove this. By 1 June these motmots were feeding nestlings in this cave.

In southeastern Brazil, Mitchell (1957:116) found Rufous Motmots nesting in burrows in bare perpendicular banks, where they were more easily detected than was our nest in the side of a den that obviously had not been dug by the motmots themselves. This may or may not be another racial difference between Rufous Motmots at opposite extremes of their vast range, for in Costa Rica Blue-diademed Motmots dig their burrows either in exposed banks or from the side of a pit or animal burrow, although they seem to prefer these more secluded sites. Two occupied nests of the Brazilian Rufous Motmots were only 75 feet apart.

SUMMARY

An inhabitant of warm, humid forests, the Broad-billed Motmot rarely ascends to more than 3,000 feet above sea level. It is usually seen alone, perching well up in the trees.

Its diet consists of insects and their larvae, including many cicadas and a few butterflies and dragonflies, supplemented by spiders, centipedes, small frogs, and lizards. It was never seen to take fruit.

The motmot's call is a loud, wooden note, devoid of timbre. At daybreak, the hoarse croaks are among the earliest bird notes. Except in March and April, when the motmots appear to be courting, they are rarely heard after sunrise. Courtship appears to consist of interminable calling by the male and answering by the female.

In a free bird in the Panamá Canal Zone, the denudation of the shafts of the central tail feathers was followed and photographed.

In the lowlands of northern Costa Rica, these motmots nest in April, May, and June. Three burrows, in high, vertical banks partly screened by vegetation, were 33 to 39 inches long, and either quite straight or slightly curved. No lining was brought. One nest contained three plain white eggs and another two nestlings.

These motmots incubate according to the same simple schedule that the Blue-diademed Motmot follows. One parent, evidently the female, enters the burrow around midday and sits continuously until the following dawn. After an interval of 16 to 45 minutes, the other parent enters before sunrise and remains until midday, sitting for 5¾ to 8¾ hours continuously. Often, but not invariably, he waits to be relieved by his mate. The motmots incubate with head inward and long tail projecting back into the entrance tube, where alone there is room for it without bending. Nevertheless, the partner who sat through the night had, in two consecutive years, a badly damaged tail.

The nestlings, which hatch blind and perfectly naked, were fairly well feathered at 16 days. The two parents took about equal shares in feeding them, bringing a single item in the bill on each visit. Three feathered nestlings were fed 42 times in 9 hours. No waste was removed from the burrow, which soon swarmed with maggots.

The young left spontaneously at the age of 24 or 25 days, an exceptionally short nestling period for a motmot. However, they could fly well. Shortly before they emerged from the earth, they began to utter soft, mellow notes, much like the calls of certain trogons and antbirds, but wholly different from anything heard from younger nestlings or from adults. These surprising utterances continued for some days after their departure.

Neither the parents nor the fledglings returned to sleep in the burrow after the latter left.

At the northern end of its range in Central America, the Rufous Motmot is restricted to humid lowland forests and adjacent shady plantations, chiefly below 2,500 feet. It generally remains high in the trees and is usually seen alone, but one gathering of 13 excited motmots was watched before sunrise in April.

Its diet includes both fruits and small invertebrates, with an admixture of small vertebrates, all of which are usually seized on a sudden swift sally. It often forages with army ants, when it catches fugitive insects and other small creatures from low elevations or even from the ground.

The call, a hollow, ghostly *hoo hoo hoo*, uttered in contrasting pitches, is one of the characteristic dawn sounds of the lowland forests.

In May, a pair of these motmots were discovered carrying food into a cave-like den or burrow, apparently dug by some middle-sized mammal, in a steep, wooded bank above a river. The nestlings, which could not be seen, were evidently at the end of a tunnel that the motmots had dug from the side of the semicircular cavern. These nestlings were given both fruits and insects, in contrast to the diet of a neighboring brood of Broad-billed Motmots, which consisted of only animal food.

The outcome of this nesting is unknown, but in early June the Rufous Motmots were again entering the cave to dig. The male and female took turns at the work and emerged from the earth with muddy bills. Most of the earth appeared to be removed by kicking backward as the birds entered the ground, but sometimes they emerged holding a lump of clay in their bills.

In May of the following year, Rufous Motmots were again nesting in a burrow dug from the side of this den, and by 1 June they were feeding nestlings here.

ACKNOWLEDGMENTS

These studies were supported by a research grant from the Frank M. Chapman Memorial Fund of the American Museum of Natural History. Dr. and Mrs. Leslie R. Holdridge, who then owned La Selva, kindly permitted us to occupy their house and gave much friendly help in 1967. In the following year, the Organization for Tropical Studies, which in the interval had acquired the property, extended the same courtesy, through its resident director, Señor Jorge Campabadal. The Tropical Science Center of San José, Costa Rica, provided transportation. My wife, Pamela, and son, Edwin, helped in the field. I am most grateful to all these institutions and individuals who assisted my work during the two seasons at La Selva.

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EL QUIZARRÁ, SAN ISIDRO DEL GENERAL, COSTA RICA, 15 MARCH 1970.

NEW LIFE MEMBER

A recent addition to the list of Life Members of the Wilson Ornithological Society is Dr. George A. Clark, Jr. Dr. Clark is a graduate of Amherst College and Yale University and is currently Associate Professor of Biology at the University of Connecticut. He has published a number of scientific papers on birds, including one on pages 66–73 of this issue of *The Bulletin*, and his interests spread over a wide area of anatomical and behavioral subjects. He is a member of the A.O.U., Cooper Society, American Society of Naturalists, Society for the Study of Evolution, A.A.A.S., Ecological Society of America, and numerous other scientific organizations.

GENERAL NOTES

Insecticide residues in Little Blue Herons.—Breeding colonies of Little Blue Herons (*Florida caerulea*) have recently become established in shortleaf pine (*Pinus echinata*) plantations in southeast Missouri. Chlorinated hydrocarbon insecticides that have been used in the area include DDT, toxaphene, aldrin, dieldrin, and heptachlor. DDT has been used in southeast Missouri since approximately 1949. In recent years, it has been applied in May and June for the control of the corn borer (*Ostrinia nubilalis*) and, in combination with toxaphene and an organophosphate insecticide, for the control of the cotton bollworm (*Heliothis zea*) and armyworm (*Pseudaletia unipuncta*) in September. DDT has also been used for fly control on beef cattle. Aldrin has been used to control corn cutworms (Family Noctuidae) and dieldrin has been used primarily around buildings for the control of termites (*Reticulitermes flavipes*). Heptachlor has been used as a soil insecticide for the control of the corn rootworm (*Diabrotica* spp.).

Eggs, nestlings, and adults of Little Blue Herons were collected from heronries located in Scott and Mississippi counties in May, June, and July, 1967, and in May and June, 1968. The samples were analyzed for residues of chlorinated hydrocarbon insecticides (DDT, aldrin/dieldrin, and heptachlor) at the Wildlife-Pesticides Laboratory, Illinois Natural History Survey, Urbana. We were unable to analyze for residues of toxaphene because of limitations of time and of column sensitivity. Residues were extracted from tissue samples with a 1:1 mixture of acetonitrile and hexane. Florisil columns were used for cleanup. Egg contents were prepared by saponification in alcoholic potassium hydroxide and by acetonitrile partitioning (Burchfield, Johnson, and Storrs, Guide to the analysis of pesticide residues, Vol. 1, U.S. Public Health Service, Office of Pesticides, 1965). All specimens were analyzed with a Beckman model GC-4 gas chromatograph equipped with an electron capture detector. Columns were packed with 1 percent Shell EPON resin 1001 and 0.5 percent DuPont Viton A fluoroelastomer on a solid support of 100/120 mesh Varian Aerograph Chromosorb W. The lower limit of detection was considered to be 0.01 ppm.

Results of the analyses (Table 1) indicated that the herons were contaminated with higher levels of DDT residues than with those of aldrin/dieldrin or of heptachlor. *p,p'*-DDE was detected in all specimens that were analyzed individually. Maximum levels of *p,p'*-DDE in egg contents were 1.34 ppm in 1967 and 2.67 ppm in 1968. Eggs contained significantly lower levels of *p,p'*-DDE in 1967 than in 1968. Maximum levels of *p,p'*-DDE in breast muscle and in brain tissue of adult herons collected in 1967 were 5.56 ppm and 2.09 ppm, respectively. Adults appeared to have significantly higher levels of *p,p'*-DDE than did nestlings.

Dieldrin was detected in 9 of 18 eggs collected in 1967 and in 2 of 10 eggs collected the following year. Maximum levels were 0.45 ppm in 1967 and 0.47 ppm in 1968. In adult herons collected in 1967, dieldrin was detected in 6 of 11 breast muscles and in 9 of 14 brains. Maximum levels were 0.21 ppm in the breast muscle and 1.06 ppm in the brain.

Heptachlor epoxide was found in 5 of 18 eggs collected in 1967. No heptachlor epoxide was found in the 10 eggs collected in 1968, despite the fact that heptachlor was used in the area that year. The maximum level in 1967 was 0.15 ppm heptachlor epoxide. In adult herons collected in 1967, heptachlor epoxide was detected in 2 of 11 breast muscle samples and in 2 of 14 brains. Maximum levels were 0.25 ppm in the

TABLE 1

LEVELS OF *p,p'*-DDE, DIELDRIN, AND HEPTACHLOR EPOXIDE IN LITTLE BLUE HERONS.

Sample	Number of Specimens	Concentrations (ppm wet weight)[a]		
		p,p'-DDE	Dieldrin	Heptachlor Epoxide
1967				
Egg contents	18	0.18±0.08	0.06±0.03	0.011±0.008
Range		d−1.34	c−0.45	c−0.15
Nestlings				
Breasts	19[b]	0.25	0.02	c
Brains	18[b]	0.04	0.01	c
Adults				
Breasts	11	1.10±0.49	0.05±0.02	0.024±0.023
Range		0.08−5.56	c−0.21	c−0.25
Brains	14	0.75±0.16	0.17±0.07	0.012±0.010
Range		d−2.09	c−1.06	c−0.14
1968				
Egg contents	10	0.71±0.24	0.07±0.05	c
Range		0.10−2.67	c−0.47	c−c
Nestlings				
Breasts	10[b]	0.12	0.01	c
Livers	10[b]	0.48	c	0.01
Adults				
Breasts	10[b]	0.37	c	0.09
Livers	10[b]	0.39	c	c

[a] Concentration given as mean ± standard error for specimens analyzed individually.
[b] Pooled specimens analyzed as a single sample.
c Not detected at 0.01 ppm.
d Detected at levels below 0.01 ppm.

breast muscle and 0.14 ppm heptachlor epoxide in the brain. Heptachlor epoxide levels in the breast muscle of adult herons appear to have been significantly higher in 1968 than in 1967.

The food of the Little Blue Heron consists of "Small fishes, frogs, lizards, snakes, turtles, crustaceans, spiders, and insects" (Palmer, Handbook of North American birds, Vol. 1, Yale University Press, p. 437, 1962). The adult herons feed in meadows, marshes, ponds, and sluggish streams within a few miles of their heronries. Analysis of a pooled food sample (mostly small crayfish plus a few minnows, earthworms, and some submergent aquatic vegetation), taken from the crops of nestlings in 1968, indicated 0.01 ppm *p,p'*-DDE. No other residues were detected. It seems likely that the DDT residues detected in the nestlings and in the eggs were due to ingestion of contaminated food and to subsequent concentration of residues in the parent females, with resultant passage of these residues at relatively high levels into the lipid-rich egg yolks.

There are no indications of a major change in the number of Little Blue Herons nesting in the two southeast Missouri counties. Nest counts conducted during the first week in June, 1965 through 1969, include a high count of 4,759 nests in 1968, a low count of 3,887 nests in 1967, and an average of 4,218 nests for the five years. Although these counts include other species of herons, their total numbers are insignificant when compared with the number of Little Blue Herons.

Least Bittern (*Ixobrychus exilis*) eggs from southern Louisiana were reported to contain *p,p'*-DDE at levels ranging from 0.15 to 0.42 ppm (Causey and Graves, Wilson Bull., 81:340–341, 1969). These levels are similar to those we found in eggs of Little Blue Herons, which is not surprising since the food habits of the two species are similar.

We thank Glen C. Sanderson, William H. Elder, Helen C. Schultz, William L. Anderson, and Stanley L. Etter for reading this manuscript and offering helpful criticisms.—Robert E. Greenberg, *Illinois Natural History Survey, Urbana, Illinois 61801,* and Paul L. Heye, *Southeast Missouri State College, Cape Girardeau, Missouri 63701, 2 July 1970.*

Nesting record of Mexican Duck (*Anas diazi*) in Texas.—Aldrich and Baer (Wilson Bull., 82:63-73, 1970) have recently reported on the status and speciation of the Mexican Duck (*Anas diazi*). They state that though it has been found in the past along the Rio Grande near El Paso, there are no definite nesting records in Texas. On 18 June 1969, we observed an adult Mexican Duck with six small young along Ash Creek on the Babcock Ranch, 16 miles SSE of Alpine, Brewster County. This locality is approximately 60 miles north of the Rio Grande and 200 miles southeast of El Paso. The following day we saw two adults fly overhead in this vicinity, but did not see the young again.

The three adults were identified by their similarity to a female Mallard (*Anas platyrhynchos*), but differing in having conspicuously darker tails.

The area is primarily grassland with scattered ash trees (*Fraxinus* sp.) along the creek. The stream is perennial with flow during the wetter seasons, primarily late summer and fall. There was some flow at the time this observation was made and water depth was generally less than one-half meter.

On 27 May 1970, Ohlendorf saw an adult duck accompanied by three small young at a small lake 2 miles SW of Balmorhea, Reeves County. These may have been either Mallards or Mexican Ducks, as they could not be identified with certainty. Water here was less than one foot in depth, with some flow into irrigation ditches. Accompanied by Tony Mollhagen and Bill Mealy, Ohlendorf returned to this locality on 6 July 1970. A pair of Mexican Ducks was seen there. Their legs were more reddish than those of Mallards and their tails were darker.

Recent reports by local residents suggest that Mallards also breed in the Trans-Pecos area of Texas. We have ourselves observed paired Mallards throughout the summer.

Contribution No. TA 8495 of the Texas Agricultural Experiment Station.—Harry M. Ohlendorf and Robert F. Patton, *Department of Wildlife Science, Texas A&M University, College Station, Texas 77843, 6 May 1970.*

Egg turning by an incubating Wood Duck.—Although it is generally known that birds turn their eggs during incubation, little is known about the actual process. Because of the difficulty in making direct observations of the turning of eggs by a

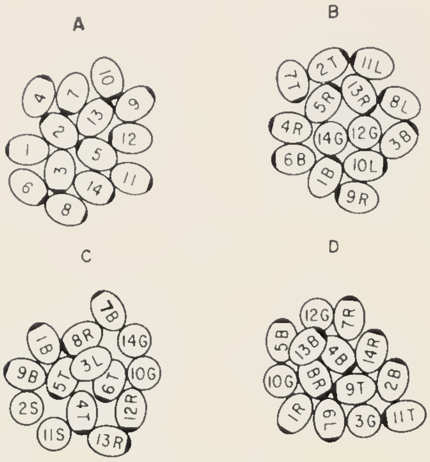

Fig. 1. Maps of Egg Locations and Positions. T:top, B:bottom, R:right-hand side, L:left-hand side, G:great end, S:small end. Maps were made as follows: A, 16:30, 15 May; B, 14:00, 16 May; C, 11:00, 18 May; D, 09:00, 19 May. All Ts were on top in Map A.

wild bird with its head beneath its body, in this study the indirect method was adopted of marking the eggs and later checking their relative positions. The work was done in Ohio during 1956 with a Wood Duck (*Aix sponsa*) clutch of 14 eggs. This relatively large clutch provided opportunities for following the course of movement of individual eggs, such as over the top of the clutch, that would not have been available with small clutches of several eggs.

At the start of the study an automatic recording device, such as was described by Stewart (Bird-Banding, 33:85–89, 1962), was installed on an occupied Wood Duck nesting box, and on the next day the recorder sheet was checked at various intervals until the incubating female was found to be absent from her nest. With India ink, the eggs were then marked with numbers and letters on four "sides" and the two ends. Daily thereafter the recorder sheet below the nesting box was checked at various intervals in an effort to find a time when the female was absent from her nest, and such a time was found on each of five successive days, 15 to 19 May, 1956, except 17 May. Egg locations and positions were then mapped, and the eggs were left unchanged where they had been found.

The successive maps (Fig. 1) of egg locations showed that the eggs seldom remained unchanged from day to day. However, they were sometimes later found with the same "side" on top and with little change of location, as with Egg 7 in the 21.5 hr period between the making of Maps A and B. An egg in such a situation could, of course, have gone through one complete turning cycle and returned to its original position and location, but this can be considered an unlikely eventuality. The eggs, too, were sometimes moved to new locations in the nest but left with the same side up as with Egg 8 in the change from C to D. Then the completion of a full turning cycle seems more probable. Holcomb (Bird-Banding, 40:105–113, 1969) marked the eggs of various species of passerine birds and found that incubating birds turned their eggs in an effort to keep the marks concealed. My Wood Duck eggs were marked on all "sides" and it was thus impossible for the bird to conceal all of the marks by turning them to the down position. Hence, it may be that egg turning was stimulated by the markings so that the eggs were turned more often than they would have been in the absence of the marks. The seeming failure of one egg to be turned in a 21.5 hr period is thus made increasingly important by this possible tendency to attempt to conceal foreign marks on the eggs, and incubating Wood Ducks seemingly do not normally turn all of their eggs daily.

Eggs sometimes appeared on opposite sides of the clutch on successive days, as with Egg 10 during the 22 hr period between the making of Maps C and D. Also, an occasional egg was left on top of the others, as with Eggs 3 and 13 in Maps C and D, and Egg 13 in Map D was presumably being moved over the top of the clutch from side to side. Presumably eggs thus being moved were sometimes crowded down among the others in the center of the clutch, as with Egg 9 in the change from C to D. Thus, it appeared that one way the incubating Wood Duck turned her eggs was by rolling them from the outside of the clutch toward the center and ultimately all of the way across the clutch or to other positions not directly across the clutch from the starting position. On the other hand, eggs were not invariably moved across the clutch to its opposite side but were simply moved short distances to new positions on the same side of the clutch, as with Egg 7 which remained near its original location throughout the four days of observation.

All of the eggs in this clutch hatched in due time, and the egg turning regimen can thus be assumed to have been normal, or at least satisfactory for hatching.—PAUL A. STEWART, *Entomology Research Division, Agricultural Research Service, USDA, Oxford, North Carolina, 15 March 1970.*

Spruce Grouse attacked by a Northern Shrike.—On 18 October 1969 at 09:30, I saw five Spruce Grouse (*Canachites canadensis*) fly across a graveled road on the Kenai National Moose Range, Kenai Peninsula, Alaska. The birds had flown from a forest edge about 350 yards away, and landed 50 or more yards back from the road, in a moderately dense stand of white spruce (*Picea glauca*) and paper birch (*Betula papyrifera*). They landed in spruce trees and were scattered singly 50 or more yards apart. At 09:35 I located a female sitting in the open on the end of a limb about 15 feet above the ground. Upon seeing me, she became nervous and began clucking loudly, a typical reaction of a Spruce Grouse when approached by man. As I slowly approached to within 30 feet in an attempt to noose her, a Northern Shrike (*Lanius excubitor*) struck the grouse from above. After a brief struggle lasting less than 3 seconds, the shrike flew off and the grouse flew to the ground, where she gave a display normally performed by a hen with young chicks; the tail was fanned vertically, head raised with neck feathers ruffled, wings cupped out from body and drooped to ground, and body feathers fluffed. This display may have been given to increase her apparent size, as a potential prey, and thus discourage the predator. The shrike had already flown off though, and the grouse maintained the display for only 15–20 seconds before also flying away.

I believe the shrike was attracted to the hen by her clucking. In conducting field studies of Spruce Grouse over several years, I have seen Goshawks (*Accipiter gentilis*) appear several times in similar circumstances. Goshawks are also occasionally attracted by the distress call of a grouse chick.

Apparently shrikes rarely attack grouse-sized birds (500–700 g for Spruce Grouse) and White (Wilson Bull., 75:461, 1963) thought his observation of a Northern Shrike attacking a Sharp-tailed Grouse (*Pedioecetes phasianellus*) might have been due to "redirected" behavior. A shrike he had been watching had killed a Pine Grosbeak

(*Pinicola enucleator*) but before the shrike could eat the grosbeak, White flushed three Sharptails near the shrike. White thought that his presence and the startling flight of the grouse interrupted the shrike's feeding behavior, and that the shrike attempted to consummate its feeding sequence by attacking the grouse. None of the elements of this situation appeared to be present in the instance of the shrike attacking the Spruce Grouse, and as White notes (pers. comm.) shrike attacks on grouse-sized birds may be more frequent than suggested by the literature.—LAURENCE N. ELLISON, *Museum of Vertebrate Zoology, University of California, Berkeley, California 94720, 7 April 1970.*

Black-necked Stilt nesting in Delaware.—On 13 May 1970 I observed two pairs of Black-necked Stilts (*Himantopus mexicanus*) building nests in the north impoundment of the Little Creek State Wildlife Area near Little Creek, Kent County, Delaware. This 800-acre impoundment of shallow, saline water was completed in 1967 by the diking of tidal salt marsh bordering Delaware Bay. An estimated 95 percent of the area is open water and flooded salt-meadow cordgrass (*Spartina patens*) and saltgrass (*Distichlis spicata*) marsh.

On 15 May I waded into the impoundment and inspected the two nests. Both were low mats, fairly wet and muddy, built of pieces of dead marsh grasses. Each nest was situated on a small irregular island of very soft mud in open water. There were three eggs in the shallow central depression of one nest and none in the second.

On 28 May I again waded into the impoundment. The three egg nest had been built up to a height of five inches, was completely dry, and now contained six eggs. The second nest was empty and appeared little changed from its condition on 15 May. With additional search, four more nests with clutches of 8, 8, 4 and 2 eggs, respectively, were located. During early June five more stilt nests were observed from the impoundment dike. No precise data on nesting success were obtained but chicks were seen at four of the eleven nests during June and early July.

In the eastern United States, the Black-necked Stilt breeds in South Carolina, central and eastern Florida (A.O.U. Check-list of North American birds, 1957:210) and coastal North Carolina (Audubon Field Notes, 14:443, 1960; 16:467, 1962). It formerly nested on the salt marshes of southern New Jersey (Fables, Annotated list of New Jersey birds, 1955:36) but there is no definite evidence of breeding there since 1810 (Stone, Bird studies at old Cape May, 2:510–512, 1937). In 1952 an attempt was made to re-establish a breeding population in New Jersey by placing stilt eggs from Florida in Willet nests (Fables, op.cit.). The effort was unsuccessful though four eggs hatched. On 24 May 1962 Lesser (Cassinia, 47:31, 1963) observed the Black-necked Stilt on the Little Creek State Wildlife Area, Delaware, apparently the first record on the Delmarva Peninsula this century, and it has been observed there every year subsequently. Efforts to find nests were unsuccessful in 1964 (Delmarva Ornithologist, 2:15, 1965) and in 1965 (Delmarva Ornithologist, 3:4, 1966). However, two family groups of two adults and three to four immatures each were seen on the area 26 July 1964 (Audubon Field Notes, 18:502, 1964) and Carlson (Atlantic Nat., 24:171, 1969) reported a mated pair accompanied by three young birds on 5 July 1969.

The Little Creek nests are the first Delaware nest records for the Black-necked Stilt and the first definite records north of North Carolina since 1810.—NORMAN E. HOLGERSEN, *Bombay Hook National Wildlife Refuge, Smyrna, Delaware 19977, 19 June 1970.*

Pheasant chases Fox.—Errington (Of Predation and Life, Iowa State University Press, 1967:222) proposed the theory that prospective prey displaying alertness towards predatory dangers yet conducting itself in a recognizably confident manner may discourage predators from attacking. The following incident seems to be an example of this phenomenon.

On 5 June 1969, about 18:30, on Letterkenny Army Depot, Chambersburg, Pa., I noticed a red fox (*Vulpes fulva*) walking through a grassy roadside ditch. A hen Ring-necked Pheasant (*Phasianus colchicus*) ran out of the ditch about 10 feet in front of the fox and onto the road. She stopped when about 20 feet from the fox and they looked at each other. A cock pheasant was standing in the grass about 15 feet on the other side of and about 1 foot above the fox. When the hen ran onto the road the cock stretched his neck and looked at the hen and fox. Then he walked straight towards the fox while extending himself to full height, half-flapping his wings, and making "clucking" sounds. The fox turned its head suddenly towards the cock and moved several steps away from him. They stared at each other for a few seconds and then the pheasant repeated the performance, this time coming within about 1 m of the fox. The fox then trotted off away from both pheasants, without a backward glance.

Errington also stated that predatory vertebrates can surmise when an attempt is not worth the effort. In this instance the pheasant posed no danger to the fox, but its aggressive behavior seemed to cause the fox to leave the scene, although the distance between the two appeared to be small enough for the fox to attack if it had been so disposed.

I doubt that my presence scared the fox, as I was inside a truck about 100 yards away and had been parked 15 minutes before the fox appeared. I observed the happenings with 7 × 35 binoculars.

Humphries and Driver (Science, 156:1767–1768, 1967) stated that protean behavior, unsystematic escape behavior, serves to confuse predators and allow prey to escape. It seems that confident and/or aggressive behavior on the part of the prey may also be an important factor in prey survival, as Errington stated, although the result may depend more on the relative sizes of predator and prey.—John Ludwig, *Cooperative Wildlife Research, Southern Illinois University, Carbondale, 2 March 1970.*

Predation on a netted bird by Smooth-billed Anis.—On 21 February 1970 while netting seedeaters and doves at the edge of a field on the llanos of eastern Colombia 85 km east of Villavicencio, we were surprised to observe a group of Smooth-billed Anis (*Crotophaga ani*) attacking and eating an immature male Blue-black Grassquit (*Volatinia jacarina*) that was caught in the net. The anis were not present near the net prior to our "drive" and must have come towards us from the adjacent plaintain patch while we were walking towards the net. At least eight anis were perched in the vegetation opposite the seedeater and several were observed to fly at it. Two anis became loosely trapped in the net near the seedeater but flew off as we came close. The rest of the anis also left, easily avoiding the net. In the few brief minutes before we reached them, the anis had decapitated the seedeater and devoured most of its skull. That the attack on the seedeater was intentional rather than the fortuitous action of frightened and entrapped anis is indicated by the coming of the anis to the net from the opposite direction, the flights at the seedeater before being flushed by our approach, and the fact that the anis in the net were not close enough to the seedeater to bite it.

Anis are primarily insectivorous (Bent, U.S. Natl. Mus. Bull., 176:22, 1940; Davis, Auk, 57:179–218, 1940; Rand, Auk, 70:26–30, 1953; Skutch, Auk, 76:284–286, 1959) though occasionally they take small lizards and in times of food shortage vegetable matter. They may also rob nests (Bent, U.S. Natl. Mus. Bull., 176:22, 1940; Haverschmidt, Auk, 72:325–331, 1955) but observations to this effect are rarely included in descriptions of their feeding habits. To our knowledge there are no reports of predatory acts comparable to what we observed. It would be interesting to know how often natural analogs of such behavior occur during the dry season or other times of food shortage.

We are grateful to W. B. Dixon Stroud for making this trip possible and to Alexander M. and Mary Ross Fisher for their generous hospitality in Colombia.—Frank B. Gill and C. C. Stokes, *Academy of Natural Sciences, Philadelphia, Pennsylvania 19103, 2 April 1970.*

Chipmunk predation on Bank Swallows.—On the afternoon of 22 June, 1969 I was observing nesting activities at a colony of Bank Swallows (*Riparia riparia*) located in the town of Sunderland, Franklin Co., Massachusetts. As I watched an eastern chipmunk (*Tamias striatus*) appeared at the top of the bank in which the colony was located, moved down the bank, and began entering burrows. It spent some five to ten minutes in each of two burrows, then entered a third burrow from which it emerged dragging a dead Bank Swallow. At this point it was mobbed by eight to 10 other Bank Swallows, (it had previously been unmolested) upon which it took refuge in a fourth burrow. The dead bird proved to be a recently killed adult female that had been bitten at the base of the skull.

This may be the first recorded instance of chipmunk predation on Bank Swallows. Other examples of chipmunk predation on birds have, however, been noted. Crandall (J. Mammal., 17:287, 1936) relates an instance of predation on immature sparrows. Smiley (J. Mammal., 23:91–92, 1942) relates several instances involving adult birds caught in bird traps.—Michael E. Ginevan, *Department of Zoology, University of Massachusetts, Amherst, Massachusetts, 16 August 1969.*

Seaside Sparrow hits a TV tower near Raleigh, North Carolina.—On 5 November 1968 Robert Searcy found a dead Seaside Sparrow (*Ammospiza maritima*) at the WRAL television tower (1175 feet high; 190 feet above sea level), 9 miles southeast of Raleigh, North Carolina. The bird, a female, was identified by R. C. Laybourne as *A. m. maritima.* The specimen is in the North Carolina State Museum (NCSM 2904).

This record is unusual in that no instances of a Seaside Sparrow hitting an obstruction at night are known to us, and therefore this is the first direct evidence that the Seaside Sparrow is a nocturnal migrant. It is generally believed that the Seaside Sparrow stays close to the coast during migration, and this belief is supported by the lack of Gulf Coast winter records for any of the Atlantic coast subspecies (A.O.U. Check-list, 1957). In addition, Stoddard and Norris (Tall Timbers Research Sta., Bull. No. 8, 1967) did not find any Seaside Sparrows among the 29,400 birds picked up at a TV tower in northern Florida.

Raleigh is 90 miles west of the nearest Seaside Sparrow habitat, the brackish marshes at the head of the Pamlico River. However, it is more likely that the bird came from farther north, as *A. m. maritima* breeds only as far south as northeastern North Carolina, or about 140 miles northeast of Raleigh. That the bird did come from this direction is supported by the fact that the prevailing wind on the night of 4–5 November was northeast, averaging 1–8 mph, and gusting to 17 mph.—WILLIAM POST AND MICOU M. BROWNE, *Department of Zoology, North Carolina State University, Raleigh, N.C., 27607, 20 February 1970.*

Nesting habits of the Oregon Junco in Montana.—In the extreme northwestern corner of Montana, the Oregon Junco (*Junco oreganus*) occurs as a common breeding bird from the valley farmlands and woodlands upward through Canadian and Hudsonian zone forests to near timberline on the higher peaks. In total numbers for the entire valley and mountain area, it probably ranks second to the Pine Siskin (*Spinus pinus*) in abundance.

An indication of the habitat preference and decline in numbers at my ranch near Fortine during the years 1928 to 1931 is given by the accompanying table. Figures are from cooperative breeding census surveys which I made for the then Bureau of Biological Survey, and record the number of pairs present during the breeding season rather than numbers actually found nesting. As shown, the decrease in numbers of Oregon Juncos during the period is comparable to a general decrease in the total bird population which occurred despite very little alteration of the habitat. During the 40 years since, the population of most species in comparable habitat areas in the same locality has declined very markedly.

My permanent records contain data on 46 occupied nests, of which seven have been in sites varying from the usual. Both normal habits and these unusual nests will be described briefly.

In the valleys of northeastern Lincoln County (2,500 to 3,500 feet altitude), in occasional years, a few Oregon Juncos (probably of more than one subspecies) are present throughout the winter. Normally, summer resident birds arrive in late February or March, and a few commence nesting activity late in April. My earliest date for a normal set of four eggs is 4 May 1947, but I found young in a nest 10 May 1930.

An irregular pattern of May and June nesting is suggested by these dates for eggs (in different years): 1 to 10 May, three nests; 11 to 20 May, one nest; 21 to 31 May, four nests; 1 to 10 June, one nest; 11 to 20 June, eight nests; 21 to 30 June, two nests. A more systematic and continuous study during this period would perhaps show a less variable seasonal pattern.

After hatching, young birds have remained in nests from 11 to 14 days. Young birds on the wing, fed by adults, have been seen as early as 1 June, and become common by 15 June.

Late season nesting or re-nesting in the valleys occurs in late July and early August. Some dates: 2 July 1937, first egg; 10 July 1937, three eggs; 14 July 1927, young hatching; 19 July 1955, three eggs; 25 July 1934, nestlings two-thirds grown; 3 August 1930, one egg and three nestlings perhaps two days old.

At least some of the Oregon Juncos that nest in the higher mountains move upward in March or April, although the snow cover is still deep. I have found them in early April at 7,300 feet where the snow depth was 7 to 10 feet. Nesting takes place in July

TABLE 1

NUMBER PAIRS ADULT OREGON JUNCOS PRESENT DURING BREEDING SEASON

Area	1928	1929	1930	1931
60 acres farm land and deciduous woods	47	33	10	10
40 acres open pasture and sparse conifer woods	18	9	3	1
40 acres heavy second-growth fir-larch-lodgepole pine	32	24	12	8
80 acres heavy uncut forest fir-larch-lodgepole pine	57	49	22	10
Total for 220 acres	154	115	47	29
Total pairs all bird species	1009	870	705	595

after the snow has largely but not entirely disappeared. Here are some dates: 4,500 feet: 24 June 1932, nestlings 3 or 4 days old; 5,590 feet: 2 July 1922, one nest with five eggs, one with four small nestlings; 6,500 feet, Canadian zone: 1921, four eggs 4 July, young left the nest 27 July; 6,350 feet, Canadian zone: 1932, four young hatched 30 July to 1 August.

At my ranch near Fortine, some nests have been placed in unusual sites. For three years a pair constructed its nest and successfully raised young in the side of a strawstack several feet from the ground. In 1941 a nest was placed 6 inches back in packed hay in the side of a hayshed, 3 feet from the ground. The young birds left the nest 27 June.

In 1931, a female Oregon Junco constructed and used a nest on the inside wall of a log barn, its top 38 inches from the floor. This nesting venture has previously been described (Bird-Lore, 35:155–156, 1935. Photograph printed sidewise).

In 1941, a pair nested successfully in an old Robin nest saddled on a rafter of an open-end garage, 8 feet from the floor. The young birds left the nest 26 May.

Most unusual was a 1956 nest constructed in the interior of a woven-reed fish basket hanging on a garage wall 5 feet from the floor. Entrance and exit were gained through the 2 × 3½ inch slot in the basket's cover, about 9 inches from the bottom and an inch out from the nearest side. Four eggs were laid 11 to 14 May, and the young birds left the basket 6 June.—WINTON WEYDEMEYER, *Fortine, Montana 59918, 5 March 1970.*

Large number of birds exploiting a fruit tree in Surinam.—Near Phedra on a hill overlooking the Surinam River I noted on 13 November 1969 many birds feeding in a fruit-bearing tree amidst dense secondary growth. The tree had a height of about 15 meters and was filled with dense clusters of round fruits of the size of a cherry which had split open showing orange seeds. The tree was identified by Dr. G. F. Schulz of the Surinam Forest Service as *Guarea guara* (Meliaceae) and is locally known as Doivisiri (pigeon seed or kernel).

A number of birds constantly came to the tree, took seeds from the splitting fruits, and then flew away. This prevented my counting the individual birds that took part, but 23 species were recorded. They were: Little Chachalaca (*Ortalis motmot*), Black-spotted Barbet (*Capito niger*), Cinnamon Attila (*Attila cinnamomeus*)*, Grayish Mourner (*Rhyptipterna simplex*)*, Cinereous Becard (*Pachyramphus rufus*)*, Tropical

Kingbird (*Tyrannus melancholicus*), Streaked Flycatcher (*Myiodynastes maculatus*), Boat-billed Flycatcher (*Megarhynchus pitangua*), Rusty-margined Flycatcher (*Myiozetetes cayanensis*), Great Kiskadee (*Pitangus sulphuratus*), Short-crested Flycatcher (*Myiarchus ferox*)*, Yellow-olive Flycatcher (*Tolmomyias sulphurescens*), Yellow-bellied Elaenia (*Elaenia flavogaster*)*, Forest Elaenia (*Myiopagis gaimardii*)*, Ochre-bellied Flycatcher (*Pipromorpha oleaginea*)*, McConnell's Flycatcher (*Pipromorpha macconnelli*)*, Red-eyed Vireo (*Vireo olivaceus*)*, Ashy-headed Greenlet (*Hylophilus pectoralis*)*, Blue Dacnis (*Dacnis cayana*)*, Blue-gray Tanager (*Thraupis episcopus*), Palm Tanager (*Thraupis palmarum*), Silver-beaked Tanager (*Ramphocelus carbo*), and Buff-throated Saltator (*Saltator maximus*)*. Specimens of those species marked (*) had *Guarea* seeds in the gizzards.

The presence of *Attila cinnamomeus* and *Hylophilus pectoralis* (I collected three specimens of the latter) came as a surprise for although they are well-known birds in the coastal area of Surinam I had not previously found them so far into the interior. They may have been wanderers. None of my specimens was in breeding condition except a male *Pipromorpha macconnelli* that had greatly enlarged testes.

The chachalaca, the Black-spotted Barbet, the Blue Dacnis, and the tanagers took the seeds while sitting on a branch, but all the others removed them in flight, fluttering in front of the fruits.

Unhappily in the course of the day a sweeping fire destroyed the whole lower vegetation of the area, and scorched the lower branches of the tree so that in the end it stood isolated in a burnt-over area. Nevertheless, I observed the same species feeding on the fruits of this tree on 16, 19, 23, and 30 November.—F. HAVERSCHMIDT, *Wolfskuilstraat 16, Ommen, Holland, 16 March 1970.*

NEW LIFE MEMBER

Dr. Walther Thiede, a scientific adviser for the Far East for a German pharmaceutical firm has recently become a Life Member of the Wilson Ornithological Society. Dr. Thiede, who is both a pharmacist and a zoologist, obtained his doctorate at the University of Bonn. His major ornithological interests are the geographical distribution and life histories of palearctic birds, and he has published three books and 15 papers on ornithology. He is a member of ornithological societies in Germany, Sweden, Denmark, Finland, Switzerland, and the United States. Dr. Thiede is married and lives currently in Kobe, Japan.

ORNITHOLOGICAL NEWS

With a great sense of loss we report the death on 3 February 1971 of Aaron M. Bagg, a Patron, and a Past-President of The Wilson Ornithological Society.

The publication of the biennial membership list as a separate supplement to the December issue of the *Bulletin* was done as an experiment with a cheaper method of reproduction than standard letterpress. The Editor would welcome comment and opinion, both favorable and unfavorable, on this matter.

Members are advised that accommodations for the Annual Meeting on Dauphin Island, Alabama may be in limited supply. Advance reservations are a necessity.

Mrs. Hazel Bradley Lory, longtime chairman of the Membership Committee is the latest addition to the list of Patrons of the Society.

For his contributions in ornithology, ecology, and international conservation, S. Dillon Ripley, Secretary of the Smithsonian Institution, was awarded the seldom-given Gold Medal of the Royal Zoological Society of Antwerp, Belgium.

A "Bibliography of Wildlife Theses" containing about 3000 citations of American and Canadian theses from 1900 to 1968 is currently available from: Biological Information Service, 601 South Vermont Avenue, Los Angeles, California 90005, for $8.85.

A set of LP records of bird vocalizations to accompany the "Field Guide to the Birds of Britain and Europe" is being published abroad. Jeffery Boswall of Birdswell, Wraxall, Bristol BS19 1JZ, Great Britain has submitted a long list of species for which recordings are still needed. Most of these, of course, are of Palearctic forms but such North American forms as: Magnificent Frigatebird, Black Duck, Bufflehead, Hooded Merganser, Purple Gallinule, White-rumped Sandpiper, Buff-breasted Sandpiper, Pomarine Jaeger, Royal Tern, and Noddy are on this list. Persons who might be able to provide such tapes are asked to contact Mr. Boswall. The Editor of the *Bulletin* will be happy to supply a copy of the complete listing to anyone interested.

REQUEST FOR INFORMATION

I am trying to locate the field notebooks and journals of Albert J. B. Kirn, Texas field naturalist, who lived in Somerset, Texas from 1922 until his death in 1950. I am gathering information for a biographical article and other projects concerning his work. Mr. Kirn collected all sorts of natural history specimens, including bird eggs and skins, in Texas, Oklahoma and Kansas, and perhaps in Louisiana and California. I would like to correspond with anyone who knew Mr. Kirn and/or knew of his work.—*Emma H. Messerly, 344 S. E. Elmhurst, Bartlesville, Oklahoma 74003.*

ORNITHOLOGICAL LITERATURE

Australian Parrots. By Joseph M. Forshaw. Livingston Publ. Co., Wynnewood, Penna., 1969: 10 × 12 in., xiv + 306 pp., 72 color pls., 54 range maps, 8 figs., 1 map, 20 black and white photos. $29.50.

This formidable tome describes, depicts, and discusses all species of Australian parrots. Parrot literature is profuse and widely scattered, and the author has done a good job of bringing together that which is pertinent to the Australian species. He also has added many notes from his own observations, primarily from field and aviary.

With the inclusion of the Red-fronted Parrot (*Cyanorhamphus novaezelandiae*) and the Kaka (*Nestor productus*), both from Norfolk Island, the splitting of the seven species of *Platycercus* of Peters (1937) into 10, and the lumping of Peters' four species of *Calyptorhynchus* into three, the number of species included is 54. These are arranged in a new classification that recognizes three parrot families, the Loriidae, Cacatuidae, and Psittacidae, with the Cockatiel (*Nymphicus hollandicus*) placed in a separate subfamily within the Cacatuidae, and the Kaka placed in a separate subfamily of the Psittacidae. *Eolophus* is the generic name used for the Galah (*E. roseicapillus*); *Eclectus* is used instead of *Lorius* for the Eclectus Parrot (*E. roratus*); *Barnardius* is the generic name used for the Mallee Ringneck (*B. barnardi*) and the Port Lincoln Parrot (*B. zonarius*); and Bourke's Parrot, *Northiella haematogaster* in Peters, is considered a species of *Psephotus.*

The introduction includes a brief, and in my opinion grossly oversimplified, discussion of Australia's zoogeographic regions, habitat descriptions with twelve good black and white photographs, an explanation of the format for the species accounts, and a brief section on keeping parrots in captivity. Two maps of the continent, one outlining three zoogeographic regions, the other delimiting the states and showing numerous localities, occupy full pages. The information they give could be assimilated more easily if presented on one map. The method used to depict the external anatomy of a parrot is poor. I doubt that one can understand the feather groupings of a bird's pectoral appendage by studying a diagram of a folded wing. The confusion that persists regarding the parts of the avian leg is furthered by labeling the ankle joint the thigh.

The families, subfamilies, and genera are briefly characterized, and the species accounts are arranged in systematic sequence. These accounts include plumage descriptions of all species and endemic subspecies, and measurements for the nominate or some endemic race. Distribution, including a range map, status, and habitat are given for each species. Behavioral observations are included under the headings habits, movements, flight, calls, feeding, and breeding. Lists of other common names and aviary notes complete the accounts.

Each species is illustrated by one, sometimes two (and in one case three) large color plates. Mostly these are excellent portrait photographs of captive individuals or occasionally pairs. Several of the photographs of wild birds are first rate. The five species for which color photographs do not exist are depicted in paintings by J. C. Yrizarry. Unfortunately, the color plates are not bound in with the text, but are glued in, and at the top only! Already several in my copy are partially unglued and others are dog-eared at their unattached bottom corners. Such construction also results in the book being thicker within than around the edges which means through the years dust will filter onto the pages and plates. Certainly when one pays $30 for a book he expects better construction.

My major criticism of *Australian Parrots* pertains to another feature of its construction, the plethora of blank pages. In this dawning of an era of environmental awareness I shudder when I think of the trees that were killed and the waters that were polluted to produce paper on which nothing is printed. Even ignoring the bountiful margins, over 22 square feet of unprinted paper exists in this book. And the waste does not end once the book is finished because librarians will have to provide space for the tome forever after.—GLEN E. WOOLFENDEN.

BIRDS OF WEST CENTRAL AND WESTERN AFRICA. AFRICAN HANDBOOK OF BIRDS. SERIES III, VOLUME I. By C. W. Mackworth-Praed and C. H. B. Grant. Longman Group Ltd., London, 1970: 8¾ × 6 in., 671 pp., 45 col. pls., numerous range maps and text figures. £ 6. ($14.40).

With the appearance of Volume I of Series III, on the birds of western Africa, the Handbook of African Birds approaches its completion. Series I and II covered eastern and northeastern, and the southern third of Africa respectively, and Series III completes the coverage of the whole of Africa south of the Sahara. The same arrangement is followed in each series, two volumes divided roughly between the non-passerine and passerine birds, and the format varies only slightly from series to series. Since these books have been only sparsely noticed in the North American literature, Series I only in the *Auk* (72: 307–308, 1955; 73: 297–298, 1956), and Series II not at all, this review may be considered as applying to the whole Handbook.*

Each Series is opened with an introduction containing brief sections on taxonomy, identification, nomenclature, migration, molt and geography. The bulk of the volumes is occupied by the systematic list, and each has its own index. The list is divided by families, with the ordinal groupings ignored, and each family is headed by a dichotomous key to the species. The species accounts open with a full description, including plumage variations due to age, sex or time of year; in polytypic species one race is described first, followed by brief diagnoses of the other subspecies. The ranges of each species or subspecies are described and also shown on small outline maps on the margin of the page. Then, for the species as a whole, follow paragraphs on habits, nest and eggs, breeding records, food, calls, and the range of the species outside the area covered by that particular volume. The great majority of the species are illustrated by color plates, and for those not shown, there is usually a marginal sketch showing the diagnostic characters. Although many species are found throughout Africa, they are treated in full in each series, so that each of the latter is complete for its area.

As stated explicitly by the authors, these volumes are intended primarily for field use, to provide local residents and travelers with the sort of introduction to the bird life that was completely lacking when the authors themselves first visited Africa. As such they are both more and less than the typical Peterson field guide, more in that they provide much more of descriptions and life history notes, and less in that they cannot compare as ready means of identification. This last is inevitable because many African species are still known almost entirely from museum skins. This is particularly true in western and west-central Africa, and in the present volume the authors were unable to add the section of black and white photographs found in the previous ones because so

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* Birds of Eastern and Northeastern Africa. African Handbook of Birds. Series 1, Volumes I and II. By C. W. Mackworth-Praed and C. H. B. Grant. Longmans, Green and Co. Ltd., 1952 and 1955. Birds of the Southern Third of Africa. African Handbook of Birds. Series II, Volumes I and II. By C. W. Mackworth-Praed and C. H. B. Grant. Longmans, Green and Co. Ltd., 1962 and 1963.

few were available. Color plates, keys, descriptions, ranges, call notes and habitat must all be combined to produce reliable identifications, and in genera like the grass warblers, *Cisticola*, years of experience as well.

Now that the final volumes of the Handbook are being published, it is interesting to review their history and the place they occupy in African ornithology. According to the senior author, the African Handbook of Birds was started on 1 January 1933. From 1933 to 1951, a series of taxonomic revisions, primarily the work of Claude Grant, appeared in the *Ibis* and the *Bulletin of the British Ornithologists Club*, and in 1952 the first of the Handbook volumes was published. Grant died in 1958, but Mackworth-Praed has completed its publication. Considering the unfinished state of a number of other major handbooks and monographs, this is a major accomplishment and one reflecting great credit on the authors. As for its place in African ornithology, it is the only handbook or guide to large areas of the continent, such as the Congo (*pace* Schouteden who published in Flemish) and Angola, and the only one to cover the Ethiopian fauna as a whole. In fact Africa now has the distinction of being the only major faunal region to have its avifauna encompassed in a single handbook. For anyone studying African birds either in the field or the museum, these volumes are a must.—Melvin A. Traylor.

Finding Birds in Mexico. By Ernest P. Edwards. Ernest P. Edwards, Sweet Briar, Virginia. 2nd ed., 1968: 6¼ × 9¼ in., xxi + 282 pp., 15 pls. (4 in color) and 7 maps. $4.95 paperback, $6.95 clothbound.

Finding the Birds in Western Mexico, A Guide to the States of Sonora, Sinaloa and Nayarit. By Peter Alden. University of Arizona Press, Tucson, Arizona, 1969: 7 × 10 in., xiv + 138 pp., 9 col. pls., 10 habitat photos, and 17 maps. $5.95 paperback, $7.50 clothbound.

An ornithologist is faced with a dilemma when reviewing books written for bird watchers, especially when they cover geographic areas less well known than the continental United States. Should one review them as contributions to our knowledge of ornithology, or as to how well they fulfill the stated objectives; in this case in aiding those involved in avian bridgemanship or avian golfmanship, i.e., seeing the maximum number of kinds of birds? Suffice to say the books under review accomplish the latter mission in a satisfactory manner. Both books briefly describe subdivisions of the regions covered. Alden's "Western Mexico" comprises essentially the northern half of Edwards "Pacific Lowland Region." Both authors include maps, small scale in Edwards, large scale with many local details in Alden, and both include lists of birds at major localities discussed in the texts. These lists are apparently complete in Alden, while they include only species most likely to be seen in Edwards. The plates help fill one of the gaps in the literature of the Mexican avifauna by providing illustrations of non-A.O.U. Check-list species. John O'Neill, who did the nine fine colored plates in Alden, had fewer species to illustrate than Edwards as well as the luxury of a slightly larger format. Thus his figures are considerably larger, less crowded and more detailed, although some color values, undoubtedly lost in the printing, are unfortunately poor in some plates (yellows tend to be greenish and browns too dark). The diagrammatic and rather amateurish illustrations in Edwards suffer by comparison, yet provide unique colored illustration of a number of species including Dwarf Vireo, Slaty Vireo and Sierra Madre Sparrow and the characteristic juvenal plumage of the Yucatan Jay.

A checklist of species is presented in each book, and Edwards adds a Spanish name (mostly never notated), coded range and a few words on calls or descriptions. Alden's English nomenclature is based on the A.O.U. Check-list and that in Eisenmann's "Species of Middle American Birds." Much of Edwards' nomenclature is his own; for example, "Green Woodpecker" for Bronze-winged Woodpecker; "Tucuchillo" for Ridgway's Whip-poor-will; "Laughing Creeper" for Ivory-billed Woodcreeper; and "Jungle Tanager" for the Red-throated (or Dusky-tailed) Ant-Tanager. Edwards lists as species (one suspects for the sake of the listers) many distinctive (but some not so in the field) subspecies. Thus he includes two Rough-winged Swallows, two Brown Jays, six House Wrens and seven species of *Junco* (Eisenmann lists only four of the latter for Mexico and there are probably only two biological species!).

Both books provide ornithologists with frustrations! Edwards personally has had more field experience with Mexican birds than the six authors of the three most frequently encountered books on the subject, yet little solid information can be gleaned from his book.

Ranges are occasionally given that differ from information now available, but without substantiating data; for example, the Eared Grebe is said to be a winter visitant in the "southern highlands," and the Least Bittern is found in "all" regions. I have confidence in these statements, but wish dates and localities were cited. Alden, covering a much smaller area, is able to provide complete locality lists with season or months often cited. Unfortunately the completeness of the lists does not indicate their degree of credibility and they will probably mislead beginners. Some examples (*fide* Allan Phillips): Black Swifts are not known even to migrate through Sinaloa; there are only two Sinaloa records for Cassin's Sparrow (thus hardly a species to point out to be looked for, p. 512); neither San Blas nor Green Jays range north of the San Blas region, nor does the White-lored Gnatcatcher occur north of Michoacan; Rufous-sided Towhees do not inhabit Cerro San Juan, near Tepic, and Baltimore Orioles and Purple Martins have not been definitely recorded at Tepic! Especially notable is the inclusion of a summary of "Christmas Bird Counts" for 4 years 1964–1967 at San Blas, Nayarit including apparently first state records for a number of species and including the only Pacific coastal records or southernmost records along the Pacific for the Double-crested Cormorant, Surf Scoter, Dunlin, Glaucous-winged Gull and Bonaparte's Gull among others. While some unbelievable records for San Blas and elsewhere too, distributed earlier in mimeograph form in the "Vermilion Flycatcher," have been deleted, still included are sight records of species that are not known to winter at San Blas such as Semipalmated Sandpipers (probably were Western), Wood Pewees, Philadelphia Vireo, and Virginia's Warbler, among others. There are no valid winter records for the Semipalmated Sandpiper from any place in Mexico! One wishes that someone along on each Christmas Count would ride shotgun! Alden is to be congratulated for listing difficult species only within complexes such as "*Empidonax*, light-breasted (White-throated, Dusky, Least and/or others)" and "*Myiarchus*, medium size (Nutting's and/or Ash-throated)" but apparently other confused species should also have been listed in this manner such as small sandpipers and "Orioles, medium sized, dull (Baltimore/Bullock's Oriole)."

In summary, ornithologists and bird watchers who have had no experience in Mexico will find Edwards' distributionally reliable book helpful, but the former will soon outgrow it. Alden's book is a useful gazetteer and gives lists of species by locality. We await being proved wrong in our judgment of some records by the production of well-documented specimens.—Robert W. Dickerman

SASKATOON WETLANDS SEMINAR. Canadian Wildlife Service Report Series—No. 6. The Queen's Printer, Ottawa, 1969: 8¼ × 11 in., 262 pp., illus., paperback. $5.25.

The "Saskatoon Wetlands Seminar" is the sixth publication of a new series by the Canadian Wildlife Service. All of the previous numbers have been highly attractive publications; the present report continues this format with pleasing typography, imaginative layout and skillful editorial treatment. The opening of the Canadian Wildlife Service's Prairie Migratory Bird Research Centre in Saskatoon, Saskatchewan, was the occasion of the above document. The size and scope of the report underscore the importance of prairie small water areas in the ecology of our continental waterfowl populations. As D. A. Munro indicates in his introductory remarks, nearly two-thirds of the most sought-after ducks are produced in the small wetlands of the prairie provinces. The opening of the new laboratory emphasizes the need for research and management in these wetland complexes if we are to cope with the continued disappearance of small prairie wetlands as intensified agriculture works them into crop or forage production.

The book is divided into four sections; Part I examines the significance of small wetlands in waterfowl production, beginning with an excellent statement of management goals by F. G. Cooch. Other papers in this section concern the agricultural uses of wetlands, engineering problems, legal considerations and the economic values of small wetlands. These papers present a broad sweep of viewpoints. Part II is a review of research progress and needs on prairie potholes; hydrology, soils and habitat classification make up the backbone of this section. Part III relates to waterfowl populations and the responses of these birds to small wetland ecology. Part IV is an excellent review of methods and problems of measuring waterfowl breeding populations by ground counts. L. R. Jahn presents summaries of each section which do much to pull the material together. The seminar concludes with a summary by J. B. Gollop of a day-long discussion which ranged freely over the various subjects presented earlier.

While there are many very interesting papers in this collection, two authors deserve special mention. W. F. Crissey sets forth a great many exciting ideas which need continued thought and study. Two papers by Alex Dzubin are also highly stimulating reading for anyone concerned with waterfowl biology.—DANIEL Q. THOMPSON

MEMOIRS OF A NATURALIST. By Herbert L. Stoddard, Sr. University of Oklahoma Press, Norman, 1969: 9½ × 6½ in., xix + 303 pp., clothbound. $6.95.

Most of us know Herbert L. Stoddard, Sr., for the monumental work "The Bobwhite Quail: Its Habits, Preservation, and Increase." Those who read this biography will perhaps be surprised to learn that Stoddard was first an ornithologist and, later, a pioneer in wildlife management.

The book is divided into three major sections which correspond to the author's experiences. The first section, "The Florida Years," suggests that Stoddard's strong affinity for the pinelands of the southeast had its roots in his early boyhood. These were rigorous but rewarding years before the turn of the century, when his family struggled to create a new life in the pine flatlands of east-central Florida. The author's recollections of these early years are remarkably detailed and offer valuable insights into the vast changes which have occurred in Florida in little more than 60 years.

The second section of the book, "The Museum Years," describes the author's growing interest in descriptive ornithology and museum work. This portion of the book will be of interest to those who wish to see the background of the modern museum. Many prominent scientists are mentioned in these chapters. The last section of the book, "The Georgia Years," describes the author's emergence as a wildlife ecologist. Stoddard's career in the Biological Survey and the organization of the Co-operative Quail Study Association are described. In this section, the history of what is now the field of wildlife management emerges. The author's relationships to the leaders in this growing field are interesting to pursue.

There is perhaps more detail in this work than the reader will wish to become immersed in; however, I was fascinated by the descriptions of institutions, scenes, and personalities now long gone. One is struck by the remarkable achievements of this self-made man who never had the opportunity to attend high school.—DANIEL Q. THOMPSON

ASPCA GUIDE TO PET CARE. By Diana Henley. Taplinger Publishing Company, New York, 1970: 5 × 8 in., paper covered, x + 70 pp., many photos. $1.25.

Devoted mostly to dogs, cats, and rodents, this book includes a few concise pages of practical advice on keeping parakeets and canaries. The author is the Head of Education for The American Society for the Prevention of Cruelty to Animals.—P.S.

AVES. Compiled by Carolyn Roberts and Dorothy Thelwall. The Zoological Record, Vol. 104, Section 18, 1967. The Zoological Society of London, 1970: 7¼ × 9¾ in., v + 264 pp. $8.40.

This is the latest number of a most useful bibliographic reference, a catalog of ornithological literature published in 1967. Entries are listed in author, subject, and systematic indexes. The author index is 50 percent larger than that for the previous year, an indication of the mushrooming scientific literature. While many libraries receive the complete Zoological Record, many zoologists find it convenient to subscribe to the individual section for their own field.—P.S.

BIRDS IN WESTERN COLORADO. By William A. Davis. Prepared for the Colorado Field Ornithologists, 1969: 5½ × 8½ in., paper covered, 61 pp., 15 charts. $1.75. Order from the Historical Museum and Institute of Western Colorado, 4th and Ute, Grand Junction, Colorado 81501.

Charts and text remarks summarize the seasonal and locality distributions of western Colorado birds. These are followed by detailed suggestions to help visiting birders—trips for bird finding in general, and ways to see special birds which are not seen in most parts of the country. This booklet is well prepared and should prove useful to birders in this region, where birding is difficult.—P.S.

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CONTENTS

GENERAL NOTES

PRE-ATTACK POSTURE OF THE RED-TAILED HAWK

James W. Grier

Thorpe (1951:253–254), Meinertzhagen (1959:13) and others have suggested that prey animals may not only recognize predators as such but also be able to distinguish between times when the predators are ready to attack and those times when they are not. During experiments performed by Hamerstrom (1957), various song birds mobbed a tethered Red-tailed Hawk (*Buteo jamaicensis*) more often when it was hungry than when it was well-fed. Hamerstrom suggested that the song birds recognized differences in body and feather postures of the hawk. Several interesting biological questions arise from the implied possibility that a *perched* hawk shows evidence of readiness to attack. Although young raptors show evidence of hunger by food-begging while still being fed by their parents, it seems that any behavior that might warm prey of danger would be quite disadvantageous and should be selected against.

While many raptor attacks on prey occur from perched positions, most raptor-prey observations have dealt with flying raptors (e.g. Rudebeck, 1950) or with perched raptors that were being mobbed but not actually seeking prey themselves (e.g. Curio, 1963). The little information on pre-attack behavior of perched raptors is vague and often contradictory (cf Hamerstrom, 1957; Mavrogordato, 1960:5; Cade, 1960:221). In attempt to identify possible cues of a raptor's readiness to attack, I recorded the postures of captive and free-living Red-tailed Hawks, then offered them prey, and recorded their reactions.

The Red-tailed Hawk was chosen because: it is common and readily available for study; it is relatively easy to observe under both captive and field conditions; its general ecology, behavior, and distribution are well known (Bent, 1937; Fitch et al., 1946; and Craighead and Craighead, 1956): and it is a species in which potential prey are alleged to be able to distinguish "hunger" (Hamerstrom, 1957).

METHODS

Three Red-tailed Hawks were placed independently in a flight room with solid walls (Fig. 1) specially designed for detailed observations and analyses of responses to prey. "One-way" plastic windows prevented the hawk from seeing the investigator. A time-lapse 16 mm motion-picture camera (Bolex), with a 15 mm wide-angle lens, placed approximately one meter from the bird, took one picture every six seconds during day periods (artifically lighted) from 06:00–18:00. I induced the hawks to spend most of their time before the camera by placing the highest, thus most preferred, perch at

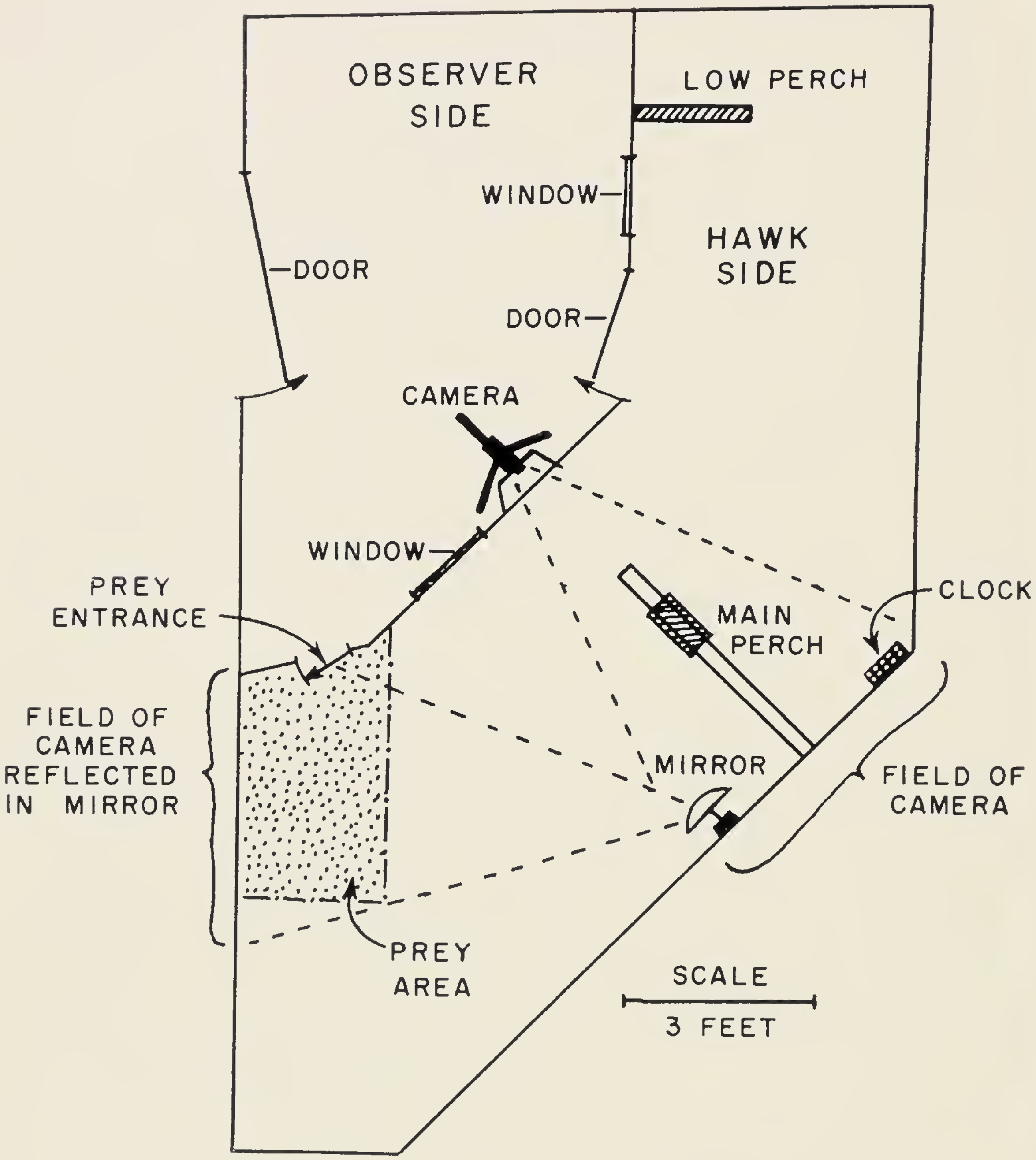


Fig. 1. Diagram of laboratory, as viewed from above.

that point. A parabolic mirror reflecting the part of the room where prey were presented and a clock were also included in the camera's field (Fig. 1).

To analyse the hawk's postures, single frames from the time-lapse film sequences were sampled by running the films through a single-frame analysing projector and stopping it randomly. From the projected picture several aspects of the birds' appearances, such as body posture, angle of tail from vertical, diameter of eye, etc., were either measured or categorized and recorded on prepared tally sheets.

Two of the Redtails were subadult birds trapped from the wild and placed into the room. The third Redtail was taken from its nest as a downy chick and raised in the observation room.

The formerly free-living individuals adjusted to the observation room quickly. Within hours they showed normal preening behavior, but both birds refused prey (live or dead) during the first four days.

Prey for all birds consisted of mice tossed through a small door onto the floor at one end of the room (Fig. 1). Care was taken that no cues of the forthcoming prey, such as noise from the observer, were available to the hawks.

I observed free-living hawks from roads in south-central Wisconsin from November 1966 to June 1967 and from September 1967 to November 1967. Bal-chatri raptor traps (Berger and Mueller, 1959), noose-covered cages containing live starlings or mice, were dropped onto the road near the perched birds then watched until either the hawk responded to the trap or 30 minutes elapsed. Various pertinent environmental conditions and the hawk's appearance and behavior were recorded on prepared tally sheets.

RESULTS

Contrary to earlier suggestions, neither captive nor free-living hawks displayed obvious cues of readiness to attack when unaware of a prey stimulus.

All three captive birds were inactive most of the time. They perched vertically with feathers fluffed and one foot often drawn up into the plumage. Aside from frequent head movement and occasionally preening. inactive birds showed little movement; however, after one-half hour to three hours of inactivity, the birds became restless and active for periods of a few minutes to two or more hours. The Craigheads (1956:30–34) have described similar alternating activity periods in free-ranging Redtails. During active periods the captive birds flew between perches. Between flights they characteristically assumed a forward posture with feathers compressed and moved their heads considerably. The first active period usually began about mid-morning following a long period of inactivity and preening. The birds showed much day to day variability in the frequency and extent of these active periods.

Since hawks obviously appeared differently when relaxed than when restless and active, pictures from time-lapse sequences were identified not only as to whether or not the hawk took subsequent prey but also whether the picture occurred during an active or inactive period. Thus birds that subsequently took prey could be compared with those that did not. not only on an overall basis but within periods of activity or inactivity. It appeared that the amount or frequency of activity was independent of amount or recency of previous feeding.

In three of four of the hawks' postures that were categorized (Table 1). no significant differences (by Chi-square) occurred between those which attacked subsequent prey and those which did not. whether the hawk was active or inactive. In the fourth aspect, whether or not the eyes were wide

TABLE 1

POSTURES OF CAPTIVE HAWKS AND REACTION TO SUBSEQUENT PREY

		Condition of Hawk and Reaction to Subsequent Prey							
						Totals			
Hawk Posture		Active, attacked	Active, did not attack	Inactive, attacked	Inactive, did not attack	Active	Inactive	Attacked	Did not attack
Feet on perch:	1	0	0	20	28	0	48	20	28
	2	39	38	7	16	77	23	46	54
Body posture:	upright	0	0	26	43	0	69	26	43
	forward	39	38	1	1	77	2	40	39
Plumage:	compressed	38	35	5	10	73	15	43	45
	fluffed	1	3	22	34	4	56	23	37
Eye:	wide open	31	26	15	7	57	22	46	33
	partly closed	1	4	11	28	5	39	12	32
	(not discernable in picture)	(7)	(8)	(1)	(9)	(15)	(10)	(8)	(17)
Sample size*	(no. of photo)	39	38	27	44	77	71	66	82

* Photos selected randomly from all available for each condition of hawk but sample sizes for each condition were chosen to be approximately equal (movement, etc. caused loss of some pictures hence prevented equal replication).

open, a significant difference ($p < 0.05$) occurred between inactive birds: those which attacked subsequent prey had their eyes wide open more often (discussed below).

Several aspects of the birds appearances (e.g. width of eye, extent feathers raised on various parts of body) were additionally measured from photographs and multiple-comparison statistics applied. Those results, however, simply confirmed the above data.

Free-living Redtails similarly responded to prey independently of their behavior prior to seeing the prey. Birds in the upright posture before testing responded less often than birds in the forward posture (Table 2); however, this difference is not statistically significant. Furthermore, the two Redtails that responded fastest and most persistently, despite disturbances which

TABLE 2

POSTURES OF WILD RED-TAILED HAWKS PRIOR TO PREY PRESENTATION AND SUBSEQUENT RESPONSES TOWARDS THE PREY

	Response		
Posture of Bird	Clear *	Slight or none	Total
Upright	6	17	23
Forward	9	10	19
Total	15	27	42

$\chi^2 = 1.23$, $p > 0.20$

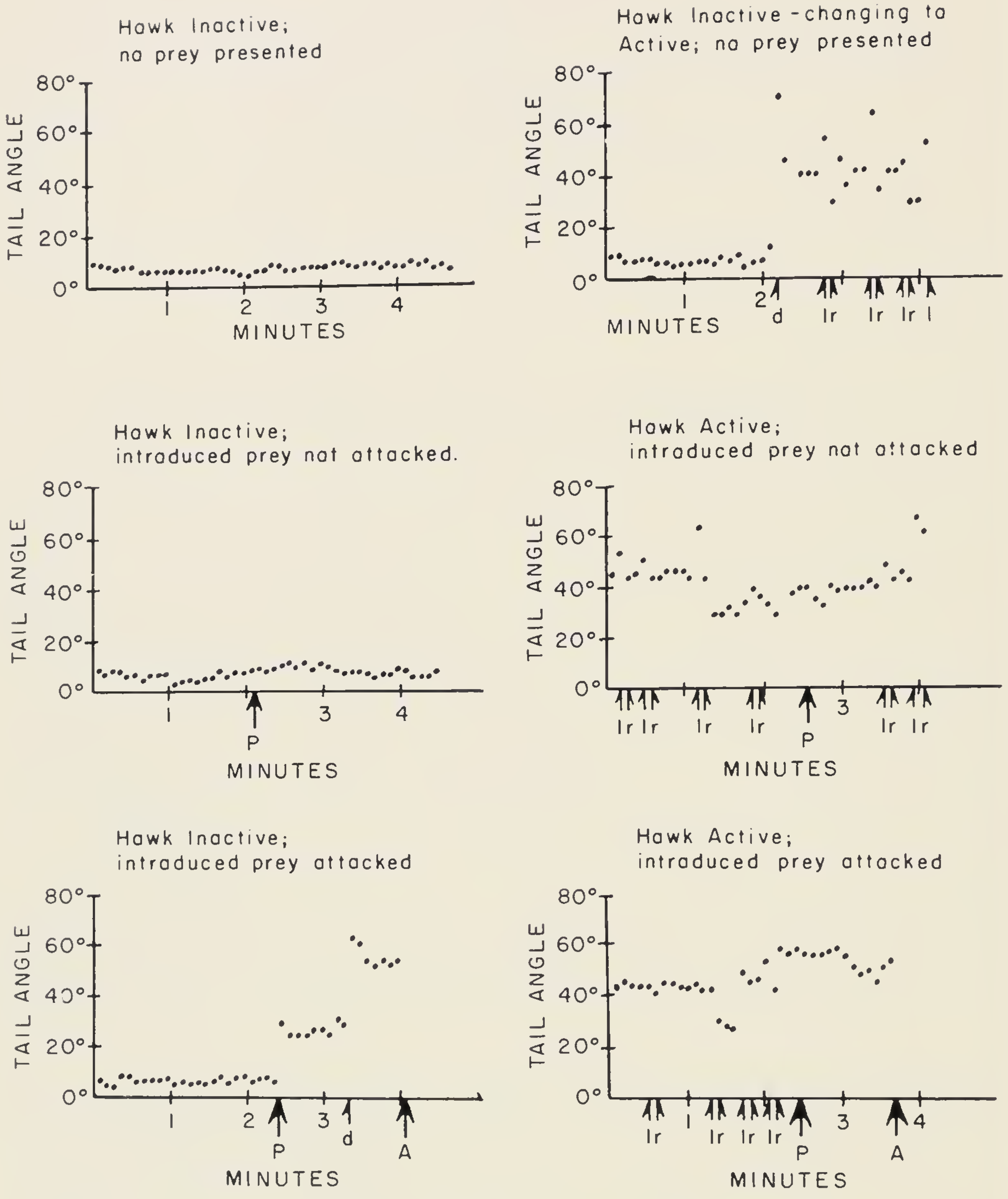
* Hawk flew to within ten feet of natural or artificially presented prey.

usually frighten Redtails, were birds initially recorded as upright and with very fluffed plumages.

In contrast to hawks in the absence of prey, hawks that were *aware* of prey items generally left little doubt to future action, since the observer knew the location of the prey. Those birds which attacked compressed their plumage upon sensing the prey, oriented their body toward the prey, stood forward on both feet, then left the perch to attack, often after first defecating. Those which did not attack usually simply remained as they were before sensing the prey. The change to the alert posture in a relaxed bird that would attack was very noticeable. Such change can be seen, for example, in changes of tail angle (from vertical, as representing body angle) from consecutive time-lapse photographs (Fig. 2). Due to the birds' being already in a forward standing position during active periods, the reaction toward prey was less noticeable (and not detectable in tail angles, Fig. 2). Knowing that the hawk was preparing to attack *prey* involved knowing the *location* of the prey and recognizing the hawk's orientation towards it. Aside from the direction of orientation, however, the simple pre-flight posture previous to attack was identical to that shown previous to flight not involving attack.

The *time* required for a bird to leave its perch, in cases of attack, appeared to depend largely on the birds familiarity with the situation. In extreme cases in the laboratory, after the birds had become conditioned to the surroundings and procedures, they would leave the perch in less than 0.5 second after seeing the prey. This fast reaction occurred even from relaxed upright postures suggesting that the forward posture may not give the bird and advantage in reducing attack-time. It may merely be a posture assumed while the bird determines whether or not to attack.

Free-living Redtails responded to prey essentially as captive birds did. Birds that did not attack usually remained as they were before the trap was



Hawk Inactive; no prey presented

Hawk Inactive-changing to Active; no prey presented

Hawk Inactive; introduced prey not attacked.

Hawk Active; introduced prey not attacked

Hawk Inactive; introduced prey attacked

Hawk Active; introduced prey attacked

Fig. 2. Changes in angle of hawk tails, from time-lapse photograph sequences. P = prey presented to hawk, A = hawk left perch to attack prey, d = hawk defecated, l = hawk left main perch to fly (not attack), r = hawk returned to main perch.

presented and only glanced occasionally at it. In some instances the hawk briefly stood forward then gradually resumed a relaxed apearance or left the vicinity. Hawks that attacked usually stood forward and watched the trap intently for periods ranging from about ten seconds to over ten minutes, then left their perches to attack. As in the case of the captive birds, however, the pre-flight postures were not unique for prey capture. Hawks were seen to fly on several occasions under circumstances not involving food, such as avoiding a disturbance or simply changing perches. Aside from the direction of orientation, such flights were preceded by postures that were identical to those involving attack, i.e. forward body posture on both feet, compressed plumage, and attention focused at a distant point.

DISCUSSION AND CONCLUSIONS

The various postures and aspects of the hawks' appearances that I analysed, specifically included those listed by Hamerstrom (1957) as being potential cues to a hawk's readiness to hunt. Yet no differences were found between birds that would attack and those which would not for any of the characteristics except the diameter of the eye: inactive hawks held their eyes wide open more often when likely to attack. A wide open eye could possibly serve as a cue of readiness to attack but such by itself would not seem to be a very obvious or useful cue at a distance.

When a hawk was aware of a specific prey item and prior to leaving its perch to attack, it showed clear indications, as described in the results, that it was about to fly. Such flight intention movements were also seen, however, in almost all situations involving flight, i.e. simply changing perches, moving from disturbances, and in extended periods of flight. Knowing that a bird was preparing to pursue prey would require knowledge of the location of prey. If a particular potential prey item is *the* object of a hawk's attention, and was aware of the hawk, it might be able to sense the hawks intent to attack and react accordingly. But otherwise seeing a hawk preparing to fly would not indicate whether or not it would be ready to attack prey.

Not only were subtle indications of readiness to hunt absent but even the most obvious appearances yielded no clues. Hamerstrom (1957) stated that, "A healthy hawk standing on one foot with the other foot tucked up under his feathers is not inclined to hunt." I found numerous exceptions to this in free-living birds, and captive Redtails regularly perched on one foot with relaxed plumage even though ready to attack if the opportunity occurred. Apparently the observations by Cade (1960:221) and Mavrogordato (1960:5) of raptors taking prey from an initially relaxed posture were not exceptions from normal behavior.

Indication of hunger by food-begging behavior is common in young raptors, between mates, and is commonly shown towards humans by hand-reared raptors trained in falconry. Similar behavior is also shown occasionally by other captive raptors, particularly Accipters (cf "yarak," illustrated in Beebe and Webster, 1964). Cade (1962) has shown that Northern Shrikes

(*Lanius excubitor*) on occasion employ behavior resembling food-begging during interactions with prey, resulting in the flushing of the prey. Such behavior, or some subtle trace of it, could provide prey with cues of readiness to attack. However, I observed no detectable evidence of food-begging by Redtails during encounters with prey at any time during the course of my experiments. Food-begging in raptors is probably restricted to interactions between members of a species or involving a human trainer.

Although I have found little in the appearance of a hawk to indicate readiness to attack, one might hypothesize that some prey have ability to detect something about the raptor that I cannot. Recent work on other aspects of recognition of raptors by prey (e.g. flying raptors: von Schleidt. 1961; perched raptors: Hinde, 1954) indicate that the raptor is apparently regarded by potential prey, at least initially, not as a predator as such (except perhaps with owls) but as an unfamiliar or suddenly appearing stimulus to be avoided or mobbed. If no attack results with the repeated presence of the raptor, the prey animal become habituated to its presence and the avoidance response subsides. Habituation seems to me to be possible even when the raptor is hungry but does not attack because the prey is not seen, is not of a type familiar to the raptor, or is of a species which the raptor has been unsuccessful in capturing and therefore no longer attempts to capture. If the raptor *does* attempt an attack but fails and the potential prey individual survives, the avoidance response may become heightened in the prey (see Berger et al. 1963:781).

In view of my evidence that Red-tailed Hawks display no overt unique indication of readiness to attack and since concepts of habituation afford plausable alternative explanations, I feel that a potential prey's lack of escape behavior in the presence of a raptor is due either to the prey not being aware of the raptor or the prey's regarding the raptor as a familiar and harmless object. Those potential prey items that show escape behavior in the presence of a raptor either regard it as an unfamiliar object or recognize that an actual attack has commenced.

SUMMARY

Perched captive and free-living Red-tailed Hawks were categorized according to posture and then offered prey to test for differences between those that would and those that would not attack. No differences were found in hawks before they sensed an actual prey item. After sensing prey hawks that were likely to attack could be identified by their alert reaction toward the prey but such behavior was identical, except for orientation, to pre-flight behavior when food was not involved. It is doubtful whether prey can distinguish between hungry and satiated hawks, except after the hawk has begun an actual attack. Habituation of prey to the raptor provides an alternative explanation for most prey behavior that has been observed.

ACKNOWLEDGMENTS

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NOTES ON THE LIFE HISTORY OF THE RUSTY-MARGINED FLYCATCHER IN SURINAM

F. Haverschmidt

In Surinam the Rusty-margined Flycatcher (*Myiozetetes cayanensis*) is one of the commonest birds. For a general description, its habitat and breeding habits the reader is referred to my "Birds of Surinam" (Haverschmidt, 1968). Two life-histories have been published, a short one by Skutch (1960) from Barro Colorado in Panama and an extensive one by de Carvalho (1960) from Brazil. My records from Surinam corroborate the observations by both authors and give some additional details of its life history.

VOICE

The call or song is uttered by both sexes while flapping their wings, often as a duet. It is a shrill and high pitched note described by Snyder (1966) as *keeeyeee.*

I have noticed another, quite distinct call given only when a hawk or hawk-like bird passed low over or alighted nearby. This is a shrill and long-drawn *eeeeeee.* When a Roadside Hawk (*Buteo magnirostris*) or a Gray Hawk (*Buteo nitidus*) came to my garden to look for lizards or a Yellow-headed Caracara (*Milvago chimachima*), which is a notorious nest-robber, alighted the flycatchers sounded this "hawk alarm" immediately. I have often profited by this behavior in locating hawks. I have also heard it regularly in the mangroves where the Crab Hawk (*Buteogallus aequinoctialis*) abounds, but the flycatchers have nothing to fear from this species which specializes on crabs.

The flycatchers made sometimes "mistakes" in uttering this alarm. In 1957 a pair of Cayenne Swifts (*Panyptila cayennensis*) nested against the wall of my house. Every time a swift approached with tremendous speed, low over the ground to shoot upward into its nest this "hawk alarm" was heard, and when on 7 August 1964 a Dusky Parrot (*Pionus fuscus*) dashed with a terrific speed through the trees of a coffee plantation the flycatchers there uttered the same alarm call.

TERRITORY

The birds are strictly territorial and do not allow the presence of other individuals of the species near their nest. On 21 November 1962 I observed an interesting incident of this. There was a Rusty-margined Flycatcher nest high up in a tree and one of the birds pursued a flying insect down to the ground. During this pursuit it came in front of a parked car and on seeing its image in the front shield of the car, it started fighting it, dashing against the glass. This fight lasted about four minutes.

BREEDING SEASON

Many nests are high up in trees and their contents cannot be inspected. Of 33 nests that were inhabited, two were in January, seven in February, four in March, three in April, one in May, two in June, one in July, two in August. three in September, three in October, three in November, and two in December.

NEST-BUILDING

The nest is an untidy ball of long and dead grasses with a wide side entrance (Fig. 1). As the sexes are alike it was often difficult to be sure which bird was building and I often got the impression that only one bird took part in it. However, on 16 October 1963 I observed on five occasions both partners arriving simultaneously with long pieces of nest-material in their bills and both working together at the nest.

Very often a nest is started and pulled down the same day or a few days later to begin again at another place, the material for the new nest being pulled out of the first trial. A nest started on 18 January 1958 was demolished the next day and another nest started in which a brood was reared. Another nest where building began on 2 March 1958 was pulled down the same day, the second nest was demolished on 5 March and a brood was reared in the third nest.

Nest-building was accomplished in from 9–14 days. In the nest started on 19 January 1958, the first egg was laid on 28 January, building lasting nine days. The nest started on 5 March 1958 contained two eggs on 16 March, building taking about 10 days and in the third nest that was started on 20 May two eggs were present on 7 June, building lasting here about 14 days.

The birds are very active in building in the early morning and late afternoon and I observed building as late as 18:20, just before sundown.

EGG-LAYING AND CLUTCH SIZE

As already remarked by Skutch (1960) the eggs are laid on alternate days and I could corroborate in two cases. In one nest the first egg was laid on 28 January 1958; in the afternoon of 29 January there was still one egg: and the second and last egg was found on 30 January at 17:45. Another nest

FIG. 1. Nest of *Myiozetetes cayanensis*, Paramaribo, Surinam, 6 February 1950.

contained one egg on 25 August 1961; in the afternoon of 26 August there was still one egg; the second and last egg was found in the afternoon of 27 August. De Carvalho observed the same behavior but said that laying on consecutive days may also occur.

In nine full clutches there were six of two eggs and three of three eggs.

INCUBATION PERIOD

Only one bird, probably the female, incubates. The incubation period estimated from the laying to the hatching of the last egg was 16 days. The last egg was laid on 30 January 1958, on 14 February at 18:00 there was one agg and one nestling, and on 15 February at 15:30 two nestlings. This seems to be in contrast to the incubation period of 14 days mentioned by de Carvalho in the English summary of his paper. However, he states in the original text that the incubation period was estimated from the laying of the last egg till the hatching of the first nestling, hence this difference. He also mentions an incubation period of 15–16 days, taking into account that the eggs are laid on alternate days.

NESTLING PERIOD

Two nestlings that hatched on 14 and 15 February 1958 left the nest on 6 March after about 19 days. Both of them remained in the neighborhood of the nest where they continued to be fed by their parents till 26 March, 20 days after having left the nest. The second breeding cycle was already under way at this time.

NUMBER OF BROODS REARED IN A SEASON

De Carvalho (1960) says that possibly two broods are reared in a season. In 1958 a pair in my garden reared three broods and after a pause of six months at least another two.

On 2 March 1958 the two nestlings are still in the nest but it was obvious that a second brood would start soon. Both birds often sang, with flapping wings, in a duet and the building of a new nest in a coffee shrub near by began. Feeding of the nestlings in the nest and the building of the new nest alternated. The new nest was pulled down on the same day another one was started. On 5 March this nest was pulled down and just below the nest with the nestlings still in it, a third one was built.

On 16 March this last nest contained two eggs that hatched on 2 or 3 April and fledged about 20 April. It is clear from these data that brood II overlapped with brood I in the building stage of brood II. The interval between the day the nestlings of brood I left the nest and the day of laying the eggs of brood II was about nine days.

On 20 May the nest of brood II was pulled down and building started at the place of nest I where a few grasses remained. On 7 June I found two eggs. Two nestlings were reared that left the nest at the end of June.

In a period of five months (the end of January until the end of June) this pair bred three times, rearing six young. There followed a pause of six months though the pair stayed in my garden.

On 29 December 1958 after several false starts a new nest was built that contained three eggs on 13 January 1959 and three nestlings left this nest on 17 February. On the same day a new nest was built high up in a tree in which the second brood was reared.

PREDATION

Nests in the process of building but also containing eggs or nestlings are sometimes pilfered by Great Kiskadees (*Pitangus sulphuratus*) that use the material for building their own nests. Inhabited nests are often taken over by the Piratic Flycatchers (*Legatus leucophaius*).

A notorious nest robber is the Yellow-headed Caracara that I surprised sometimes robbing nests in my garden. On 1 September 1961 there was a nest of *Myiozetetes cayanensis* in my garden with two eggs. I suddenly heard the piercing "hawk alarm" and saw two of these hawks in the nest tree. One of them on the nest, the other one perched above it. After having chased them away I found the nest in disorder and the eggs already damaged.

SUMMARY

The Rusty-margined Flycatcher (*Myiozetetes cayanensis*) is one of the commonest breeding birds in Surinam. The birds are strictly territorial. Breeding takes place all through the year.

Apart from its shrill call which is uttered by both birds while flapping their wings in a duet, a special alarm call for hawks and hawk-like birds is described.

The nest is an untidy ball with a wide side entrance, and the male may on occasion help build it. A newly started nest is often pulled down and the material from it used for the next trial. Nest-building lasts from 9–14 days.

The eggs are laid on alternate days. Nine full clutches contained six of two eggs and three of three eggs.

Incubation is by one bird only and lasted 16 days. The nestling period lasted 19 days and the fledglings were fed for another 20 days.

With one pair three broods were reared in rather quick succession, the second brood overlapping with the first during the building period of the second nest. The rearing of three broods from which six nestlings fledged took a period of five months. After a pause of six months two more broods were reared.

Predators are the Great Kiskadee (*Pitangus sulphuratus*) which pilfers nests. the Piratic Flycatcher (*Legatus leucophaius*) which takes over inhabited nests, and the Yellow-headed Caracara (*Milvago chimachima*) which robs nests.

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16 WOLFSKUILSTRAAT, OMMEN, HOLLAND, 16 MARCH 1970.

AN EXTRAORDINARY AUTUMN MIGRATION OF WHITE-BREASTED NUTHATCHES

Donald S. Heintzelman and Robert MacClay

For 56 days, between 11 August and 30 November 1968, the authors systematically observed migrating hawks, and carefully observed other birds, passing Bake Oven Knob (elevation 1,600 feet), Lehigh County, Pennsylvania. By early September, large numbers of White-breasted Nuthatches (*Sitta carolinensis*) and Red-breasted Nuthatches (*Sitta canadensis*) passed the Knob almost daily. This paper details the White-breasted Nuthatch migration and compares it with that of the Red-breasted Nuthatch.

Special efforts were made to observe each passing nuthatch with 10× binoculars to verify its identification. Rarely, a bird was heard vocalizing but was not observed; these were recorded as unidentified nuthatches in our notes. This technique eliminated some birds from our sample, but assured positive identification of each record used here.

FIELD DATA

Prior to 1968, White-breasted Nuthatches were observed irregularly during autumn at Bake Oven Knob (Heintzelman and Armentano, 1964; Heintzelman. 1969). During the period 1961 through 1967, only 53 were counted, whereas 297 were counted during the autumn of 1968. During the following autumn (1969), when 73 days of observation were made between 10 August and 26 November, 22 were counted.

On 4 September 1968, we observed eight White-breasted Nuthatches to pass the Knob—the vanguard of a migration which continued through 24 October. The heaviest flight occurred on 17 September when 80 were counted; other exceptional flights included 29 on 15 September, 22 on 29 September, and 20 on 21 September (Heintzelman, 1969:23). A graph of the 1968 Bake Oven Knob White-breasted Nuthatch data (Fig. 1) shows numerous peaks closely paralleled by the graph of our Red-breasted Nuthatch data.

Curiously, few White-breasted Nuthatches were noted elsewhere in Pennsylvania and New Jersey during the autumn of 1968. None were counted at Hawk Mountain Sanctuary located about 16 miles southwest of Bake Oven Knob (Alexander C. Nagy, letter of 8 June 1969), despite the fact that both stations are on the same mountain—the Kittatinny Ridge. However, Nagy points out that some volunteer observers on duty at the Hawk Mountain lookouts have little interest in recording small birds and their daily records

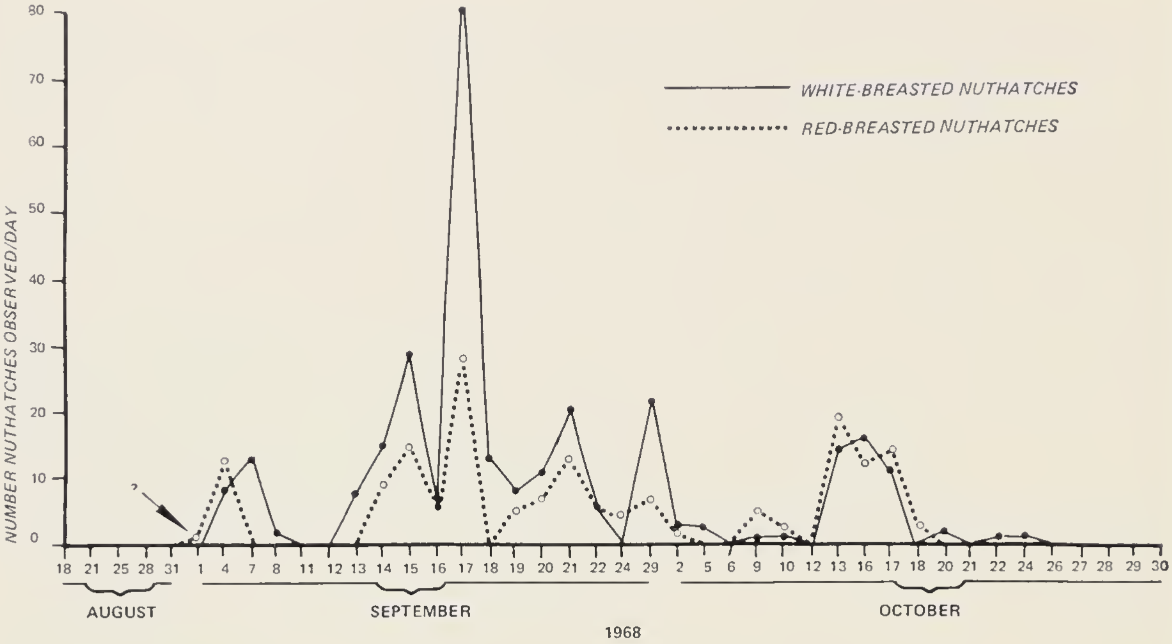

Fig. 1. Numbers of White-breasted and Red-breasted Nuthatches observed passing Bake Oven Knob, Lehigh County, Pennsylvania during the autumn of 1968.

would not reflect their presence or absence. Considerably fewer Red-breasted Nuthatches also were counted at Hawk Mountain than at Bake Oven Knob, but for similar reasons these data are not comparable.

On the other hand, no large autumn migration of White-breasted Nuthatches occurred during 1968 at Carnegie Museum's Powdermill Nature Reserve located 3 miles south of Rector, Westmoreland County, Pennsylvania; only 12 birds were caught and banded (Mary H. Clench, letter of 19 May 1969). This station is west of the Allegheny Front in western Pennsylvania approximately 185 miles in a west-southwest direction from Bake Oven Knob. However, Clench points out that "Migrations on the eastern side of the mountains and over to the coast often just don't show on the western side—and vice versa." At Island Beach State Park, New Jersey, bird banders engaged in the 1968 Operation Recovery project netted and banded only 27 White-breasted Nuthatches during the period 25 August through 30 October; in contrast, 504 Red-breasted Nuthatches were netted and banded at Island Beach during the same time period.

DISCUSSION

Conflicting data concerning the occurrence, or lack of occurrence, of White-breasted Nuthatch migrations have existed for decades, and this lack of agreement still continues in the literature. In the New York City area, for example, Bull (1964:320, 322) definitely documents spring and autumn

White-breasted Nuthatch migrations. Stewart and Robbins (1958:228) also list definite spring and autumn migration dates for Maryland and the District of Columbia, and specifically state that a light movement frequently occurs in early July. These are birds moving into areas 10 miles or less from their nesting range. The normal autumn migration period extends from 15 September to 10 November, with a peak from 10 October to 1 November. Finally, in parts of Kentucky, Mengel (1965:338) presents convincing evidence demonstrating that autumn White-breasted Nuthatch migrations occur.

Our 1968 data from Bake Oven Knob also clearly demonstrate that a definite White-breasted Nuthatch migration occurred and paralleled, in greater numbers, a Red-breasted Nuthatch migration. Unfortunately, it is extremely difficult to determine what primary cause or causes were responsible for this extraordinary movement. Probably factors other than those directly relating to the White-breasted Nuthatch migration were responsible, at least in part, for the Red-breasted Nuthatch migration. Nevertheless, the fact that both nuthatch species show remarkably similar peaks and lulls in their 1968 migration data suggests that some unknown but common external factor, perhaps weather, was at least partly responsible for precipitating the nuthatch flights observed at Bake Oven Knob.

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SONGS OF *AIMOPHILA* SPARROWS OCCURRING IN THE UNITED STATES

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Six species of *Aimophila* occur in the United States, one in the East and the other five in the Southwest:

1. Bachman's Sparrow (*A. aestivalis*) breeds from Maryland to Missouri and south to Florida and eastern Texas; generally occurs in abandoned fields with scattered trees and shrubs.
2. Rufous-winged Sparrow (*A. carpalis*) breeds in desert areas in south-central Arizona.
3. Botteri's Sparrow (*A. botterii*) breeds in grassy areas in the Brownsville region of Texas and in southeastern Arizona.
4. Cassin's Sparrow (*A. cassinii*) breeds in arid grasslands from western Kansas to southern Texas and southeastern Arizona.
5. Rufous-crowned Sparrow (*A. ruficeps*) breeds in southwestern United States, and generally occurs on slopes between 3,000 and 6,000 feet elevation.
6. Five-striped Sparrow (*A. quinquestriata*) breeds in brushy, semi-desert slopes in Mexico; with recent records in south-central Arizona.

Bachman's, Cassin's, and Botteri's Sparrows are plain-colored and similar in appearance; Rufous-crowned and Rufous-winged Sparrows are not conspicuously marked but are relatively easy to identify by sight; the Five-striped Sparrow is distinctive in appearance, and readily distinguished from the other U. S. species of *Aimophila.* Rufous-crowned, Cassin's, and Botteri's Sparrows may occur together in south-central Arizona; Bachman's is eastern, and its breeding range does not overlap that of any other U. S. *Aimophila*; The Rufous-winged and Five-striped Sparrows probably do not occur with any other species of *Aimophila* (at least in the U. S.), though I have found Cassin's and Rufous-winged Sparrows only a few miles apart in south-central Arizona.

Brief descriptions of the songs of all these sparrows except the Five-striped are given in various guides, with somewhat more complete accounts of their songs in U. S. National Museum Bulletin, No. 237. I know of no detailed study of *Aimophila* songs based on audiospectrographic analyses of tape recordings (except Bachman's: Borror, 1961*a*, 1961*b*, and 1970); the only published sonagrams of *Aimophila* songs that I have seen are of Bachman's Sparrow by Borror (1961*b*, Fig. 14, and 1970, Fig. 53), and one song each of the Rufous-crowned, Cassin's, and Bachman's Sparrows by Robbins et al. (1966:316).

TABLE 1
SUMMARY OF *AIMOPHILA* RECORDINGS STUDIED

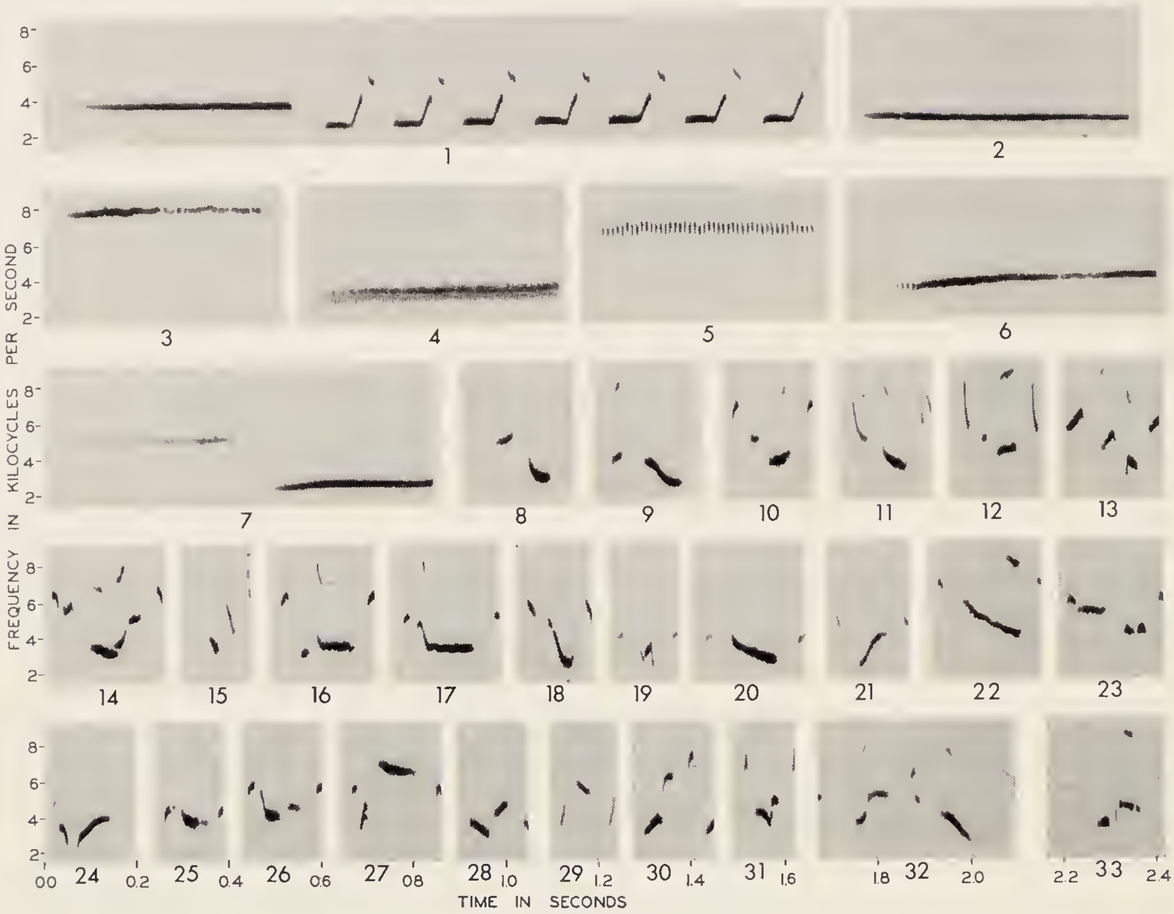
Species	Where Recorded	Number of Birds	Number of Recordings	Total Songs
Bachman's Sparrow	Ohio	4	8	551
	Florida	9	11	280
Rufous-winged Sparrow	Arizona	6	10	416
Botteri's Sparrow	Arizona	1	1	20
	Mexico[1]	3	3	63
Cassin's Sparrow	Texas	12	14	163
	Arizona	11	12	100
Rufous-crowned Sparrow	Arizona	6	6	63
Five-striped Sparrow	Arizona	1	1	113
TOTAL		53	66	1,769

[1] Recordings borrowed from the Laboratory of Ornithology, Cornell University.

This paper is based on a study of 66 recordings—63 made by me and in the collection of recorded animal sounds of the Faculty of Zoology, Ohio State University, and three borrowed from the Laboratory of Ornithology, Cornell University (recordings made by L. Irby Davis). These recordings are summarized in Table 1. The graphs were made with a Kay Electric Co. Vibralyzer, using the wide band filter; the source of each graph is indicated in the figure captions by a hyphenated number: the number preceding the hyphen is the number of the recording, and the number following the hyphen is the song in the recording.

BACHMAN'S SPARROW

The songs of this species generally consist of two parts, an introduction of one or two relatively long notes that are steady in pitch or nearly so, and a trill (a rapid series of similar phrases). The trill phrases are usually all alike (rarely the first or last is incomplete), but in some songs the trill is 2-parted (a series of phrases of one type, then a series of another type; see Figs. 32–33). Occasionally the song is double: a long note, a trill, another long note, and another trill. The most common type of song in this species is one consisting of a clear whistled note followed by a trill (*WT* in Table 2: Fig. 1). The songs illustrated by Borror (1961*b*, Fig. 14, and 1970, Fig. 53) are fairly typical songs of this species; that illustrated by Robbins et al. (1966:316) is rather atypical (double, with each trill 2-parted; the intro-



Figs. 1–33. Graphs of Bachman's Sparrow songs. Fig. 1, a typical song (8487-5). Figs. 2–7, different introductions: Fig. 2, a low-pitched *W* note (1419-9); Fig. 3, a high-pitched *W* note (1419-14); Fig. 4, a low-pitched *Z* note (1419-31); Fig. 5, a high-pitched *Z* note (1419-5); Fig. 6, a *w* note (1419-27); Fig. 7, a *WW* introduction (1419-30). Figs. 8–31, individual trill phrases: Fig. 8, 3139-5; Fig. 9, 3139-4; Fig. 10, 3139-25; Fig. 11, 4478-28; Fig. 12, 4979-13; Fig. 13, 4478-24; Fig. 14, 4478-5; Fig. 15, 4489-26; Fig. 16, 4478-9; Fig. 17, 4489-15; Fig. 18, 4478-3; Fig. 19, 3782-13; Fig. 20, 3782-11; Fig. 21, 3782-9; Fig. 22, 3782-5; Fig. 23, 1419-2; Fig. 24, 1031-5; Fig. 25, 8487-1; Fig. 26, 1033-3; Fig. 27, 1033-9; Fig. 28, 8487-16; Fig. 29, 1419-15; Fig. 30, 8487-27; Fig. 31, 1033-12. Figs. 32–33, the middle of a two-parted (*TT*) trill, showing the last trill phrase of the first type and the first one of the second type: Fig. 32, 4444-42; Fig. 33, 1419-28.

ductory note for the second part was apparently quite weak, and does not show in the graph). Descriptions of the songs of this species are given by Borror (1961*b*, 1970) and Weston (1968).

The different types of introductions found in the songs studied were as follows (see Table 2):

—: no introduction (in only 2 of the songs studied)
W: a whistled note (Figs. 1–3)
w: a note similar to *W* but beginning with a buzz (Fig. 6)
Z: a buzzy note (Figs. 4–5)

TABLE 2
SONG TYPES IN BACHMAN'S SPARROW

	Ohio			Florida			All Birds		
Song Type[1]	No. of Patterns	No. of Songs	% of Songs	No. of Patterns	No. of Songs	% of Songs	No. of Patterns	No. of Songs	% of Songs
–T	1	1	0.2	1	1	0.4	2	2	0.2
WT	40	279	51.7	103	183	65.4	143	462	56.3
ZT	12	84	15.6	30	57	20.4	42	141	17.2
wT	4	13	2.4	9	19	6.8	13	32	3.9
–TT	–	–	–	1	2	0.7	1	2	0.2
WTT	2	5	0.9	9	14	5.0	11	19	2.3
WTTWT	1	3	0.6	–	–	–	1	3	0.4
WTTWTT	1	8	1.5	–	–	–	1	8	1.0
ZTT	1	1	0.2	2	2	0.7	3	3	0.4
WWT	11	84	15.6	–	–	–	11	84	10.2
WWTT	4	25	4.6	–	–	–	4	25	3.1
ZWT	6	21	3.9	–	–	–	6	21	2.6
WTWT	–	–	–	1	1	0.4	1	1	0.1
WTZT	3	9	1.7	–	–	–	3	9	1.1
WTWZT	1	7	1.3	–	–	–	1	7	0.9
ZTWT	–	–	–	1	1	0.4	1	1	0.1
Total[2]	87	540		157	280		244	820	

[1] *T*, a single trill; *TT*, a 2-parted trill; other letters are explained in the text.

[2] The total number of *different* patterns, taking into account instances of a given pattern being sung by more than one bird; these totals do not include the 11 songs (five patterns) of one bird that mimicked Field Sparrow songs.

WW: two whistled notes (Fig. 7), found only in songs of Ohio birds; the first *W* was higher pitched in 7 of the 15 song patterns that began with *WW*, the second *W* was higher pitched in 7 patterns, and in 1 pattern the two *W* notes were the same pitch

ZW: a buzzy note and a whistled note, found only in songs of Ohio birds; the buzzy note was always higher pitched than the whistle.

The trill phrases vary greatly (Figs. 8–33), both in the songs of a given bird and in the songs of different birds. Most of the notes in these phrases are abruptly slurred, sometimes over a considerable pitch range. Phrases of a given type in different songs vary in number but only very slightly in rate; phrases of different types vary (in different songs) in both rate and number.

Each bird has a repertoire of a number of different introductions and trills, but a given trill is almost always preceded by the same type (and pitch) of introduction—producing a particular *song pattern*. A bird usually sings songs of a given pattern 1 to 4 times, then changes to another pattern. Most

Table 3

Characteristics of Bachman's Sparrow Songs

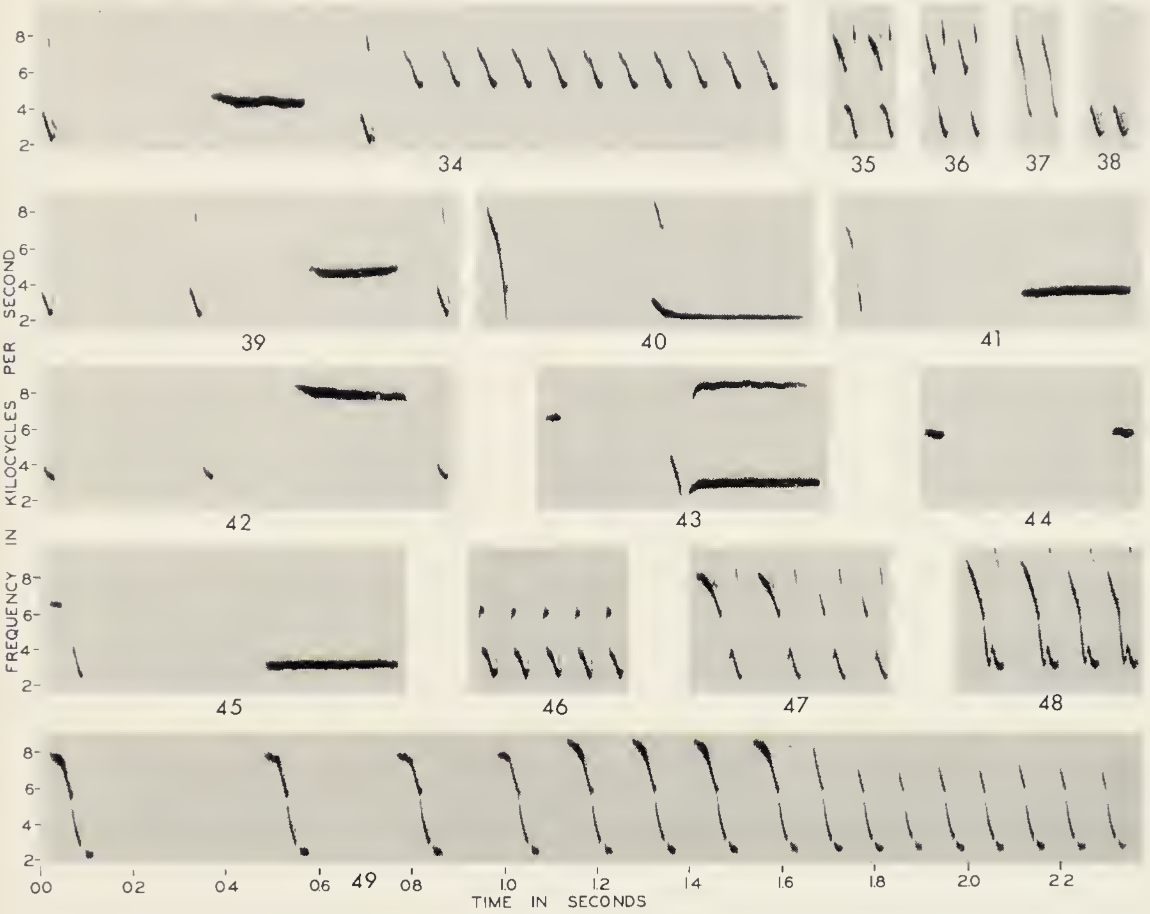
Character		Ohio		Florida		All Birds	
		Range	Average	Range	Average	Range	Average
	W	1.8–10.8	4.43	1.8–8.5	4.69	1.8–10.8	4.54
Pitch (KHz)	*Z*	2.3–8.5	5.15	2.6–8.7	5.38	2.3–8.7	5.26
	w	3.6–7.0	4.78	3.2–5.0	3.94	3.2–7.0	4.15
	W	0.13–0.70	0.45	0.17–0.75	0.55	0.13–0.75	0.49
Length (sec.)	*Z*	0.15–0.82	0.50	0.42–0.73	0.56	0.15–0.82	0.53
	w	0.52–0.78	0.67	0.44–0.72	0.61	0.44–0.78	0.63
Modulation rate of	*Z*	44–224	174.0	90–213	165.3	41–224	168.7
T phrase length (sec.)		0.03–0.22	0.13	0.04–0.27	0.16	0.03–0.27	0.15
No. of *T* phrases		1–20	8.9	2–15	8.8	1–20	8.8
No. of notes in the *T* phrases		1–4	2.2	1–6	2.8	1–6	2.6

of the birds studied had 20 or more song patterns; the largest repertoire found in an Ohio bird was 36 song patterns, and the largest in a Florida bird was 39 song patterns. Several instances were found in both the Florida and Ohio birds of different birds singing songs of the same pattern, but no pattern was sung by both an Ohio and a Florida bird. A total of 244 different song patterns were found in the recordings studied—87 in the Ohio recordings and 157 in the Florida recordings. There is evidently a tremendous amount of variation in Bachman's Sparrow songs, most of it being in the trill phrases.

Table 2 compares the *types* of song patterns sung by Ohio and Florida birds. Fewer types (but more different patterns) were sung by Florida than by Ohio birds. Much of the variation in the Ohio birds was found in the songs of one bird, some of whose songs were recorded after playbacks of its songs to it. None of the Florida songs contained a 2-note introduction (*WW* or *ZW*), and only 2 of the 280 Florida songs were double (*WTWT* and *ZTWT*). About three-fourths of the Bachman's Sparrow songs studied consisted of a single introductory note and a trill (*WT*, *wT*, and *ZT*).

The 26 songs recorded from one Ohio bird included 11 (of five different patterns) that were imitations of Field Sparrow (*Spizella pusilla*) songs. No playbacks were used when this recording was made.

Table 3 contains data on the characteristics of the songs of Ohio and Florida birds. The pitch range of the *W* notes, which represents the pitch



Figs. 34–49. Graphs of Rufous-winged Sparrow songs. Fig. 34, a song of Type II (9716-2). Figs. 35–38, parts of trills: Fig. 35, 10151-47; Fig. 36, 10215-6; Fig. 37, 10143-18; Fig. 38, 10151-70. Figs. 39–45, introductions of Type II songs: Fig. 39, 9716-27; Fig. 40, 10215-4; Fig. 41, 10282-130; Fig. 42, 10143-18; Fig. 43, 10151-68; Fig. 44, 10151-47; Fig. 45, 10143-26. Figs. 46–48, portions of Type I songs: Fig. 46, 9732-1; Fig. 47, 10143-3; Fig. 48, 10151-1. Fig. 49, a song of Type I (10143-8).

range in the songs, was from 1.8 to 10.8 KHz; introductory notes over about 6 KHz were usually quite weak, and audible only if the bird was fairly close. Songs with two introductory notes (*WW* and *ZW*) nearly always had the second note shorter than the first. The principal difference between the songs of Ohio and Florida birds was in the character of the trill; the trill phrases of the Florida birds averaged 0.16 sec. in length (about six per second), while those of the Ohio birds averaged 0.13 sec. (about eight per second).

RUFOUS-WINGED SPARROW

Songs of the Rufous-winged Sparrow are of two general types: Type I (Fig. 49), an accelerating series of similar notes or phrases (a little like the songs of a Field Sparrow), and Type II (Fig. 34), songs resembling those of an eastern Rufous-sided Towhee (*Pipilo erythrophthalmus*), and consisting

TABLE 4

DATA ON RUFOUS-WINGED SPARROW SONGS

	Character		Bird						All Birds
			1	2	3	4	5	6	
Type I Songs	No. of Songs		0	0	5	49	54	1	109
	No. of Trill Phrases	Range	–	–	9–18	6–21	1–16	19	1–21
		Aver.	–	–	14.6	16.0	10.9	19.0	13.0
	No. of Song Patterns		0	0	1	6	8	1	10[1]
Type II Songs	No. of Songs		8	29	17	113	140	0	307
	No. of Trill Phrases	Range	2–13	6–13	0–17	12–25	0–17	–	0–25
		Aver.	10.6	10.9	11.9	17.6	14.1	–	14.1
	No. of Song Patterns		3	2	3	12	11	–	24[1]
All Songs	No. of Songs		8	29	22	162	194	1	416
	No. of Song Patterns		3	2	4	18	19	1	34[1]

[1] These figures have been corrected for instances of a given song pattern being sung by more than one bird, and represent the numbr of *different* patterns in the songs studied.

of an introduction of 2 to 4 notes followed by a trill. A bird may sing songs of both types. An account of the songs of this species is given by Phillips (1968).

Type I songs consist of abrupt down-slurs, beginning at the rate of about 1½ per second and ending at the rate of about 11 per second. The song may contain up to 21 phrases (see Table 4), with the last few usually uttered at a constant rate and often slightly different from the first phrases (Figs. 47–49). Some Type I songs are short (up to a half a dozen or so phrases), with the phrases alike and the tempo increasing through the series.

The introduction in Type II songs contains from one to four notes; one of these is often a long note (about ¼ second in length) that is steady in pitch or very slightly down-slurred (Figs. 34, 39–43, 45), and the others (or, in some cases, all the notes of the introduction) are very short and either abruptly down-slurred (like the short notes in Fig. 39) or steady in pitch (Fig. 44). The trill consists of abrupt down-slurs, often slurred over about an octave; sometimes these are a single slur (Figs. 37, 49), sometimes they are 2-parted slurs (Figs. 35–36), and sometimes there is a short low note (Fig. 49) or slurs (Fig. 48) at the end.

The trill phrases in the Type II songs studied varied in number up to 25 (see Table 4); rarely, the trill was absent. The number varied in different songs of the same pattern sung by a given bird. The rate was uniform or nearly so through the trill, and varied (in different trills) from about 8 to 20 (13–15 in most songs) per second. The long steady note in the introduction was sometimes quite high-pitched (Fig. 42); such a high note was often weak, and not audible unless the bird was fairly close.

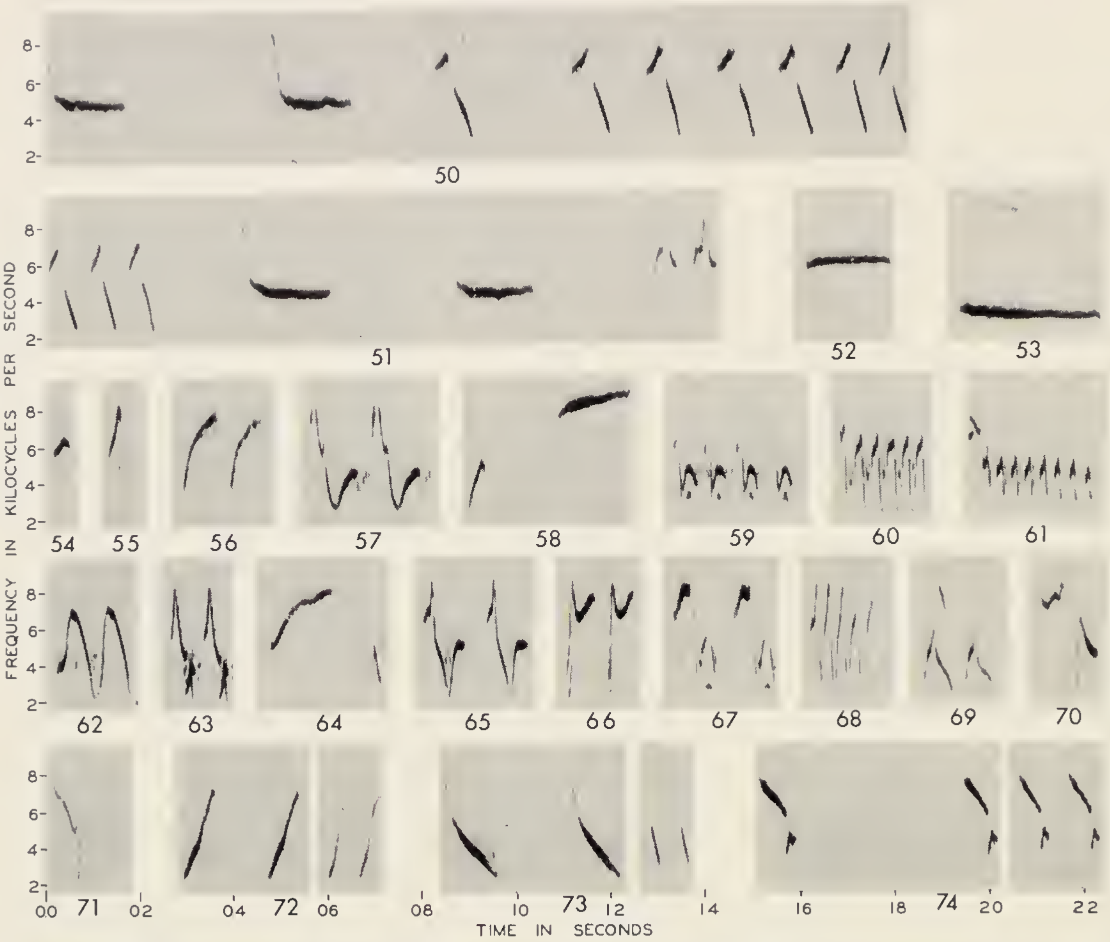
Most of the songs studied had a pitch range of about two octaves (2–8 KHz); the extremes found were 1.8 and 10 KHz. The final phrases in most Type I songs appeared a little lower pitched than the first phrases, due to the dropping out of some of the higher frequencies (Figs. 47–49). The highest pitch in most Type II songs was in the trill, except in some songs having a high pitched note in the introduction (as in Fig. 42).

Each bird apparently has a repertoire of several different introductions and trill phrases, which are variously combined to produce a number of different song patterns; the most found in one bird was 19. The songs of different individuals were often similar or identical; of the 34 different song patterns found in the songs studied, two were sung by three birds, 10 by two birds, and the rest by only one bird. Birds 4 and 5 (Table 4) had territories about a mile apart; 11 song patterns were sung by both birds.

A Rufous-winged Sparrow generally sings songs of one pattern for a while and then changes to another pattern. Some patterns of a given bird are very similar, and may not be recognized in the field as different unless one is heard immediately after the other—an uncommon event, as when a bird changes song patterns it usually changes to one noticeably different from the last.

BOTTERI'S SPARROW

The song of this species consists of up to seven short notes or phrases, followed by a trill that increases in tempo in about the middle, usually followed by one or two 1- or 2-note phrases (Figs. 50–51). The phrases preceding the trill are uttered slowly (about 2 per second), giving the impression that the bird takes a little time to work up to the more rapid tempo of the trill; this impression is enhanced by the fact that the bird often utters isolated phrases (similar to the introductory phrases) between songs. The song is similar to Type I songs of the Rufous-winged Sparrow, with some extra phrases at the beginning and end. Some notes (e.g., Figs. 52–53) are relatively steady in pitch, but most (Figs. 54–74) are rather abruptly slurred. The extremes in pitch found were 1.4 and 12.2 KHz; the pitch of most songs was between 2 and 8 KHz. An account of the songs of this species is given by Monson (1968).



FIGS. 50–74. Graphs of Botteri's Sparrow songs. Figs. 50–51, a complete song (9751-7), with 10 trill phrases; Fig. 51 begins where Fig. 50 ends. Figs. 52–53. notes occurring after the trill: Fig. 52, Cornell-1-7; Fig. 53, 9751-15. Figs. 54–71, Notes and phrases occurring in the introductory part of the song, preceding the trill: Fig. 54, Cornell-3-25; Fig. 55, Cornell-3-22; Figs. 56–57, Cornell-3-25; Fig. 58, Cornell-3-19; Figs. 59–61, Cornell-3-25; Fig. 62, Cornell-3-19; Fig. 63, Cornell-3-2; Figs. 64–66, Cornell-1-5; Figs. 67–68, Cornell-2-2; Figs. 69–71, 9751-15. Figs. 72–74, the first two (left) and last two (right) trill phrases: Fig. 72, 9751-15; Fig. 73. Cornell-3-22; Fig. 74, Cornell-2-7.

Songs of a given song pattern contain particular introductory phrases (usually uttered in the same sequence), a particular type of trill phrase. and particular terminal phrases. The songs of a given pattern may vary in length, due to variations in the number of introductory and/or trill phrases, or to just where along this sequence the song ends (some songs end before the trill). Different song patterns generally contain different phrases.

Two of the recordings studied contained songs of a single pattern, and the other two recordings contained two patterns each. In the recordings with two patterns, the birds sang songs of one pattern for a while, then changed to the other pattern.

CASSIN'S SPARROW

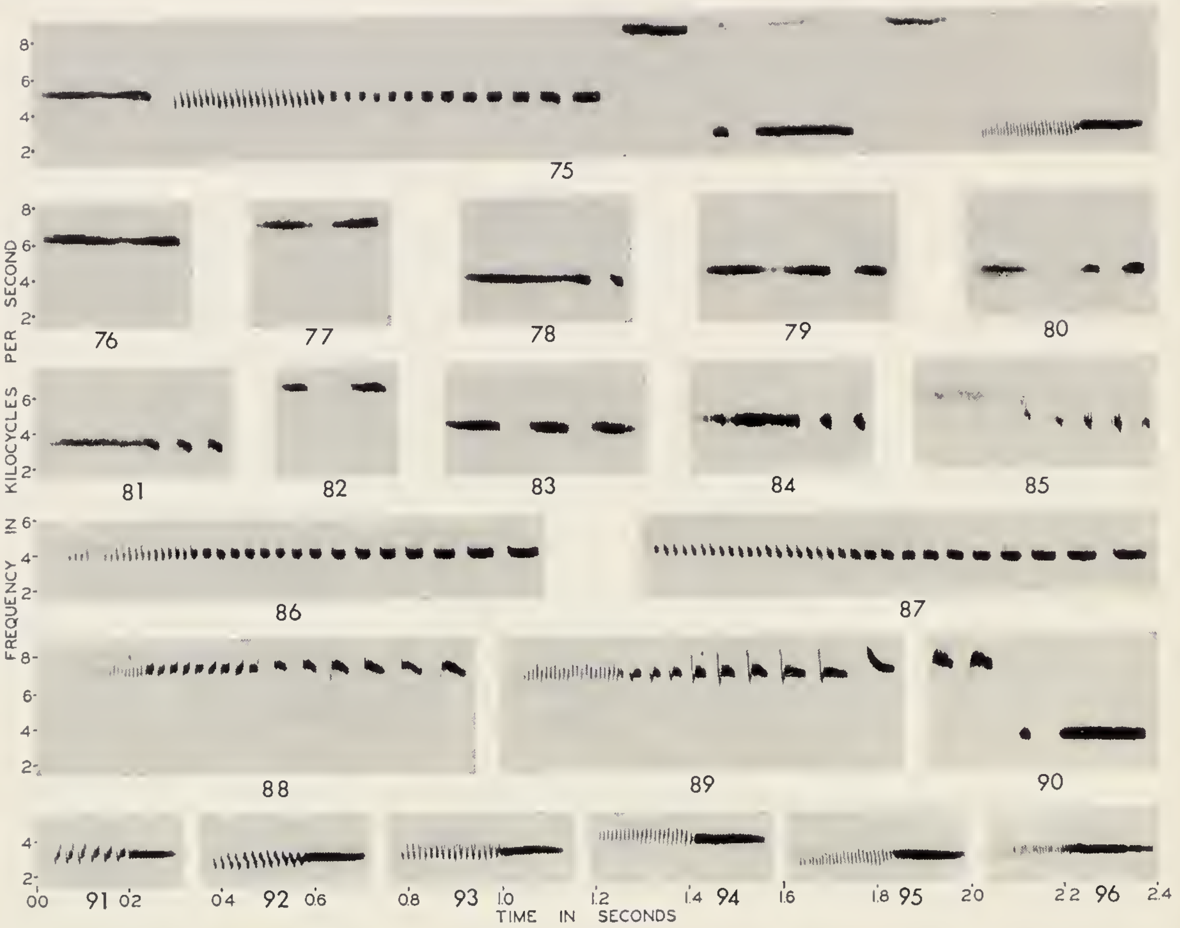
The Cassin's Sparrows recorded in Texas were presumably nesting birds; those recorded in Arizona were not. This species does not appear in the areas southeast of Tucson (where my recordings were made) until about mid-July, apparently after nesting farther east and then making a westward postnuptial flight. In this area of Arizona it sings quite a bit and acts as if it were defending territory, but apparently (Phillips et al., 1964) does not nest here.

A Cassin's Sparrow may sing from a perch (a fence, bush, or low tree) or in flight. When it sings in flight it sings while flying upward from a low perch at an angle of about 30°; near the end of the song the bird flies down to the ground or a low perch.

A typical Cassin's Sparrow song (Fig. 75) consists of a short introduction (*I*) of 1–5 notes, a prolonged phrase (*B*) that starts as a buzz and ends as a trill, a weak high-pitched note (*W*), a pair of low-pitched and relatively loud notes (*X*), another weak and high-pitched note (*Y*) similar to *W*, and a relatively loud and low-pitched final phrase (*Z*) that begins as a buzz and ends as a clear whistle: *I-B-W-X-Y-Z*. Descriptions of this species' song in the literature (e.g., Williams and LeSassier, 1968; Robbins et al., 1966) make no mention of the two high-pitched notes *W* and *Y*, and the graph by Robbins et al. (p. 316) does not show them, but nearly all the recorded songs studied contained them (*W* was lacking in a few songs, and a few songs ended before the *Y* note).

Each of the six parts of the song is steady in pitch or nearly so; there is occasionally a very slight drop in pitch through *I* and/or *B*, and the *W* and *Y* notes are usually slightly down-slurred (especially at the beginning). *I* and *B* are at the same pitch, or *B* may be a little lower than *I*. *W* and *Y* are at about the same pitch (or *Y* may be a little higher), and *X* and *Z* are about the same pitch. *W* and *Y* are the highest-pitched notes in the song, and *X* and *Z* are the lowest.

The songs of this species are subject to variation in the pitch and character of each of the six parts of the song. Some of these variations are apparent to the ear (in the field) and some are not; the different songs of this sparrow sound very much alike. The songs in two of the 26 recordings studied were of a single pattern, those in 19 recordings were of two patterns, and those in three recordings were of three patterns. When a bird sang songs of two or more patterns, it generally sang one to three songs of one pattern, then changed to another. Thirteen of the 263 songs studied (in eight recordings) were short, ending before the final *Z* phrase. The songs of one pattern (of



Figs. 75–96. Graphs of Cassin's Sparrow songs. Fig. 75. A typical song: *I-B-W-X-Y-Z* (9746-2). Figs. 76–85. Variations of *I*: Fig. 76, I_1, 5571-2; Fig. 77, I_2, 5558-2; Fig. 78, I_3, 10266-2; Fig. 79, I_4, 5583-1; Fig. 80, I_5, 5561-3; Fig. 81, I_6, 9747-5; Fig. 82, I_7, 9755-3; Fig. 83, I_8, 5572-1; Fig. 84, I_9, 10672-6; Fig. 85, I_{10}, 10683-2. Figs. 86–89. Variations of *B*: Fig. 86, type *a*, 5625-2; Fig. 87, type *b*, 5583-1; Fig. 88, type *c*, 10280-9; Fig. 89, type *a* (the last note in this figure is a short *W*), 5558-2. Fig. 90. The middle of a song lacking *W*; the first two notes in the figure are the end of *B*, and the remaining two notes are *X*. Figs. 91–96. Variations of *Z*: Fig. 91, 9755-3; Fig. 92, 5571-1; Fig. 93, 5571-2; Fig. 94, 10265-7; Fig. 95, 9754-1; Fig. 96, 9755-1.

a Texas bird) ended in a partial or complete second *Z* phrase, and one song of another pattern of this same bird began with 2½ *Z* phrases: *Z-Z-½Z-I-B-W-X-Y-Z* (the ½*Z* consisted of the buzzy part of the phrase only). A summary of the variations in the songs studied is given in Table 5.

The *I* phrase varied in the number, character, and pitch of the notes it contained; the pitch variation was from 3.0 to 8.1 KHz in the different series, and the notes were of the following types (indicated by subscript numbers in the figure captions): 1—A relatively long whistled note of even amplitude (Figs. 75–76); 2—A note similar to No. 1, but with the amplitude reduced in the middle and the note appearing more or less 2-parted (Fig. 77); 3—Two notes, the first similar to No. 1 and the second shorter (Fig. 78);

TABLE 5
CHARACTERISTICS OF CASSIN'S SPARROW SONGS

Phrase	Character		Texas Songs	Arizona Songs	All Songs
	Number of song series[1] with I of type[2]	1	5	12	17
		2	8	1	9
		3	1	2	3
		4	5	0	5
		5	1	0	1
		6	0	3	3
		7	6	4	10
		8	3	2	5
		9	1	0	1
		10	1	0	1
I	Length (in seconds)	Range	0.24–0.49	0.21–0.49	0.21–0.49
		Aver.	0.319	0.298	0.310
	Median pitch (KHz)	Range	3.9–7.5	3.0–8.1	3.0–8.1
		Aver.	5.45	5.49	5.47
	No. of song series with *B* of type[2]	*a*	18	12	30
		b	12	8	20
		c	1	4	5
	Median pitch (KHz)	Range	3.6–7.1	3.0–7.7	3.0–7.7
		Aver.	4.96	5.03	4.99
B	Modulation rate at beginning of phrase	Range	52–180	47–168	47–180
		Aver.	100.7	98.7	99.8
	Modulation rate at end of phrase	Range	9–15	9–13	9–15
		Aver.	11.0	11.1	11.1
	Length (in seconds)	Range	0.68–1.19	0.45–1.04	0.45–1.19
		Aver.	0.914	0.870	0.895
	No. of song series (with song complete) with *W*:	Short	3	1	4
		Lacking	0	3	3
W	Pitch at beginning (KHz)	Range	8.2–10.3	8.2–9.5	8.2–10.3
		Aver.	8.70	8.64	8.67
	Pitch at end (KHz)	Range	7.1–8.6	7.5–9.0	7.1–9.0
		Aver.	8.10	8.23	8.15
	Length (in seconds)	Range	0.07–0.29	0.08–0.22	0.07–0.29
		Aver.	0.170	0.150	0.162

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[1] The term "song series" refers to the songs in a given recording of a particular pattern; a song pattern in this species is one in which the different parts of the song are of a particular type and pitch.

[2] The different types of *I* and *B* phrases are explained in the accompanying text.

TABLE 5 (*Continued*)

Phrase	Character		Texas Songs	Arizona Songs	All Songs
X	Pitch (KHz)	Range	2.5–3.8	2.3–4.4	2.3–4.4
		Aver.	3.13	3.07	3.10
	Length (in seconds)	Range	0.19–0.31	0.25–0.32	0.19–0.32
		Aver.	0.273	0.283	0.278
Y	Pitch at beginning (KHz)	Range	8.4–9.0	8.1–9.3	8.1–9.3
		Aver.	8.61	8.74	8.66
	Pitch at end (KHz)	Range	7.6–8.7	7.8–9.3	7.6–9.3
		Aver.	8.28	8.46	8.35
	Length (in seconds)	Range	0.13–0.22	0.11–0.17	0.11–0.22
		Aver.	0.161	0.145	0.154
Z	Modulation rate in first part of phrase	Range	44–195	39–170	39–195
		Aver.	81.4	97.3	86.4
	Pitch of last part of phrase (KHz)	Range	2.6–3.8	2.7–4.4	2.6–4.4
		Aver.	3.26	3.25	3.26
	Length (in seconds)	Range	0.27–0.40	0.27–0.39	0.27–0.40
		Aver.	0.348	0.335	0.342
Song Length (sec.)	Complete normal songs	Range	2.00–2.83	1.55–2.72	1.55–2.83
		Aver.	2.498	2.316	2.418
	All songs	Range	1.5–3.67	1.44–2.72	1.44–3.67
		Aver.	2.811	2.247	2.383

4—Two notes, as in No. 3, but the first like No. 2 (Fig. 79); 5—Two notes, similar to No. 3, but slightly buzzy (Fig. 80); 6—Similar to No. 5 but with two short buzzy notes at the end (Fig. 81); 7—Two short whistled notes, each less than half as long as No. 1 (Fig. 82); 8—Three notes like those in No. 7 (Fig. 83); 9—Three whistled notes, the last two short (Fig. 84): 10—A buzzy note plus four short notes at a lower pitch (Fig. 85).

The *B* phrase was the same pitch as *I* or slightly (1–2 musical intervals) lower. It varied in the different series in pitch (similar to the pitch variations in *I*), the way the modulation rate decreased through the phrase, and the modulation rate at the beginning of the phrase. Based on the way the modulation rate decreased through the phrase, the *B* phrases were of three types: *a*—With the decrease relatively abrupt near the middle of the phrase (Figs. 75, 86, 89); *b*—With the decrease more gradual (Fig. 87); *c*—With the decrease in two relatively abrupt steps, the phrase appearing more or less three-parted (Fig. 88).

The modulation rate at the beginning of the *B* phrase varied in different series from 47 to 180 per second. The elements in the buzzy part of this phrase were sometimes (Figs. 75, 87) slightly down-slurred; in other cases they were more abruptly down-slurred (Fig. 88), or with both down- and up-slurred elements (Figs. 86, 89). The notes at the end of the *B* phrase were generally clear whistles of uniform pitch (Figs. 75, 86, 87), but in a few cases they began with an abrupt down-slur (Fig. 89).

The *W* and *Y* notes were high-pitched, and generally somewhat down-slurred (especially at the beginning). The *W* note was 0.13–0.29 sec. in length in most songs, but in songs with *I* and *B* very high pitched it was shorter (0.07–0.08 sec.) and distinctly down-slurred (Fig. 89). The *W* note was lacking in a few song patterns (Table 5 and Fig. 90).

The *X* phrase consisted of two clear and relatively loud notes, a short one and a long one (Fig. 75). It was uniform in pitch, but in different song series varied in pitch from 2.5 to 4.4 KHz; it was generally the lowest-pitched phrase in the song. In one song of one recording (a Texas bird) this phrase began with two short notes.

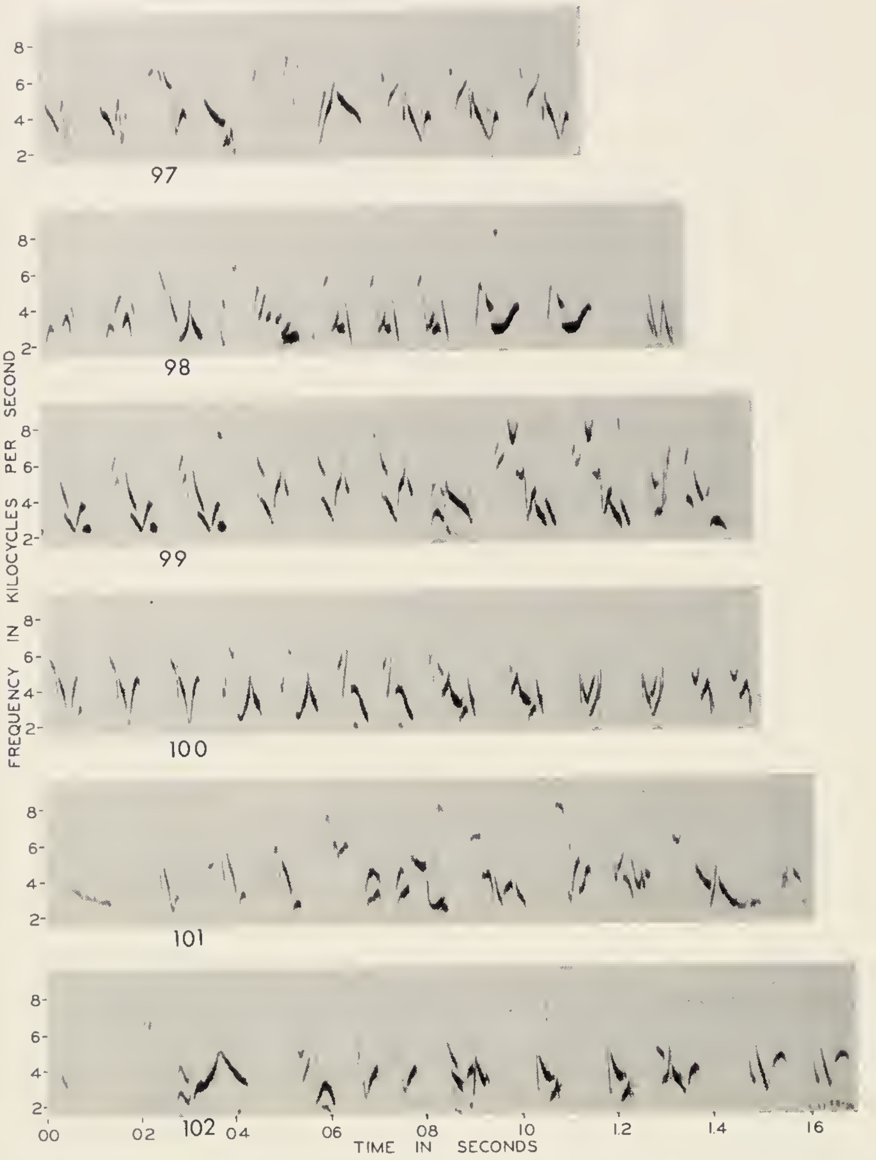
The *Z* phrase began with a buzz and ended in a clear note; the buzz had a relatively uniform modulation rate throughout, and the change from buzz to clear note was quite abrupt (Figs. 75, 91–96). The pitch of the final part of this phrase was the same as that of *X*, or a little higher. The modulation rate of the buzzy part of this phrase varied in different song series from 39 to 195 per second.

Forty-eight different song patterns were found in the recordings studied, 25 in the Texas birds and 23 in the Arizona birds; only one instance was found of a given pattern being sung by two different birds (about ½ mile apart, in Texas).

Most of the differences found between the songs of the Texas and Arizona birds (Table 5) were relatively minor; the more significant differences were: (a) a long clear note in the *I* phrase was more often 2-parted in Texas songs; (b) a *B* phrase of type *c* (more or less 3-parted) was more common in Arizona songs than in Texas songs: (c) the only complete songs lacking the *W* note were sung by Arizona birds; and (d) the modulation rate in the buzzy part of the *Z* phrase averaged higher in Arizona songs than in Texas songs.

RUFOUS-CROWNED SPARROW

The songs of this sparrow have a chippery and somewhat canary-like quality, and resemble those of a House Wren (*Troglodytes aedon*) or an



Figs. 97–102. Graphs of Rufous-crowned Sparrow songs. Fig. 97, 10253-3; Fig. 98, 7198-1; Fig. 99, 9749-2; Fig. 100, 7197-1; Fig. 101, 9616-2; Fig. 102, 7065-3.

Indigo Bunting (*Passerina cyanea*); they are higher pitched than those of a House Wren, and faster than those of an Indigo Bunting. The average frequency range found was 1.8–7.3 KHz, with extremes of 1.2 and 8.5 KHz. An account of the song of this species is given by Phillips and Cogswell (1968), and a sonagram of a song (weak, and difficult to make out) is given by Robbins et al. (1966:316).

Rufous-crowned Sparrow songs consist of a series of phrases, most of which are uttered two or three times in succession: 1–3 phrases of one type, 1–3 of another type, and so on; rarely, a phrase may be uttered four or five times in succession. The phrase rates in the songs studied varied from 3.8 to 14.7 per second (average, 7.6 per second). Individual songs contained 9–16 (average, 12.6) phrases, of 6–10 (average, 6.4) types.

Individual phrases are usually rather complex, consisting of several slurred elements, sometimes with successive slurs overlapping (Figs. 97–102). Most of this slurring is quite abrupt—over an octave or so in 0.02 sec. or less.

The different songs in some recordings were alike in the number of phrase types present and in their sequence, but differed in the number of certain phrases; in other recordings there was variation in the particular phrase types present and/or in their sequence. Three of the six birds studied had a repertoire of six phrase types; the others had repertoires of seven to sixteen phrase types. It is probable that most birds have a repertoire of a dozen or more types of phrases, but rarely use more than six or eight of them in a given song. Different renderings of a given phrase type by a particular bird (in the same or different songs) often differed slightly. The recordings studied contained no instances of different birds having identical phrases in their songs, but there were instances of very similar phrases in the songs of different birds.

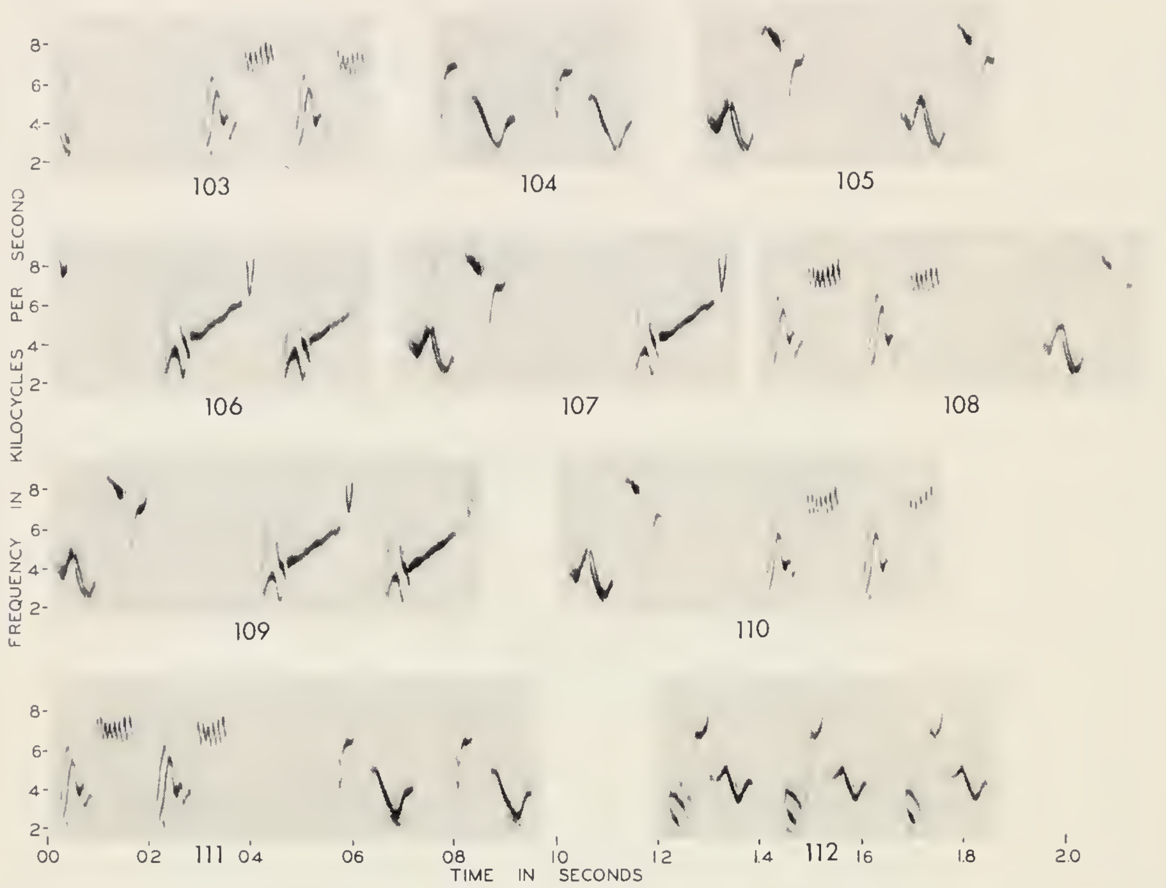
FIVE-STRIPED SPARROW

The only recording of this species studied (OSU Recording No. 10185) was made at a roadside picnic area on Arizona Route 82 about 3½ miles southwest of Patagonia, 28 June 1969. This appears to be only the second occurrence of this species in the United States; the first was a specimen collected in Madera Canyon (about 20 miles north of the area where my recording was made), 18 June 1957 (Phillips, Marshall, and Monson, 1964).

The songs of this species are relatively short, consisting of 1–4 phrases. of one or two types. There were five types of phrases in the songs studied; these may be designated by letters, *A–E* (Figs. 103–110). There were two types of calls in the recording, a short and very high pitched *pip* (Fig. 106), and a lower-pitched *chuck* (Fig. 103); these were uttered more or less irregularly between songs, sometimes just before a song (and thus appearing to be the first note of the song, as in Figs. 103 and 106).

The 113 songs in the recording studied were of the following types: *A-A*—25 songs; *B-B*—12 songs (Fig. 104); *C*—12 songs; *C-C*—11 songs (Fig. 105); *D*—4 songs: *D-D*—27 songs; *E-E*—3 songs; *E-E-E*—10 songs (Fig. 112); *A-A-C*—1 song (Fig. 108); *A-A-B-B*—1 song (Fig. 111); *C-A-A*—1 song (Fig. 110); *C-D*—4 songs; *C-D-D*—2 songs (Fig. 109).

Most (82 of the 113) of the songs contained two phrases; 16 contained only one phrase, 14 contained three phrases, and one contained four phrases. The bird sang songs containing two or three different phrases for a while, then changed to songs of other phrases. Songs containing different phrases were sung more or less alternately (*A-A*, *B-B*, *A-A*, *B-B*, etc.).



Figs. 103–112. Graphs of Five-striped Sparrow songs (from Recording No. 10185). Fig. 103, *chuck-A-A*, song 49; Fig. 104, *B-B*, song 2; Fig. 105, *C-C*, song 67; Fig. 106, *pip-D-D*, song 50; Fig. 107, *C-D*, song 73; Fig. 108, *A-A-C*, song 29; Fig. 109, *C-D-D*, song 75; Fig. 110, *C-A-A*, song 35; Fig. 111, *A-A-B-B*, song 31; Fig. 112, *E-E-E*, song 94.

The phrases were uttered at rates of 2.8 to 5.6 per second. The two-phrase songs were generally 0.3–0.4 second in length, and the three-phrase songs 0.6–0.7 second in length.

DISCUSSION

Some songs of the Rufous-winged and Bachman's Sparrows are very much alike, and the songs of Botteri's Sparrow are similar to those of the Bachman's and Rufous-winged Sparrows in that they contain a trill, but the songs of the other three species are different from one another and from the aforementioned three species.

Table 6 presents a comparison of certain features of the songs of these six species. In three species (Bachman's, Rufous-winged, and Five-striped Sparrows) each bird may have a relatively large song repertoire—13 or more different song patterns; the repertoires of a given individual of the other three species appear to be very limited. The greatest variation from individual to individual in the species appears to be in the Bachman's Sparrow—where

TABLE 6

SUMMARY OF SOME FEATURES OF *AIMOPHILA* SONGS

Species	Total Song Patterns in the Recordings Studied	Maximum Number of Song Patterns per Bird	No. of Songs in a Series[1]	Identical Song Patterns by Different Birds	Average Singing Rate (songs per minute)[2]
Bachman's Sparrow	244[3]	39	1–4	rare	5.7[4]
Rufous-winged Sparrow	33	19	many	common	10.5
Botteri's Sparrow	6	2	many	none found	4.8
Cassin's Sparrow	42	3	1–3	rare	4.2[5]
Rufous-crowned Sparrow	6	1	many	none found	6.4
Five-striped Sparrow	13	13	1–2	–	15.1

[1] Songs of a given pattern, before changing to another pattern.
[2] Based on all the inter-song intervals measured.
[3] Excluding the imitations of a Field Sparrow (11 songs, of five patterns, by one bird).
[4] 6.2 in Ohio birds, 4.4 in Florida birds.
[5] 4.1 in Texas birds, 4.5 in Arizona birds.

each bird may have a relatively large repertoire, and the repertoires of different individuals are generally different. The sample of Rufous-crowned Sparrow songs was small, but there is probably a great deal of variation from bird to bird in this species. Cassin's and Botteri's Sparrows exhibit a large amount of intraspecific variation in song, but the differences between different song patterns in these species are relatively slight. The material of the Rufous-winged Sparrow studied indicates that different individuals in this species frequently sing songs of the same patterns. There is probably a large amount of intraspecific variation in the songs of the Five-striped Sparrow.

There are differences in the singing behavior of these six species. Cassin's Sparrow appears to be the only one that frequently sings in flight. The singing rate is relatively high in two species (averaging 15.1 songs per minute in the Five-striped Sparrow, and 10.5 per minute in the Rufous-winged), and distinctly lower (4.2–6.4 songs per minute) in the other four species. The Rufous-winged, Botteri's and (apparently) the Rufous-crowned Sparrows sing songs of a given pattern for some little time before changing to another song pattern; the Bachman's, Cassin's, and Five-striped Sparrows generally sing only a few (one to four) songs of one pattern before changing to another pattern.

On the basis of the character of their song and their singing behavior, and on the basis of appearance, four of these species appear to be very closely related—Bachman's, Botteri's, Cassin's, and Rufous-winged Sparrows; the other two species differ in both appearance and song. In its singing behavior the Rufous-crowned Sparrow is probably closer to a *Melospiza* (e.g., Lincoln's Sparrow, *M. lincolnii*) than to the other species of *Aimophila*. The Five-striped Sparrow looks a little like a Black-throated Sparrow (*Amphispiza bilineata*), but its songs are quite different.

SUMMARY

Descriptions are given of the songs and singing behavior of the six species of sparrows in the genus *Aimophila* occurring in the United States (Bachman's, Rufous-winged, Botteri's, Cassin's, Rufous-crowned, and Five-striped), based on a study of 66 recordings (1,769 songs). The songs of Bachman's, Rufous-winged, and Botteri's Sparrows are similar in some respects, but there is little similarity between the songs of these three species and those of the other three species. The six species differ in the size of individual repertoires, the way the repertoires are used, the occurrence of identical songs by different individuals, and the singing rate.

ACKNOWLEDGMENTS

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COLLEGE OF BIOLOGICAL SCIENCES, THE OHIO STATE UNIVERSITY, 1735 NEIL AVENUE, COLUMBUS, OHIO 43210, 17 OCTOBER 1970.

FIRST INTERNATIONAL CONGRESS OF SYSTEMATIC AND EVOLUTIONARY BIOLOGY

The Society of Systematic Zoology and the International Association for Plant Taxonomy have joined forces to develop this first opportunity for botanical/zoological interaction at an international level. The Congress will be held on the campus of The University of Colorado at Boulder, 4–11 August 1973. The program plans include interdisciplinary symposia and contributed paper sessions. The botanists will not convene a nomenclatural section but a zoological one on this subject is anticipated. All suggestions for program and other activities will be gratefully received. Further information can be obtained from the Secretary of the Steering Committee: Dr. James L. Reveal, Department of Botany, University of Maryland, College Park, Maryland 20740.

THE BREEDING SUCCESS OF TWO SYMPATRIC GULLS, THE HERRING GULL AND THE GREAT BLACK-BACKED GULL

R. Michael Erwin

Various aspects of the breeding biology of the Herring Gull (*Larus argentatus*) and the Great Black-backed Gull (*Larus marinus*) were examined on Sandy Point, a small coastal island near Westerly, Rhode Island. Since no extensive studies have been made on interactions between gull species, the project provided an ideal opportunity to examine several parameters of breeding in the two species.

The major emphasis was placed upon comparing egg-laying patterns and hatching success between the species. For this study, three groups of gulls were designated: (1) All nesting Great Black-Backs, (2) "Experimental" Herring Gulls—those nesting in proximity to Black-Backs, and (3) "Control" Herring Gulls—those nesting at a considerable distance from the Black-Backs.

METHODS

The field work was conducted from early April until early June of 1969. Visits were made to the study area every three days, when nest checks were made. The laying date of each egg and its fate were recorded. Statistical tests used were the Newman-Keuls Multiple Range test, Student's *t*-test, and Chi-Square analysis (Steel and Torrie, 1960). Arcsine transformations were performed on the individual hatching percentages (Mosteller and Youtz, 1961).

RESULTS

Analysis of the hatching success was made for each of the three groups studied (Table 1). Using the Newman-Keuls Multiple Range test, highly significant differences were found between the hatching percentages of the three groups. Control Herring Gulls had significantly greater success than either Experimental Herring Gulls ($q = 7.19$, $P < 0.01$) or Great Black-backed Gulls ($q = 13.96$, $P < 0.01$). In turn, Experimental Herring Gulls had greater success than did Black-Backs ($q = 6.77$, $P < 0.01$). Since hatching percentages are significantly different, the number of young produced per pair will also be significantly different.

Egg-laying patterns for each group based on the date of laying of the first egg in the clutch are given in Figure 1. The Black-Backs (mean laying date = 22–25 April) lay eggs about two weeks earlier than either group of Herring Gull (mean laying date = 7–10 May). The Black-Backs exhibited a more protracted laying period than either Herring Gull group.

Since nests were visited every three days, the breeding season was sub-

TABLE 1

HATCHING SUCCESS FOR HERRING GULLS AND GREAT BLACK-BACKED GULLS

Group	Number of Nests	Total Number of Eggs Laid	Number of Young Produced	Per cent Hatched	Number of Eggs Per Pair	Number of Young Produced Per Pair
Black-Backs	48	136	60	44 **	2.83	1.25
Herring (Control)	48	142	117	82 **	2.90	2.39
Herring (Exp)	48	129	86	67 **	2.69	1.76

** All are significantly different at .01 level.

divided into 3-day intervals. To test the significance of laying date on hatching success, the 3-day intervals were blocked into three categories; "Early," "Peak," and "Late" layers (Table 2). The "Peak" layers category consisted of the mean interval plus the interval immediately before and after the mean. "Early" layers were all those laying eggs before these three intervals, while "Late" nesters included all those after. According to Newman-Keuls analysis, "Late" laying Black-Backs had significantly greater success than "Peak" layers ($q = 3.92$, $P < 0.05$) but not "Early" layers ($q = 2.92$, $P > 0.05$), even though "Early" eggs were 15 per cent less successful. There was no difference between "Early" and "Peak" layers ($q = 1.00$, $P > 0.05$). In the Control Herring Gull group, "Late" nesters were significantly lower in success than "Peak" ($q = 3.52$, $P < 0.05$), but not "Early" layers ($q = 2.72$, $P > 0.05$), although "Late" eggs were 9 per cent less successful than "Early." Again, there was no difference between "Early" and "Late" success. Experimental "Late" nesters were significantly less successful than were "Early" layers ($q = 3.87$, $P < 0.05$) but not "Peak" ($q = 3.05$. $P > 0.05$). "Early" and "Peak" layers showed no differential success ($q = .83$. $P > 0.05$). Even though "Late" and "Peak" layers were not significantly different, the "Late" had a 5 per cent lower hatching success, the q value (3.05) being close to significant (3.44) at the 0.05 level. The correlation between laying date and hatching success is shown in Table 2.

DISCUSSION

The hatching success of the three groups was vastly different. The Great Black-Backs were significantly lower in success than the other two groups. The 44 per cent hatching success was much lower than the 76 per cent success reported for Black-Backs in 1963 (Harris, 1964). Harris interpreted his high success as being a result of lack of predation. Whether the reduced success of the Black-Back on Sandy Point can be attributed solely to the

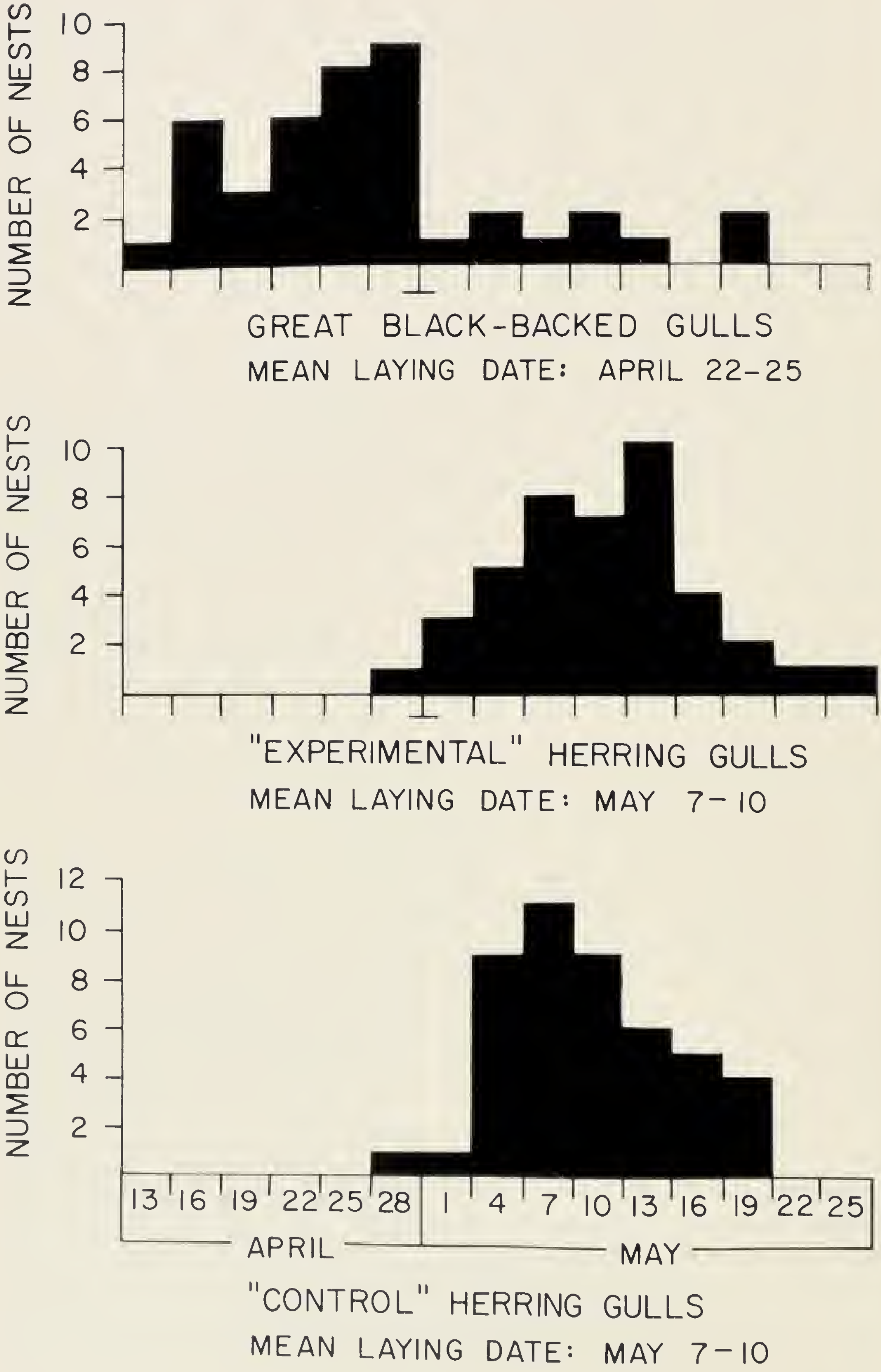
NUMBER OF NESTS
10
8
6
4
2
GREAT BLACK-BACKED GULLS
MEAN LAYING DATE: APRIL 22-25
NUMBER OF NESTS
10
8
6
4
2
"EXPERIMENTAL" HERRING GULLS
MEAN LAYING DATE: MAY 7-10
NUMBER OF NESTS
12
10
8
6
4
2
13
16
19
22
25
28
1
4
7
10
13
16
19
22
25
APRIL
MAY
"CONTROL" HERRING GULLS
MEAN LAYING DATE: MAY 7-10

TABLE 2

THE EFFECT OF LAYING PERIOD ON HATCHING SUCCESS OF HERRING AND GREAT BLACK-BACKED GULLS

Group	Laying Period	Number of Nests	Number of Eggs Laid	Number of Young Produced	Per cent Hatched
Black-Backs	"Early" (10–19 April)	10	30	15	50
	"Peak" (19–28 April)	23	62	28	45
	"Late" (28 April–19 May)	9	26	17	65
Herring (Control)	"Early" (25 April–4 May)	9	31	27	87
	"Peak" (4–13 May)	25	74	66	89
	"Late" (13–19 May)	8	27	21	78
Herring (Exp)	"Early" (25 April–4 May)	11	26	20	77
	"Peak" (4–13 May)	26	67	47	70
	"Late" (13–25 May)	9	20	13	65

predatory effects of the Herring Gulls nesting in proximity to them is questionable. Human disturbance was undoubtedly a significant factor.

One hypothetical explanation for the low hatching success might involve nest neglect. Since Black-Backs lay eggs about two weeks earlier than Herring Gulls, there is some degree of asynchrony in the breeding cycles. While Black-Backs are completing nest-building and beginning to lay eggs, the majority of Herring Gulls are establishing territories. With the establishment of territories and subsequent nest-building, fights and aggressive displays are at a peak (Tinbergen, 1956). This widespread fighting and aggressive activity of the Herring Gulls may incite excessive aggression in the Black-Backs (Ripley and Hagen cited by Udvardy, 1951). Nest neglect may result with the eggs becoming increasingly vulnerable to predation. Similarly, human presence on the island causes nests to be neglected and occasionally abandoned with continuous disturbance.

The 82 per cent success found in the Control Herring Gull group was compared to the result of 75 per cent on Sandy Point (North Control) in 1963 (Kadlec and Drury, 1968). No statistical difference was found ($\chi^2 = 2.78$, $P > 0.05$). It may be concluded that the Sandy Point Herring Gull Colony generally has a very high hatching success relative to other reported colonies (Brown, 1967; Harris, 1964; Paynter, 1949; and Kadlec and Drury,

←

FIG. 1. Egg-laying patterns of Herring and Great Black-backed Gulls in three-day intervals.

1968). The reduced success of the Experimental Herring Gull group (67 per cent) relative to the Control group (82 per cent) suggests that Black-Back predation may be significant in reducing the success of gulls nesting in proximity to them. However, whether this predatory effect would severely limit the population size of Herring Gulls, as suggested by Pough (1951) is doubtful since Brown (1967) found that the rapidly increasing population on Walney Island had only a 66 per cent success.

Darling (cited by Hailman, 1964) suggested that in colonial nesters, social stimulation caused large-scale synchrony of the breeding cycle. Hailman (1964) disputed this, finding only local synchrony in Swallow-tailed Gulls (*Creagrus furcatus*). The patterns of Control and Experimental Herring Gulls in this study would lend support to Darling's hypothesis. The study areas were considerably distant, yet the mean laying dates were identical, as was the onset of egg laying. This could possibly be due to social stimulation as suggested by Darling, as well as similar seasonal hormonal responses.

Fisher and Lockley (cited by Orians, 1961) suggested that this "Darling Effect" was important in interspecific stimulation in mixed breeding colonies. If this were the case on Sandy Point, the Experimental Herring Gulls, nesting close to the earlier-nesting Black-Backs, would be expected to nest and lay eggs somewhat earlier than Control Herring Gulls. Since this was not the case, one cannot assume that Black-Backs are socially stimulating the Herring Gulls to nest earlier.

Patterson (1965) and Brown (1967) found differential hatching success in gulls depending on when the eggs were laid. Patterson found in Black-headed Gulls (*Larus ridibundus*) that birds laying at the peak of the season were more successful than early or late breeders. Brown noted that late layers were significantly less successful than peak layers, and that early nesters tended to be less successful (but not significantly so) than those laying at the peak of the season. The results from the two Herring Gull groups tend to support Brown's findings. In both groups, "Late" layers were significantly ($P < 0.05$) less successful than either "Early" layers (Experimental group) or "Peak" layers (Controls). In the Experimental group, the "Late" layers were close enough to being significantly lower in success than "Peak" layers that notice should be taken. In the Control group, although "Late" and "Early" were not significantly different, the "Late" birds did have 9 per cent less success. Brown (1967) attributes the low success of late egg-laying Herring Gulls to increased predation and parental neglect during the waning period of the breeding season.

As suggested earlier, these same factors could act in reverse on Great Black-Backs. The asynchrony of the breeding seasons of the two species, coupled with human disturbance, could have a relatively greater detrimental effect on the success of Black-Backs laying early in the season. Both "Early" and "Peak" layers had less success than did "Late" layers ("Late" vs. "Peak" difference was significant at the 0.05 level). Although not statistically significant, "Early" layers had 15 per cent less hatching success than did "Late" egg-layers.

SUMMARY

The hatching success of the Great Black-backed Gull and two Herring Gull groups was significantly different. The "Control" Herring Gull group had the greatest success (82 per cent) while the Black-Backs (44 per cent) were least successful. "Experimental" Herring Gulls were intermediate having a 67 per cent success.

The Great Black-Backs laid eggs about two weeks earlier than either Herring Gull group. The mean laying interval was 22–25 April for Black-Backs and 7–10 May for both groups of Herring Gulls.

Hatching success was somewhat dependent on the laying date of the eggs. In Black-Backs, "Late" layers had a higher hatching percentage than either "Early" or "Peak" egg layers. Conversely, "Late" laying Herring Gulls were less successful than "Early" layers (Experimental group) or "Peak" layers (Control group).

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NEW LIFE MEMBER

Among the new Life Members of The Wilson Ornithological Society is John P. O'Neill, one of the country's most talented young bird painters. A graduate of the University of Oklahoma, Mr. O'Neill is currently working on his doctorate at Louisiana State University. His ornithological interests center in Neotropical birds and he is a co-describer of four new species of South American birds. In addition to illustrating his own papers with paintings of these new species he has supplied the plates for two published books and for two more in preparation. He is an Elective Member of the AOU, a member of the Cooper Society, the American Society of Mammalogists, the Texas Ornithological Society, and the Avicultural Society. When not engaged in his ornithological work in South America he has made studies of the local Indians as a hobby. The picture shows him working on a painting of antbirds for a forthcoming book on the birds of Trinidad and Tobago.

REPRODUCTIVE BEHAVIOR OF YELLOW-BELLIED SAPSUCKERS

I. PREFERENCE FOR NESTING IN *FOMES*-INFECTED ASPENS AND NEST HOLE INTERRELATIONS WITH FLYING SQUIRRELS, RACCOONS, AND OTHER ANIMALS

Lawrence Kilham

A concept presented below is that woodpeckers have search images of optimal nest trees and in this regard Yellow-bellied Sapsuckers (*Sphyrapicus varius*) are attracted to mature aspens (*Populus tremuloides*) bearing conks of the false tinder (*Fomes igniarius* var. *populinus*) (Shigo and Kilham, 1968). The fungus renders these trees particularly favorable in several ways: first in inducing extensive decay of the heartwood (Fig. 1) and second in sparing the sapwood which remains as a tough outer living shell protecting the nest cavity. As described below, sapsuckers may re-nest in a suitable aspen over many years. Selection pressures which may operate in formation of search images form the basis of a final discussion. Those emphasized in the following accounts being predation by raccoons (*Procyon lotor*), close association with tree squirrels and, to some degree, interspecific competition with Hairy Woodpeckers (*Dendrocopos villosus*).

This report is based on 50 nestings, of which 29 were in aspens, noted between 1958 and 1970 in Tamworth and in Lyme, New Hampshire. Reports giving background to these studies on sapsuckers are one on breeding behavior (Kilham, 1962*a*) and another on feeding behavior (Kilham, 1964).

Other accounts of nesting sapsuckers are given by Bent (1939) and by Lawrence (1967). Both authors mention aspens as nest trees but do not discuss the role played by *F. igniarius*. Philipp and Bowditch (1917), however, noted of *S. varius* in New Brunswick that "The favorite (nest) situation was the dead heart of a live poplar."

NESTINGS OF SAPSUCKERS IN FOMES-INFECTED ASPENS

The tinder fungus infects a wide variety of trees and sapsuckers may nest in butternuts (*Juglans cinerea*) and in beech (*Fagus grandifolia*) as well as in aspens infected with them. A number of attributes, however, such as the type of decay, the straightness of the bole, and usual diameter when mature (20 to 25 cm) make aspens particularly favorable as nest sites. The nature of the decay has already been described in a note by Shigo and Kilham (1968). As shown in Figure 1 the area of softening and discoloration may extend for a distance up and down the bole from the vicinity of a conk

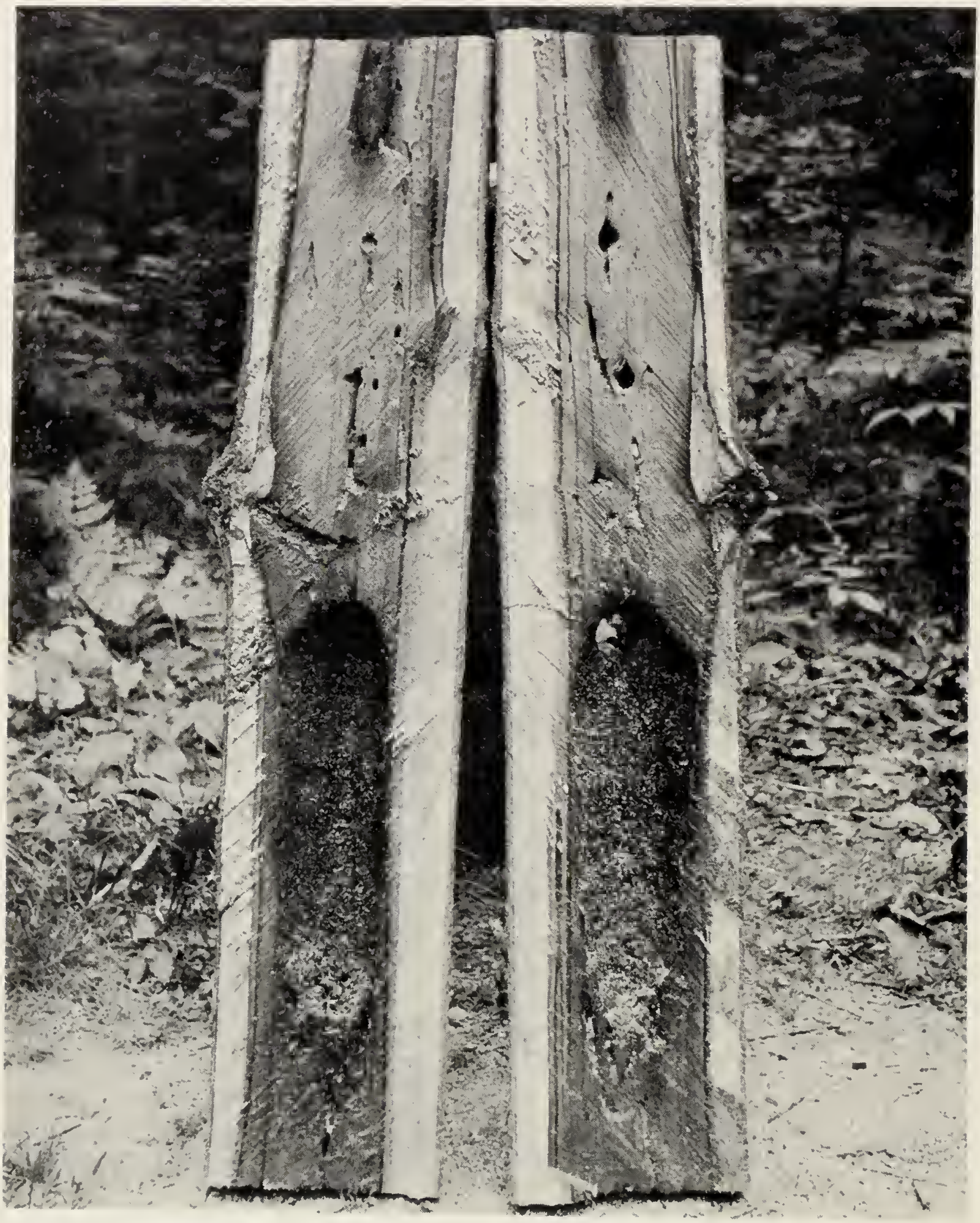

FIG. 1. Longitudinal cross section of an aspen (age 75 years and 22 cm dbh) showing extensive heart rot as well as conks of *F. igniarius*. Tunnels above and below, as well as frass in bottom of the nest cavity of a sapsucker are due to carpenter ants.

or sporophore leaving the sapwood unaffected, a nest entrance (Fig. 2) made through 3 cm of such wood being more or less impregnable to likely predators.

In the following accounts I have designated sapsuckers occupying the

Fig. 2. Longitudinal and front view of the nest of a sapsucker in a mature aspen (age 65 years and 20 cm dbh), in which area of heart rot due to *F. igniarius* is more limited than in Figure 1.

same territory in successive years by the same letter even though individuals making up the pair might change. Thus, Pair A 1963, for example, was a definite pair, just as Pair A 1969 was another.

Territory A.—I located the first nest hole in Aspen A, which had many

TABLE 1

OBSERVATIONS MADE OVER A 6-YEAR PERIOD OF A PAIR OF SAPSUCKERS IN TERRITORIES A AND B, SHOWING PERSISTENCE OF ATTRACTION TO ASPENS INFECTED WITH *FOMES IGNIARIUS* AS NEST TREES

Year	Height of Nest Hole	Date of Nest-leaving	Special Events
		Territory A (Nested in single aspen 5× in 6 years)	
1963	7m	6 July	Hole chewed by raccoon 1 July (no harm).
1964	6m	29 June	1963 nest hole occupied by flying squirrel.
1965	10m	Trial excavation only. No nest	——
1966	8m	23 July	——
1967	12m	14 July	——
1968	13m	28 June	——
		Territory B (Nested in successive *Fomes*-infected trees)	
1963	6m	4 July	Nest in butternut infected with *F. igniarius.*
1964	7m	5 July	Dying *Fomes* aspen. Last year used.
1965	11m	Nest failed.	*Fomes* aspen too narrow for normal nest cavity.
1966	nest not found	Juveniles seen in July.	20 April—trial excavation in "healthy" aspen.
1967	5m	5 July	Dying aspen.
1968	8m	20 June	Same dead aspen used successfully 1968 and 1969.

conks over a 10 cm extent of the bole in 1963. From the time the young sapsuckers hatched on 12 June until they left the nest on 6 July (see Table 1) they made a persistent and increasing volume of harsh vocalizations. Such vocalizations may have survival value among sapsuckers in keeping the parent birds steadily on the job of collecting food. One may wonder, however, whether the noise might not also attract predators, for on the morning of 1 July I found a rosette of tooth marks around the bark of the nest entrance. Similar tooth marks, which I have found on other nest aspens along with claw marks and bits of fur have indicated that such attacks are probably all made by raccoons. The attack made on the nest of Pair A had no apparent effect as the young left successfully 5 days later.

A second nesting of sapsuckers in Aspen A was equally successful in 1964. In 1965 sapsuckers started an excavation in late April. They had abandoned it by 2 May and it is conceivable that in such cases the fungus decay may not have advanced sufficiently within the heartwood to furnish another site as one can see for example in Figure 2. Such decay takes time. After a year away the sapsuckers returned to nest successfully in the aspen in 1966, 1967, and 1968 (Table 1), but failed to return in 1969 when the aspen was still alive. With 5 nest holes in addition to an equal number of trial excavations it resembled a much used tenement house with possibly no space left for an additional cavity.

I judged nesting success among sapsuckers from several lines of evidence. The most satisfactory of these was presence of juveniles on nearby trees on the morning of nest leavings as happened in the 1966, 1967, and 1968 pairs in Aspen A. Juveniles may leave the vicinity of the nest within an hour or less. This makes them difficult to locate and in 1963 and 1964 I considered nestings of the pair successful when full grown young were putting heads out of the entrance one day and were gone the next without signs of the nest having been destroyed.

I was not sure how many individuals had been involved in the various nestings of pairs using Aspen A between 1963 and 1968. In 1967, however, certain peculiarities marked the individuals of the pair as the ones which returned to nest in 1968. The female of both years was a black morph, having a black instead of red crown, and her mate almost invariably used a particular location on the bark of a small hornbeam to discard sawdust and feces after he had cleaned the nest (Kilham, 1962*b*).

Territory B.—The sapsuckers occupying this territory nested in a butternut in 1963 and in an aspen in 1964, both trees bearing prominent conks of *F. igniarius.* The aspen had died by 1965 and was not re-used. I had come to believe by this time that sapsuckers would only nest in aspens that were still alive even if barely so, as was true for the one used by Pair B in 1967. This tree had died by 1968. To my surprise, however, the sapsuckers made fresh excavations and nested successfully in the dead aspen in both 1968 and 1969 (Table 1).

1965 was a difficult year for Pair B and exemplifies the efforts sapsuckers can made to nest in *Fomes*-infected aspens. On 24 April, for example, I found the female working a small funnel-shaped excavation in the smooth bark of a seemingly healthy aspen. This seemed unusual for I could see no conks. Closer inspection, however, revealed three small ones where the female was working. The smoothness of the bark below made it difficult for her to cling and she slipped several times, each time fluttering back to regain her position. A few days later I found that she had roughened the bark over a 6 by 10 cm space below the hole and on 26 April she bent down to roughen it a bit more. Although now able to grasp the bark securely she made little headway with her excavating in this relatively sound tree with little inner decay.

The sapsuckers of Pair B were working on a second *Fomes*-infected aspen by early May. The tree had many mature conks but was unusual in having a diameter of only 12 cm and a long, spindly, crooked bole obviously unsuitable for nesting. The sapsuckers, however, continued to excavate in relays and on 7 May they were able to enter their excavation completely. For the next 3 weeks I was never sure just what they were doing. They visited their crooked aspen repeatedly, performed a variety of courtship displays, and yet gave no signs of nesting. They finally abandoned the tree in early June and I was puzzled to know the reason for failure after so much effort. I therefore cut the aspen down and found that the cavity within had a surprising shape. With a diameter of 8.6 cm and a length of 51.4 cm it was narrower as well as twice as deep as a usual nest and resembled a long, narrow mailing tube. The excessive depth was probably due to the marked slant of the bole which allowed light rays to penetrate farther down than usual.

ATTACKS BY RACCOONS

I had to come to feel by 1967 that sapsuckers nesting in *Fomes*-infected aspens had excellent chances of nesting success, as only one of 10 nests in such trees had failed. In 1967, however, I encountered three nests in *Fomes*-infected aspens that were destroyed by raccoons. Details of events at two of these followed most closely were as follows:

Pair W.—Female W had already lost her mate when I first found her nest in a live *Fomes*-infected aspen on 24 June. I was surprised to find her still caring for her nestlings as a lone parent a week later. This was the last time she did so. On the following day, 2 July, there were fresh raccoon gnawings around the entrance in addition to an old set which had been there when I found the nest originally. I now searched the ground and found two piles of feathers. One of these apparently belonged to the male that had been killed before I found the nest. These were old and matted, as though exposed to the weather for a week or more, and contained 31 wing and eight tail feathers. A second pile a few meters away from the first had 26 wing and seven tail feathers. These were fresh and obviously those of the female. It is difficult to know why the raccoon had succeeded so well. The nest entrance was located 10 m above the ground and I wondered whether the nest cavity may not have been too shallow, the sapsuckers having been limited in their excavating by the insufficient extent of fungus decay. Thus, the raccoon must have reached through the entrance and caught the sapsuckers with a paw, for it had not been able to enlarge the hole by chewing around it.

Pair C, 1967.—A raccoon had already attacked nest C, located only 2 m up, when I found it on 5 June. The ring of tooth marks became more extensive following a second attack on 7 June, but the sapsuckers continued feeding their young in usual fashion until 20 days later. At this time the raccoon made what must have been a prolonged attack. So much bark had been chewed away that I could see the exposed white sapwood of the aspen from a distance and I was not surprised to find that the male had been killed, a pile of his feathers lying below the nest. The raccoon, however, had not destroyed the entrance. I thus imagined that by continually reaching into the nest, while snarling and biting, the raccoon may have finally gotten the over-excited male to come within reach of one of his paws.

The female now fed her nestlings alone for 2 days during which time she attracted a new mate, who, to my surprise, was feeding his adopted young on 29 May. The raccoon made a fourth attack on the following night. The gnawing and bite marks around the entrance were even more extensive than those seen previously. The well-grown nestlings had all been pulled out through the still intact entrance and their feathers lay on the ground. One might ask why the raccoon had been so successful at this nest hole, built as it was in a seemingly ideal aspen which, I found later, had provided ample inner decay for a nest cavity 25 cm in depth. It seemed likely that the closeness of the nest to the ground was what attracted the raccoon. At 2 m it was the lowest nest of all the 50 which I have found and this accessibility may have made the raccoon far more persistent than he would have been had the nest hole been located higher up.

CARPENTER ANTS

A nest which may have been disturbed sufficiently by carpenter ants (*Camponotus pennsylvanicus*) to lead to its abandonment was that of Pair E in 1965. The entrance was 8 m up above swampy ground and the sapsuckers had been feeding their young for a week when, on 12 June. I found that a raccoon had gnawed the entrance. The attack seemed to have had little effect. The living sapwood had withstood the attack and I watched the male feeding its young on the following morning. I was, therefore, puzzled to find the nest deserted a week later. The nestlings had not been old enough to leave in so short a time and, seeking a clue, I cut the aspen down. I then found that carpenter ants had tunnels leading into the nest cavity. There was no proof that the ants had caused the destruction of the nest. They had, however, partially filled it with frass and it is conceivable that their activities, especially at night when the sapsuckers might not be able to see and protect themselves, might have led the sapsuckers to leave.

Figure 1, while of a different tree than that of Nest E, is a longitudinal section of a *Fomes*-infected aspen showing tunnels of carpenter ants above and below a sapsucker nest cavity as well as an accumulation of frass at the bottom of it.

INTERRELATIONS WITH SQUIRRELS

Of the three arboreal squirrels found in New Hampshire, the gray squirrel (*Sciurus carolinensis*), the red squirrel (*Tamiasciurus hudsonicus*), and the flying squirrel (*Glaucomys* sp.),* the last two are somewhat dependent on the excavations of Hairy Woodpeckers and sapsuckers for secure resting as well as nest holes. Sapsuckers nesting in straight aspens within woods appear to be of particular importance to flying squirrels which almost invariably occupy old sapsucker nest holes sooner or later. This leads to close interrelations, especially where the sapsuckers return to nest in the same tree in a following year. As described below sapsuckers appear able to cope with squirrel neighbors without undue excitement.

Pair D, 1965.—In the spring of 1965 I had found a flying squirrel occupying the 1964 nest hole of this pair. The returning sapsuckers excavated a new hole only 30 cm above the one occupied by the squirrel. A low afternoon sun attracted the squirrel to look out on both 5 June, as well as inducing the male sapsucker to stop incubating, at least temporarily, to catch insects close to its nest. The male sapsucker attacked the squirrel by swooping at it six times and followed through by clinging to the outside of its hole and pecking down as the squirrel withdrew. The squirrel seemingly unfazed by the attacks put its head out again after the bird had left.

Pair C, 1969.—The sapsuckers of Pair C nested in one *Fomes*-infected aspen from 1963 through 1970, with the exception of a single year, 1967. I had found flying squirrels occupying their old nest holes over a number of years and on observing that the sapsuckers were behaving in an unusual manner on 13 June, I wondered whether a flying squirrel might be responsible. The nestling sapsuckers in this nest had hatched about 10 days previously. First one parent, then the other, would stay in the nest looking out until relieved by its mate arriving with a bill full of insects caught in the immediate vicinity. After 10 minutes of watching I saw a gray squirrel raise its head in the gnawed entrance of a hole several meters below the nest of the sapsuckers. Either of the parent sapsuckers arriving at the nest would first turn its head to eye the squirrel before feeding the young. Neither bird, however, attacked the squirrel or gave signs of alarm.

On the following noon I found the sapsuckers of Pair C behaving in similar fashion. I then sat down at a distance expecting to see the gray squirrel appear again. To my surprise, however, a red squirrel came down past the sapsucker's hole and squeezed into another old nest hole about 30 cm below the one occupied by the gray squirrel the day before. The red squirrel put its head out, rested 5 minutes and then came out. Passing by the sapsucker's nest a second time it leapt onto branches of other trees and did not return. The sapsuckers changed their behavior immediately by ceasing to guard their nest hole and as is the usual behavior of sapsuckers with advanced nestlings flying away after a few brief seconds of feeding their young to catch more prey.

Pair C, 1967.—Sapsuckers and Hairy Woodpeckers which use nest trees of the same general diameter appear to have differing reactions to flying squirrels. A pair of Hairy

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*There are two sympatric species of flying squirrel in central New Hampshire, *G. volans* and *G. sabrinus*. I was, unfortunately, unable to identify them as to species from just seeing a head in a nest hole, for they are difficult to distinguish unless seen at close range.

Woodpeckers in 1965 nested in a typical *Fomes*-infected aspen used by the sapsuckers of Pair C in 1967. Flying squirrels took over the woodpecker's old nest hole later on, enlarging the entrance to such an extent that in July 1966 heads of four squirrels shot out simultaneously when I knocked below. Presence of one or more squirrels in this hole did not deter Pair C from using the aspen in 1967. Their new excavation was only a meter below the one being used by the squirrels. The squirrels remained in residence here until near the end of the sapsucker nesting period. I have wondered in such cases, of which I have observed two, whether the almost incessant, harsh, clambering of nestling sapsuckers made during the day when squirrels would normally be sleeping, might not lead them to move to a cavity in some other tree.

This nesting of the sapsuckers and Hairy Woodpeckers in the same *Fomes*-infected aspen, although in different years, has interest in showing that both species, which have approximately the same body size, have essentially the same requirement in the bole diameter of potential nest trees.

NESTINGS IN TREES OTHER THAN ASPENS

Sapsuckers, like other woodpeckers, will nest in trees and stubs that are far from optimal through necessity and this probably explains why 21 of 50 nestings encountered were not in *Fomes*-infected aspens but in stubs or in dead portions of otherwise living trees such as elms, maples, paper birches, and beeches. These latter nestings were not followed closely, some having been seen but once on remote mountain trails and three having been interrupted to procure young for hand-raising. What appeared common to all, however, was that they were in woods either without aspens or without those rare ones which have the right diameter combined with extensive heart rot due to *F. igniarius*.

Three of the nests found in other than aspens and followed subsequently were destroyed by raccoons. Here the animals, with only dead, rotten wood to chew through, appeared to have had an easy time breaking through the front, side, or rear (see Fig. 3) of a nest cavity, whichever was weakest.

COMPARISONS WITH OTHER SPECIES

The idea of a search image is almost classically illustrated by the Red-cockaded Woodpecker (*Dendrocopos borealis*) which, to draw upon Steirly's (1957) account of this species in eastern Virginia, nests almost exclusively in mature loblolly pines (*Pinus taeda*) affected with heart rot due to *Fomes pini.* There is, of course, the difference that sapsuckers live in a more varied habitat and are *eurytopic*, whereas *D. borealis* is notably a *stenotopic* species. An interesting and recent account of the nesting of *D. borealis* is that of Ligon (1970).

Hairy Woodpeckers are sympatric with sapsuckers in New Hampshire have a search image of an optimal nest tree which overlaps that of sapsuckers to some extent, for the two species are close enough in body size

Fig. 3. Front (a) and rear (b) views of the nest of a sapsucker in the bole of a dead beech. Although the entrance (a) was made through 4 cm of solid wood, a raccoon was able to destroy the nest by breaking through the back (b) which was 1 cm or less in thickness.

to require the same outside nest diameters. Neither these nor any other species of eastern woodpecker can excavate a nest cavity in solid wood. The most they can do is excavate an entrance through living sapwood and here even Hairy Woodpeckers, with stronger bills than sapsuckers, are also dependent on heart rot produced nearly always by *F. igniarius* which infects a wide range of tree species in addition to aspens.

Table 2 gives the hypothetical search image of an optimal nest site for Hairy Woodpeckers. It lies in open situations and when the woodpeckers are forced to seek a site in woodlands due to pressure from starlings (*Sturnus vulgaris*) or other reasons, they may come into competition with sapsuckers (Kilham, 1969). An hypothesis as to why they generally do not do so, however, relates to flying squirrels. These animals favor nest cavities high up in straight boles of trees and on three occasions I have found where they had apparently taken over the nest holes of breeding Hairy Woodpeckers (Kilham, 1968). I have never, however, noted flying squirrels displacing nesting sapsuckers in such situations. The stratcgy of sapsuckers. be it

TABLE 2

SEARCH IMAGES OF OPTIMAL NEST TREES OF YELLOW-BELLIED SAPSUCKER AND HAIRY WOODPECKER IN NEW HAMPSHIRE

Woodpecker Species	Search image of optimal nest site	Selection Pressures		
		Predator	Nest-hole Competitors	
		Procyon lotor	*Sturnus vulgaris*	*Glaucomys* Sp.
D. villosus	On underside of curved limbs of trees growing in moderately open situations.	Highly successful in destroying nests located in less than optimal situations.	Dispossesses *D. villosus* from holes in straight tree trunks, but avoids nest holes on the under side of limbs and near foliage.	Frequently dispossesses woodpeckers nesting within woods, especially where nests are high in boles of straight trees.
S. varius	Mature, straight aspen in woods bearing conks of *F. igniarius.*		Not attracted to sites within woods. Hence not a competitor.	Not competitors for new sapsuckers nest holes due to prior occupation of old ones.

innate or coincidental, is that by re-nesting in aspens they provide flying squirrels with what are ideal nest cavities. The squirrels, being well established when the sapsuckers return in a following year, have no incentive to face attacks of these birds to move from where they are already well established to new excavations. Sapsuckers, on the other hand, are adapted to tolerating and coping with their squirrel neighbors.

As a resident species seeking a nest tree in March before arrival of the migratory sapsuckers, Hairy Woodpeckers might take over a *Fomes*-infected aspen already in use were it not for the tree being occupied by flying squirrels. The squirrels would then be a factor favorable to the sapsuckers in preserving a nest aspen against what might otherwise be a closely competing species of woodpecker. In any event, I have never found a Hairy Woodpecker even attempting to excavate an aspen used by sapsuckers in previous years.

In conclusion it might be noted that while much is owed to Haartman (1957) for his discussions on adaptations in hole-nesting birds and to Nice (1957) for her findings that 65 per cent of eggs resulted in fledglings among hole-nesters as compared to 43 per cent for open nesters, neither of these authors included woodpeckers among the species studied. Woodpeckers should in many ways be considered in a separate category. They select trees in which to excavate rather than nest holes already built and while some species such as the Hairy Woodpecker do have to compete with both avian (Starlings) and mammalian (flying squirrel) competitors, sapsuckers appear to face almost no competition of this type whatever. The selection pressures which may have led to the evolution of their search image of the safest and most secure type of nest tree may have consisted largely of that highly versatile predator, the raccoon, as well as of other factors as varied as carpenter ants whose presence might never be suspected in a tree unless one examined a nest aspen by cutting it down and sectioning it with a power saw. There is obviously, in this regard, much to be learned about the adaptations of sapsuckers and other woodpeckers which enable them to survive as hole-nesting species.

SUMMARY

An hypothesis arising from present studies is that Yellow-bellied Sapsuckers have a search image of aspens having straight boles and diameters of 20 to 25 centimeters as being optimal nest sites when they bear mature conks of *Fomes igniarius.* This fungus also attacks the heartwood of other trees. When butternuts are infected they may be as suitable for nesting as aspens in providing a tough living shell of sapwood surrounding a center of soft decay which can be excavated readily. Such trees offer maximal, although not always complete, protection against raccoons which appear to be the main predators. Raccoons may leave a characteristic circle of superficial tooth marks in unsuccessful attacks on nest entrances but several examples are given where they succeeded, after persisting efforts, in dragging sapsuckers out through undamaged entrance holes, as evidenced by piles of feathers on the ground below. The nest sites involved were either too near the ground or possibly too shallow.

Sapsuckers, unlike other species of eastern woodpeckers, have a habit of re-using suitable nest trees, making fresh excavations each year and in some *Fomes*-infected aspens, for periods of 6 or 7 years. Such trees come to resemble tenement houses with the old nest holes being not infrequently occupied by flying squirrels. Yellow-bellied Sapsuckers appear to be well adapted to living in the close presence of squirrels and this may give them a competitive advantage in relation to Hairy Woodpeckers which can, under some circumstances, seek the same type of a nest tree.

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DEPARTMENT OF MICROBIOLOGY, DARTMOUTH MEDICAL SCHOOL, HANOVER, NEW HAMPSHIRE, 9 APRIL 1970.

ANNOUNCEMENT

"The Zoological Miscellany," published privately in several parts from 1831 to 1844 in London by John Edward Gray, is one of the rarest yet taxonomically-important natural history periodicals. Articles are mostly by Gray himself and cover species from all parts of the world. Individual papers deal with mammals (2 articles), birds (17), amphibians and reptiles (12), fishes, and invertebrates, plus four plates (3 of birds). The fascimile reprint includes a new introduction and biography of Gray, plus a table of contents.

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PREDATION ON AN INLAND HERONRY IN EASTERN TEXAS

Reese J. Taylor and Edwin D. Michael

A nesting study was conducted in an inland heronry in Nacogdoches County, Texas during spring and summer, 1969. The findings of this study are unique in that both the initial and re-nesting attempts failed and no young survived.

METHODS

A 25-foot observation tower was constructed on the western shore of the heronry pond during February 1969, from which arrival of birds, courtship, and nest construction were observed. After the initiation of egg-laying, numbered tags were attached beside each nest containing eggs. The heronry was visited once a week before the initiation of egg-laying, twice a week during the first nesting attempt, and once a week during the second nesting attempt.

The heronry is in a natural pond bound by pine-hardwood hills on the south and west and a pasture on the north and east. A small creek passes within 50 yards of the eastern edge and several underground springs assure a water supply throughout the year. The pond is approximately 3 acres in size with one island of about one-tenth acre near the eastern shore. Buttonbush (*Cephalanthus occidentalis*) occurs extensively, comprising 80 per cent of all shrubs and trees in the pond. Rushes (*Juncus* sp.) are common throughout the pond and spatterdock (*Nuphar* sp.) covers the surface during summer. Other woody plants present in the pond in order of abundance are: red maple (*Acer rubrum*), willow (*Salix* sp.), river birch (*Betula nigra*), ash (*Fraxinus* sp.), alder (*Alnus* sp.), and sweetgum (*Liquidambar styraciflua*). The Angelina River, a large lake, and numerous small ponds and creeks, all within 3 miles of the heronry provide feeding areas for the nesting birds.

RESULTS

The birds nesting in the heronry and their estimated numbers of pairs were: Little Blue Heron (*Florida caerulea*) 181, Anhinga (*Anhinga anhinga*) 10, Green Heron (*Butorides virescens*) 6, and Common Egret (*Casmerodius albus*) 3.

A total of 127 Little Blue Heron nests were located during the first nesting attempt. Of these 67.7 per cent were in buttonbushes, 28.4 per cent in red maple, 2.3 per cent in river birch, 0.8 per cent in willow, and 0.8 per cent in sweetgum. The average height of nests above water was 3.6 feet. During the second nesting attempt 168 Little Blue Heron nests were located, most of which were newly constructed. Of these 50.7 per cent were in buttonbushes, 33.8 per cent in red maple, 10.1 per cent in willow, 2.7 per cent in ash, 2.0 per cent in alder, and 0.7 per cent in rushes. The average height of nests was 4.3 feet. The increase in average height of 0.7 feet was due to the dropping of the water level.

Ten Anhinga nests were present during the first nesting attempt: seven in willows, two in red maple and one in buttonbush. The average height of Anhinga nests during the first nesting attempt was 5.5 feet but increased to 7.4 feet during the second nesting. This increase was not due entirely to the water level dropping. Seven Anhinga nests were present during the second nesting attempt: four in red maple, two in willow, and one in ash.

Only three nests were constructed by Common Egrets, one in a buttonbush and two in red maple. The average height of nests was 3.3 feet above the water. These birds were very nervous and were the first to leave when observers approached the heronry. This possibly explains why they were not present during the second nesting period.

Six Green Heron nests were found during the second nesting period, but none during the first period. Three were in buttonbushes, two in willow, and one in red maple. The average height of nests was 2.8 feet.

Of the 127 Little Blue Heron nests located during the first nesting attempt 119 contained eggs. These had an average of 2.91 eggs each. During the second nesting 148 of the 168 nests contained eggs. They had an average of 3.01 eggs. Three of the ten Anhinga nests located during the first nesting attempt contained eggs. They had an average of 2.67 eggs. The seven nests located during the second nesting attempt had an average of 2.86 eggs. The Common Egret nested only during the first attempt and produced three nests, with an average of 2.67 eggs. The Green Heron was found nesting only during the second nesting period. Six nests with an average of 3.33 eggs each were found.

During the first nesting attempt all eggs were lost; mostly to predators. The second nesting attempt also failed due primarily to predators. Twelve Little Blue Herons and 12 Green Herons were hatched but none survived. The first nests were examined on 17 April, when 75 nests with eggs were tagged (Table 1). No evidence of predation was noted on 17 April but on 19 April predation was obvious. Forty more nests with eggs were tagged on 19 April, but in 22 of the first 75 nests tagged the eggs had been destroyed. A 4.5 foot Texas rat snake (*Elaphe obsoleta*) was collected from a Little Blue Heron nest in a clump of buttonbushes containing seven nests, four of which contained no eggs. An autopsy revealed seven Little Blue Heron eggs in the snake. At this stage of nesting most nests contained two or three eggs, indicating that at least three nests were preyed upon. Other signs of predation were several nests with egg shells and yolk and many nests without the eggs which were present 2 days previous. One nest was completely destroyed. Most of the egg predation was due to the Common Crow (*Corvus brachyrhynchos*) which were observed in the vicinity of the heronry on each visit and were observed robbing nests on several occa-

TABLE 1

EFFECTS OF PREDATION AT A HERONRY IN EASTERN TEXAS

	1st Nesting Attempt						2nd Nesting Attempt			
	April				May		June			
	17	19	22	26	1	4	13	21	28	5
Number of nests with eggs	75	115	120	125	125	125	136	147	161	161*
Number of clutches destroyed	0	22	105	111	124	125	0	47	121	160

* One nest contained two Green Heron nestlings, but were assumed destroyed since they were not present on 12 July.

sions. Raccoon (*Procyon lotor*) predation was suspected but no substantial evidence was found.

On 22 April five new nests contained eggs but 105 of the 115 previously tagged nests had no eggs. On 26 April 5 new nests with eggs were found but 111 of 120 previously tagged nests had no eggs. Most nests were destroyed by crows but 10 nests were smeared with mud indicating a predator such as a raccoon had climbed the trees. Thirteen of the remaining nests were destroyed by 1 May. A crow was observed in a clump of buttonbushes containing six of the remaining nests and mud was also found in three of the nests. On 4 May the remaining nest was found to contain no eggs; thus all 125 nests were destroyed in 17 days. The heronry was visited twice the following two weeks and no renesting attempts were observed. Only a few birds were seen feeding around the heronry. On 29 May, 66 Little Blue Herons, six Anhingas, and six Green Herons were present. One Anhinga was sitting on a nest, Little Blue Herons were standing around the pond. and Green Herons were engaged in courtship activity.

On 13 June, 136 nests with eggs were tagged but there were no signs of predation. Eleven new nests were tagged on 21 June, but 47 of the 136 previously tagged nests contained no eggs. Twenty-seven nests were completely or partially destroyed, possibly due to robbing of nest material by other birds. Several nests had egg shells and yolk material while one contained a dead, adult Little Blue Heron. The bird's neck was stripped of feathers, while the remaining parts were intact. This suggests a mink (*Mustela vison*) since they often attack the head and neck regions. On 28 June, 14 new nests were tagged but 121 of the 147 previously tagged nests had no eggs. However, young birds were found for the first time: 12 Little Blue Herons and 12 Green Herons. Fifty-six nests were partially or completely destroyed; 20 contained eggs shells or yolk material and two contained dead birds. One bird had the same characteristics of mink predation as previously mentioned, but the second was almost completely devoured.

On 5 July, 160 of the 161 tagged nests had no intact eggs or young and no new nests were found. All nestlings were missing except two Green Herons in one nest. One week later these two birds were missing, probably due to predation. The heronry was visited once a week until September and there were no indications of further nesting activity among the few birds observed.

DISCUSSION

Findings of this study, except for predation aspects, are similar to those for heronries in other southeastern states. Arrival, courtship, nest location, and nest construction for all species were similar to that reported by Meanley (1954, 1955) and Allen (1961).

Several aspects of predation are noteworthy. The complete failure of the first nesting attempt did not seem to change any aspects of nesting during the renesting attempt. A few more birds nested in red maple and fewer in buttonbush during the renesting attempt but the majority still utilized buttonbush. Nest height increased slightly during the renesting attempt but this was due mainly to the water level dropping. Due to predation, clutch size for all species was approximately one egg less than the average reported in the literature. Meanley (1955) wrote that the average clutch size of Little Blue Herons was 4.04 eggs as compared to 2.97 in our study. For Anhingas, Meanley (1954) reported an average of 3.82 compared to our 2.80. Palmer (1962) wrote that the Common Egret lays between three and four eggs as compared to our average of 2.67. Palmer also noted that Green Herons lay three or four eggs, whereas six nests in our study had an average of 3.33.

The extent of nest destruction by each predator cannot be determined but crows were thought to be responsible for the majority. Predation is present in most bird populations and usually most prevalent in the immature stages. Baker (1940) found that crows completely destroyed the eggs of a large colony of Little Blue Herons and Snowy Egrets (*Leucophoyx thula*) in Waller County, Texas. Teal (1965) in a study in Georgia found a large number of Common Egret nests destroyed by raccoons. Dusi and Dusi (1968) found in an Alabama heronry that all 214 Cattle Egret (*Bubulcus ibis*) nests were unsuccessful, and only 14.5 percent of 117 Little Blue Heron nests were successful. Predation, however, is not always present in heronries as noted by Peterson (1965), who wrote that Little Blue Herons in Missouri were not troubled by humans or predation. Also, natural mortality, such as loss of nestlings that fell from nests or fledglings that wandered from the nest and starved, was not excessive.

A factual account of the history of the heronry we studied is not available, but according to the owner it has been used every year for at least 10 years. Detailed observations were first made in August 1968 when several nestling, fledgling, and immature birds were present. Predation has certainly not occurred in the past to the extent it did during this study or the birds would not have continued nesting there. However, it does not seem likely that predation would have been completely absent until 1969. Thus, why the sudden increase? Human activity had occurred in the past in the form of boys shooting at the birds, but no one regularly spent extended periods in the pond. Human activity may increase predation among nesting birds (Hammond and Forward, 1956) but we do not feel that our presence was the cause of this total destruction. However, we have no other suitable explanation at this time.

SUMMARY

An inland heronry consisting mainly of Little Blue Herons was studied in detail during the summer of 1969 in Nacogdoches County, Texas. Behavior associated with nesting was observed from an observation tower and nest success was followed by tagging each nest. Nesting occurred primarily in buttonbush, which was the most abundant woody plant in the heronry pond. Time of arrival, courtship, and nest building were similar to that for heronries in other southeastern states. Predation, however, was one of the most extensive ever reported. A total of 140 nests were located during the first nesting attempt but no young were produced due primarily to predators. Renesting was initiated one month later and 181 nests were located. Predators also caused the failure of this attempt although 24 young survived for a few days. Crude estimates indicate that crows destroyed the majority of the eggs and young although raccoons, snakes, and mink perhaps destroyed a few. Nesting has occurred in the pond every year for at least 10 years but detailed observations were not made prior to this study. No explanation for the total nest destruction is available although increased human activity may have been partially responsible.

ACKNOWLEDGMENTS

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NEW LIFE MEMBER

Dr. Gustav A. Swanson, distinguished conservation educator, is a recent addition to the list of Life Members of The Wilson Ornithological Society. Formerly at Cornell University Dr. Swanson is currently Head of the Department of Fishery and Wildlife Biology at Colorado State University. Dr. Swanson holds three degrees from the University of Minnesota and has published numerous papers on ornithological and conservation subjects. He is a past Treasurer of the Wilson Society, an Elective Member of the AOU, Past President of the Wildlife Society, Fellow of the AAAS, and a member of the American Society of Mammalogists, National Audubon Society, and other wildlife and conservation organizations. He is married and has three children, and considers nature photography and bird watching to be his hobbies.

AN EVALUATION OF REPORTED REPRODUCTIVE SUCCESS IN RED-WINGED BLACKBIRDS

William J. Francis

The Bureau of Sport Fisheries and Wildlife, through its Ohio Blackbird Research Laboratory at Sandusky, Ohio, is conducting investigations on the Red-winged Blackbird (*Agelaius phoeniceus*), with the objective of reducing agricultural damage by this species. Nesting success in different substrates and micro-environments is an important variable in such study. Eight published studies that deal with the nesting success of Redwings (Table 1) have been reviewed and results compared by using statistical significance calculations. This approach was taken to establish firm conconclusions, where possible, regarding conditions which control nesting success.

RECENT NESTING STUDIES REVIEWED

Smith (1943:195), in Cook County, Illinois, found an overall reproductive success (which he defined as the ratio of young fledged to eggs laid) of 59.7 per cent in 1941; there was no correlation between success and the size of the breeding population. Meanley and Webb (1963), in the marshes of Chesapeake Bay, Maryland, found that 57 per cent of active nests (those containing at least one egg or nestling) were successful in fledging one or more young in 1959–61. Success varied only from 58.6 per cent in 1959 to 52.8 per cent in 1961. They compared success by ecological communities, by kinds of plants in which nests were built, and by the height of nests above ground. Young (1963), in Wisconsin, found that 29 per cent of active nests were successful in 1959–60, and plotted survival curves through the nestling stage. Case and Hewitt (1963), in New York, found that 32 per cent of active nests were successful in 1960–61; there was markedly higher success in three marshes than in two upland situations. Brenner (1966), in a Pennsylvania marsh, found that 53 per cent of active nests were successful in 1960–64; success varied from 37 to 67 per cent during those years. The population declined from 42 to seven females in 3 years, and recovered to 17 females in the fourth year. He suggested that the amount and distribution of rainfall determined the number of nests constructed, but did not show that nesting success varied with rainfall. Fankhauser (1964), in Maryland, studied the re-nesting of color-marked females in 1962; he found that 50 per cent of all nests were successful: seven of 16 first nesting attempts, four of five second attempts, and one of three re-nestings. Goddard and Board (1967), in Oklahoma, found an overall nesting success of 26.7

TABLE 1

RED-WINGED BLACKBIRD REPORTED NESTING SUCCESS, BY ECOLOGICAL FACTORS

Source[1]	Habitat, Vegetation, Timing	Year	Nest Height	Active Nests	Successful Nests
1.	Cattail marsh	1941	–	167	([2])
2.	Tidal marsh	1959–61	<2 ft	44	20
	Tidal marsh	1959–61	2–4 ft	360	199
	Tidal marsh	1959–61	>4 ft	271	169
2.	Estuarine Shore	1959–61	All	299	159
	Brackish Tidal River	1960	All	176	122
	Brackish Bay	1959	All	88	57
	Fresh Tidal River	1960	All	50	23
	Salt Bay	1959	All	42	16
	Fresh Bay	1961	All	20	11
2.	Tidal marsh	1959	All	232	136
	Tidal marsh	1960	All	335	195
	Tidal marsh	1961	All	108	57
2.	Hightide-bush	1959–61	All	330	178
	Groundselbush	1959–61	All	179	116
	Grasses and sedges	1959–61	All	56	33
	Shrubs and trees	1959–61	All	35	24
	Cattails	1959–61	All	15	8
	Other vegetation	1959–61	All	35	12
3.	Cattail marsh	1959	–	238	83
	Cattail marsh	1960	–	280	67
4.	Cattail marsh	1960	–	379[3]	208
	Upland fields	1960	–	57[3]	17
	Cattail marsh	1961	–	402[3]	146
	Upland fields	1961	–	147[3]	48
5.	Initial nesting	1962	–	16	7
	Renesting after failure	1962	–	6	4
	Second nest	1962	–	3	1
6.	Cattails and sedges	1960	–	45	29
	Cattails and sedges	1961	–	24	12
	Cattails and sedges	1962	–	16	6
	Cattails and sedges	1963	–	6	4
	Cattails and sedges	1964	–	18	7

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[1] Source: 1. Smith (1943)—Illinois. 2. Meanley and Webb (1963)—Maryland. 3. Young (1963)—Wisconsin. 4. Case and Hewitt (1963)—New York. 5. Fankhauser (1964)—Maryland. 6. Brenner (1966)—Pennsylvania. 7. Goddard and Board (1967)—Oklahoma. 8. Holcomb and Twiest (1968)—Ohio and Michigan.

[2] 336 young fledged from 563 eggs laid; number of successful nests unknown.

[3] Estimated. Data specified number of deserted nests which were "active" in only one location containing 60 percent of all nests.

TABLE 1 (*Continued*)

Source	Habitat, Vegetation, Timing	Year	Nest Height	Active Nests	Successful Nests
7.	Early nests	1965	All	155	45
	Late nests	1965	All	88	20
7.	Old cattails only	1965	All	52	20
	Old and new cattails	1965	All	83	16
	New cattails only	1965	All	89	26
	Other plants	1965	All	19	3
7.	Cattails and sedges	1965	0–12 in	34	13
	Cattails and sedges	1965	13–24 in	125	34
	Cattails and sedges	1965	25–36 in	53	12
	Cattails and sedges	1965	> 36 in	31	6
8.	Marsh and upland	1964–65	< 24 in	79	15
	Marsh and upland	1964–65	24–48 in	34	10
	Marsh and upland	1964–65	> 48 in	44	19

Source	Vegetation	Year	Water Depth	Active Nests	Successful Nests
7.	Cattails and sedges	1965	0–10 in	155	36
	Cattails and sedges	1965	11–20 in	65	19
	Cattails and sedges	1965	> 20 in	23	10

per cent in 1965; they reported higher success for nests initiated before 1 June, those constructed in old cattails, those closer to the ground or water surface, and those over deeper water. Holcomb and Twiest (1968), in two marsh habitats and one upland habitat in Ohio and Michigan, found nesting success to be greater in nests more than 48 inches above the ground or water than in lower nests.

RESULTS OF ANALYSIS

The above eight studies included 3,013 active Redwing nests in eight states during nine different years, an average of 42 nests per state per year. This total sample, however, is inadequate for a meaningful statistical analysis of the differences between all eight states and between all nine years. Nevertheless, a comparison of the results obtained can reveal some of the factors that have or have not been shown to be important in nesting success. The data are well adapted to the chi-square analysis, and I have made comparisons both between and within the cited studies in order to determine in what respects the differences are of significance.

BETWEEN YEARS

If the data are grouped by years, the differences between years are large; but, except when data from the same locality are compared, it is impossible to say whether the differences are due to year-to-year changes or not. Brenner's study during five consecutive breeding seasons in Pennsylvania (Brenner, 1966) shows no significant differences between years in that locality ($P > 0.20$), but the sample size is less than 20 nests in three of the five years. In the Estuarine Shore community of Maryland studied by Meanley and Webb (1963), data collected for four consecutive years show no significant difference between years in the number of fledglings produced per adult female ($P > 0.50$). On the other hand, Case and Hewitt (1963) found a highly significant difference in nesting success between the two years of their study in New York ($P < 0.01$). Young (1963) also found a significant difference in nesting success between the two years of his Wisconsin study ($P < 0.01$). Difference between years at the same locality must, therefore, be regarded as possibly an important factor in nesting success.

BETWEEN LOCALITIES

In the three years 1960–62, comparable nesting data are available for more than one locality. In 1960, nesting success was very much lower in Wisconsin (Young, 1963) than in New York (Case and Hewitt, 1963) and in Pennsylvania (Brenner, 1966) ($P < 0.01$). In 1961, the difference between Pennsylvania and New York was not significant at the 0.05 level. In 1962, the difference between Pennsylvania (Brenner, 1966) and Maryland (Fankhauser, 1964) was not significant. These differences are between nests in similar habitat (cattail marshes); they must, therefore, be attributed to regional differences in the ecological environment, such as climate, predators, nutrition, water characteristics, etc.

HABITAT TYPES

Three studies provide direct comparison between nesting success in different habitat types. Meanley and Webb (1963) studied nests in marshes in different ecological communities. Success was significantly different ($P < 0.01$) among six communities; highest success was in Brackish Tidal River (two colonies, 1960), and lowest in Salt Bay (two colonies, 1959). The differences between communities may be real even though the data were collected in different years. In only one of the six communities were data collected for more than one year: the Estuarine Shore community, where four years of data showed no significant difference between years.

Case and Hewitt (1963) compared three marsh habitats and two upland habitats. In 1960, the marsh habitats did not differ among themselves in nesting success, but differed greatly from the upland habitats ($P < 0.01$). In 1961, the marshes differed significantly among themselves ($P < 0.01$), but did not differ from the two upland habitats. Success was much lower in 1961 in the marsh habitats, the proportion of successful nests being about the same as in the upland habitats. These results suggest that subtle ecological deficiencies in some marshes will be masked in good years. In less favorable years, these deficiencies will assume more importance and result in poorer nesting success.

An important factor in the habitat is the vegetation in which the nest is built. Meanley and Webb (1963) listed the plant species in which nests were built. I grouped these into six classes, and found that nesting success differed significantly among classes ($P < 0.01$): greatest success was in groundselbush (*Baccharis halimifolia*), poorest success in a miscellaneous grouping of fern and herbs. Success also was high in shrubs and small trees. Goddard and Board (1967) compared the success of nests in different growth stages of cattail, and they reported higher success in old cattails and lower in a combination of old and new cattails. The chi-square analysis shows the differences to be not significant ($P > 0.05$). These two studies together suggest that nest success is related to the vegetation form, with relatively sturdy shrub-like forms more favorable than less sturdy herbs and vines; but that species and growth stage within a single vegetation form have only a minor effect.

NEST PLACEMENT

The height of nests above the water or ground has been suggested as a factor affecting nest success. Goddard and Board (1967) reported that nesting success was greater as the depth of the water below the nest increased. The data given fail to show a significant difference ($P > 0.10$). Goddard and Board also found that nesting success decreased from 38.2 per cent for nests less than 1 foot high to 19.4 per cent for nests more than 3 feet above the surface; chi-square analysis of their data shows that this difference in nest success was not significant ($P > 0.30$). Meanley and Webb (1963) also compared nest success by height, but found the opposite—that the higher nests were more successful than the lower. Analysis of their data, however, also shows that the difference with height was not significant ($P > 0.05$).

Holcomb and Twicst (1968) also found reproductive success (ratio of young fledged to eggs laid) to be significantly greater as the nest height increased; success ranged from 17.2 per cent for nests under 24 inches high to 34.8 per cent for nests above 38 inches. The number of successful nests also was significantly different at different heights ($P < 0.02$). However. these data combined nests in grasses, weeds, and cattails at a mean height of 21.7 inches. and nests in shrubs, bushes, and trees at a mean height of 56.6 inches. The reported differences in nest success, therefore, may in fact be related to nest substrate rather than to height per se.

TIME OF NESTING

Nesting success and clutch size were reported higher in nests initiated prior to 1 June than in later nests (Goddard and Board, 1967). Neither of these findings were significant ($P > 0.70$ for nesting success, and $P > 0.10$ for clutch size).

DISCUSSION AND CONCLUSIONS

The above analysis of reported nesting studies shows several real differences. Nesting success may differ between years, but the differences may not appear every year or in all regions. Large differences in nesting success may be expected between geographical regions, even in the same year. Differences in success among habitat types are frequently found, but the magnitude is affected by year-to-year variations and by geographical location. Nesting success has been shown to be related to vegetation form; mechanical sturdiness probably is the important factor (Orians, 1961). Other hypotheses relating success to nest location (including nest height above ground, depth of water. or time of nest initiation) are not substantiated by analysis of the authors' data.

The factors responsible for differences between years and between regions most probably are meteorological, since other factors generally are constant. Development of vegetation forms needed for successful nesting depends on the distribution of precipitation and temperature for each region. Long-term climatic conditions determine the development of ecological communities. but one abnormal year may radically change conditions and reduce food and cover below that necessary for fledging young. Catastrophic weather events, which are direct results of the meteorological pattern but are different in various localities, are obviously important: storm tides may inundate marshes, heavy rains may kill nestlings or even adults by chilling, and strong winds may flatten vegetation or knock down nests. Weather factors also are related to the greater nest success in sturdier vegetation forms. since such nests are less likely to be knocked down by wind and rain.

A potentially important factor about which little is known is the energy balance (the balance of net energy exchange with the environment by radiation, conduction, convection. and evaporation on one hand, and internal energy sources on the other) of the developing embryo and nestling. Metabolic response of Redwings to temperature has been studied under laboratory conditions by Dyer (1968); and Collins (1968) studied the effect of environmental temperatures on nest temperatures and development rates in the field. The net radiation received from short-wave sun and sky radiation and long-wave earth radiation, the fluxes of heat and water vapor, and local air turbulence also affect the energy balance (Birkebak, 1966; Gates, 1968). These may be important determinants of the success of the breeding season.

Analyses of nesting success should include all these factors if they are to uncover causal relationships between the animal and the environment. Both large-scale and micrometeorological data must supplement the usual measurements of more stable components of the ecosystem.

SUMMARY

An analysis of eight studies of nesting success in Red-winged Blackbirds shows that there are significant differences in success among years, localities, ecological habitats, and vegetation form. Differences in nest success as related to nest height, water depth, and time of initiating nests were not substantiated by statistical analyses.

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U.S. BUREAU OF SPORT FISHERIES AND WILDLIFE, OHIO BLACKBIRD RESEARCH LABORATORY, P.O. BOX 2097, SANDUSKY, OHIO 44870, 4 OCTOBER 1970.

PUBLICATION NOTES AND NOTICES

Three state check-lists have recently appeared.

Georgia Birds: Pocket Check-list. By J. Fred Denton and Milton Hopkins, Jr. Georgia Ornithological Society, 1969: 4 × 6 in., 57 pp., $0.75.

Obtainable from Louis C. Fink, c/o Trust Company of Georgia, P.O. Drawer 4418, Atlanta, Georgia 30302.

An Annotated List of Iowa Birds. By Woodward H. Brown. Reprinted from the Iowa State Journal of Science, 1971: 6 × 9 in., 81 pp., $1.00.

Obtainable from the Iowa Ornithologists Union, Woodward H. Brown, Treasurer, 4815 Ingersoll Avenue, Des Moines, Iowa 50312.

The List of West Virginia Birds. By George A. Hall. Reprinted from The Redstart, 1971: 6 × 9 in., 17 pp., $0.50.

Obtainable from the Brooks Bird Club, Inc. 707 Warwood Avenue, Wheeling, West Virginia 26003.

PHYSICAL AND BEHAVIORAL DEVELOPMENT OF A ROADRUNNER RAISED AT THE NATIONAL ZOOLOGICAL PARK

Kerry A. Muller

On 15 December 1967, the National Zoological Park in Washington, D. C., received a pair of Roadrunners (*Geococcyx californianus*) that had previously raised young in captivity at Duke University, Durham, North Carolina (Calder, 1967).

Upon completion of quarantine procedures, the pair of Roadrunners was housed in an outdoor aviary, 10 × 15 × 8 feet high. One end was provided with a shelter 5 × 3 × 4 feet high, which was heated in cold weather by means of a 250-watt infrared heat lamp. The floor of the aviary and shelter was covered with a 6-inch layer of sand, which was used on many occasions by the birds to take "dust baths." They also were extremely fond of lying in the sun whenever possible. The top 3 feet of the aviary was covered in the colder months with a layer of transparent plastic to keep out rain and snow.

A pair of Green Hunting Cissas (*Cissa chinensis*), a species of corvid indigenous to south Asia, was also housed in the aviary, and as these are arboreal birds and the Roadrunners are primarily terrestrial, there proved to be little competition between the species for space.

The daily diet for the Roadrunners consists of pre-killed white mice and ground horsemeat, enforced with Pervinal (a powdered vitamin supplement manufactured by the U. S. Vitamin and Pharmaceutical Corporation). In addition, an occasional live English sparrow manages to enter the aviary through the wire mesh and is killed and eaten by the Roadrunners.

Early in the spring of 1968 the pair of Roadrunners began the typical breeding behavior of the species. This subject has been described at length by several authors so it will not be dealt with here. (Rand, 1941) (Calder, 1967) (Bent, 1940).

To encourage breeding efforts by the pair, nesting material in the form of twigs and pine needles was provided, as well as a breeding platform on the ground within the shelter 12 inches square and 18 inches high. These facilities were acceptable to the pair and they soon had a substantial nest constructed. It was decided at this time to minimize interference and disturb the pair as little as possible. The female began spending extended periods of time on the nest in May and it was assumed she had begun incubation.

At this time, the cissas were noticed attempting to enter the shelter and some aggression was observed on the part of the male Roadrunner. We were well aware that corvids are practiced egg stealers; however, it was believed that the Roadrunners, being larger and more aggressive, could quite adequately protect their nest. Later circumstances proved this hypothesis to be erroneous, however, when one morning late in May the keeper observed the female out of the shelter in the aviary acting in a listless manner. Examination of the nest revealed the broken remains of one egg. The pair of cissas was removed from the aviary, but no further nesting activities were observed that spring.

In October, 1968, the infrared lamp in the shelter of the Roadrunners' aviary was turned on in anticipation of cold weather. The resultant increase in light rays served to stimulate the birds and they were again observed in courting and breeding activities. The female proved less enthusiastic than the male in this instance, and only desultory efforts were made in nest building.

On 22 November 1968, the keeper found a single egg deposited on the sand floor of the aviary, which he removed. The following day the male Roadrunner, unable to force the female to set in the normal manner, vented his frustration in the displacement activity of attacking the female. This resulted in severe scalp lacerations and she was removed for treatment and recuperation.

On the afternoon of 23 November the egg was placed in an electric forced-air incubator at a temperature of 99.5° F and a relative humidity of 83 per cent. The egg was turned manually three times daily, and on the morning of 12 December it hatched after an incubation period of 18½ days. (Descriptions of Roadrunner eggs can be found in Bent, 1940, pp. 40–41).

HATCHING DESCRIPTION

The young Roadrunner presented a very distinctive appearance when hatched. Its skin was a dull black and had a peculiar oily appearance. The eyes were closed and covered with black skin, as were the legs. The upper and lower mandibles were black and the mouth commissure was dull flesh pink. White nessoptiles were very noticeable against the black skin, and were present in the areas of the pterylae, the apteria being bare.

An interesting modification noticed in the young Roadrunner was that the spinal tract was divided laterally into two distinct tracts and an additional apterium was formed behind the capital tract along the spine. The marginal covert tracts on the wings were also set back further from the anterior edge of the wing than is normal for most bird species, and this condition was retained when the feathers emerged. (Perhaps this modification might have some advantage in increased air contact to the skin, therefore aiding heat dissipation in a warm climate).

The weight of the young Roadrunner at 24 hours was 19.92 g. It was strong and active upon hatching and as soon as it was dry, responded to touch by gaping.

GAPE DESCRIPTION

The interior of the young Roadrunner's mouth was as distinctive in appearance as his other physical aspects. The upper and lower mandibular tomia were black, as was the tip of the tongue. The rictus was flesh colored. The hard palate was white, and the remainder of the buccal cavity was a bright red, with the exception of four white directive markings. Two of these markings were located as stratum corneum on the tunica propria in the stratified epithelium of the two soft dorsal areas at the base of the grooved tongue. The remaining two white markings were located as conical processes originating from either the lamina propria or the submucosa of the palatal folds in the lateral wall of the oral pharynx. These were posteriorly located on the sides of the choanal slit above and to both sides of the two tongue markings. [Similar conical processes are found with more exaggeration in the semi-terrestrial Crested Coua (*Coua cristata*), a species of cuckoo indigenous to Madagascar (Welty, 1963). This may be an anatomical feature common to the young of other cuculids.] The dorsal surface at the base of the tongue and the posterior areas of the two palatal folds exhibited very noticeable white, posteriorly directed cornified papillae.

It is of interest to note that the areas containing the directive markings are those described in other species as also being most abundant in taste buds (Farner, 1960). It would be an interesting study to determine whether there is a correlation between the directive markings and taste buds in young Roadrunners.

Calder (1967) failed to rear artificially hatched Roadrunner chicks. although young were successfully raised in captivity when hatched and reared by the parents. It was his hypothesis that perhaps digestive enzymes were passed by the parent to the chick and were necessary for food digestion. Our experience disproved this hypothesis, as our young Roadrunner chick was raised to maturity without any digestive enzymes being added to the diet.

DIET, GROWTH AND BEHAVIORAL DEVELOPMENT

First Day.—The young Roadrunner was first fed 24 hours after hatching. The food consisted initially of the soft abdominal parts of grey crickets, the soft white grubs of stable flies; small, whole, freshly killed anolis lizards (*Anolis carolinensis*) with an average weight of 1.4 g, and small diced pieces of freshly killed white mice. This varied diet was supplemented once daily with one drop of ViDaylin-M (a liquid vitamin-mineral supplement manufactured by the Ross Laboratories, Columbus, Ohio).

The young bird was fed 1.5–3.0 g of food hourly from 07:00 to 21:00. Further food

Fig. 1. Roadrunner, 4 days old. Dorsal view.

was usually refused after 21:00 and it was his custom to remain quiet throughout the remainder of the night. I noticed that the abdomen was quite elastic and had a great capacity for food storage and I believe that much of the food ingested during the day completed the digestive processes during the night hours.

The young bird was removed from the incubator when dry. He was housed in a cloth-lined shoe box and placed in an electric brooder set at 90° F. This temperature was later lowered at 7 days to 85° F and at 14 days to 75° F.

Third Day.—At 3 days the Roadrunner's weight had increased to 33.5 g. The sheathed tips of the primaries and rectrices began to emerge.

Fourth Day.—By four days the chick's weight had increased to 45.5 g. The primaries and rectrices had further developed and the tips of the secondaries had begun to emerge. The tips of the sheathed primaries emerged white in color; the secondaries were black.

Fig. 2. Roadrunner, 7 days old. Dorsal view.

Fig. 3. Roadrunner, 11 days old. Side view.

The four middle rectrices emerged completely black. The remaining outer rectrices showed white tips.

By this age the young bird's gaping movements could be visually induced by the extended hand, and there was some improvement of the muscular control of neck movements.

His eyes were first noticed open at 84 hours and were black in color.

Sixth Day.—The chick's weight at six days was 68.5 g. Emerging pinfeathers were visible on all pterylae. Faint white tips were discernible on the sheathed secondaries

The four middle rectrices emerged completely black. The remaining outer rectrices showed white tips.

and the tips of the two middle rectrices were free of the sheath.

The young bird had become much more alert and responded by gaping and wing fluttering to visual stimulation. He began uttering a very characteristic rasping note accompanied by a hissing sound. This was performed with the gape open.

At this age he was able to rise on the tarsometatarsus and exhibited a very strong grasping reflex when lifted. The neck and head movements were much more controlled; the head no longer jerked to the back and sides.

On the sixth day the length of time was increased between daytime feeding periods to two hours. Larger amounts of food were consumed at a feeding, including whole grey crickets and larger pieces of mice, as well as whole hairless mice. The chick could easily swallow articles of food weighing 3 g.

Eighth Day.—The weight of the chick at eight days was 93.7 g. He had become more active and could move about in his box. His legs and feet were growing very noticeably, and were larger in relationship to the body size than at a previous age.

Throughout the growing process the fecal matter was enclosed in a fecal sac. Most roughage was passed through the digestive system intact, including bones and chitinous material.

Eleventh Day.—By eleven days the chick was growing with amazing rapidity. His weight was 131.5 g. Most of his feather tips were clear of the sheaths and the feathers of the ventral pterylae were over 50 per cent clear of the sheaths, as were the marginal coverts. At eleven days the young Roadrunner could walk around on his feet, unsupported

FIG. 4. Roadrunner, 11 days old. Gape Markings.

by the tarsus. His legs and feet had grown remarkably large and had changed in color from black to grey, with the ventral portions of the feet and toes flesh color.

The young bird could no longer be confined to the shoe box and ran about in the 3 × 2 × 3 foot high brooder. At this age the chick first showed signs of fear and an awareness of everything that occurred in his field of vision. As a result of these initial fear reactions, he often refused food when offered, and his weight gain showed a slight decline. This fear reaction stage was manifested for a period of three days, then regressed.

Fourteenth Day.—At 14 days the young bird weighed 153.7 g. All the feathers were clear of the sheaths excepting the primaries, secondaries and rectrices which retained the proximal half of the sheaths. The natal hairs were still evident on the distal ends of most feathers. By this age the young bird displayed the full feather color patterns characteristic of the adults, and the red bare skin patch on the sides and rear of the head, characteristic of the species, was first noticed.

The chick had become very active and spent a lot of time running about. He still accepted his food from the keeper's hand and could now consume a whole, freshly killed white mouse. He was not noticed picking up food for himself at this time.

The chick was experimentally fed a small whole lake smelt. Apparently the taste was offensive, as he would not again voluntarily accept smelt when offered.

Sixteenth Day.—The weight of the young Roadrunner at 16 days was 174.0 g. He had begun exhibiting the bill clacking, tail bobbing, and crest raising behavior so characteristic of Roadrunners. When allowed the occasional freedom of the room, he was able to run very rapidly with a full leg stride. It was noticed he would now stretch his wings and he began some preening motions.

At 16 days he began picking up and swallowing food objects; however, he would still beg for food from passing people. He was moved to a wire cage 3 × 3 × 3 feet high.

Twenty-fourth Day.—At 24 days the Roadrunner chick weighed 255.0 g. He habitually ate whole mice and bits of raw meat from a pan, and seldom begged for food from the

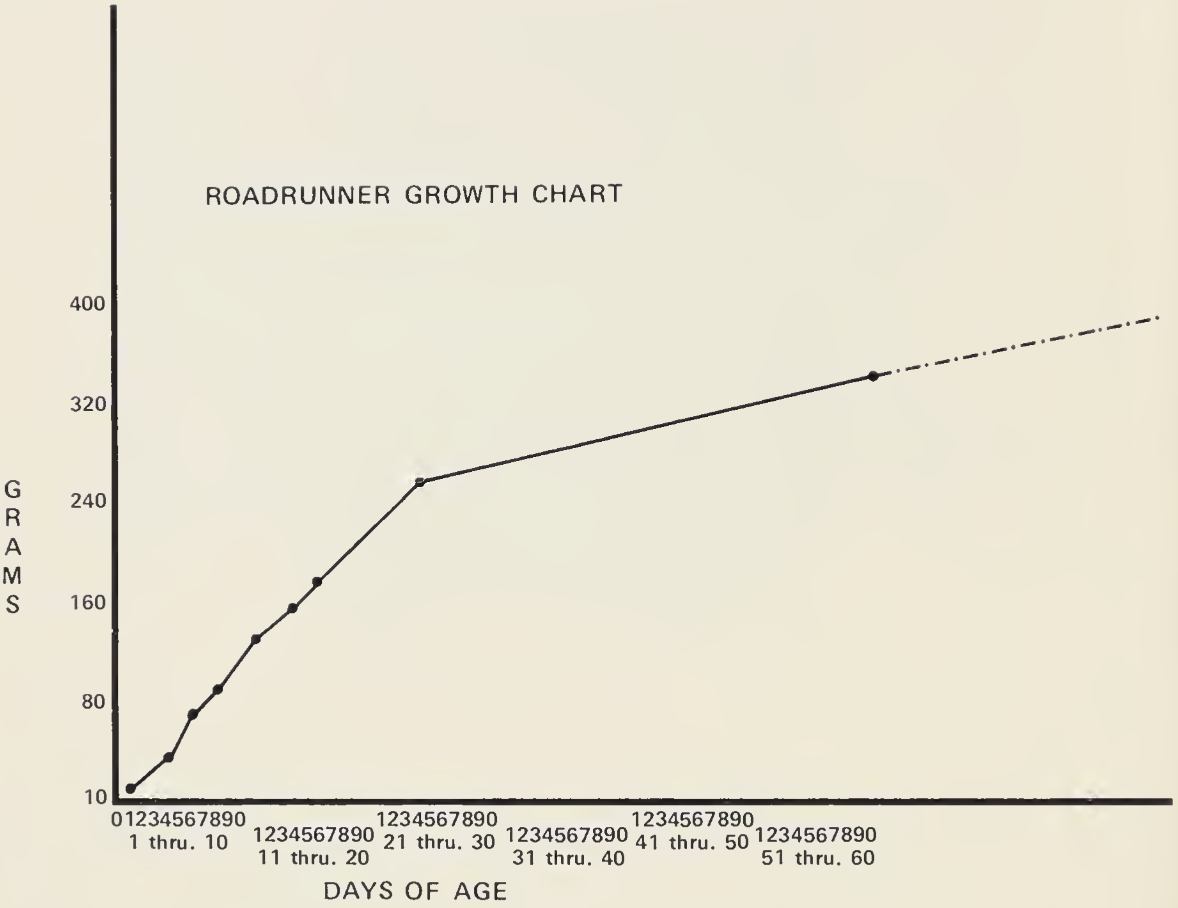

FIG. 5. Roadrunner Growth Chart.

keepers. In appearance the young Roadrunner look much like an adult, with the exceptions that he lacked feather sheen, was smaller in size, had dark eyes and had only three-quarter growth to the tail. All feather sheaths and natal hairs and been discarded.

The Roadrunner was moved to a 10 × 4 × 7 foot high aviary. He could now fly and habitually perched near the top of the aviary at night.

Sixtieth Day.—By 60 days the Roadrunner had achieved a near adult weight of 340.10 g. His iris had changed from black to light grey. In details of behavior, size and appearance he was indistinguishable from an adult. He had not moulted any of the juvenile plumage at this age. The young Roadrunner was moved to an outdoor aviary in April, and was able to kill and devour an intruding sparrow with expertise. This was apparently done instinctively as he had had no contact with other Roadrunners, or birds of any species.

It is of interest to note the very steady growth rate of this bird. This is evidenced by Figure 5, which illustrates a very moderate sigmoid curve.

SUMMARY

A young Roadrunner was hatched in an artificial incubator at the National Zoological Park, Washington, D. C., after an incubation period of 18½ days. Descriptions of size, appearance and mouth patterns are given.

Detailed descriptions are given of growth patterns, behavior manifestations and rearing techniques from the age of 24 hours to 60 days.

ACKNOWLEDGMENT

The writer wishes to thank Mrs. Constance P. Warner for her excellent photographs and Dr. George M. Sutton for his valuable assistance in assembling this paper.

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NATIONAL ZOOLOGICAL PARK, WASHINGTON, D. C. (PRESENT ADDRESS: TARONGA ZOO PARK, SYDNEY, AUSTRALIA) 25 MAY 1970.

NEW LIFE MEMBER

Eliot F. Porter of Santa Fe, New Mexico is a new Life Member of The Wilson Ornithological Society. A graduate of Harvard Medical School, Dr. Porter is currently a self-employed photographer and writer. Members of the Society are certainly familar with his many excellent color photographs which have illustrated such things as "The Birds of Arizona," five of the Sierra Club Exhibit Format books, as well as many other books. Mr. Porter is a member of the AOU, Cooper Society, National Audubon Society, Wilderness Society, and a Director of The Sierra Club. He is married and has five sons.

GENERAL NOTES

Additional notes on pre-nesting and nesting behavior of the Swainson's Warbler.—Since the publication of my recent paper "Pre-nesting and nesting behavior of the Swainson's Warbler" (Wilson Bull. 81:246–257, 1969), I have obtained additional notes on courtship, copulation, nest building, and incubation period of the Swainson's Warbler (*Limnothlypis swainsonii*).

During pre-nesting I observed a paired male giving a display which resembled a female soliciting copulation. His quivering wings were partly extended; his head, tail, and rump feathers raised. The male was perched about 3 feet from the ground. The female approached to within about one foot of the posturing male, where she alighted. The male then uttered a faint *twee-twee-twee* that was barely audible from where I was standing less than 8 feet away. In a display the next day the same male only extended his rump feathers and uttered the faint *twee-twee-twee* notes.

Before I wrote my earlier paper I had not observed that during pre-nesting, copulation sometimes takes place when a mated male flies to the female, pounces on her as she forages on the ground, pecks at her rump, and struggles with her along the ground for a few feet. The movements are usually so rapid that it is difficult to determine if copulation is actually consumated. My earlier observations involved only one pair, but I have since observed pouncing numerous times in two additional pairs. It was difficult to believe that copulation could occur during such rapid movements. However, on several occasions, when the action was a little slower, I observed that copulation was consumated in the ensuing struggle on the ground following pouncing. Hann (Wilson Bull. 49:154, 1937) made similar observations of copulation on the ground by Ovenbirds (*Seiurus aurocapillus*): "When copulation takes place on the ground, it is practically always accompanied by a struggle, which looks more like mortal combat than sexual intercourse."

I also have observed that copulation may occur when the female is perched in a bush or tree. Then the male often grasps the crown feathers of the female.

For three or four days prior to nest-building, an activity of the pair is the examining of nest-sites. The male of a pair that I watched led the way more than his mate, and at times he examined nest-sites alone. One such potential nest-site frequently visited by a male was subsequently used by the female for her nest. One might therefore conclude that the male selects the nest-site.

At two Dismal Swamp nests the female, which builds the nest, did virtually all of the building in the forenoon. Building of a nest took parts of 3 days between 07:00 and 11:00, and between 16:00 and 17:00. The female made 100–125 trips each morning, but no more than a half-dozen each afternoon. From 09:25 to 10:00 one morning, she made 34 trips, an average of about one trip per minute. She spent an average of 24 seconds at the nest, with a range of 9 to 70 seconds. The female sometimes *chipped* a few times while working on the nest. During the nest-building period, her mate rarely sang after 08:00.

A second example on record of a definite incubation period was determined through the cooperation of Mrs. Floy Burford of Norfolk, Virginia. I discovered a nest under construction in the Dismal Swamp on 23 April 1969. The four eggs were laid each morning before 07:00 during the period 1–4 May. I was unable to make continued visits to the nest, but Mrs. Burford visited the nest and found the first egg hatching at 06:30 on 17 May. Thus, the incubation period was determined to be 13 days.—BROOKE MEANLEY, *U.S. Department of the Interior, Patuxent Wildlife Research Center, Laurel, Maryland, 6 July 1970.*

Unusual activity of Starlings at Yellow-Shafted Flicker nest.—On 15 May 1969 in the back yard of my Pennington, New Jersey home, my attention was often attracted to noisy encounters between adult Starlings (*Sturnus vulgaris*) and Yellow-Shafted Flickers (*Colaptes auratus*). A nest, containing flicker young, was in a dead elm tree, DBH approximately 18 in, with the entrance about 18 feet above the ground. Some 75 feet from this tree, there were noisy Starling young in a nest-box at a height of about 10 feet.

As I watched, a Starling with food in its beak flew directly to the flicker nest-hole, entered and emerged with empty beak a few moments later, apparently having fed the flicker young. Within an hour, Starlings made several similar feeding flights to the flicker nest. On one occasion, a Starling chased the female flicker away from her perch on the nest-hole edge before entering to feed the young. Only rarely did a flicker fly to challenge a Starling, and only once did a flicker (male) fly out of the nest-hole to frighten away a Starling.

On the following three mornings I seated myself partially concealed by a woodpile in order to observe this nest more closely with 7 × 50 binoculars. The Starlings made many rapid flights out over the meadow to a recently cultivated corn field to find larvae and other food for the nestlings. However, when the flickers left their nest they flew in the opposite direction into a wooded area to feed. It soon became apparent that the Starlings were attracted by the calling of the young flickers, although their calls were scarcely audible to me and contrasted strongly with the harsh and almost incessant calling of the young Starlings. The Starlings made many flights to the flicker nest-tree both before and after feeding their young. Only occasionally did they seem to feed the flicker young. At times the head of an adult flicker appeared at the entrance as the Starling flew away.

The most complete account of Starling-flicker competition I have found is that given by A. Brazier Howell (Auk, 60:90–91, 1943) who describes conflicts between the two species extending over a five-year period. He reports that the Starlings perched nearby as the flickers made the nest-hole and as soon as it was finished a Starling would remain in the cavity almost continuously. He reports seeing a flicker emerging with a Starling clinging to it and both tumbling to the ground. He even records seeing a Starling dropping flicker eggs to the ground below. My observations revealed no such hostile and physical contact. Howell also (loc. cit.) describes hostile behavior between the Starling and a Downy Woodpecker (*Dendrocopos pubescens*) in which the Starling "dangled food" in front of the nest hole "before giving a mighty jab . . . evidently trying to entice, with bait, a young Downy within reach of a crippling blow . . ." The impression I had of Starlings carrying food to the flicker nest was quite the opposite. Rather than hostile or threatening behavior it appeared as a typically hurried feeding flight.

It is especially noteworthy that Starlings not only fed (apparently) flicker young but removed a fecal sac. One Starling, after feeding its young, flew directly to the flicker tree, entered the nest-hole and emerged with a large fecal sac in its beak. As it began to fly, the sac broke and dropped to the ground below.

Four days after my first observation, the flicker nest was empty. Neither the young nor adult flickers were in evidence. The first day after the flickers had left this nest cavity, a pair of Starlings examined it closely. The male attracted the female Starling to the hole by flying to the edge, puffing out his feathers and calling softly. Once, he held a small green leaf in his beak which he took into the nest cavity. She seemed reluctant to enter even though he entered several times in what seemed to be an encouraging manner. A week later, a Starling pair were nesting in this recently vacated flicker nest.—Kenneth W. Prescott, *New Jersey State Museum, Cultural Center, Trenton, New Jersey 08625, 18 December 1969.*

The junco as a food item for the Rough-legged Hawk in Alaska.—On 9 August, 1969, I found a male Rough-legged Hawk (*Buteo lagopus*) dying from injuries apparently inflicted by a motor vehicle at Mile 1280 on the Alaskan Highway, 34 miles southeast of Tok Junction, Alaska. The stomach contained a partially digested mass of fur, feathers, and bones. Both forelimbs and several ribs of an immature Arctic ground squirrel (*Spermophilus undulatus*) were found in the stomach. The scapulae of the ground squirrel were broken, but the remaining bones were intact except for some separation at the epiphyses.

The right and left feet and the prenarial portion of the upper jaw of a junco (*Junco* sp., cf. *J. hyemalis*) were also present and were identified by me by direct comparison with appropriate skeletal material. Feathers associated with these bones were matted, partially decomposed, and discolored. The presence of fur and feathers gives additional support to statements made by Leffler (Bull. Kansas Ornithol. Soc., 17:9–10, 1966) and Bent (U.S. Natl. Mus. Bull. 167:274, 1937) that Rough-legged Hawks do not pluck their prey.

Leffler (op. cit.) discussed feeding habits of *B. lagopus* and presented the fourth published American record of bird remains in the stomach of this species. Bannerman (The birds of the British Isles, 5:138, 1956) indicated that about 12 per cent of the prey records for *B. lagopus* in Norway were avian. Additional records are presented by Witherby (Handbook of British birds, 3, 1948) and Dementiev (Birds of the Soviet Union, 1, 1966). The fifth American record reported in the present paper provides further data on the bird-eating habits of *B. lagopus*. Perhaps when sufficient stomachs of New World representatives of this species are examined, the presence of birds as food items will not be found to be unusual.—Sanford R. Leffler, *Department of Zoology, Washington State University, Pullman, Washington 99163, 16 February 1970.*

Common Grackles prey on big brown bat.—On 4 July 1970, I took a subadult big brown bat (*Eptesicus fuscus*) alive from a dog, and left it hanging in a bittersweet bush in my backyard, where the bat was found by three Common Grackles (*Quiscalus quiscula*). One grackle pulled the bat down onto the lawn. Another chased the first away, and pecked at the bat's chest. The first grackle then attempted to seize the bat, whereupon the second grackle flew out of the yard with the small bat carried easily in its beak.

Hawks, Mississippi Kites, and owls often feed on bats but, to my knowledge, no other birds except Blue Jays mentioned by Hoffmeister and Downes (Southwestern Nat., 9: 102–109, 1964), Allan (J. Mammal., 28:180, 1947), and Elwell (J. Mammal., 43:434, 1962), a Roadrunner reported by Herreid (Condor, 62:67, 1960), and these Common Grackles have been observed preying on bats.—Claudine F. Long, *Department of Biology, Wisconsin State University, Stevens Point, Wisconsin 54481, 8 July 1970.*

Herring Gull predation on common water snake in Lake Erie.—Many herpetologists have studied the common water snake, *Natrix sipedon*, in the western part of Lake Erie, for these snakes often differ from water snakes on the adjacent mainland of Ohio and Ontario. Water snakes from the islands of western Lake Erie tend to be uniformly gray above and cream below without the saddle-shaped marking and bands of mainland *Natrix sipedon.* Camin and Ehrlich (Evolution, 12:504–511, 1958) compared the pattern of 11 different females from the Bass Island complex to the distribution of patterns within their litters and found that in all but one litter the female was more uniformly patterned than the majority of her offspring. They argued that only differential elimination could explain these observations and suggested that Herring Gulls (*Larus argentatus*), common birds in the Bass Island region, may be the selecting agent.

During the summer of 1967 I observed a mature Herring Gull which had captured a three-foot water snake along the east shore of Gibralter Island, Ottawa Co., Ohio. This part of the island has dense vegetation on a dolomite substrate. The gull, which appeared to have swallowed about six inches of the anterior end of the live snake, flew off with most of the snake's body dangling from its mouth. The snake resembled mainland water snakes in coloration and patterning. Thus, this instance of predation supports Camin and Ehrlich's model of selection.—PETER GOLDMAN, *Department of Zoology, The Ohio State University, Columbus, Ohio 43210, 20 July 1970.*

***Turdus grayi* feeding on snake.**—Recent records of the North American Robin (*Turdus migratorius*) killing and/or feeding on snakes (Davis, Wilson Bull., 81:470–471, 1969; and Netting, Wilson Bull., 81:471, 1969) prompt me to place on record the following observation of the common Central American robin (*Turdus grayi*). On 19 May 1968, on a gravel road between Turrialba and Siquirres, Costa Rica (1 mile east of bridge over Rió Reventazón), I observed an individual of *Turdus grayi* pecking at a small snake (*Tantilla armillata*) about the size of the North American DeKay's snake (*Storeria dekayi*). The robin killed the snake, but I collected the reptile before the robin had a chance to demonstrate whether or not it was an intended food item. Skutch (Pacific Coast Avifauna, 34:68, 1960) reported that *Turdus grayi* may include an occasional small lizard in its diet. The snake was identified by Douglass Robinson of the Department of Biology, University of Costa Rica.—J. ALAN FEDUCCIA, *Department of Biology, Southern Methodist University, Dallas, Texas 75222, 16 June 1970.* (*Present address: Department of Biology, University of North Carolina, Chapel Hill, North Carolina*)

Predatory behavior in Montezuma Oropendola.—The diet of some of the larger icterids, especially grackles (*Cassidix* spp.) includes vertebrates, even other birds (Skutch, Life histories of Central American Birds, Pacific Coast Avifauna, 31, 1954; McIlhenny, Auk, 54:274–295, 1937). However, according to Skutch, the diet of oropendolas consists of fruits, and perhaps nectar.

During early June, 1970, a large fruiting tree at Finca La Selva, Heredia Province, Costa Rica, attracted numerous individuals and species of fruit-eating birds (as well as a concentration of frugivorous fish in the stream just below the tree). Black-faced Grosbeaks (*Caryothraustes poliogaster*) and Montezuma Oropendolas (*Gymnostinops montezuma*) were regular foragers in the tree. Flocks of each species tended to come and go from the tree, never using the total available food supply. On the morning of 8 June 1970, a noisy flock of *Caryothraustes* was foraging in the tree when several oropendolas flew in. After a short period there was a commotion in the area of the tree occupied by individuals of the two species and the grosbeaks set up a loud screeching note and converged on a single point. Coincidentally a male oropendola flew out of the area to a nearby tree followed closely by one then several other individuals. The grosbeaks stopped the loud calling and left the tree shortly after the oropendolas. The oropendolas continued to fly from tree to tree, the male leading the others, in a nearly circular path. As they flew across a large open area I could see that the male oropendola was carrying something in its bill. The male stopped and while manipulating it in the bill dropped a young *Caryothraustes* to the ground. The *Caryothraustes* was fully grown but still in nearly complete juvenal plumage, having just begun the postjuvenal molt. The carcass was bleeding from one leg, probably not a mortal wound, and from a puncture in the parietal region on the righthand side of the skull. The skull had not yet started to ossify and probably was very easy for the oropendola to pierce. It appeared to be this wound that killed the bird.

Very possibly oropendolas, probably of all species, are facultative predators, especially when prey is readily available during the course of regular foraging activities in a fruiting tree coincidentally visited by smaller species of frugivorous birds. A facultative predator of this sort might also have a marked influence on the pattern of utilization of fruiting trees that are such an important part of the exploitation patterns of many tropical frugiviores (Land, Wilson Bull., 75:199–200, 1963).

Field work in Costa Rica was supported by the National Science Foundation (GB-7611).—LARRY L. WOLF, *Department of Zoology, Syracuse University, Syracuse, New York 13210, 14 August 1970.*

Blackpoll Warbler on winter quarters in Rio de Janeiro, Brazil.—The Blackpoll Warbler (*Dendroica striata*) is one of the most common North Ameriean migrants on the coast of Venezuela (Beebe, 1947). More to the south the records of this species are rare and spotty, probably because of the lack of observers and also because fewer birds may reach so far. From Brazil there seem to exist only two records, both from the northern border of Amazonia: upper Rio Negro and Rio Branco (Pinto, 1944:433). Apparently, no speeies of migrant North American warbler has hitherto been recorded from eastern Brazil south of the Amazon. The only other records of the Blackpoll known to us from southeastern South America are from the Argentine (1—Misiones, and 1—Buenos Aires); there are records in western South America as far south as Valdivia. Chile (once) (Meyer de Schauensee, 1966:445). Migration from the Venezuelan coast to the region of Rio Negro and the reappearance in the interior of the Argentine could suggest a route used by certain other northern birds, such as the Bobolink (*Dolichonyx oryzivorus*), and apparently also the Connecticut Warbler (*Oporornis agilis*). Such species, however, are not usually found in eastern Brazil (Sick, 1968:268). The Blackpoll Warbler winters also in the Guianas (Snyder, 1966), including Surinam (where taken three times in November, December, and February (Haverschmidt, 1968:371)). According to Meyer de Schauensee (1966) the reported dates from South Ameriea run between September and April.

On 28 January 1969, I noted for the first time the presence of a Blackpoll Warbler in Rio de Janeiro. I heard a call unknown to me in that region, coming from a bird in a large tamarind tree (*Tamarindus indicus*) which spreads its crown at the height of our house, situated on a steep slope at Santa Teresa, near the very center of the city of Rio. It was not until 4 February that I was able to see the bird well enough to identify it as a male Blaekpoll. The bird was observed again in the leafy branches of that tree, feeding on small insects (probably Diptera), which were swarming around its perch. On 6, 21, 22, and 28 February I recorded the Blackpoll again, in the same or in a neighboring tamarind, usually in the afternoon. The conditions were so similar that I assume it was the same individual. The bird was noted to the beginning of May.

Although the assumption that only one individual was involved is hypothetical, the circumstances are nonetheless interesting, as information about the behavior of northern migrants on their winter quarters in South America (Schwartz, 1964) is scarce. On 4, 5, 7, 8, 10, 11, 13, 16, 18, 23, 25, 26, and 30 March I noted the Blackpoll again. Most of these observations were made, like the former ones, in the late afternoon, perhaps because at that time the bird became restless and noisier, similar to thrushes before roosting. The warbler continued calling well into twilight. In nearly all cases the warbler was detected by its voice.

On 4 March I heard the bird singing for the first time (only one short song). At that time the characteristics of the adult male (contrasting black and white pattern of the plumage and yellow legs and feet) became more distinct. Once, to roost, the bird entered one of the cypress bushes adorning a neighboring garden, possibly attracted by a remembrance of its native conifers in the northern hemisphere.

In April the warbler was recorded on 5, 6, 7, 9–13, 15, 16, 19, 20, 24, 26, 27, and 30. On 12 April the Blackpoll sang frequently for the first time. From that time on, I noted the warbler often both in the morning and in the afternoon. The observations of Blackpolls continued during May, on the 2nd, 3, 13, and 16, although I suspect that 3 May was the last day that the particular individual first noted in January was recorded. On 13 May there were two, or probably three, Blackpolls present in the study area in Santa Teresa, among them one female: the first time I saw that sex. The last definite record for Blackpolls in Rio for that season was on 16 May.

It was on 31 March and on 18 and 24 April that I had realized the presence of more than one individual Blackpoll in Rio. On these days I observed several solitary individuals in Quinta da Boa Vista Park, five km from Santa Teresa, feeding also in dense tamarinds. These noble trees, frequently cultivated in Rio, may be especially attractive for Blackpolls as a habitat niche since their leaves are composed of numerous leaflets, which may to a certain degree suggest the needles of northern coniferous forests. The Blackpolls observed by me were usually in the shaded interior of the upper part of the crown.

A study of several species of warblers on their wintering grounds showed that most of them fed in a manner similar to that used in the nesting region (MacArthur, 1958). Habitat-niche selection may be more important to most warblers than habitat selection (Parnell, 1969). Blackpolls are unable to find a real corresponding habitat on their winter quarters in tropical South America.

In Rio the Blackpolls met on some occasions with intra-Brazilian migrants coming from the cooler south of that country, or from the nearby mountains, Serra do Mar. For example on 20 April the warbler was present in Santa Teresa together with some Swallow-Tanagers (*Tersina viridis*) and on 24 April at Quinta da Boa Vista with a White-crested Tyrannulet (*Serpophaga subcristata*), species not breeding in the city of Rio de Janeiro. On 13 May it was suggestive that some warblers could have arrived in the previous night from the south, as apparently did some Yellow-legged Thrushes (*Platycichla flavipes*) and one Pale-breasted Thrush (*Turdus leucomelas*). On 29 March I recorded two Peregrines (*Falco peregrinus*) flying overhead in Santa Teresa, compatriots of the Blackpoll. Except for some shorebirds, only a few migrants from the north come to Rio.

The continued presence of the Blackpoll in Rio well into May coincides with the very late arrival of that species on its breeding grounds. The Blackpoll is one of the last warblers to return in the northern hemisphere spring.

The Blackpoll must be irregular or very uncommon in Rio. Otherwise I would surely have found the birds previously at Santa Teresa, which is particularly favorable for observations and where I had lived for the past 14 years.

Since writing the above I have learned that a male Blackpoll Warbler was collected at the Ilha Comprida, São Paulo, on 16 March 1969 by H. Misch.

This work supported by a grant of the Conselho Nacional de Pesquisas, Rio de Janeiro.

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The humerus of the Early Miocene cracid, *Boreortalis laesslei* Brodkorb.— While examining the fossil bird collections in the Museum of Comparative Zoology, Harvard University, I found a distal end of a left humerus (MCZ 7068) from lower Miocene deposits, Thomas Farm locality, Gilchrist Co., Florida. This humerus was subsequently identified as that of a cracid. Brodkorb (Wilson Bull., 66:180–183, 1954) has described a new genus and species of cracid, *Boreortalis laesslei*, from the same deposits in which the Harvard humerus was found. The type of *B. laesslei* is a distal right tibiotarsus and cannot be compared directly with the humerus, but both elements are from a cracid of about the same size, and the morphology of both suggests a relationship to the Recent genus *Ortalis*. Hence, it is possible to assign the humerus to *B. laesslei* with some confidence.

The Pierce Brodkorb Collection at the University of Florida contains another humerus from Thomas Farm that also can be assigned to *B. laesslei*. This specimen, a distal end of a right humerus (PB 2061), is very fragmentary and lacks the external condyle. A direct comparison of PB 2061 with MCZ 7068 shows that the humeri are nearly identical.

The humerus of *Boreortalis* is very similar to those of *Ortalis* but differs in the following characters: (1) the external condyle is relatively heavier and slightly more robust, (2) the olecranal fossa is deeper, (3) the entepicondyle projects less distally, and (4) the shaft (just proximal to the condyles) appears slightly broader. The morphology of the distal end of the humerus is relatively uniform within cracid genera, and thus the intergeneric affinities of *Boreortalis* are not easily discernible solely on the basis of this element.

Measurements of MCZ 7068 are as follows: lateromedial breadth across distal end, 12.5 mm; depth of external condyle, 6.3 mm; depth of internal condyle, 4.2 mm. The only measurement possible on PB 2061 is depth of internal condyle, 4.3 mm.

I want to thank Drs. Pierce Brodkorb and Raymond A. Paynter, Jr. for loaning the fossil material. This work was supported by a Frank M. Chapman Fellowship, 1969–1970, from the American Museum of Natural History.—Joel Cracraft, *Department of Ornithology, American Museum of Natural History, New York City, New York 10024. (Present Address: Department of Anatomy, University of Illinois at the Medical Center, Chicago, Illinois 60680), 20 July 1970.*

Birds feeding on an ant mating swarm in Maine.—On 23 June 1970 my attention was called to an ant mating swarm by the flycatching activities of several Purple Finches (*Carpodacus purpureus*). During the next 6½ hours (09:00 to 15:30 DST) I watched steadily and observed five species of birds feeding on the ants. These observations were from a porch and lawn on a wooded slope of a hill during a calm hazy day in South Brooksville, Hancock County, Maine. The ant species involved in the flight was not determined.

SPECIES OBSERVATIONS

Purple Finch (*Carpodacus purpureus*).—Two males and one female (or subadult male) were first observed capturing flying ants at 09:00 by flying from the upper and lower branches of evergreens into the air in flycatcher fashion. These three birds were observed feeding throughout the observation period. They would fly to within a few feet of the ant and hovered as they maneuvered themselves within striking range. They were generally successful and performed in this manner throughout the day. The finches also fed on grounded ants and would fly from branch to branch, or branch to ground, wherever an ant had landed. The finches were so intent in their pursuit of ants that they often landed on some stone steps within several feet of where I was sitting.

Cedar Waxwing (*Bombycilla cedrorum*).—Two were observed flycatching from 11:10 to 11:45 and 13:00 to 14:05 in this same area. However, they came back to the same tree most of the time. The waxwings did not feed as actively as the finches (nor were they observed pursuing grounded ants).

Hermit Thrush (*Hylocichla guttata*).—A male that sang most of the morning and the latter part of the afternoon was seen to feed on ants on five separate occasions. He took both flying ants which he captured by "flycatching" and by pursuing grounded ants which had alighted on a branch or the trunk of a tree.

Magnolia Warbler (*Dendroica magnolia*).—One male was seen feeding on flying ants. His manner of feeding was to fly up to the prey and hover in front of the ant while he snapped at it. He was successful twice while I observed.

Blackburnian Warbler (*Dendroica fusca*).—A nesting pair of Blackburnians made only sparse use of this abundant food supply. While it was not possible to watch the male closely for any length of time he was not observed to flycatch and was seen taking an ant off a pine branch only once. The female was busily engaged in nest building, but was seen chasing and feeding on ants several times.

Barn Swallow (*Hirundo rustica*).—Several were seen flying through this area during the day, and by their actions were presumably feeding. The longest time they were observed in the area was for several minutes moving back and forth over the hill slope, but positive sightings of ant captures were not made.

Tree Swallow (*Iridoprocne bicolor*).—Several were seen in this general area at one time. Their attitude was similar to that of the Barn Swallows, staying in the area for short periods of time but no sightings of ant captures were observed.

The following were noted during the observation period, but were not seen to feed on ants: Yellow Warbler (*Dendroica petechia*), Black-throated Green Warbler (*Dendroica virens*), Chestnut-sided Warbler (*Dendroica pensylvanica*), American Redstart (*Setophaga ruticilla*), Nashville Warbler (*Vermivora ruficapilla*), and Black-and-White Warbler (*Mniotilta varia*). The last two species were seen feeding on insects other than ants.

Unlike the observations of Baird and Meyerriecks (Wilson Bull., 77:89–91, 1965) the food supply (represented by the ants) was not heavily used by birds. Certainly there was no observed social stimulation during this period. Only the Purple Finches fed heavily on ants, and their activities were apparently not sufficient to stimulate or attract other species to this abundant food supply.

I noted several species feeding on grounded ants, while Baird and Meyerriecks apparently saw none. This was most evident with the Purple Finches and Hermit Thrush which were observed taking grounded ants. Although exact capture counts were not made, I would estimate that both these species fed as much on grounded as on flying ants.

I would like to thank James Baird for his advice.—Richard A. Harlow, Jr., *Tabor Academy, Marion, Massachusetts, 02738, 10 August 1970.*

Nesting of Bell's Vireo in North Dakota.—The first known nesting record of the Bell's Vireo (*Vireo bellii*) in North Dakota was obtained by the junior author, approximately one mile northwest of Bismarck, North Dakota on 11 July 1954. The male had been seen, and its characteristic song heard, in the immediate vicinity on 9 July, but the nest had been overlooked at that time. When discovered, the nest contained one dead young and had been abandoned. A severe rainstorm which had deluged the site, one day prior to the discovery, was believed responsible for the death of the young bird and the desertion by the adults.

The nesting site was in a thicket of dogwood (*Cornus* sp.) in the bottomland on the east side of the Missouri River. Similar dogwood thickets form a part of the woodland-edge complex of the bottomland hardwood forest found in this river valley for many miles up and down from Bismarck. This habitat was similar to that described for the species in South Dakota (Over and Thomas, "Birds of South Dakota," Univ. of South Dakota Mus., 1946).

A search of the literature has revealed no earlier records of this species from North Dakota. Barlow (Univ. Kansas Publ. Mus. Nat. Hist., 12:241–296, 1962) stated that it "is a summer resident in riparian and second growth situations in the central United States south of North Dakota." It has, however, been reported in increasing numbers during recent years from both Minnesota and South Dakota. Huber (Flicker, 33:109–110. 1961) has summarized known information from southeastern Minnesota, and more recently he has reported it for Rock County in southwestern Minnesota (Loon. 36:53, 1964). For South Dakota this species is listed as a summer resident in four of the state's six ornithological regions, including the three regions bordering on North Dakota (Checklist of South Dakota Birds. South Dakota Bird Notes, 8:13–19, 1956). The species has been found as far west as La Creek Refuge near Martin (South Dakota Bird notes, 9:24, 1957) and as far north as Chamberlain (loc. cit. 4:29,

1952) and Pierre, where it was recorded in the then unflooded Oahe Dam Site (loc. cit. 5:28, 1953 and by N. R. Whitney, Audubon Field Notes, 16:425, 1962).

Since the Missouri River Valley between Pierre, South Dakota and Bismarck, North Dakota has had very little ornithological exploration it is not surprising that this species should have first been observed in the latter state in the Bismarck area. It is doubtful, however, if the species exists at present in most of this Missouri valley region for woodland habitat suitable for the species has now been inundated by the Oahe Reservoir.

It appears that this species may either be spreading northward or is just now being observed by ornithologists, for in the 1960's several additional records of this species have been recorded in the state. The first observation of this species made by the senior author occurred in 1961 while he was making breeding bird observations on a study area three miles southwest of Riverdale in McLean County, North Dakota. The song of this species was heard on 20 June 1961 in thick, low willow growth adjacent to the Missouri River but off the study area. He was unable to find the bird at the time, however, and no further verification was made of its presence. In June of 1968 the senior author was again making breeding bird censuses in the Riverdale area when he found this species breeding there. The area being surveyed was a portion of the abandoned main channel of the Missouri River approximately one quarter mile south of Garrison Dam which had contained water in 1958, but had since 1960 grown up into a savanna consisting of relatively open areas interspersed with dense stands of young diamond willow (*Salix missouriensis*), 5–8 feet high. Two singing males were found on territory in this willow habitat and were observed on six separate visits between 11 June and 10 July 1968, when the last visit was made to the area. Considerable effort was made to locate nests in the dense tangle of vegetation but only one was found and it had already been abandoned.

We know of only one other reported observation of this species in North Dakota from outside the Missouri River area. This is of a singing male observed by R. E. Stewart on 4 June 1966 "along Brush Creek, a tributary of the Knife River in Mercer County, about 4 miles SSW of Beulah" (Stewart, Audubon Field Notes, 20:579, 1966). —EDMUND A. HIBBARD, *Dept. of Zoology, North Dakota State University, Fargo, North Dakota 58102* AND PAUL D. KLINE, *Iowa Conservation Commission, Indianola, Iowa 50125, 5 August, 1970 (originally received 21 April 1965).*

Persistence of remains of birds killed on motor highways.—There are published in the literature numerous counts of birds killed on motor highways, and the counting of dead birds appears to hold possibilities for use in evaluating the magnitude of bird mortality on the highways. However, if the resulting data are to be used in a meaningful way to evaluate even the magnitude of the mortality, the counts must be supplemented with information on the durability of evidence of automobile-killing of different species on highways having different amounts of motor traffic. In this note data are given on the durability of parts of House Sparrows (*Passer domesticus*) on an interstate highway and on a country road in North Carolina.

In the forenoon of 20 May 1968, I threw 50 dead House Sparrows from an automobile window onto the surface of Interstate Highway 85, between Oxford and Creedmoor, North Carolina. I returned 90 minutes later and found remaining the parts of only five birds. In driving over the highway another 30 minutes later, no part of any of the birds was found, and all evidence of dead birds observable from a moving automobile had thus been obliterated by the heavy motor traffic within two hours.

In the forenoon of 28 May 1968, 20 dead House Sparrows were thrown onto the surface of a blacktop country road running 2 to 7 miles southward from Oxford; another 20 birds were placed beside the birds on the blacktop in the clipped vegetation on the shoulder of the same section of highway. The birds on the blacktop were all crushed before evening by wheels of motor vehicles, but all birds remained clearly visible. The 20 birds, feathers and all, were gone from the road surface the following morning, the crushed birds presumably having been removed by unidentified scavengers during the night or early morning. The birds on the shoulder remained undisturbed during the following five days, and 16 days passed before all evidence of the birds' presence had disappeared. The difference in durability of bird parts on the road surface and on the shoulder was confirmed with various species of birds killed by automobiles during the four seasons of 1968.

Unless they are appropriately planned, counts of small birds dead on interstate highways with the amount of travel of Interstate 85 have little value for measuring mortality because parts of the birds remain on the highway very short periods of time, and the length of time is variable. Much modern cross-country motor travel is over interstate highways and thus cannot be expected to yield useful data on highway mortality of small birds. Perhaps a reasonably accurate count could be made on an interstate highway by repeated trips over the same section of highway every few minutes throughout a daylight period.

By making daily counts of only birds on the pavement in the late evening, partial counts can be made of birds killed on country roads. All of the first preceding daylight period and little or no more time can be considered to be involved. However, if the count is to be complete for all birds killed, it must also include the birds thrown onto the shoulder by the automobiles striking them, and this necessarily involves counts made when the observer is walking to determine the proportion of the birds thrown from the highway onto the shoulder. A significant but unknown portion of the birds killed by automobiles are still lost from the count by their having been caught in the radiator grills of automobiles striking them. Counts made at other times than in the evening involve various periods of time depending on the length of time before evening at which they were made. Counts not giving consideration to the time of day at which they were made have relatively little value for measuring the actual magnitude of mortality, and they thus have lost much of their potential value. Daily travel over the same route, such as evening travel home from work, provides the best source for useful counts on traffic-killed birds.—Paul A. Stewart, *Entomology Research Division, Agricultural Research Service, USDA, Oxford, North Carolina 27565, 5 January 1970.*

ANNOUNCEMENT OF PUBLICATION

A limited edition of 250 copies of Audubon's "Birds of America" will be reprinted starting in September 1971 by the Johnson Reprint Corporation, New York. The price will be $5,400 ($4,500 before the publication of the first part) for the complete set of 435 colorplates.

ORNITHOLOGICAL NEWS

The 1971 Annual Meeting on Dauphin Island, Alabama is now history, and the 400+ persons who attended would surely agree that it was one of the most interesting meetings in recent years. The southern hospitality was warm indeed, and the Program Committee, chaired by Vice-President Kenneth Parkes, had arranged an outstanding series of papers. On Saturday morning the papers session was devoted to a symposium on Bird Migration in the Region of the Gulf of Mexico organized by George Lowery. On Saturday afternoon the birds put on their own demonstration of trans-Gulf migration as a considerable precipitation of grounded migrants occurred, just as had been predicted in the advance advertising of the meeting. As might be expected with such a concentration of ornithologists a species was turned up that constituted a new addition to the Alabama list.

The Meeting closed with the election of a new slate of officers whose names appear on the inside front cover.

At the Annual Banquet the following prizes and awards for 1971 were announced. The prizes donated by Ernest P. Edwards, $150 for the best paper appearing in *The Wilson Bulletin* in 1970: William J. Maher, The Pomarine Jaeger as a Brown Lemming predator in northern Alaska; and $50 for the second best paper in the *Bulletin* in 1970, John P. Ryder, A possible factor in the evolution of clutch size in the Ross' Goose; the Wilson Prize for the best paper given at the Annual Meeting by a person not holding a doctoral degree: Kenneth P. Able, The flight directions of autumn nocturnal migrants on the Louisiana Coast; the Margaret M. Nice Research Award for persons not connected with an institution of higher learning: T. A. Beckett III for his work on the Red-cockaded Woodpecker; and The Louis Agassiz Fuertes Research Award to Flash Gibson, Oregon State University, for his work on American Avocets.

The Presidential Address of retiring President William W. H. Gunn was devoted to an analysis of the interesting results of the questionnaire recently circulated to the membership. It is hoped that some of these results can be published in a future issue of the *Bulletin*.

We have learned of the recent death of Miss Mildred Stewart, a longtime member and faithful participant in Annual Meetings, who for several years carried out the tedious and exacting task of preparing the annual index for the *Bulletin*.

The Asa Wright Nature Centre, a 200 acre cocoa-coffee-citrus estate at an elevation of 1,200 feet in the Northern Range of Trinidad, largely surrounded by government forests, was established to provide a facility for the enjoyment and study of natural history and as a wildlife sanctuary (particularly for the Oilbird colony on the property).

About 25 guests can be accommodated at rates from $14. to $17. per person per day with meals. Special rates may be arranged for students or for naturalists on extended stay for study purposes. For further information and/or reservations write *air mail* to: The Manager, The Asa Wright Nature Centre, G. P. O. Box No. 10, Port of Spain, Trinidad, W.I.

Aside from the very rich flora and fauna of the immediate area, the Centre provides a reasonably comfortable operating base for field work in other habitats on the island.

ORNITHOLOGICAL LITERATURE

LAST SURVIVORS: THE NATURAL HISTORY OF ANIMALS IN DANGER OF EXTINCTION. By Noel P. Simon and Paul Géroudet. Illustrated by Helmut Diller and Paul Barruel. The World Publishing Co., New York, 1970: 8½ × 10¼ in., 276 pp., 44 col. pls., 31 text figs., 6 maps. $19.95.

This is another handsome "Christmas present" nature book, but a particularly attractive and useful one, which will no doubt help the cause of animal preservation and promote interest among a wide range of readers.

It is the well-documented story of 36 species of mammals and 12 of birds, the existence of which is threatened at present. They can, however, still be saved from extinction if adequate measnres are promptly taken. Let us hope they will be!

The birds, which have been chosen at random, so it seems, are extensively and carefully studied by the veteran French Swiss ornithologist Paul Géroudet and faithfully depicted by Paul Barruel, the well-known French bird artist, two highly reliable naturalists. The 12 species mentioned are: for America, the Galapagos Penguin, the California Condor, the Whooping Crane, Atwater's Prairie Chicken and Kirtland's Warbler; for Europe, the Imperial Eagle and Audouin's Gull; for Asia, the Brown-eared Pheasant, the Japanese Crested Ibis, and the Philippine Monkey-eating Eagle; for Africa and Madagascar, the Long-tailed Ground Roller; for Oceania, the Kakapo.

One cannot help regretting that no more of the threatened species have been considered. There is certainly no shortage of threatened birds today. It would no doubt be highly beneficial to the cause of bird preservation if other such studies were soon made available to the general public.

The work is prefaced by H. R. H. Prince Bernhardt of the Netherlands, President of the World Wildlife Fund.—JEAN DELACOUR

BIRDS OF GUATEMALA. By Hugh C. Land. Livingston Publishing Co., Wynnewood, Pennsylvania. 1970: 7½ × 5 in., xvi + 381 pp., 5 maps, 44 col. pls. by Land and Wayne Trimm. $10.00.

The publication of the "Birds of Guatemala" by the late Hugh Land marks the appearance of the first comprehensive, illustrated, field guide book covering an entire Central American republic. But it is much more than a standard field guide, containing a wealth of condensed information on many aspects of Guatemalan ornithology, the result of a (tragically short) lifetime's dedication spanning a decade of field research. Indeed, I am continually surprised at the quantity of material presented in this book while retaining its size along the lines of many modern field guides (meaning it will not *quite* fit in one's pocket). It is comparable in size to Smithe's "Birds of Tikal," the only other field guide presently available for northern Central America, but of course covers a much greater geographical area with a far greater diversity of species.

The introductory section of the book contains discussions of geography, climate, life zones, and ornithological history of the Republic; the life zones (Holdridge system) are treated in some detail, with an accompanying map and zonal breakdown of characteristic species.

The main body of the text is devoted to the species accounts. Each family is introduced by a very brief general paragraph relating distribution of the group overall and number of species occurring in Guatemala, as well as zonal patterns of occurrence in the Republic and other short comments of pertinence. The species accounts proper treat the 667 species reported from Guatemala (including 13 hypothetical ones); sequence of treatment follows Eisenmann's "The Species of Middle American Birds" modified by Meyer de Schauensee's "The Species of Birds of South America . . ." Both English and Spanish names are provided. Each account contains sections on Range, Subspecies (those that occur in Guatemala), Status (including relative abundance), Elevation, Habitat, Description, and Remarks. Range maps of Guatemalan distribution are provided for all but the accidental or hypothetical species. Forty-four color plates by Land and Wayne Trimm depict 294 species; virtually all tropical forms not found in North American guides are illustrated. Land's plates are typical of many field guides, with emphasis on identification, the birds of each group arranged in rows of identical poses; Trimm's paintings are more esthetically pleasing, with birds in natural and varying poses.

From a negative side, there are two items that drew my attention. First, and perhaps not even a legitimate criticism in view of the book's intent, is that there are very few specific references to records; however, citations are available for most of the rarer species. Second, and most annoying to me, are the range maps. I suppose everyone has his own ideas as to what such a map should show, but I feel that many of these are decidedly misleading. Land admits that areas of occurrence are omitted from the maps where specific records are lacking, but inconsistency causes confusion. For example, on page 82 there are range maps for *Ortalis* (*vetula* and *leucogastra*), *Penelopina nigra*, and *Oreophasis derbianus*. The range of *Ortalis vetula* encompasses the entire eastern lowlands, including all of Petén, which most assuredly is correct; but, as Land mentions in the introduction, many areas of Petén have not been studied, thus the range of *O. vetula* is based on the fact that the species is common everywhere in suitable habitat and its range must thus conform to that of the habitat. But he does not follow through with *Penelopina*, a species common everywhere in cloud forest habitats south to Nicaragua. One gets the impression from the map that its range to the southeast ends in central Guatemala, as (correctly) does that of *Oreophasis* on the adjoining map. While the actual records from eastern Guatemala are lacking, data from adjoining El Salvador and Honduras indicate the species' certain occurrence in suitable habitat throughout Guatemala. Thus a great number of ranges are misleading and incomplete in the sense that evidence other than specific locality records indicates a more extensive or continuous distribution.

One other minor point: some space saving could have been achieved by combination of the Status, Habitat, and Elevation comments into but a single section per species account, and perhaps also the Range and Subspecies into but one other.

Despite a few shortcomings, this book is the first comprehensive guide to birds of a Central American republic. It fulfills all the criteria as an excellent field handbook as well as a reference to Guatemalan ornithology. It is a must for all those interested in Middle American birds, from the serious research student to the general bird watcher.—Burt L. Monroe, Jr.

Las Aves de Puerto Rico. By Virgilio Biaggi. Editorial Universitaria, Universitad de Puerto Rico, 1970: 6¾ × 9¾ in., xii + 371 pp., 6 col. pl., 51 text figs. $6.50.

Virgilio Biaggi has been interested in the birds of the Antilles ever since he was a small boy when he accompanied the late Stuart Danforth not only on collecting excursions in Puerto Rico and to many other Caribbean islands, but also on visits to museums in the

United States. He thus acquired at an early age considerable knowledge of the Antillean avifauna. He is now Director of the Department of Biology at the University of Puerto Rico in Mayagüez. Danforth, who was likewise a professor of zoology at Mayagüez, was author of an excellent handbook published in 1936, entitled "Los Pájaros de Puerto Rico," and it is fitting that Biaggi has carried on with this work.

"Las Aves de Puerto Rico" is by no means a field guide or handbook but a reasonably priced, comprehensive book of reference. The introduction includes sections on the history of Puerto Rican ornithology, migration, the economic importance of birds, and wildlife conservation. The area covered comprises not only Puerto Rico, but also its satellite islands such as Vieques, Culebra, and Mona. It is essentially a compilation, and little new information is provided. The addition of English names is an improvement over Danforth's book.

Comparison of these two books is of interest. Danforth included 182 species and subspecies plus 12 considered of hypothetical occurrence, Biaggi 239 with 20 others listed as hypothetical. However, six species known only from subfossil material are added in the main text of Aves de Puerto Rico as well as many species and subspecies the identifications of which are questionable, and four species that were escaped cage birds or that have been unsuccessfully introduced. Six species recorded from Puerto Rico during the past twelve years should be added—*Anas penelope*, *Larus fuscus*, *Rynchops nigra*, *Amazona ventralis* (introduced), *Vermivora chrysoptera*, and *Pheucticus ludovicianus*, some of these no doubt reported too recently for inclusion.

There are remarkably few typographical errors or misspellings, and the classification, which differs slightly from my own, cannot be seriously criticized. Some of the remarks on nidification are confusing since the information was evidently derived from localities other than Puerto Rico. The Masked Duck is said to lay 3–4 eggs with a bluish tinge, although clutches from other of the Antilles were decidedly larger and the eggs not bluish. This species is definitely known to breed on the island, for Roger Peterson told me of seeing a brood of young there. Comparatively minor errors are the statements that the type of the Puerto Rican race of the Broad-winged Hawk is the only specimen; that there is no description of the eggs of any of the Antillean parakeets of the genus *Aratinga*; that nothing is known of the nesting of the Whip-poor-will of Puerto Rico.

The illustrations by Lucila Madruga de Piferrer and Christine Boyce are rather crude but sufficiently accurate to enable one to identify most of the species. Those depicting the Plain Pigeon and some of the hummingbirds are particularly poor, and the postures of the Audubon's Shearwater and Wilson's Petrel are incorrect. It would have been preferable if the captions to the colored plates had been printed on the pages facing these.

It is stated on the dust jacket that the birds of Puerto Rico are better known than those of any other of the Antilles, but this is debatable. Perusal of this book clearly shows that there is still much to learn about the indigenous avifauna of the island.—James Bond.

The Birds of the Department of Lima, Peru. By Maria Koepcke. Translated by Erma J. Fisk. Livingston Publishing Co., Wynnewood, Pennsylvania, 1970: 5¾ × 8¼ in., 144 pp., 331 sketches, 2 maps, 1 photo. $4.95.

Favorable reviews (*i.e.*, Eisenmann, Auk 82: 296, 1965) greeted the original Spanish language version of this little field guide in 1964. The present version, in English, deserves similar praise, not only because the translator has done a good job but because the author, Maria Koepcke, has updated her treatment.

During the interval between editions, an ornithological combing of most parts of Peru occurred, not without noteworthy results for the Department of Lima. Various marine and coastal habitats yielded first records in this area for the Great Grebe, Gull-billed Tern, four shorebird species and the Short-eared Owl, while the western slopes of the Andes contributed three species of hummingbirds, three tyrant flycatchers, an antbird, two honeycreepers and a male specimen of the White-cheeked Cotinga, the first known to science. Furthermore the Canary-winged Parakeet and Yellow-hooded Blackbird established enduring colonies from escaped stock around the city of Lima.

To deal with all this the present guide treats 331 species, 18 more than the previous edition.

All birds are illustrated in very pleasant line and shadow drawings—the work of Maria Koepcke herself. Most of the portraits have been reproduced less sharply this time than before, at least in the two copies I have seen. The artist's talent for economic depiction of field markings thus appears to have been served less flawlessly in this new book, but not at all disastrously, for despite their faded appearance the drawings fulfill the purposes of the book.

Overall the present version surpasses the former on such counts as quality of paper, clarity of type, scientific nomenclature and use and arrangement of headings (family divisions and also English names, omitted in the Spanish edition, are given). The one unsuccessful illustration in the Spanish edition, that of the Hook-billed Kite, has been redrawn.

The new book nevertheless repeats some material of doubtful value. For example, a certain spinetail once seen by the author is again figured and described along with the other furnariids, yet it remains today, as in the past, unidentified. Together with dubious records of the Royal and Gray-headed Albatrosses and Gray-necked Wood-Rail, such an elusive bird might better have been mentioned in a hypothetical list, although to be frank I like the creature presented where and as it is.

Erma Fisk, the translator, is to be doubly congratulated, for she first initiated and then sponsored publication of this valuable work.—William G. George.

Ornithology of the Marshall and Gilbert Islands. By A. Binion Amerson, Jr. Smithsonian Institution, Atoll Research Bulletin No. 127, 1969: 8¼ × 10¾ in., viii + 348 pp. Price not given.

This useful compendium on the birds on the innumerable bits of barely emergent land that constitute the Marshall and Gilbert islands is based upon approximately 60 days of field work and a thorough review of the literature. Although it includes 20 new avian records and reports on more than 1100 specimens, the study must be considered only a beginning. Field parties landed on but 25 of the 50 atolls that make up these island groups, and some of the atolls have nearly 100 islands, of which only a few were visited.

A summary for each atoll contains information on location, size, topography, soil, vegetative features, human demography, previous scientific visits, and the avifauna. A list of birds gives full information on each specimen collected! Species accounts for each atoll provide data on habitat, status, and numbers. Since the specimens for any one atoll are relatively few and, generally speaking, are the basis for the species accounts, there is considerable redundancy. This detraction is further compounded by later general species accounts which largely duplicate the previous lists and data. However, this latter duplication does make for easier use by the person interested in a particular species.

Seventy-nine avian species were encountered, 37 seabirds, and 42 land or fresh-water birds. Nineteen species of seabirds are known to breed in these islands. Of the land and fresh-water species: 9 are regarded as probable breeders; 17 are regular migrants; and 15 are thought to be vagrants. Sixteen of the migrants are breeders in the Northern Hemisphere and one, the cuckoo *Urodynamis taitensis*, breeds in New Zealand. Six of seven introduced species breed on these atolls.

The data relative to the number of species per atoll and the postulation of north-south and west-east clines of decreasing numbers of species must be considered with caution. Clines there may be, but the data to support this hypothesis are yet to be gathered. Too many of the islands, and even whole atolls, are ornithologically unknown. Further, the Marshall Islands, lying to the north and west of the Gilberts, have been much more frequently visited, even by the author's research parties. The southern Gilberts were not investigated. The Marshalls are a larger group, encompassing 12° of latitude and 10° of longitude compared to 5° of latitude and 6° of longitude for the Gilberts, and the atolls in the Marshalls are larger and have more islands. The Marshalls thus provide a longer screen to intercept migrants moving in any direction and more landfalls for them, even though the Gilberts have a greater total land area.

Nonetheless, the author offers several factors that might well produce such clines. The northeast and southeast trade winds may act differentially in bringing migrants and vagrants to the archipelagos, and the Equatorial Counter Current may be vital in providing a major energy source for seabirds in the north. Rainfall is heaviest in the southern Marshalls and northern Gilberts, and there are differences in its season. Vegetation, both in amount and numbers of species, appears to vary directly with rainfall. Man's influence, through predation, reduction of native vegetation, and plantings of coconut trees, may have been significant, although it must be noted that natives on many of the Pacific atolls regularly set aside certain islands as sanctuaries to be "managed" for eggs and birds for food and feathers for ornaments.

As an "old Pacific hand" and ornithologist, I think this publication will be valuable not only for its avian contribution but because if its readable accounts of the atolls. Although much less complete they do supplement the narrative in Bryan (American Polynesia and the Hawaiian Chain, Tongg Publ., Honolulu, 1942). Despite current interest, the Pacific atolls are mostly uninvestigated, unknown scientifically, and they are beautiful in their loneliness and relatively simple terrestrial ecology. They merit more than intermittent, casual, and incidental study. In depth, long-term investigations should be undertaken before further encroachment by "civilization" occurs.

One comment on non-avian affairs deserves attention. The monitor lizard, *Varanus indicus*, is said to occur only at Eniwetok. It is known that the Japanese established them on a number of Islands in the Marshalls, and I collected specimens on Majuro, Aur, and Arno in the Marshalls in December 1945. This variance in observation points up either the rapidity with which species may be eliminated on small land masses or the need for more detailed investigation.—Harvey I. Fisher.

The Albatross of Midway Island. A Natural History of the Laysan Albatross. By Mildred L. Fisher. Southern Illinois University Press, Carbondale and Edwardsville, 1970: 5¾ × 8¾ in., x + 161 pp., photos, maps. $5.95.

This book describes the life story of a Laysan Albatross, beginning with the mating of the parents and continuing until after the adult or breeding phase of life is well underway.

The book is written for "naval personnel, their friends and mainlanders who have not seen the birds" (p. vii). It is thus not necessarily intended as "a must for all ornithologists" as the dust cover states.

The book probably accomplishes the author's objectives to a reasonable degree. The non-ornithologist reader will find Mrs. Fisher's poetic writing of daily episodes in the life of an albatross pleasing and entertaining. "Our" albatross, of course, survives all adventures. The reader will gather much lore about albatrosses. Although the book presents many results of the scientific work of the author and her husband, Dr. Harvey I. Fisher, it should be used with caution as a reference because of the lack of documentation.

The author notes her awareness of anthropomorphism in the Foreword. From among the many anthropomorphic and teleological expressions I will quote a few that may cause ethologists and ornithologists to squirm. Of birds whose mates failed to return. Mrs. Fisher writes (p. 12): ". . . the bereaved birds moved back to the sea . . ."; of the female with her new egg (p. 14): ". . . she rose to show her egg to those who neared her"; of an encounter between two incubating birds (p. 27): "The victorious bird . . . was exhilarated from the battle . . ."; of the mother's feeling for her young, that she (p. 32): "was intent only on keeping the new baby warm . . ."; that a nesting albatross had a special feeling for the human child (p. 40): "No albatross pecked at or cut a child with its sharp-edged bill"; that the education of a young albatross (p. 44): ". . . depended upon aping his elders . . ."; and further (p. 63): ". . . he gazed skyward for hours at a time at the stars . . . fixing forever in his mind his position in . . . the North Pacific Ocean. . . . His learning took time. . . . Nature demanded that he . . . spend at least five months on the land. . . ."

Some statements are misleading. For example, I discovered that the eyes of the Laysan Albatross are (p. 12): ". . . protected by long black and white eyelashes . . ." structures that, as far as I know, have not been observed before. Further, the author says of the incubation or brood patch (p. 14): ". . . the egg slid out of her pouch"; here the "pouch" sounds like a kangaroo pouch. Of nest building (p. 19): "He dragged in mouthful after mouthful of sand . . .", whereas sand is raked in by the bill tip, not by "mouthfuls." Of the female's first period at sea after laying, she returned (p. 25): ". . . at the end of her allotted twenty-four days." This sounds like a fixed period but in observing 110 nesting pairs we found that this period ranged from 1.5 to 32.0 days (Rice and Kenyon, Auk, 79: 543, 1962). It is a little difficult to accept that an albatross avoided being captured by a shark because he was (p. 29): "Warned by a shock wave that a tremendous fish was approaching. . . ."

Although marine mammals are not the subject of this book, it seems unfortunate that when they are mentioned the information is not always correct. It is said of the Hawaiian monk seal (p. 129): ". . . the mother seal was molting; her fur was falling out in great patches." Many observations indicate that the monk seal mother does not molt until *after* her pup is weaned.

Dr. Fisher's 67 photographs, which were chosen to illustrate specific stages of albatross development and characteristic attitudes, accomplish their objective ably. They are not listed in the contents and the book is not indexed.

My general reaction to this book is that it may safely be read by those who "like birds," want to be entertained, and will be cautious about what they accept as fact. I feel, though, that to captivate readers by ascribing human characteristics to birds may cause sentimental complications that are not necessarily advantageous either to birds or to people.—KARL W. KENYON.

FEATHERS FROM SAND DUNE CAVE: A BASKETMAKER CAVE NEAR NAVAJO MOUNTAIN, UTAH. By Lyndon L. Hargrave. Tech. Ser. No. 9, Museum of Northern Arizona, Northern Arizona Society of Science and Art, Inc., Flagstaff, Ariz., 1970: 7 × 9½ in., paper covered, 52 pp., 45 pen drawings. Price not given.

Bird bones and feathers are found at some Southwestern archaeological sites and are clues to the ecological factors affecting the people who lived there. This booklet is a report on bird remains from an important site. Identification of bone fragments and an estimated 350 feathers revealed 18 species ranging from Mallard to Red-winged Blackbird. Five more species (Canada Goose to Rufous-sided Towhee) are also discussed, based on feather remains from Western Basketmaker II horizons at other sites. The remains of Common Turkeys were more numerous than those of other birds, and provide the basis for describing a new fossil subspecies, *Meleagris gallopavo coltoni*. Although this report is written for archaeologists and ethnobiologists it should be of interest to ornithologists also, if only for showing how many birds can be identified from individual feathers. Ornithology furthermore can be seen assisting other disciplines because the habits of the birds as they are known today, together with the nature and location of the specimens indicate which birds were actually used by Basketmaker II people.—PETER STETTENHEIM.

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CONTENTS

GENERAL NOTES

ORDINATIONS OF HABITAT RELATIONSHIPS AMONG BREEDING BIRDS

FRANCES C. JAMES

In an attempt to express habitat relationships in a new way, I have applied two methods of multivariate analysis to a large set of data pertaining to the habitats of 46 species of common breeding birds. The question asked was: How do these species distribute themselves with respect to the structure of the vegetation? This required (1) devising field techniques that would give quantitative measurements of the vegetation within the breeding territories of individual birds, (2) analyzing these by species in order to obtain a sample of the characteristic habitat dimensions of the species niche, (3) reconstructing the relationships among the species according to their relative habitat separation, and (4) considering the ability of the vegetational variables to describe differences among habitats mathematically.

Data were gathered in the spring and summer of 1967 in Arkansas. The vegetation was sampled in 0.1-acre circular plots, using singing male birds as the centers of the circles. The statistical procedures used which were principal component analysis and discriminant function analysis provided a tool for describing bird distribution objectively as ordinations of continuously-varying phenomena along gradients of vegetational structure. The relative positions of the species were located within multidimensional "habitat space." The relationship between this approach and studies involving ordinations of plant and animal communities is discussed.

FIELD METHODS

Estimates of the characteristics of the structure of the vegetation were obtained by means of sampling one 0.1-acre circular plot within the territory of each singing male bird. A 0.1-acre is a large enough area (radius 37 feet) that it should include an adequate sample of the vegetation. It is convenient to have a circular plot with its center at a singing perch selected by a territorial bird. This might give a biased view of habitat for species which occur in open areas and choose singing perches in places very different from their foraging areas, but this objection is minimized in the forest (including most of the species considered here).

The sampling technique was a modification of the range-finder circle method recommended by Lindsey, Barton, and Miles (1958) as a very accurate and efficient procedure. The range-finder itself was found to be unnecessary. Instead, I suspended a brightly colored yardstick at or below the spot where a territorial male bird was singing. This was sighted by holding at armslength a second yardstick having a mark equal to the length of the first when viewed from the perimeter of the circle. This proved to be an accurate and efficient way of determining whether I was within the area to be sampled. A total of 401 0.1-acre circles was measured in the territories of 46 species. No attempt was made to remain within a fairly uniform stand. In fact as many habitat types as

Table 1

Fifteen Variables of the Structure of the Vegetation Considered in the Analysis of 0.1-acre Plots Showing the Corresponding Symbols Used in Tables 2 and 3

1	% GC	Per cent ground cover divided by 10
2	S/4	Number of shrub or tree stems less than 3 inches DBH per two armslength transects (0.02 acres) divided by 4
3	SPT	Number of species of trees
4	% CC	Per cent canopy cover divided by 10
5	CH	Canopy height divided by 10
6	T_{3-6}	Number of trees 3 to 6 inches DBH
7	T_{6-9}	Number of trees 6 to 9 inches DBH
8	T_{9-12}	Number of trees 9 to 12 inches DBH
9	T_{12-15}	Number of trees 12 to 15 inches DBH
10	$T_{>15}$	Number of trees greater than 15 inches DBH
11	CH × S	Canopy height × shrubs (variable 2 × variable 5)
12	$CH \times T_{3-9}$	Canopy height × trees 3 to 9 inches DBH [variable 5 × variables (6 + 7)]
13	$CH \times T_{>9}$	Canopy height × trees greater than 9 inches DBH [variable 5 × variables (8 + 9 + 10)]
14	T^2_{3-9}	Number of trees 3 to 9 inches DBH squared [square of variables (6 + 7)]
15	$T^2_{>9}$	Number of trees greater than 9 inches DBH squared [square of variables (8 + 9 + 10)]

possible were sampled. Data were obtained in eighteen different counties in various parts of Arkansas. In the few cases in which two species were singing in the same 0.1-acre circle, data for that circle were used to describe one observation of each of the species. In the subsequent analysis data from the circles were organized by species of bird, regardless of where the data were obtained.

Each tree greater than three inches in diameter at breast height (DBH) within the circle was identified to species and the size class was recorded. The same sighting stick mentioned above was graded on the other side for three-inch size-class estimates of tree diameters. Calibrations on the stick were determined by using the formula $S = \sqrt{(aD^2)/(a + D)}$, where S is the graduation on the stick, a is the armlength of the observer, and D is the diameter at breast height (Forbes, 1955).

To estimate shrub density, two armlength transects together totalling 0.02 acres were made across the circle and the number of stems intersected that were less than three inches DHB was recorded. An estimate of ground cover was made by taking 20 plus-or-minus readings for the presence or absence of green vegetation sighted through a sighting tube 1.25 inches in diameter held at armslength. An estimate of canopy cover was made by taking 20 plus-or-minus readings for the presence or absence of green leaves sighted directly upwards on alternate steps of a transect of the circle. The average height of the canopy was measured with a clinometer. After some practice a level of efficiency was reached whereby the field data for one 0.1-acre circular plot could be obtained in 15 to 20 minutes of effort. A more detailed description of this sampling technique is given elsewhere (James and Shugart, 1970).

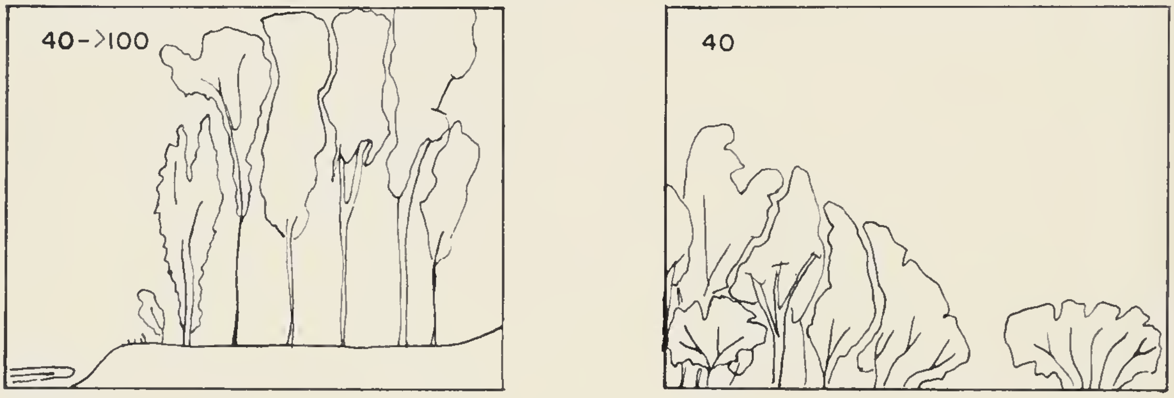
Measurements of 10 vegetational variables were made in each 0.1-acre circle (first 10 items in Table 1). To facilitate handling the data, percentage values for ground cover and canopy cover and the values for canopy height in feet were divided by ten. The number of shrub stems intersected in two transects was divided by four. The last five items in Table 1 are multiples of the first 10. These were used in the discriminant function analysis to determine whether variables were interacting in such a way that their combinations were more highly correlated with the specificity of bird habitats than were the originally measured variables.

THE NICHE-GESTALT

The assumptions underlying both the field methods and the analysis are somewhat different from those used in other recent studies of avian habitats. In the latter the experimental unit is generally the avian community. Analysis is of study plots large enough to support several coexisting species, and this permits interpretations concerning diversity, resource division, and the relative width of ecological niches (MacArthur and MacArthur, 1961; MacArthur and Pianka, 1966; MacArthur, Recher, and Cody, 1966; MacArthur and Levins, 1967; Cody, 1968; Wiens, 1969; and others). In the present study the advantages of community approach are sacrificed in favor of the opportunity to view habitat relationships among a large number of species occurring in a large geographic area as if each were dependent up a specific life form or configuration of vegetational structure. The experimental unit is the basic life form of the vegetation that characterizes the habitat of each particular species. Measurements from territories are organized by species without regard for which other species occurred nearby. This approach can be defended only if one assumes that predictable relationships exist between the occurrence of a bird and of its characteristic vegetational requirements. I have called this basic configuration of the ecological niche, the *niche-gestalt.*

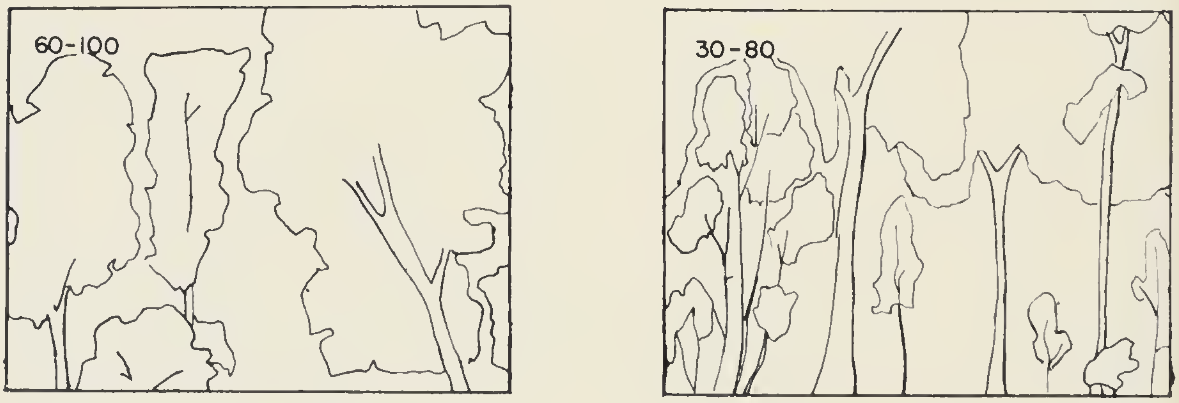
It is not required that this configuration is directly meaningful to the bird, but this hypothesis could be tested by presenting it with different configurations to see whether it recognizes them as appropriate (see Klopfer, 1963, 1965; Wecker, 1963, 1964; Harris, 1952). Inherent in the term *gestalt* are the concepts that each species has a characteristic perceptual world (the Umwelt of von Uexküll, 1909), that it responds to its perceptual field as an organized whole (the Gestalt principle, see Köhler, 1947), and that it has a predetermined set of specific search images (Tinbergen, 1951). This is

BELL'S VIREO



WARBLING VIREO

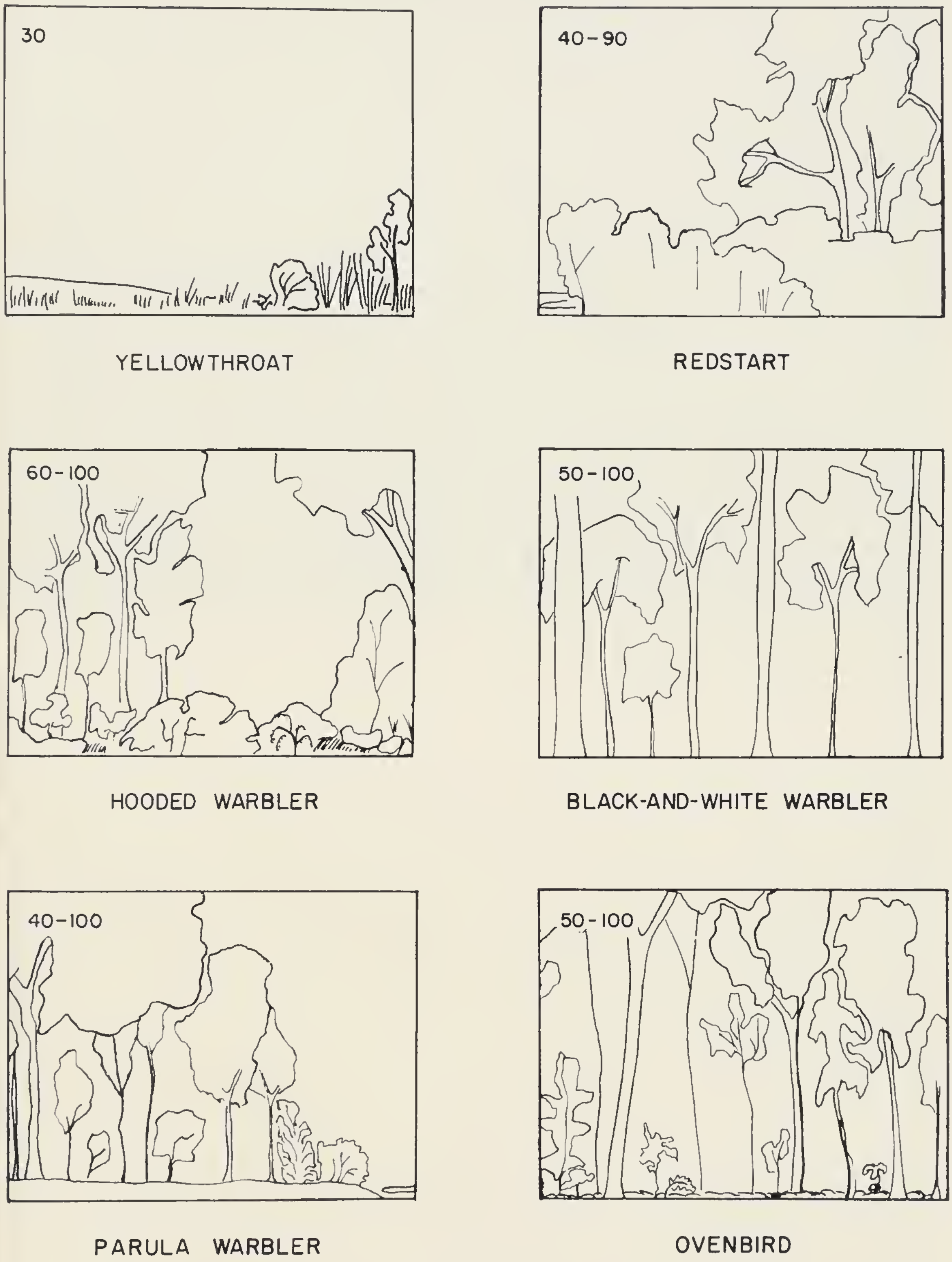
WHITE-EYED VIREO



YELLOW-THROATED VIREO

RED-EYED VIREO

FIG. 1. Outline drawings of the niche-gestalt for five species of vireos, representing the visual configuration of those elements of the structure of the vegetation that were consistently present in the habitat of each. Numbers give the vertical scale in feet.



YELLOWTHROAT

REDSTART

HOODED WARBLER

BLACK-AND-WHITE WARBLER

PARULA WARBLER

OVENBIRD

Fig. 2. Outline drawings of the niche-gestalt for six species of warblers, representing the visual configuration of those elements of the structure of the vegetation that were consistently present in the habitat of each. Numbers give the vertical scale in feet.

Fig. 3. Marsh at the edge of Lake Sequoyah, five miles east of Fayetteville, Washington Co., Ark., where Bell's Vireos and Yellowthroats had breeding territories.

assumed to be at least partially genetically determined, but is surely also modifiable by experience and subject to ecological shift under varying circumstances. Whereas the community approach is sensitive to shifts in habitat due to such factors as competition for resources, the present approach is an attempt to define relationships among birds based upon the basic life forms of the vegetation which each species requires. Since the geographic range of every species is unique and since species are uniquely adapted to utilize certain aspects of their environment, I hope the reader will agree that this approach is justified.

The outline drawings (Figs. 1 and 2) are examples of visual descriptions of the life forms of the vegetation that were consistently present in the habitats of the species in question. These were made by comparing notes and photographs of each 0.1-acre circle where a species occurred and by selecting *only* the features in common. Conversely, if definable niche-gestalt units occur, it should be possible to discover as many of these units as there are pairs of breeding birds in any one place. For example the vegetational configuration in the drawings for the Bell's Vireo (Fig. 1) and the Yellowthroat (Fig. 2) can be identified in a photograph of a place where both occurred (Fig. 3). Likewise the configurations which characterize the habi-

Fig. 4. Vegetation along the Mulberry River, five miles east of Cass, Franklin Co., Ark., where pairs of White-eyed Vireos, Redstarts, and Parula Warblers were nesting.

tats of the White-eyed Vireo (Fig. 1), American Redstart, and Parula Warbler (Fig. 2) can be identified in Figure 4; a territorial male Red-eyed Vireo (Fig. 1), Hooded Warbler, and Ovenbird (Fig. 2) were each present where Figure 5 was photographed.

An attempt will be made to reconstruct relationships between species-specific niche-gestalt units from the quantitative data and to view them in multidimensional "habitat space." Of course this space also contains gradients in types of food, nest-sites, microclimate, etc. Although these variables are undefined in the present study, they would have to be included in a thorough analysis of the ecology of adaptation.

RESULTS

Correlations Among Vegetational Variables.—The vegetational variables are highly interrelated. In the correlation matrix (Table 2) all values of r greater than 0.39 are significant at $\alpha = 0.01$ (44 df). The first column, percentage of ground cover, is negatively correlated with all of the other variables. The second column, an estimate of shrub density, has a different pattern of variation from the last eight columns, which are all characteristics of trees. Shrub density varies concordantly with the number of small trees

FIG. 5. Upland mesic forest at Cherry Bend, Franklin Co., Ark., in the Ozark National Forest, where Red-eyed Vireos, Ovenbirds, and Hooded Warblers had breeding territories.

and also with the number of species of trees and canopy cover. But shrub density varies independently of canopy height and trees greater than six inches DBH. Correlations between the number of species of trees per unit area, percentage of canopy cover and canopy height are particularly highly related to each other and to tree density by size classes (last five columns). This means that for a 10 × 46 data matrix of mean values of each vegetational variable for each species (see next section), a large amount of the variation is statistically attributable to these variables. Although there appears to be redundancy in the five interrelated variables for number of trees by size classes (last five items in Table 2), it will be shown in a later section that each contributes significantly to the statistical description of habitat differences among the species of birds.

PRINCIPAL COMPONENT ANALYSIS

Morrison (1967) defines principal components as those linear combinations of the responses which explain progressively smaller portions of the total sample variance. The components can be interpreted geometrically as the variates corresponding to the principal axes of the scatter of observations in space. If a sample of N trivariate observations had the ellipsoidal scatter

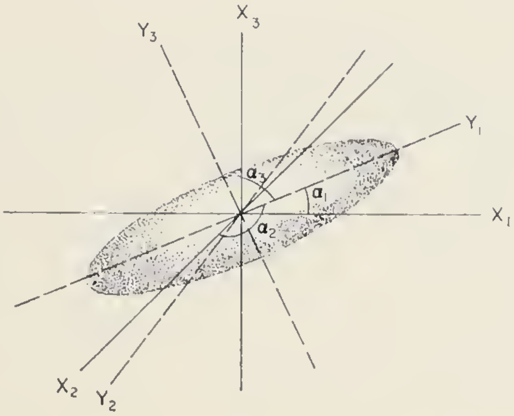


FIG. 6. Principal axes of trivariate observations (redrawn from Morrison, 1967).

plot shown in Figure 6, the swarm of points could be defined as having a major axis Y_1 and less well defined minor axes Y_2 and Y_3. If Y_1 passes through the sample mean point its position can be determined by its orientation with regard to the original response axes (angles a_1, a_2, a_3). The major axis passes through the direction of maximum variance in the points and represents a continuum of the first principal component of the system. The importance and usefulness of the component can be measured by the proportion of the total variance attributable to it. If this proportion is high, then it would be reasonable to express the variation in the data set along a single continuum rather than in N-dimensional space. The second principal component represents that linear combination of the responses that is orthogonal (perpendicular) to the first and has the maximum variance in this direction. The variances of successive components sum to the total variance of the responses. The advantage of the analysis is that it can take

TABLE 2

CORRELATION MATRIX (r) FOR 10 VEGETATIONAL VARIABLES

$N = 46$

	% GC	S/4	SPT	% CC	CH	T_{3-6}	T_{6-9}	T_{9-12}	T_{12-15}	$T_{>15}$
% GC										
S/4	–0.44**									
SPT	–0.67**	0.54**								
% CC	–0.76**	0.55**	0.80**							
CH	–0.51**	0.23	0.72**	0.77**						
T_{3-6}	–0.63**	0.54**	0.92**	0.76**	0.60**					
T_{6-9}	–0.58**	0.25	0.80**	0.79**	0.76**	0.81**				
T_{9-12}	–0.52**	0.06	0.61**	0.61**	0.63**	0.57**	0.77**			
T_{12-15}	–0.59**	0.15	0.69**	0.63**	0.65**	0.61**	0.68**	0.77**		
$T_{>15}$	–0.45**	0.16	0.66**	0.62**	0.81**	0.47**	0.55**	0.43**	0.48**	

** Significant at $\alpha = 0.01$.

TABLE 3

SUMMARY OF THE RESULTS OF THE PRINCIPAL COMPONENT ANALYSIS OF MEAN VALUES OF EACH OF 10 VEGETATIONAL VARIABLES FOR 46 SPECIES OF BREEDING BIRDS

	Component			
	I	II	III	IV
Percentage of total variance accounted for	64.8	12.5	7.7	4.9
Cumulative percentage of total variance accounted for	64.8	77.3	85.0	89.9
Correlations to original variables				
% GC	–0.77	0.21	0.15	0.53
S/4	0.46	–0.83	0.04	0.03
SPT	0.93	–0.16	0.03	0.17
% CC	0.91	–0.17	0.06	–0.12
CH	0.84	0.25	0.35	0.01
T_{3-6}	0.87	–0.25	–0.14	0.29
T_{6-9}	0.89	0.16	–0.12	0.25
T_{9-12}	0.76	0.41	–0.34	0.01
T_{12-15}	0.80	0.30	–0.27	–0.13
$T_{>15}$	0.71	0.22	0.62	–0.07

N-dimensional data and reduce it to a few new variables which account for known amounts of the variation in the original set.

In the present case, the basic ten vegetational variables (first 10 items in Table 1) are used as coordinates of a hypothetical ten-dimensional space. Each of the 46 species of birds has a position in this space according to the mean values of the variables for the 0.1-acre circles measured. This complex situation is analyzed so that a few new variables, the principal components are derived. The principal component analysis is summarized in Table 3.

The first or major component accounts for 64.8 per cent of the total variance and is highly correlated with all of the original variables. All values are positive except percentage of ground cover. The highest correlations are with number of species of trees per 0.1-acre, percentage of canopy cover, number of small trees, and canopy height. Species found where ground cover is high and where there are few shrubs and trees would be expected to have low values of the first component. Species found in mature forests, where ground cover is low and there are many trees of various species and sizes, would be expected to have high values of this component.

The second principal component accounts for an additional 12.5 per cent of the total variance (Table 3). Correlations between it and the original variables show that it represents an inverse interaction between medium-sized trees and shrub density. Species inhabiting dense shrubs would have low values of this component. Species found where there are medium-sized trees and few shrubs would have high values of the second component. The third component accounts for 7.7 per cent of the variance in addition to that already explained. It represents parkland, the presence of large trees with the absence of smaller ones. The fourth component, representing 4.9 per cent of the variance is most closely associated with ground cover. By means of these four newly-computed variables, it has been possible to account for 89.9 per cent of the variation in the original data set. The analysis has derived a parsimonious description of the dependence structure of the multivariate system.

Now it is possible to reconstruct the habitat relationships among these species using the components as coordinates. Figure 7 is a three-dimensional view of the position of each species listed in Table 4 along the axes of the first three principal components. The horizontal axis, representing the first component, has separated the species fairly regularly from open-country birds on the left found in places having high ground cover and few trees (Prairie Warbler, Bell's Vireo, Yellow-breasted Chat, Brown Thrasher) to birds on the right found in well-developed shaded forests (Ovenbird, Red-eyed Vireo, Wood Thrush). In the center along this axis falls a group of species that show remarkable latitude in their choice of habitat (Cardinal, Brown-headed Cowbird, Blue-gray Gnatcatcher). The axis of the second principal component extends backwards from species found in shrubs and low trees (Catbird, White-eyed Vireo, Kentucky Warbler) in the foreground toward species found where there is limited understory (Prothonotary Warbler, Robin, Red-headed Woodpecker). The axis of the third component extends vertically from species not dependent on large trees to those requiring large trees. The highest circles are for the Baltimore Oriole and Hooded Warbler.

Distances between species in Figure 7 represent ecological differences in "habitat space." Consider the positions of the five species of vireos. Their major separation is accomplished along the axis of the first principal component in the order Bell's, Warbling, White-eyed, Yellow-throated, and Red-eyed. This ordering corresponds to increases in the following: number of species of trees per unit area, percentage of canopy cover, number of small trees per unit area, and canopy height (see legend for Fig. 7). Along the axis of the second component (bases of the vertical lines) the same species fall in the order White-eyed, Red-eyed, Bell's, Warbling, and Yellow-throated. This axis is defined as increasing number of medium-sized trees and/or decreasing shrub density. Along the axis of the third component (height of circles) the

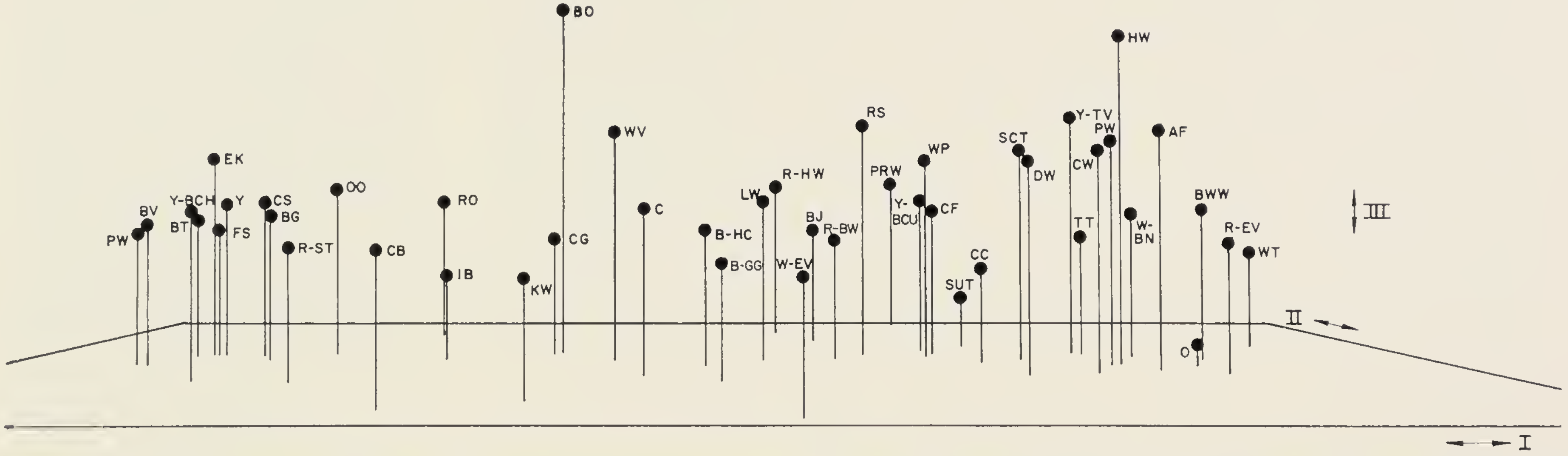


FIG. 7. Three-dimensional ordination of the distribution of 46 species of birds according to the first three principal components of their habitat relationships. The first component, extending from left to right and accounting for 64.8 per cent of the total variance, is highly correlated with all the vegetational variables measured but mainly with increasing number of species of trees, percentage of canopy cover, number of small trees, and canopy height. The second principal component, extending from front to back and accounting for an additional 12.5 per cent of the variance, represents an increasing number of medium-sized trees and/or decreasing shrub density. The third component, extending from low to high and accounting for 7.7 per cent of the variance, represents the presence of large isolated trees. The total variance explained by this ordination is 85 per cent. Symbols for the species are given in Table 4.

TABLE 4

LIST OF SPECIES IN ALPHABETICAL ORDER GIVING SYMBOLS USED IN FIGURES 7 AND 9

AF	Acadian Flycatcher	(*Empidonax virescens*)
BG	Blue Grosbeak	(*Guiraca caerulea*)
B-GG	Blue-gray Gnatcatcher	(*Polioptila caerulea*)
B-HC	Brown-headed Cowbird	(*Molothrus ater*)
BJ	Blue Jay	(*Cyanocitta cristata*)
BO	Baltimore Oriole	(*Icterus galbula*)
BT	Brown Thrasher	(*Toxostoma rufum*)
BV	Bell's Vireo	(*Vireo bellii*)
BWW	Black-and-White Warbler	(*Mniotilta varia*)
C	Cardinal	(*Richmondena cardinalis*)
CB	Catbird	(*Dumetella carolinensis*)
CC	Carolina Chickadee	(*Parus carolinensis*)
CF	Crested Flycatcher	(*Myiarchus crinitus*)
CG	Common Grackle	(*Quiscalus quiscula*)
CS	Chipping Sparrow	(*Spizella passerina*)
CW	Carolina Wren	(*Thryothorus ludovicianus*)
DW	Downy Woodpecker	(*Dendrocopos pubescens*)
EK	Eastern Kingbird	(*Tyrannus tyrannus*)
FS	Field Sparrow	(*Spizella pusilla*)
HW	Hooded Warbler	(*Wilsonia citrina*)
IB	Indigo Bunting	(*Passerina cyanea*)
KW	Kentucky Warbler	(*Oporornis formosus*)
LW	Louisiana Waterthrush	(*Seiurus motacilla*)
O	Ovenbird	(*Seiurus aurocapillus*)
OO	Orchard Oriole	(*Icterus spurius*)
PW	Prairie Warbler	(*Dendroica discolor*)
PAW	Parula Warbler	(*Parula americana*)
PRW	Prothonotary Warbler	(*Protonotaria citrea*)
RS	American Redstart	(*Setophaga ruticilla*)
RO	Robin	(*Turdus migratorius*)
R-BW	Red-bellied Woodpecker	(*Centurus carolinus*)
R-EV	Red-eyed Vireo	(*Vireo olivaceus*)
R-HW	Red-headed Woodpecker	(*Melanerpes erythrocephalus*)
R-ST	Rufous-sided Towhee	(*Pipilo erythrophthalmus*)
SCT	Scarlet Tanager	(*Piranga olivacea*)
SUT	Summer Tanager	(*Piranga rubra*)
TT	Tufted Titmouse	(*Parus bicolor*)
W-BN	White-breasted Nuthatch	(*Sitta carolinensis*)
W-EV	White-eyed Vireo	(*Vireo griseus*)
WP	Eastern Wood Peewee	(*Contopus virens*)
WT	Wood Thrush	(*Hylocichla mustelina*)
WV	Warbling Vireo	(*Vireo gilvus*)
Y	Yellowthroat	(*Geothlypis trichas*)
Y-BCH	Yellow-breasted Chat	(*Icteria virens*)
Y-BCU	Yellow-billed Cuckoo	(*Coccyzus americanus*)
Y-TV	Yellow-throated Vireo	(*Vireo flavifrons*)

Table 5

Results of the Discriminant Function Analysis and Step-down Procedure

The computed coefficients (w) for the formula $\overline{D} = \Sigma w_i \bar{x}_i$, and the ranking of the vegetational variables (x) are given in the order of their respective power to separate the species of birds by habitat. Each variable had a significant ability to separate the species in addition to that separation already achieved by all the variables above it on the list.

Rank	Original order of variable	Vegetational variable (x)	Computed weight (w)	*F*-ratio*
1	4	Percentage canopy cover	2.0197	46.05
2	5	Canopy height	1.5305	16.58
3	3	Number of species of trees	0.5807	9.76
4	12	Canopy height × trees 3–9 inches DBH	–0.0954	4.73
5	13	Canopy height × trees larger than 9 inches DBH	0.0803	5.23
6	2	Shrub stems/0.02-acre	0.3091	11.28
7	11	Canopy height × shrubs	–0.0131	6.51
8	6	Trees 3–6 inches DBH	1.1134	5.47
9	1	Percentage ground cover	–0.2861	7.24
10	14	Trees 3–9 inches DBH squared	0.0117	5.01
11	7	Trees 6–9 inches DBH	–0.2592	4.80
12	9	Trees 12–15 inches DBH	2.2260	4.88
13	8	Trees 9–12 inches DBH	2.8539	4.37
14	10	Trees larger than 15 inches DBH	2.9848	5.87
15	15	Trees larger than 9 inches DBH squared	–0.2284	6.39

* All *F*-ratios are significant at $\alpha = .001$.

Warbling and Yellow-throated Vireos have higher positions than the others, indicating that they require the presence of higher trees. These relationships can be checked by considering the drawings in Figure 1 in the order that the species fall along the respective axes. The same procedure can be applied to the six species of warblers for which the niche-gestalt is outlined in Figure 2.

Although the species in Figure 7 are fairly evenly distributed, several appear to be more isolated than the others, and these are birds that are not widely distributed in Arkansas in the breeding season. The Baltimore Oriole occurs in summer only in places having very large trees with clearings below. These are in towns and farmyards in the southern parts of the state and along river banks. Warbling Vireos are confined to cottonwoods (*Populus*) and willows (*Salix*) along major rivers or adjacent to them. Hooded Warblers occur in upland and lowland situations but only in the most mature mesic forests.

I do not want to exaggerate the validity of specific relationships. This analysis is based on mean values of the vegetational variables without regard for their variance. Sample sizes by species are small, and data pertain to a limited area of the breeding range of each. Nevertheless, a complex environmental situation has been reduced to a manageable mathematical and diagrammatic structure.

DISCRIMINANT FUNCTION ANALYSIS AND STEP-DOWN PROCEDURE

The entire data set, values of 15 vegetational variables (Table 1) for 401 tenth-acre circular plots representing the habitats of 46 species of birds was subjected to a type of multivariate technique known as Fisher's classical method of discriminant function analysis (Fisher, 1936, 1938). This procedure computes an equation that is constructed in such a way that it defines a linear axis through the data set which maximizes the differences among populations. The new axis (D) serves as a better discriminant than do any of the variables taken singly (Sokal and Rohlf, 1969). The result is a set of discriminant function coefficients ($w_1, w_2, \ldots, w_p$) for the 15 vegetational variables which maximizes the *F*-ratio of the corresponding univariate one-way analysis of variance applied to a linear combination of the multivariate measurements. The average value of the discriminant function for a species can be expressed as

$$\overline{D} = \Sigma w_i \bar{x}_i$$

where each $\bar{x}$ is the mean of the observations of that variable for that species. For an individual bird,

$$D = w_1(\%GC) + w_2(S/4) + w_3(SPT) \ldots, w_{15}\,(T_{>9})^2$$

The values w for each vegetational variable are given in Table 5.

This method provides an optimum procedure for separating the habitats mathematically and it permits a linear ordering of the species such that their separation on the discriminant function axis is a function of their differences in habitat. The order should be similar to that along the first principal component except that the species should be more evenly distributed along the discriminant function axis. Whereas the principal component analysis described the relative positions of the species in multidimensional space (each component of which is orthogonal to every other but in which differences are not necessarily maximized) the discriminant function analysis maximizes the distances between species in this space. Figure 8 gives the positions of the species along the discriminant function axis.

Here a 15-dimensional system has been reduced to one dimension, and all the measurements are accounted for simultaneously. The result is a continuum of vegetational structure along which the mean values of D for each species are located. The linear discriminant function is an expression of a con-


$\overline{D} = \sum w_i \overline{x}_i$
0.0
45.0
3.2 PRAIRIE WARBLER
5.6 BELL'S VIREO
6.5 BROWN THRASHER
6.7 YELLOWTHROAT
8.0 FIELD SPARROW
8.1 BLUE GROSBEAK
8.3 EASTERN KINGBIRD
8.8 YELLOW-BREASTED CHAT
9.0 CHIPPING SPARROW
12.9 RUFOUS-SIDED TOWHEE
14.2 ORCHARD ORIOLE
15.4 INDIGO BUNTING
19.8 ROBIN
22.3 COMMON GRACKLE
25.4 CARDINAL
25.6 RED-HEADED WOODPECKER
25.9 CATBIRD
26.1 KENTUCKY WARBLER
26.2 BLUE-GRAY GNATCATCHER
27.0 BROWN-HEADED COWBIRD
28.9 RED-BELLIED WOODPECKER
29.6 LOUISIANA WATERTHRUSH
30.0 BALTIMORE ORIOLE
31.6 BLUE JAY
32.1 SUMMER TANAGER
32.2 WARBLING VIREO
32.4 PROTHONOTARY WARBLER
32.7 WHITE-EYED VIREO
34.3 CAROLINA CHICKADEE
34.4 REDSTART
36.4 YELLOW-BILLED CUCKOO
36.6 CRESTED FLYCATCHER
36.8 WOOD PEWEE
38.7 SCARLET TANAGER
39.0 HOODED WARBLER
39.1 TUFTED TITMOUSE
39.5 DOWNY WOODPECKER
39.8 BLACK AND WHITE WARBLER
40.1 YELLOW-THROATED VIREO
40.9 WHITE-BREASTED NUTHATCH
41.5 PARULA WARBLER
41.7 WOOD THRUSH
41.8 OVENBIRD
43.0 CAROLINA WREN
43.2 RED-EYED VIREO
43.3 ACADIAN FLYCATCHER

tinuum from xeric to mesic situations, from upland to bottomland, from low to high biomass, and from open country to forest associations. Each species of bird has a unique mode of environmental response along this continuum.

A two-dimensional separation of the species was achieved by computing the second characteristic root from the same data (third graph in Fig. 9). This gave new coefficients for the vegetational variables and new average values along a second axis for each species. This second ordination (D_2) proceeds from areas having large isolated trees with relatively open understory to areas having the biomass concentrated in the lower strata, i.e. high shrubbiness or a high number of small trees. For example, the Robin requires isolated trees (low value of D_2) whereas the Catbird requires dense low trees or shrubs (high value of D_2).

The power of the method to separate the species of birds is partly determined by the number of variables considered. Examples using 3, 10 and 15 variables (in the order given in Table 5) show the additional separation that is possible as the number of variables increases (Fig. 9). Compare also with Cody (1968).

Once it has been established that discrimination can be accomplished, i.e. that the species of birds can be separated stochastically according to their habitats, Bargmann's extension (1962) can be used to find a minimal set of variables for discrimination. The method requires an a priori ordering of the variables, then proceeds by selecting a subset and testing the hypothesis that the remaining variables give no additional contribution to the discrimination. This step-down procedure provided a list of the vegetational variables in the order of their respective ability to separate the species of birds. The computed *F*-ratios of Table 5 reflect the power of each variable to separate the species in addition to that separation already achieved by all the variables above it on the list.

Surprisingly, every one of the 15 variables considered had a significant ability to separate the species of birds (Table 5). By far the most powerful were the two which would probably be the most conspicuous visually, percentage of canopy cover and canopy height. These were followed by the number of species of trees, a factor closely related to tree-species diversity. Next came two variables which combined canopy height and some aspect of tree density: canopy height times trees three to nine inches DBH, and canopy height times trees greater than nine inches DBH. The next three variables were related to the density of shrubs or small trees: shrub density,

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←

Fig. 8. Ordination of the habitats of 46 species of birds along a linear discriminant function.

canopy height times shrub density, and trees three to six inches DBH. After ground cover the last six variables, although still highly significant, were probably those that are least conspicuous in the visual configuration of the habitat. They were measurements of tree density by size class.

This does not mean that all 15 variables are required to maximally separate any two species, but only that all are required to separate some species from all of the others. It should also be possible to define other variables that would give additional separation.

DISCUSSION

The value of multivariate methods to analyze sets of dependent variables has been exploited widely in systematics under the name of numerical taxonomy (Sokal and Sneath, 1963). That the methods are equally useful in ecology is suggested by several recent applications to ecological data. Examples include cluster analyses of forests (West, 1966), the characteristics of the life history of beetles (Fujii, 1969), and of climatic variables (Johnston, 1969); principal component analysis of stands of vegetation (Orloci, 1966; Austin, 1968; Swan et al., 1969; and others) and of grain bulk ecosystems (Sinha et al., 1969); discriminant function analysis of habitats of grassland birds (Cody, 1968).

The assumptions underlying the present study are conceptually related to the individualistic concept of distribution described by Gleason (1926) for plant species. This was extended by workers at the University of Wisconsin who developed the continuum concept of plant distribution and devised mathematical procedures for its expression (Curtis and McIntosh, 1951; Bray and Curtis, 1957; Beals, 1960; and others). These studies show that in a series of stands any particular species has distinct conditions for optimum development and that to consider species as organized into discrete communities is to exaggerate the dependence between them.

Bond (1957) demonstrated that the continuum concept has usefulness in analyzing bird distribution. He concluded that "the importance of the life form and physical features of the habitat in the distribution of birds, the occurrence of similar bird species in similar life form situations in different biomes, the indistinctness of boundaries between units, all suggest that the unitary nature of community categories should be questioned." A comparison between the one dimensional ordination in Figure 8 extracted by discriminant function analysis with the position of the same species of birds along the plant continuum described by Bond (ibid.) shows many similarities. Whether the differences are due to the difference between the two methods of analysis, the difference between Wisconsin and Arkansas, or to differences in habitat preferences of the populations is not evident.

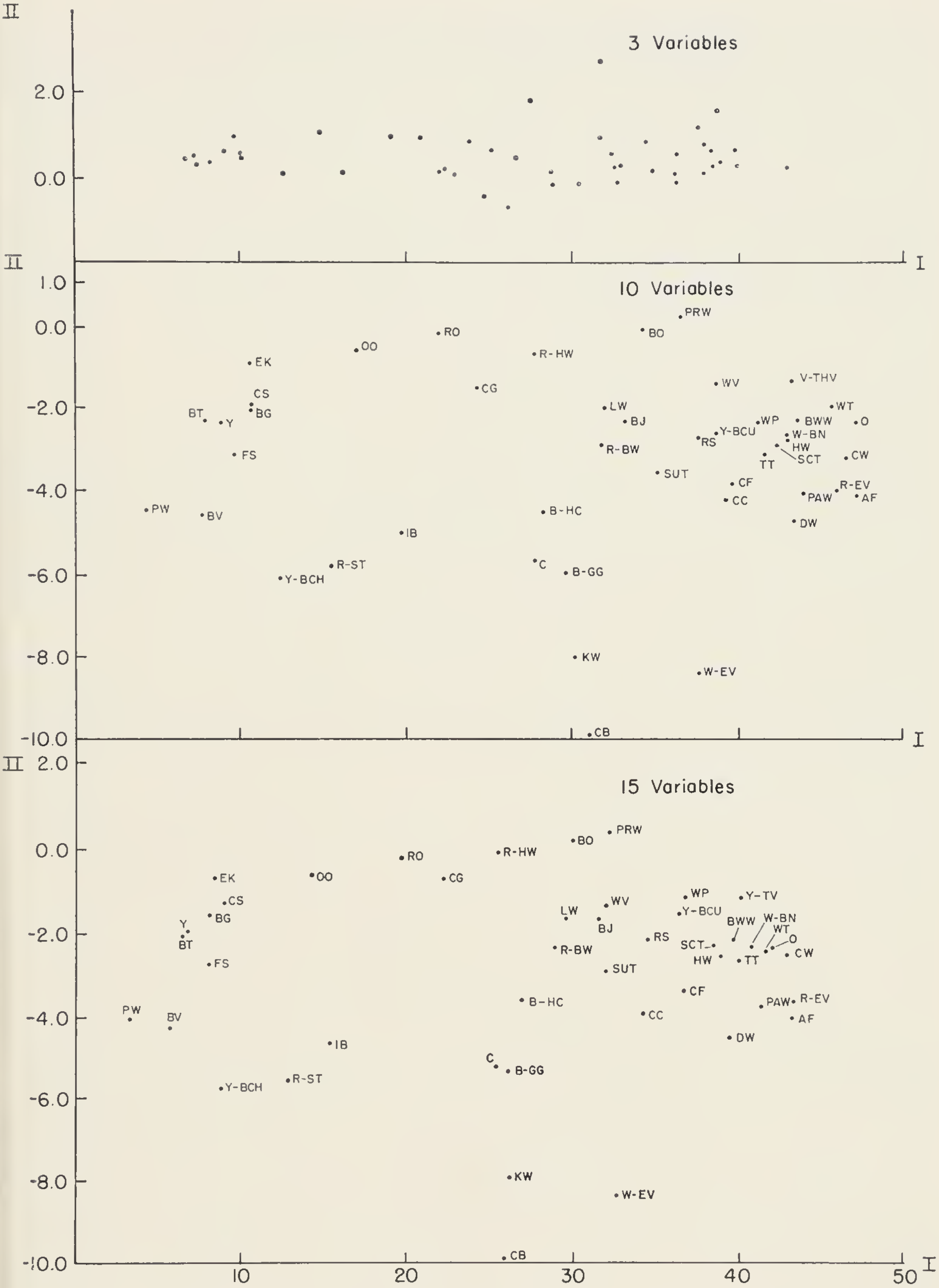

FIG. 9. Two-dimensional ordinations of the habitats of birds representing their positions with respect to the first and second discriminant function axes. Comparisons reveal the additional separation of populations that is possible by consideration of an increasing number of variables. The variables are in the order in which they are listed in Table 5. See sections on Discriminant Function Analysis and Discussion for further explanation.

Beals (1960) extended the application of the continuum concept to bird distribution by constructing a two-dimensional ordination of 24 forest stands based on their avifaunal similarities. He was able to relate this environmental complex to tree species distribution and vegetational structure. Recently the mathematical procedure he used has been criticized on the basis that the method of axis construction is a false estimate of a Euclidean measure of distance, that the axes in multidimensional ordinations are oblique rather than orthogonal (Austin and Orloci, 1966; Orloci, 1966) and that the axes are not objectively selected (Swan et al., 1969). These workers agree that a principal component analysis of a matrix of weighted similarity coefficients between species is not subject to these objections and is the best technique presently available for ordination work.

In the present study the combination of two multivariate methods proved to be more informative than either would have been alone. By considering the species means as individuals and the vegetational variables as attributes, a principal component analysis of the correlation matrix extracted four definable axes which accounted for 90 per cent of the variation in the original data set. A discriminant function analysis of 401 tenth-acre samples representing the habitats of 46 species of birds provided ordinations in which the species were maximally separated according to their habitat relationships. A step-down procedure evaluated the relative power of the 15 vegetational variables to achieve discrimination.

I would like to emphasize the point that the methods used to obtain ordinations are merely objective ways of viewing sets of multivariate data. Their use does not restrict the interpretation of results to the framework of the continuum concept. If the species had appeared as clusters in Figures 7, 8 and 9, one might be justified in interpreting these as belonging to species-groups having similar habitat types. On the other hand, the graphs in Figure 9 reveal the risk involved. The first one, made on the basis of the three most powerful variables for separating the species (canopy cover, canopy height, and number of species of trees per unit area), appears to have clusters of species at each end with a gap in the middle. When additional variables were included in the same program, the cluster on the left disappeared. The open-country birds became spread out along the second axis, but the cluster on the right remained. In other words, the choice and number of variables affect the results to such an extent that caution regarding conclusions is in order.

SUMMARY

Quantitative vegetational data obtained in the breeding territories of 46 species of birds are organized by species as samples of the characteristic life form of the vegetation for each. Examples of outline drawings of the niche-gestalt represent those structural

features of the vegetation that were consistently present where a certain species occurred. Principal components and discriminant functions are used to describe habitat relationships among the species as positions along one-, two- and three-dimensional continua representing gradients in the structure of the vegetation. Although all 15 vegetational variables contributed significantly to the ordinations, the most powerful variables for describing habitat differences were per cent canopy cover, canopy height, and the number of species of trees per unit area. If one considers the vegetation of a geographic area to be a set of continuously-varying phenomena, and if one assumes that bird distribution is at least partly based on species-specific adaptiveness to the resources offered by this heterogeneous structure, then ordination procedures are appropriate methods for its expression.

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RELATIONS BETWEEN LEWIS' AND RED-HEADED WOODPECKERS IN SOUTHEASTERN COLORADO

Carl E. Bock, Harlo H. Hadow, and Preston Somers

The Lewis' Woodpecker (*Asyndesmus lewis*) and the Red-headed Woodpecker (*Melanerpes erythrocephalus*) are nearly ecological equivalents in western and eastern North America, respectively (Bock, 1970). Both species prefer open breeding habitat such as savannah or old burns, where they rarely excavate for wood-boring insects, but instead hawk for insects on the wing (e.g., Beal, 1911; Bent, 1939). During the winter both species harvest, store, and aggressively defend caches of acorns, corn, or similar mast (Kilham, 1958; Bock, op. cit.). Both are partially migratory but may be resident in suitable habitat, and they show generally opportunistic habits by moving into areas where food is temporarily abundant (e.g., an oak woodland rich in acorn mast).

These woodpeckers have never to our knowledge been studied in sympatry, although there is limited potential overlap of their breeding ranges in central Montana, eastern Wyoming, Colorado, and New Mexico (A.O.U. Check-list, 1957). In June, 1969, we discovered substantial populations of Lewis' and Red-headed Woodpeckers nesting together along the Arkansas River and adjacent farmlands in Crowley and Otero counties, on the plains of southeastern Colorado. This paper presents information on the ecology and behavior of the two species in sympatry. By way of further comparison we carried out a structural and functional analysis of their vocalizations during the breeding season.

METHODS

Data on habitat selection and interspecific aggression were gathered by direct observation. Rates of aggressive encounters were calculated during 1465 minutes of nest observation on 15 days (Table 1). An additional 23 hours were spent driving farm and levy roads in the study area, censusing breeding pairs. Calls were recorded with a Uher 4000 Report-L tape recorder on Scotch 1.5 mil 175 Tenzar tape at 19 cm/sec. The microphone used was a pistol-type Electro-Voice Model 644 which limited the recording system to a frequency range of 40 to 10,000 hertz. The sonagrams were made at the University of Colorado Sound Laboratories using a Kay Electric 6061A Sona-Graph, set for a narrow band analysis of 45 hertz.

RESULTS

Habitat Selection.—Lewis' and Red-headed Woodpeckers nested in two habitats in the study area. The first was the bottomland along the river itself. This area consisted of an overstory of mature cottonwoods (*Populus sar-*

FIG. 1. Breeding habitat of Lewis' and Red-headed woodpeckers in southeastern Colorado—cottonwood riparian woodland. Photograph taken in August, 1970, on the Arkansas River, Crowley County, Colorado.

gentii) mixed with a variety of shrubs, herbs, and smaller trees, especially willow (*Salix* sp.) and tamarisk (*Tamarix pentandra*). Ground fires are common as an agricultural attempt to reduce shrubs and increase grass production. The result is that much of the habitat is open and park-like (Fig. 1). Both species nested in dead or partially decayed cottonwoods and foraged extensively on the ground or by flycatching in clearings between the trees. The second breeding habitat was farmland (Fig. 2). Here the woodpeckers nested in cottonwoods along roads or around buildings and foraged for emergent insects largely in or over adjacent cultivated fields.

A census of breeding pairs indicated that while habitat preferences did overlap, Lewis' Woodpeckers nested significantly more often in the agricultural areas (34 of 36 nests) while Red-headed Woodpeckers were more common in the river bottomlands (19 of 27 nests; significant differences at $\alpha = 0.05$, using the Chi-square test). This demonstrated habitat difference is consistent with two additional factors related to the life histories of these species. First, while the Red-headed Woodpecker is strictly a bird of the breeding season in southeastern Colorado some of the Lewis' Woodpeckers

FIG. 2. Breeding habitat of Lewis' and Red-headed woodpeckers in southeastern Colorado—farmland. Photograph taken in August, 1970, in Crowley County, Colorado.

were permanent residents in our study area (Hadow, MS), storing and utilizing corn as a winter food supply. This may explain the larger numbers of Lewis' Woodpeckers which we observed in agricultural areas, where the birds nested at or near their winter storage sites.

In addition, we found that even those Lewis' Woodpeckers breeding in the riparian bottomlands nested near a woodland border and foraged to a large degree by hawking insects high over adjacent open fields, as well as in the woodland area. Red-headed Woodpeckers were not restricted to the margins of the forest, but nested wherever there were clearings amongst the cottonwoods. *Melanerpes* rarely executed the high prolonged hawking flights even when near open fields. It would appear that while both species prefer open habitat conducive to aerial maneuvering and therefore do share habitats, *Asyndesmus* is very much the specialist or extremist of the two, particularly with regard to the extended hawking flights so characteristic of this species.

Interspecific Aggression.—One pair of *Asyndesmus* which we found in cottonwood bottomland nested in 1969 and 1970 within 35 meters of an established pair of *Melanerpes*. This afforded an opportunity to look for any signs of interspecific aggression and territoriality. The two pairs were discovered on 6 June 1969, when both were incubating. We returned to the

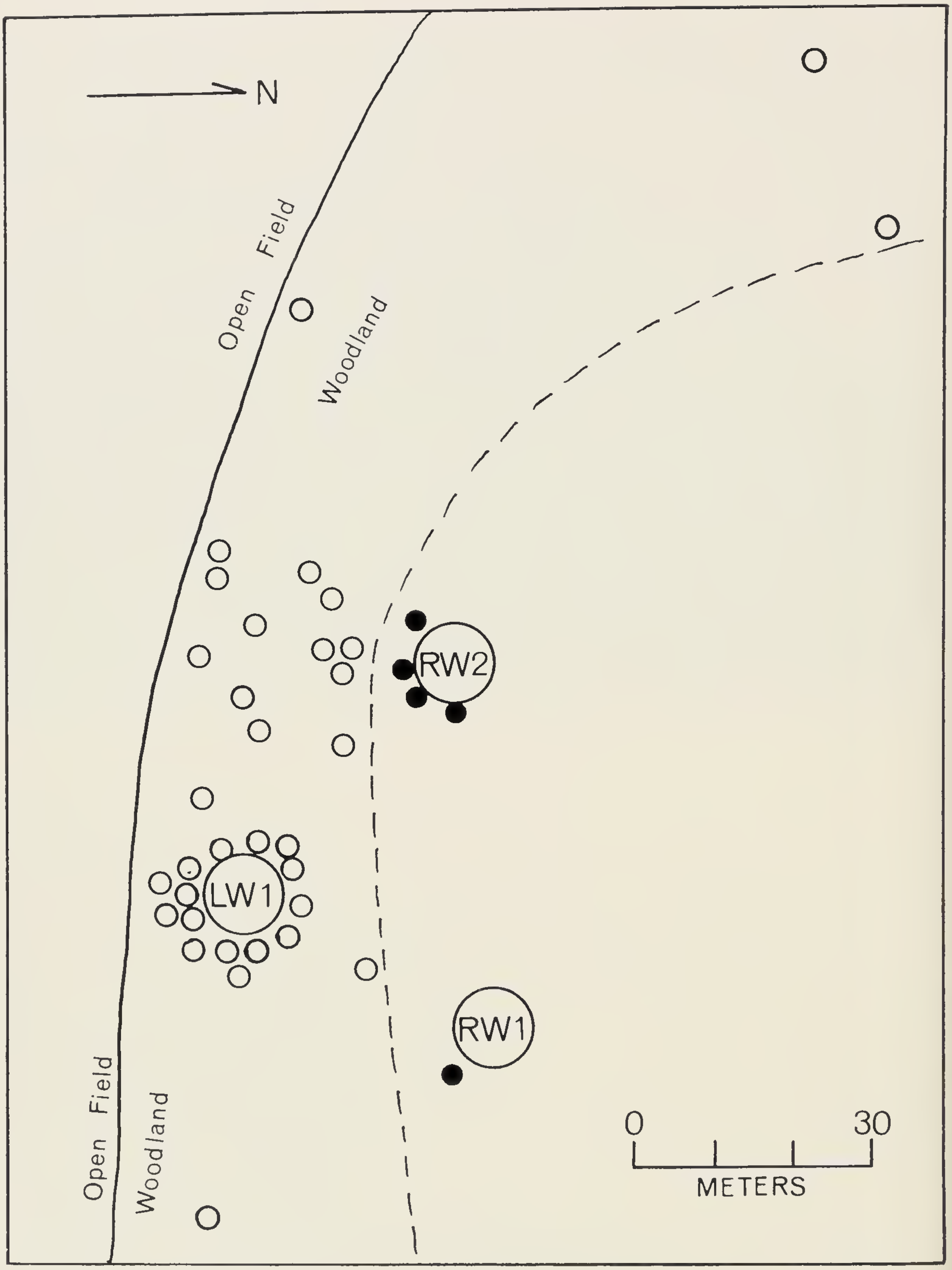

FIG. 3. Interspecific territoriality and aggression between breeding pairs of Lewis' and Red-headed woodpeckers, Arkansas River, Crowley County, Colorado. LW1 = Lewis' Woodpecker nest tree; RW1 = Red-headed Woodpecker nest tree; RW2 = partially excavated and abandoned Red-headed Woodpecker nest tree (1970 only). Open circles = locations of interspecific encounters in which Lewis' Woodpeckers dominated; closed circles = locations of encounters in which Red-headed Woodpeckers dominated. Solid line indicates border between woodland (north) and pasture (south); dashed line indicates territorial boundary between the two nesting pairs.

TABLE 1

RATES OF AGGRESSIVE INTERACTION AMONG AND BETWEEN *ASYNDESMUS LEWIS* AND *MELANERPES ERYTHROCEPHALUS* NESTING IN A COTTONWOOD GROVE ON THE ARKANSAS RIVER, CROWLEY COUNTY, COLORADO. (Based upon 252 encounters recorded during 1465 minutes of nest observation in 1969 and 1970.)

Stage of nesting cycle and dates	Minutes of observation	Rate per hour and number( ) of aggressive encounters[1]		
		Asyndesmus-intraspecific	Interspecific	*Melanerpes*-intraspecific
Early courtship;[2] 12–13 May 1970	135	—	1.3(3)	—
Advanced courtship; 16–18 May 1970	390	0.6(4)	4.0(26)	29.4(191)
Melanerpes nest excavation; *Asyndesmus* incubation; 23–30 May 1970	540	—	0.8(7)	0.7(6)
Both species incubating; 5–10 June 1969	90	—	—	—
Both species feeding young; 29 June 1970	90	—	0.7(1)	—
Both species with partially fledged broods; 12–13 July 1969	220	0.3(1)	3.0(11)	0.5(2)

[1] Does not include interactions between members of the same pair.

[2] Our first observations in 1970 were on 12 May, when both species were involved in early courtship; however, we cannot be certain when courtship began. It is apparent from the table that the *Asyndesmus* were somewhat ahead of *Melanerpes* in their nesting activities.

area on 12 July when both species had partially fledged broods. In 1970 observations were made during courtship, incubation, and fledging periods. During a total of 1465 minutes of observation at this site we recorded the numbers and locations of intra- and interspecific encounters between these two pairs and other transient individuals (Table 1; Fig. 3). Encounters almost always involved one bird physically supplanting another, accompanied by aggressive postures (see Kilham, 1958; Bock, 1970) and vocalizations (see below).

Table 1 shows the numbers and rates of inter- and intraspecific aggressive encounters during different stages of the nesting cycle. The number of encounters involving Red-headed Woodpeckers was very high due to the large number of this species present in the study area. Particularly during the courtship period in 1970 (Table 1) the resident pair of *Melanerpes* was involved in an almost continual series of encounters with transient conspecific individuals. On three occasions strange Lewis' Woodpeckers also appeared and were displaced when they landed at the Lewis' Woodpecker nest tree.

Of particular interest in this study is the fact that the resident pairs were equally intolerant of each other and all intruders of both species. This intolerance, coupled with the large number of transient *Melanerpes*, resulted infrequent interspecific encounters during the courtship period (Table 1). Later in the season when the transient *Melanerpes* disappeared the two established pairs came to occupy more or less mutually exclusive foraging areas (Fig. 3). The Lewis' Woodpeckers foraged east and west along the woodland edge and south over an adjacent open field, while the Red-headed Woodpeckers usually operated further back in the cottonwoods, with the result that there was very little interspecific contact. The birds seemed to recognize a territorial boundary (Fig. 3). The rate of interspecific encounters rose again at the end of the breeding season in 1969, when the young were fledging. Ten of the 11 observed encounters (Table 1) occurred when the parent Red-headed Woodpeckers flew into a cluster of cottonwoods west of the Lewis' Woodpecker nest (Fig. 3) to feed one of their recently fledged young which had flown there. The Lewis' Woodpeckers were especially protective of this area and drove out the Red-headed Woodpeckers when they approached.

The Lewis' Woodpeckers dominated in 43 of 48 interspecific encounters, although this may have been a result of the fact that most encounters took place when *Melanerpes* approached the *Asyndesmus* nest tree and foraging area. The Red-headed Woodpeckers were dominant on five occasions when Lewis' Woodpeckers approached their nest sites (Fig. 3).

Structural Analysis of Vocalizations.—In addition to drumming, Lewis' and Red-headed woodpeckers each gave three distinct calls during the breeding season. Sonagrams and descriptions of these calls are given in Table 2 and Figure 4.

Analysis of the vocalizations indicates that the *churr* of the Lewis' Woodpecker is intermediate in structure between the *churr* and rasp-calls of the Red-headed Woodpecker. The *churr* of both species has harmonic structure; the emphasis in *Melanerpes* is on the first harmonic, but in *Asyndesmus* it is on the wide, noisy second harmonic, which covers a frequency range more comparable to that of the *Melanerpes* rasp-call. The chatter and squeak of the Lewis' Woodpecker are similar, short, more musical notes which have no apparent structural counterpart in the Red-headed Woodpecker.

Functional Analysis of Vocalizations.—The functional significance of Lewis' Woodpecker vocalizations has been discussed previously (Bock, 1970). Breeding males give *churr*-calls to proclaim territories or nest sites and to attract mates. The chatter-call serves an aggressive function during

TABLE 2

STRUCTURAL ANALYSIS OF LEWIS' AND RED-HEADED WOODPECKER VOCALIZATIONS.
(Compare with sonagrams in Fig. 4.)

	Melanerpes calls		
	churr-calls (a)[1]	rasp-call (b)	low-call (c)
Duration of a single note (sec)	0.25–0.30	0.30–0.45	0.12–0.16
Composition	single or in bursts; irregular intervals	bursts, 0.14–0.15 sec apart	bursts, 0.14–0.18 sec apart
Fundamental frequency (kilohertz)	0.9 to 1.5 to 0.9[2] 1.5 to 2.2 to 1.9	no clear harmonics; energy between 2.0 and 5.0	no clear harmonics; energy between 1.3 and 3.0
Harmonic structure	5 harmonics; emphasis on first	no clear harmonics	no clear harmonics

	Asyndesmus calls		
	churr-call (d)	chatter-call (e)	squeak note (f)
Duration of a single note (sec)	0.40–0.55	0.07–0.09	0.07–0.13
Composition	single or in bursts; irregular intervals	bursts, 0.03 to 0.05 sec apart	single or in irregular bursts
Fundamental frequency (kilohertz)	1.5	about 1.2, up to 1.5 or 1.9, and back	1.3 to 1.6, rising to 1.6 or 1.8, and back
Harmonic structure	4 to 5 harmonics; emphasis on 2nd	3 to 4 harmonics; emphasis on 2nd or 3rd	3 to 4 harmonics; emphasis on 2nd

[1] Letter in parentheses corresponds to sonagram in Figure 4.

[2] There are two fundamental frequencies, each with its own harmonics. This is an example of what Greenwalt (1968) calls an "internal duet," each side of the syrinx producing a different sound.

inter- as well as intraspecific encounters throughout the year; males usually give chatter-calls prior to copulation, perhaps as an expression of intra-pair hostility. Squeak notes connote alarm such as would be caused by a predator approaching a nest. Lewis' Woodpeckers rarely drum, and then strictly during the courtship period.

Though Kilham (1958) has referred to vocalizations of wintering Red-headed Woodpeckers, calls associated with nesting have not been described in depth. We recorded the behavioral contexts of vocalizations given by the *Melanerpes* population breeding along the Arkansas River in 1969 and 1970

Table 3

Red-headed Woodpecker Vocalizations and Correlated Behaviors.
(Based upon the results of 1465 minutes of nest observation in 1969 and 1970 on the Arkansas River, Crowley County, Colorado.)

	Behavior			
Communication	Copulation	Intraspecific encounter	Interspecific encounter	No identified behavior
Churr-call (n = 39)	3	22	4	10
Rasp-call (n = 42)	2	28	7	5
Low-call (n = 32)	25	5	2	0
Drum (n = 46)	7	22	6	11

(Table 3). Since the species is sexually monomorphic, we could determine the sex of a calling individual with certainty only during courtship bouts.

Rasp-calls were associated with aggressive encounters, and were given in almost all intraspecific contacts, as well as during conflicts with Lewis' Woodpeckers when Red-headed Woodpeckers were dominant. They seemed to be given by all birds. We feel that this call connotes general aggressiveness, and is not territorial per se.

Twenty-five of 32 low calls were given by males prior to copulation (Table 3), indicating that this vocalization might be an invitation to or initiator of sexual behavior. However, its structural similarity to the aggressive rasp-call (Fig. 4; Table 2) and the fact that it also occurred during some intra- and interspecific encounters, suggests that both vocalizations may occur in an aggressive context, and that the low call can be a reflection of intra-pair hostility, or lower aggression levels between unpaired birds.

Churr-calling occurred with all behaviors listed in Table 3, but most frequently with intraspecific encounters and in the "not identifiable" context. It should be emphasized that *churr*-calls occurred *prior to* and *not during* aggressive encounters and copulations (unlike rasp-calls). That is, *churr*-calls seemed to advertise the territory to intruders and potential mates, and the readiness to copulate to the mate. The number of *churr*-calls in the "unidentified" category (Table 3) further supports the general advertisement interpretation of the call, as no obvious stimulus was necessary to elicit it. Only males gave *churr*-calls during courtship bouts, and it seems likely that this is strictly a male call, as is the case with the Lewis' Woodpecker *churr*-call (Bock, 1970).

The final communication is the drum or roll, which is a burst of very closely spaced taps occurring singly or in groups of two or more. The drum has been interpreted for many other species of woodpeckers as a proclama-

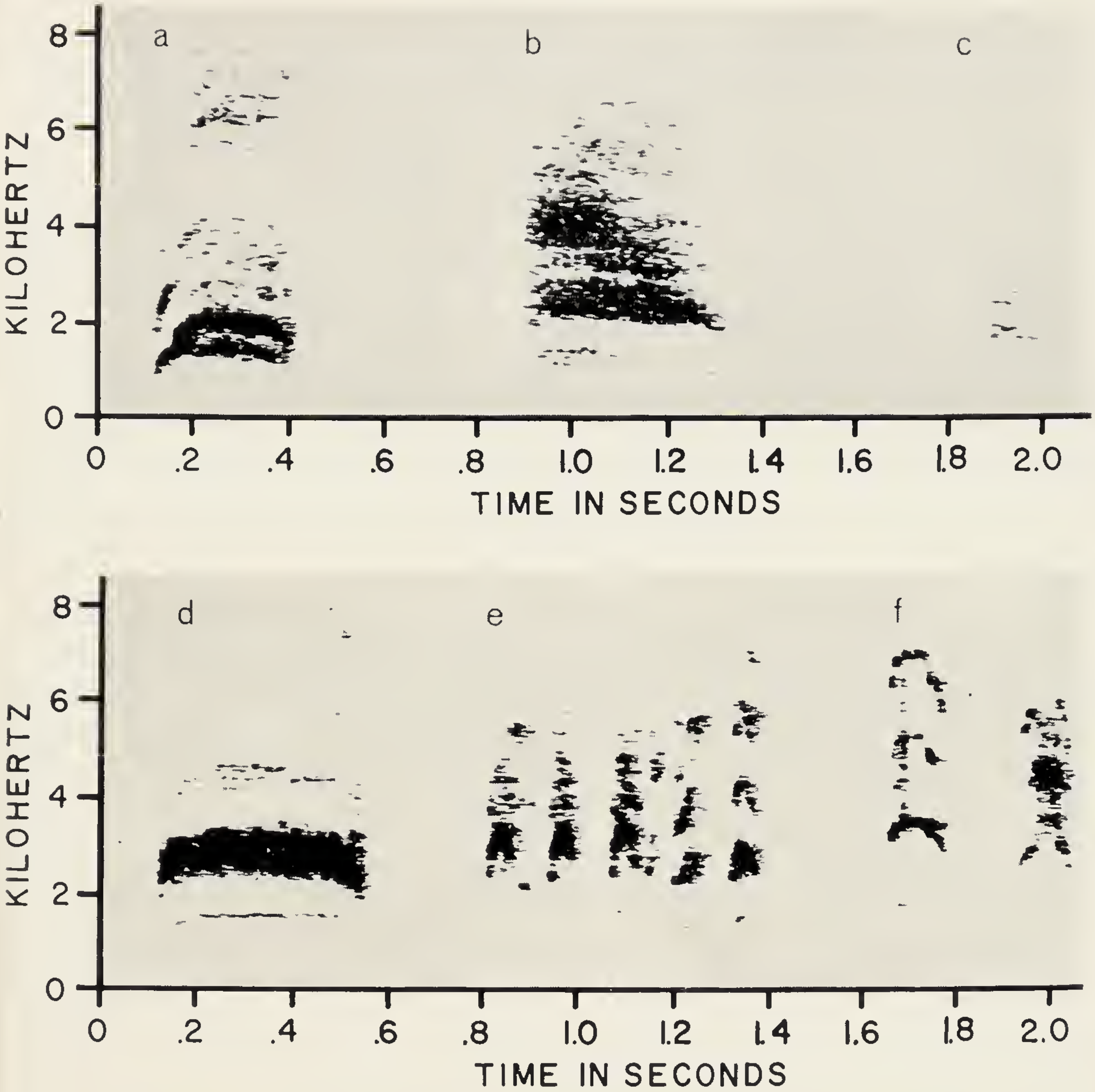

Fig. 4. Sonagrams of Lewis' and Red-headed woodpecker vocalizations recorded during June, 1970, along the Arkansas River, Crowley County, Colorado. a = *Melanerpes churr*-call; b = *Melanerpes* rasp-call; c = *Melanerpes* low-call; d = *Asyndesmus churr*-call; e = *Asyndesmus* chatter-call; f = *Asyndesmus* squeak note. See Table 2 for call descriptions.

tion of territory (e.g., Kilham, 1959, 1961, 1966; Lawrence. 1967; Bock. 1970), and this also appears to be the case for the Red-headed Woodpecker. The similarity of the distribution of drums and *churrs* in Table 3, suggests that they share the functions of territorial advertisement and invitation to copulation.

To summarize: with the exception of the *Asyndesmus* alarm note, Lewis' and Red-headed woodpeckers have functionally equivalent vocal repertoires. There is one call given only by males which advertises the territory and nest site to rivals and mates (*churr*-calls), and there is a second vocalization given by both sexes connoting aggression during intra- and interspecific encounters (chatter, rasp, and low-calls).

DISCUSSION AND CONCLUSIONS

Orians and Willson (1964:737), in a discussion of interspecific territoriality in birds, observed that "the exclusion of other species from territories strongly suggests that securing an adequate quantity of some limited resource has given selective advantage to the behavior." The limited and shared resource could be either food or nest sites, but if the latter, then territorial defense should be focused only on the nest site. Many of the interspecific encounters we observed between Lewis' and Red-headed woodpeckers did occur at their nests. However, the Lewis' Woodpeckers also drove off Red-headed Woodpeckers which persisted in flying into cottonwoods some distances east and especially west of their nest tree (Fig. 3). These trees were the main hawking perches for the Lewis' Woodpeckers. Furthermore the two resident pairs rarely transgressed the territorial boundary shown in Figure 3 once nesting had begun and transient birds had dispersed (Table 1). This behavior is in decided contrast to that directed toward other hole-nesting species in the area. For example, Starlings (*Sturnus vulgaris*) were common yet the woodpeckers reacted aggressively to these birds only when the Starlings actually attempted to enter their nest cavities. Although there were sizeable breeding populations of flickers (*Colaptes auratus*) in our study area, we observed only two interactions between flickers and the other woodpeckers; in both instances a flicker was displaced when it landed in the Lewis' Woodpecker nest tree. We conclude that the interspecific aggression and territoriality between Lewis' and Red-headed woodpeckers is a result of similar feeding ecology as well as nest-site requirements.

Selander and Giller (1959) discovered interspecific territoriality between the ecologically similar Golden-fronted Woodpecker (*Centurus aurifrons*) and Red-bellied Woodpecker (*C. carolinus*). In the same area, however, one pair of Red-bellied Woodpeckers held a territory which completely overlapped the range of a pair of Red-headed Woodpeckers. They suggested that in the second instance differences in habitat utilization and feeding behavior precluded the evolution of interspecific territoriality.

Johnson (1963) has emphasized the importance of possible common ancestry and the retention of similar acoustic and/or display behaviorial releasers between two species showing interspecific territoriality. *Centurus aurifrons* and *C. carolinus* have virtually identical vocalizations (Selander and Giller, 1959) and similar plumages, especially in comparison to the distinctively colored Red-headed Woodpecker. The possibility exists that interspecific territoriality shown by the *Centurus* species was solely or partially the result of shared releasers, while the dissimilar *C. carolinus* and *Melanerpes* did not respond to heterospecific sign stimuli.

Resolution of these alternate ecological (Orians and Willson, 1964) and evolutionary (Johnson, 1963) explanations for the causes of interspecific territoriality seems possible in our study. First, the feeding ecologies of these species are very similar. Second, the territorial *churr*-calls of Lewis' and Red-headed woodpeckers, while generally alike, do show significant structural differences (Fig. 4; Table 2) and are readily distinguishable even to the human ear; furthermore, plumages associated with aggressive displays are totally unlike. Therefore it seems certain that the interspecific aggression shown by these species is a direct result of competition for shared resources and not similarity of territorial defense mechanisms.

SUMMARY

Lewis' and Red-headed woodpeckers for the first time were recorded nesting sympatrically, on the plains of southeastern Colorado. There was habitat overlap, although the Lewis' Woodpeckers nested primarily in farmlands while Red-headed Woodpeckers were more common in riparian woodland along the Arkansas River.

Two pairs which nested within 35 meters of each other in 1969 and again in 1970 were interspecifically aggressive and territorial.

Analysis of breeding vocalizations indicated that, with the exception of the Lewis' Woodpecker alarm note, the two species have functionally equivalent and in some ways structurally similar vocal repertoires; these consist of one call given only by males which advertises territory and nest site to rivals and mates, and a second type of call probably given by both sexes connoting general aggressivity during intra- and interspecific encounters.

It seems certain that the interspecific aggression shown by these species is a direct result of competition for shared resources and not similarity of territorial defense behaviors.

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ANNOUNCEMENT

The Australian Advisory Committee has decided that the XVI International Ornithological Congress will be held at the Australian National University in Canberra in the period 12 August to 17 August 1974.

Applications for membership will be accepted until 1 March 1974, and applications for the presentation of papers should reach the Secretary-General not later than 1 February 1974. It is probable that, apart from the those presented by invitation in a Symposium, there will be some selection of the papers that are actually read, and accordingly it is essential that each offer of a paper should be accompanied by a summary of about 200 words.

Further information can be had by writing: Dr. H. J. Frith, Secretary-General, XVI International Ornithological Congress, P. O. Box 84, Lyneham. A.C.T. Australia 2602.

DISPLAYS AND VOCALIZATIONS OF THE SPARROW HAWK

Helmut C. Mueller

In the past several years I have kept eight Sparrow Hawks (*Falco sparverius*) in captivity for use in experiments in prey selection and the motivation for predatory behavior. Four of the birds were taken from nests at approximately two to three weeks of age and were hand-reared in my laboratory and four were trapped as free-flying birds. All birds were handled frequently and became quite tame. The continuous presence of the birds in my laboratory and various experimental manipulations provided an opportunity to observe closely a variety of displays and vocalizations used by this species in social behavior.

Cade (1955) performed experiments with both taxidermist's mounts and live, captive Sparrow Hawks placed in the winter territories of wild individuals of the species. Willoughby and Cade (1964) maintained breeding pairs of *F. sparverius* in captivity and carefully observed courtship and other behaviors. I report here only my observations which are new, differ from. or extend the observations of Cade and Willoughby. Displays directed to the experimenter and to my captive Broad-winged Hawks (*Buteo platypterus*) are included along with the displays performed with conspecifics.

The birds were maintained on block perches to which they were attached by leashes approximately 35 cm long. Displays between birds occasionally occurred when two perches were placed on a bench in sufficient proximity for the birds to approach each other. Some pairings of adversaries produced frequent and prolonged interactions, others none. Displays directed to the experimenter occurred when he or she, or more particularly, when the hand approached the bird on its perch. Displays in response to the captive Broad-winged Hawks occurred when the Buteo was carried to the near vicinity of the Sparrow Hawk.

DISPLAYS

Curtsey.—The body is held nearly horizontal with the legs flexed and the head and tail touching, or nearly touching, the substrate. The feathers of the back are raised, giving it an arched appearance; the rest of the plumage is neither raised nor flattened. The wings are lowered slightly and the tail spread very slightly. The bird relaxes slowly, raising head and tail, and to a much lesser extent the body, but remains in an essentially horizontal orientation, and then quickly resumes the curtsey. In lateral display, the body.

and to a greater extent the head and tail, are twisted so as to present the dorsal surface to the adversary. Cade (1955:11) may have observed and incompletely described this display.

A bout of displaying usually begins with one bird flying toward the other, landing, and displaying frontally. In the initiation of the frontal display the tail is held above the horizontal so that the dorsal surface is shown to the adversary; when the bird then switches to a lateral display, the tail is held below the horizontal. If the other hawk joins a frontally displaying bird, the birds then curtsey laterally or, rarely, perform a "confrontation" (see below). Two birds may curtsey laterally more than 30 times each in a single bout, and a bout may last for 6 or 7 minutes. The birds usually remain in place for the entire bout, oriented parallel, head to tail, about 10 cm apart. I have seen the curtsey displayed by both sexes to either sex of Sparrow Hawk, and to me by hand-reared birds. Two of my hand-reared females also curtsey to several, but not all, of my assistants. The other two hand-reared birds usually curtsey only to me and other Sparrow Hawks.

Bow.—A frontal display somewhat similar to the curtsey. The bird suddenly assumes a near horizontal position with all feathers of the body raised, particularly those of the crown, nape, and back. The wrist is abducted slightly but the remiges are not spread. The tail is usually, but not invariably, spread. The head, and to a lesser extent the body, is periodically slowly raised and then quickly lowered to the horizontal position. The *klee* call is sometimes uttered during this display. I have seen the bow only in response to humans or my captive Broad-winged Hawks and not in response to other Sparrow Hawks. The bow, rather than the curtsey, is the display I elicit from my birds that were trapped as free-flying individuals. Individual, hand-reared birds respond to some of my laboratory personnel with a curtsey, to others with a bow. These differences in response to individuals have remained quite constant for periods up to several months. If the keeper's hand persists in its approach to the bird during a bow, an attack on his hand may follow. We have noted little inhibition in the use of either talons or beak in such an attack.

Confrontation.—Two birds assume a nearly vertical stance facing each other about 10 to 15 cm apart with heads raised and necks extended. The feathers of the crown are raised slightly and those of the nape are erected considerably. The rest of the plumage is compressed. The tail may be spread, more often in subordinate birds, but occasionally in both birds. This posture may be held for a minute or slightly more and the birds may then return to their perches, begin to curtsey, or (rarely) commence fighting. I can occasionally elicit a confrontation from one of my hand-reared birds by approaching it very closely with my hand. If I then touch it, particularly if contact is made with the feet, beak, or near the beak, the bird, occasionally but rarely, will fight with my hand.

Fighting.—The birds grapple each other by the feet and legs and fence with their beaks. The dominant bird may force the subordinate on its back where it will lie with wings and tail spread. The subordinate bird often utters the *klee* vocalization after an encounter. Cade (1955:12) described this behavior. and it is worth re-emphasizing that the birds are not hurt by such encounters. On the few occasions when my hand has been attacked, I was amazed that the sharp talons caused me essentially no discomfort. The beak fencing was a little uncomfortable, but in no case did the bird break my skin.

Tail Spreading.—The spreading of the rectrices is elicited in a variety of situations, all of which suggest that this is a fear response. It is difficult for the investigator to approach a recently trapped bird without eliciting tail spreading. The behavior is rarely seen in hand-reared birds and then only in response to an unusual stimulus, such as a large dog entering the laboratory. At high intensities the wings may also be partially spread as though in an intention movement for flight, and the entire plumage erected.

Tail Pumping.—A repeated raising and lowering of the tail, shown in a variety of situations suggesting conflict or indecision. I see it most frequently when a bird is about to attack a mouse in a new experimental situation. The bird pumps only for a brief interval before beginning the attack, or it pumps, leans forward as though it is about to attack, and then relaxes. The entire plumage is compressed during pumping, giving the bird a sleek appearance. This behavior is relatively unusual in familiar situations in the laboratory.

Mantling.—A pronounced spreading of the wings and tail, a lowering of the body, and an orientation with the back to the antagonist. Mantling is shown when the bird is hungry and has food in its talons, and it serves to hide food from the observer. Hand-reared birds mantle readily in response to the presence of the investigator or another Sparrow Hawk. Wild-caught birds rarely mantle and then only when very hungry. The only one of my four wild-caught birds that mantles in response to the investigator was less than one year old when taken into captivity. The other three were more than a year old when taken and only two of these mantle, but only rarely and only in response to the approach of other Sparrow Hawks. Mantling is a behavior commonly observed in nestlings. and presumably functions to hide food from siblings. The persistence of this infantile behavior in hand-reared birds probably is a result of the abnormally long feeding relationship with the keeper.

VOCALIZATIONS

Klee.—I agree completely with Willoughby and Cade (1964) that this call is indicative of generalized excitement and would add only that it probably involves a high level of arousal.

Whine.—This appears to be basically a begging call and is usually associated with food. The frequency of utterance of this call is directly proportional to the hunger of the bird. To my ear the call is indistinguishable from that used by nestlings during feeding. In my laboratory this call has been uttered only in response to the investigator and, with one exception, only by hand-reared birds. The wild-caught male taken when less than one year old would also utter this call when very hungry. My three hand-reared females also occasionally used the whine when not hungry, particularly if I stroke them. Presumably this was some form of courtship behavior similar to that seen by Willoughby and Cade (1964).

Chitter.—As indicated by Willoughby and Cade (1964), this call is associated with friendly approach and bodily contact. The chitter is used by all of my birds in response to my approach and particularly touch by my hand. It is used much more commonly by hand-reared birds and by females than by wild-caught birds or males. One of my hand-reared females usually chitters when I call her or approach within 3 or 4 m; with other individuals contact or near contact is necessary to evoke this vocalization. The chitter varies considerably from a soft call to a louder, harsher, more strident vocalization. The latter appears to be associated with some annoyance or aggression and is often followed by mild to moderately hard biting of the offending hand.

Whine-chitter.—This call is used by hand-reared birds of both sexes when extremely hungry. Again, hand-reared birds and females use it more commonly than other birds.

Klee-chitter.—A rarely observed vocalization and not described by Willoughby and Cade (1964). It is uttered by either sex when very hungry and food is taken away by the investigator.

DISCUSSION

The curtsey, confrontation, and fighting appear to be intraspecific territorial behaviors. The sequence given probably reflects the intensity of motivation involved. I believe all of these behaviors occur in nature, but it will probably take considerable careful observation during the time of the establishment of territories to observe these behaviors in non-experimental situations.

The vertical black and white stripes on the sides of the head are prominently displayed in the bow and confrontation. The spots on the back of the head, and the markings of the back and tail are prominently displayed in the curtsey. I suggest that these prominent markings serve a signal function in the territorial displays. Clay (1953) suggested that the head markings were disruptive and deflective color patterns, serving to distract and confuse potential predators and prey. Although the head markings may serve a secondary function as a disruptive and deflective device, in the absence of direct evidence for this hypothesis I suggest that the primary, and probably the only, function of the markings is in the territorial displays of the species.

My first impression was that the bow was a distinct interspecific display. However, I sent an earlier draft of this manuscript to T. J. Cade and he has informed me that he has seen the bow used in intraspecific encounters, both between captives and between a captive bird and the holder of a territory in which it was tethered. I now feel that the bow is a variant of the curtsey involving higher levels of aggression, fear, or a conflict of motivations. It is my impression that my assistants which elicit the bow are less perceptive and empathetic with the birds than those assistants which elicit the curtsey. If this impression is valid, then the breakdown in "communication" between bird and investigator might change the motivational state of the bird and change the behavior as well. The general erection of the plumage and the spreading of the tail during the bow suggests greater fear than is evident in the curtsey. The differences in the attacks following these behaviors might suggest a higher level of aggression in the bow. The bow thus might be a curtsey produced by very high and conflicting levels of fear and aggression.

I find it most interesting that my birds apparently recognize individual humans in spite of changes in clothing. Assistants with similar appearances do not necessarily elicit similar responses. A wild-trapped bird with considerable experience with conspecifics apparently is not able to develop the ability to communicate with humans anywhere near to the extent that is possible for a younger, hand-reared bird. Alternatively the hand-reared bird may lack the level of fear (of some of my laboratory staff) which is necessary to provide the conflict which results in a bow instead of a curtsey.

ACKNOWLEDGMENTS

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SUMMARY

I have described and interpreted a number of displays and vocalizations of the Sparrow Hawk. Most of the displays appear to function in territorial behavior and apparently have not been observed in the wild. The color patterns of the head and tail appear to

have a signal function in territorial behavior. Individual birds react differently to various humans, suggesting individual recognition.

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DEPARTMENT OF ZOOLOGY, UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL, 27514. 14 DECEMBER 1970.

BREEDING BIOLOGY OF PURPLE MARTINS AT THE NORTHERN LIMIT OF THEIR RANGE

J. Campbell Finlay

Purple Martins (*Progne subis*), North America's largest swallows, nest from southern Canada to northern Mexico and winter in South America (Peterson, 1961). In primeval times their distribution within this range, during the breeding season, was presumably dependent upon the presence of available abandoned cavities in forest trees which served as nest sites. Today, however, they nest almost exclusively in artificial nest boxes.

Early Alberta naturalists reported martins nesting in small colonies in burned-over forests of central Alberta (K. Wood, pers. comm.). My observations taken from central Alberta northward to the Arctic coast indicate that Edmonton, which has about 2,000 nesting pairs, is near the northern limit of the breeding range. Scattered pairs are found north of this city for about 150 miles. The available nest boxes and abandoned cavities, created mainly by woodpeckers. which occur along the Mackenzie River to the Arctic are not used by Purple Martins.

The breeding biology data reported here were gathered during a study of the influence of weather upon Purple Martin activity, the results of which will be published elsewhere. The objective of this study was to determine the characteristics of the breeding biology of this species at the northern limits of its breeding range.

Changes in climate occur with changes in latitude which are reflected in the biology of species with wide latitudinal ranges. Lack (1947) has stated that productivity as a function of clutch size increased from the tropics towards the poles for individual species nesting over a wide latitude. Since Allen and Nice (1952) have documented the breeding biology of Purple Martins in Michigan, it was appropriate to compare their findings with the situation at Edmonton.

MATERIALS AND METHODS

The breeding cycle was subdivided into seven arbitrarily selected stages to facilitate comparison of weather factors with activity. This subdivision was made on the basis of observations at the nest boxes together with entrance-departure activity recorded by an Esterline Angus recorder. These stages included: arrival, nest-cavity defense and pair-bond formation; nest building; nest completion; laying; incubation; nestling; and post-breeding defense of nest cavity. The activity data were obtained using photoelectric sensing devices and light sources attached to nest boxes and connected to the event recorder. When a bird passed through the light beam on entering or leaving the nest, the impulse was recorded. The method of recording and the use of these activity data are described in a paper to be published shortly.

Breeding biology data for each of the seven stages were recorded at all nests under study. Locations were in or near Edmonton, Alberta. In 1965, breeding data were collected from eight electronically equipped nests, hereafter called experimental nests, and thirteen nests not so hooked up and hereafter called control nests. The experimental nests were on one site, the others were located from 30 feet to 7.5 miles away from this location. In 1966, data were gathered from 18 electronically equipped nests and 14 unequipped nests at the same site and four others 22 miles southwest. The 1965 experimental nests were examined almost daily until all young fledged. Of the control nests, three were examined every third day, and three once a week. At five of the control nests, each young upon hatching was individually marked by painting its claws with nail polish. Later each nestling was banded with a U.S. Fish and Wildlife aluminum band. The wing chords of each marked nestling were measured daily from hatching until fledging. In 1966, all nests were checked at least every other day until just before the nestlings began to hatch, then daily until hatching was completed. Subsequent observations were made every second to fourth day until fledging.

Male Purple Martins may be separated into two age categories; those in adult plumage which are black in color, and those in first nuptial plumage which are similar to females and brown in color (Bent, 1942). Males in adult plumage will henceforth be called "adults" and males in first nuptial plumage will be called "yearlings." Both are sexually mature.

RESULTS AND DISCUSSION

Arrival, Nest-cavity Defense and Pair-bond Formation.—The first stage in the breeding cycle of Purple Martins was arbitrarily taken from the time of first defense of the nest cavity until nest building began. This stage is equivalent to the first three stages described by Allen and Nice (1952). I was unable to use their subdivision because of insufficient observational data and no significant variation of the mechanical recorded data during their three stages.

Martins begin arriving at Edmonton in mid-April. The mean first arrival date over a 17-year period (1948–1965) was 23 April (M. Fisher, pers. comm.). By 20 May most adult birds have returned. Yearling males begin arriving in late May and are generally quite abundant by early June. The first yearling males were noted 26 May 1965 and 25 May 1966 at the experimental sites.

The level of entrance-departure activity is quite high at a martin colony during the first stage. Males are continually entering and leaving the nest cavity, while defending it against other males and attempting to attract females (Gaunt, 1959; Johnston and Hardy, 1962). Entrance-departure activity was generally greater in the morning than in the afternoon, given optimum weather conditions.

Based on the data for 21 pairs, the first stage in the breeding cycle lasted 6.5 ± 7.1 days, with a range of less than one day to 30 days. In 1966, birds that arrived before 25 May took a mean time of 5.4 days, whereas later arrivals spent a mean time of 2.0 days in this stage. The pair that spent 30 days in this stage were the first to arrive at the colony in 1965. After the first day, 28 April, they remained associated with one cavity and were apparently mated. They did not begin building a nest until six of the eight pairs in the colony had arrived and three other pairs had begun nest building. This pair began laying about the same time as did the others.

It appeared that, after martins arrived, some time was spent defending the nest cavity prior to building a nest. This period was shortened after about 25 May. Late arriving pairs acquired a cavity and very shortly began nest building.

Nest Building.—The nest building stage commences with the appearance of material in the cavity and terminates when the nest cup is lined with green leaves. This period is equivalent to the first part of "Stage 4" of Allen and Nice (1952).

Nest building took a mean of 11.8 days (sample size 30) in 1965 and 1966, with a minimum of five and a maximum of 27 days. These periods compare favorably to those reported by Allen and Nice (op. cit.). Birds that were late in acquiring a cavity built their nests in the shortest time. Almost all late nesters were yearlings. A mean of 7.6 days was shown for yearling birds, whereas adults took a mean of 13.6 days to build the nest. The long period of 27 days was by a relatively early nesting pair.

The influence of the electronic equipment, including the photoelectric sensing devices, on the time involved in the nesting stage, was investigated by comparing the control and experimental nests. No significant difference was found.

Observations indicated that most nest building took place in the morning. The birds were generally not around the colony in the afternoon. Activity at the nest entrance during the nest-building stage was characterized by periods of nest construction lasting a few minutes and then periods with no activity when birds were away from the colony. Entrance-departure activity recorded during the nest-building stage was only exceeded by activity in the previous stage.

Nest Completion.—The nest completion stage covers the time interval between the day the nest cup is lined with leaves and the day laying begins. This period corresponds to the latter part of Allen and Nice's (1952) "Stage 4."

Nest completion lasted a mean of 3.2 days with a range of 0 to 9 days (sample size 27). This time interval compares favorably with the three days reported by Purchon (1948) for Barn Swallows (*Hirundo rustica*) in Europe and from 3.5 to 5.5 days for Rough-winged Swallows (*Stelgidopteryx ruficollis*) noted by Lunk (1962). The shorter periods of time generally involved late

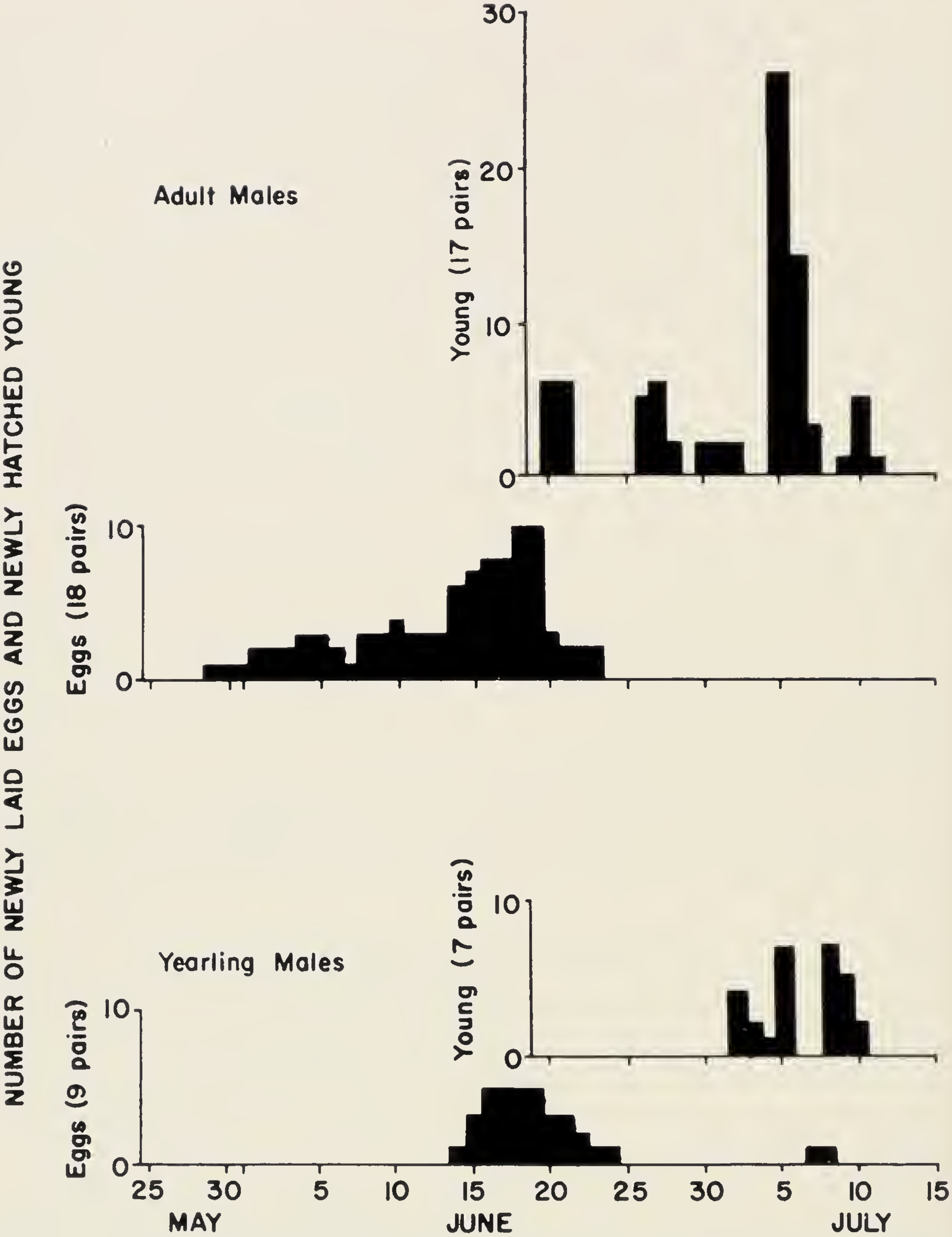

Fig. 1. A comparison of the laying and hatching dates between female Purple Martins mated to males in adult plumage and those in yearling plumage in the same colony, Edmonton area, Alberta.

nesting birds. The period of nine days was shown by a pair which took early possession of a nest cavity and began nest building within a week. Presumably the nest was finished before the female was physiologically ready to lay. There was no significant difference between experimental and control nests for the time spent in the nest completion stage. Total entrance-departure activity during the nest completion stage was slightly less than during the previous stages. At this time, males continued to defend the nest. but observations indicated there was little competition for nest sites.

A foreshortening of the nest building and nest completion stages occurred as the season progressed. Five pairs that terminated these stages after 19 June took a mean of 7.6 days for these two stages. Birds that finished this stage the week before, took 14.9 days (sample size 16). The mean for both seasons in the stages was 15.0 days. This may be an adaptation to assure that young hatch, fledge, and become strong on the wing when aerial insects are most abundant in Edmonton in late June and July.

Laying.—Purple martins generally lay in the early morning on successive days (Allen and Nice, 1952). Female martins mated to adult males began laying up to two weeks before those mated to yearling males (Fig. 1). This reduction in time explains the close agreement of peak laying for both age groups as shown in Figure 1. The skewed distribution for adults may be explained by some birds arriving early and beginning to nest immediately. The curves for hatching differ from those for laying because all eggs in a clutch hatch nearly synchronously.

Martins, in the Edmonton area, laid 4.8 ± 0.6 eggs (sample size 54) with a range of three to eight. This number of eggs approaches closely that reported by Widmann (1922) of 4.9 and Allen and Nice (1952) of 4.9 ± 0.7. It appears that Purple Martins, nesting near the northern limits of their range, have not changed their clutch size. MacArthur (1961:196) claims that "if, due to severe climate and the hazards of longer migration, mortality is always greater at high latitude, then so must clutch size be higher. or the species won't live there." Either the Purple Martin is a relative "newcomer" to these northern latitudes and has not yet adapted its clutch size, or MacArthur's assumption is not valid for these birds.

The mean number of eggs was nearly the same for both years. Larger clutches of seven and eight eggs were laid in 1966. The pair laying seven eggs was first to arrive, nest and begin laying in 1966. Eight eggs were laid by the third pair to begin laying the same season. There was no evidence to suggest that these larger clutches were laid by other than single birds. The pair with seven eggs fledged seven young, and seven of the eight young fledged from the other nest. It appears from this very small sample that should a female Purple Martin lay a greater than average number of eggs. the parents can raise at least seven young, given conditions similar to those experienced in 1966.

Female martins mated to yearling males, produced a mean of 4.29 ± 0.67 (sample size 14) eggs as compared to females mated to adults which layed

TABLE 1

CLUTCH SIZE IN PURPLE MARTINS, IN RELATION TO THE ONSET OF LAYING IN THE EDMONTON AREA, ALBERTA.

Year	First egg laid in week ending	Number of clutches	Cumulative sum % of total	Clutch size Mean ± SD
1965	4 June	2	8.3	6.00 ± 0
	11 June	5	29.1	5.20 ± 0.40
	18 June	9	66.6	4.78 ± 0.42
	25 June	5*	87.4	4.20 ± 0.75
	2 July	0		
	9 July	1*	91.6	4.00
	16 July	2*	100.0	3.50 ± 0.50
	All pairs	24*		4.71 ±0.79
1966	4 June	4	13.3	6.25 ± 0.42
	11 June	3	23.3	5.33 ± 0.15
	18 June	19	86.7	4.63 ± 1.00
	25 June	3	96.7	4.33 ± 0.15
	2 July	1	100.0	5.00
	All pairs	30		4.90 ± 0.99

* Includes replacement clutches.

5.00 ± 0.63 (sample size 40). These results compare with those reported by Meyer (1957) for Cliff Swallows (*Petrochelidon pyrrhonota*); Kuroda (1964) for Starlings (*Sturnus*) and Perrins (1965) for Great Tits (*Parus major*); and Lee (1967) for Purple Martins. Presumably the reduction in clutch size by female martins mated to yearlings, which generally begin nesting later than those mated to adults, would shorten the total time for the breeding cycle and hence nestlings would hatch out one or two days earlier than if the clutch had been of larger size. There was no evidence that the females mated to yearling males were also not yearling birds.

A comparison between the date of onset of laying and clutch size is shown in Table 1. It is apparent that clutch size was diminished as the season progressed. In addition, the daily number of newly-laid eggs and newly-hatched young are presented for the years 1965 and 1966 in Figure 2. It is apparent that the majority of Purple Martins at Edmonton laid eggs during the second and third week of June in both years. By 25 June 87 per cent had begun laying in 1965, and 97 per cent in 1966. Consequently, the majority of young were hatched by early July (Fig. 2) near the peak of insect abundance. Lack and Lack (1951) found a similar correlation between the breeding season of European Swifts (*Apus apus*) and food availability. The two females that re-nested, each laid four eggs. One had earlier

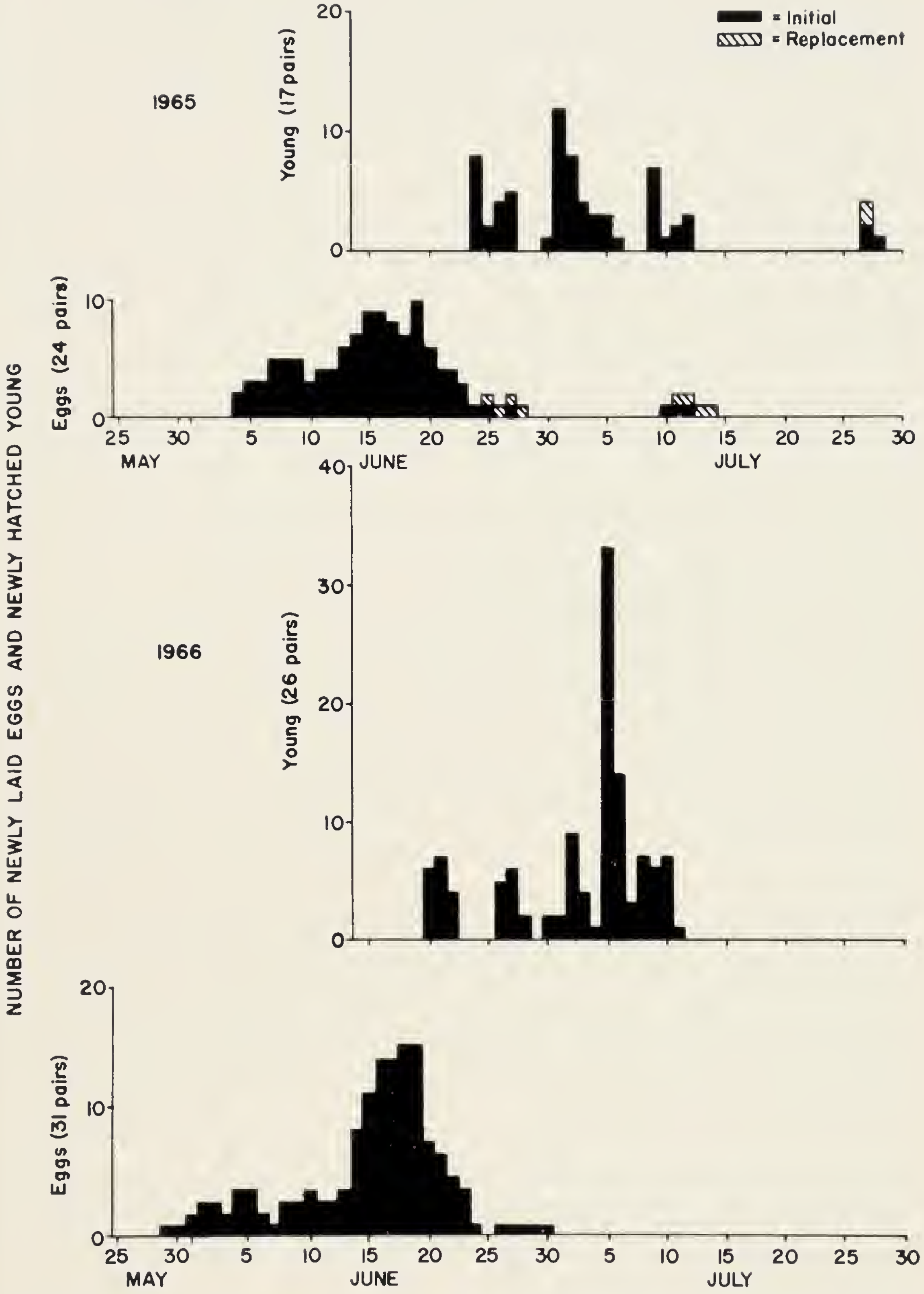

FIG. 2. Laying and hatching frequencies for Purple Martins in the Edmonton area, Alberta.

laid six eggs, the other five. Allen and Nice (1952) reported that martins, which re-nested always laid four eggs in the second clutch.

The possible influence of the continuous light source at the nest entrance on the timing of laying in Purple Martins was investigated. No significant difference in the timing between control and experimental nests was found in either year.

Entrance-departure activity during the laying stage remained relatively constant throughout the day. I suggest that this was because martins stayed closer to the nest, ready to defend the recently deposited eggs from possible predation. This greater tendency to defend the nest, once they began to deposit eggs, was noted while checking the nests each day.

Incubation.—The period of incubation is the time from the laying of the last egg in a clutch until it hatches (Thomson, 1964). To determine this time, I selected, in 1965, 11 nests and numbered each egg on the day it was laid. In one nest, the last egg hatched at the same time as the others; in two nests it hatched with the last part of the clutch; and in eight nests it was the last egg to hatch. These results are similar to that found by Lunk (1962) for Rough-winged Swallows.

The mean incubation time for the marked eggs was 16.6 days, with a range of 16–18, the same mean as that for all nests in both seasons, which ranged from 15–18 days. This time is slightly in excess of that of 15 to 16 days reported by Allen and Nice (1952). I presume the greater length of time is due to the cooler climate of the more northern latitude at Edmonton. Edmonton has a mean temperature in June of 57.8° F, whereas, at Ann Arbor, Michigan, it is 67.9° F. When a female departs to feed while incubating, she allows the eggs to cool and embryo development is retarded.

There was no correlation between either clutch size or age of males and length of incubation time. The mean incubation time for clutches in control and experimental nests was not significantly different. There was little variance in the entrance-departure activity levels throughout this period. It appeared that female birds have certain sessions and recesses, while incubating, and unless there is extremely inclement weather, activity remains relatively constant.

Nestling.—The nestling stage extends from hatching of the last egg to fledging of the last young. Purple Martins remained in the nest approximately four weeks. The mean departure time for 15 broods studied was 27.4 days (sample size 15) ranging from 26 to 31 days. In one nest not included in this analysis, a nestling remained 37 days in the cavity. The four siblings from this nest had left an unknown number of days earlier. This individual was examined and showed no observable defects. The parents continued to feed it until it departed. Reports in the literature indicate that martins re-

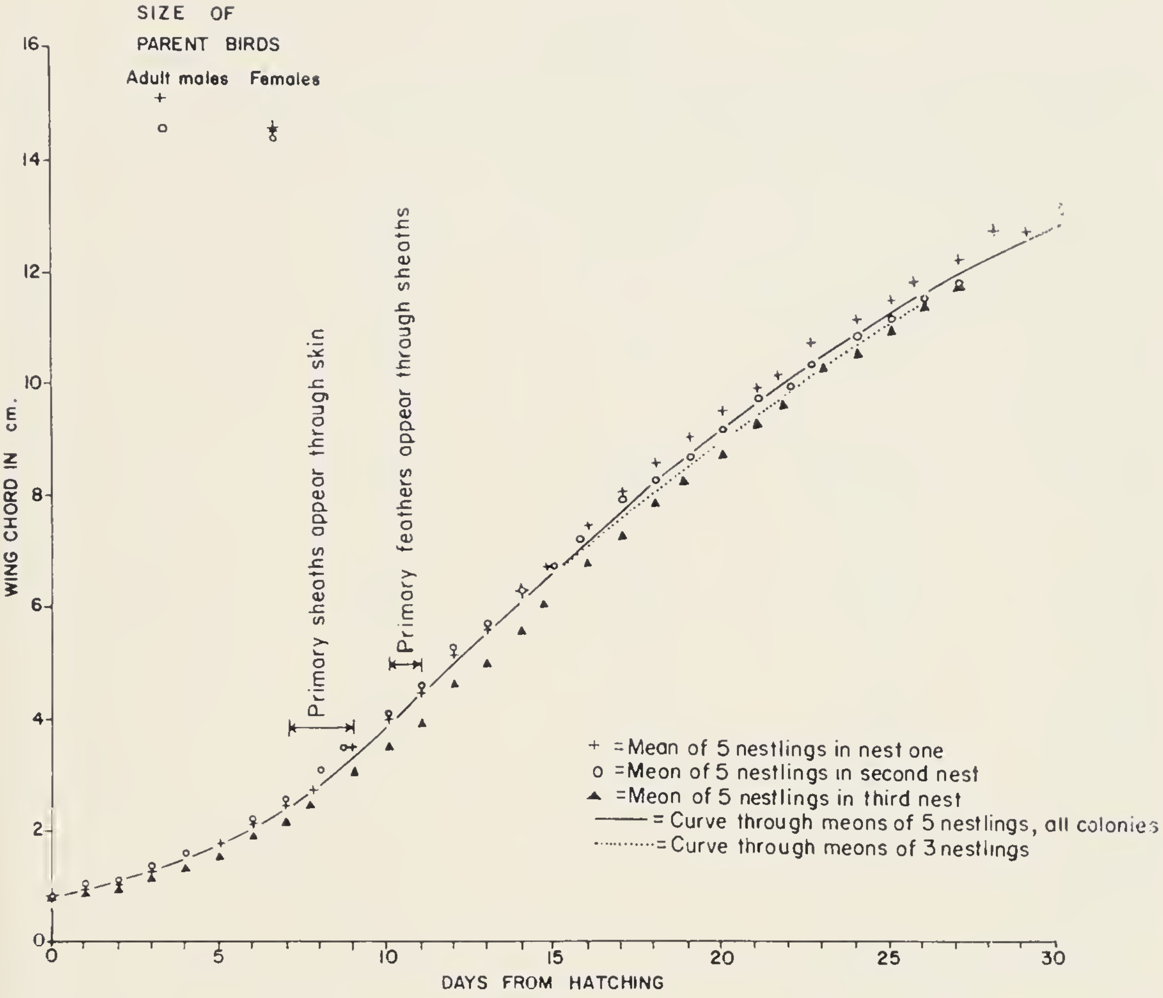

Fig. 3. A growth curve of wing lengths in Purple Martin nestlings based on three nests each containing five nestlings in 1965 at Edmonton, Alberta. Curve was drawn by inspection.

mained in the nest elsewhere slightly longer than at Edmonton. Forbush (1929) stated that martins sometimes remained in the nest for six weeks. Allen and Nice (1952) found martins fledged at between 27 and 35 days, usually about 28. The earlier fledging at Edmonton may be due to more hours of sunlight at this northern latitude which would provide more feeding time and presumably faster growth.

Between day 17 and 21 of the nestling stage, the young came to the nest entrance to beg and accept food. A mean of 19.6 days (sample size 26) was calculated for this time with a range of 14 to 24 days. There was no difference between control and experimental nests. The data were consequently combined.

To follow growth of the young, wing chord measurements were made of nestlings in two nests with three young, and three nests with five (Fig. 3). The curves were prepared using the known age of each young in the nest.

TABLE 2

MEASUREMENT OF ADULT PURPLE MARTINS FROM THE EDMONTON AREA TAKEN IN 1964 COMPARED TO BIRDS IN THE EASTERN UNITED STATES.

Measurements made according to Pettingill (1961) and are presented in millimeters.

	Edmonton			
	Male (Adult and Yearling)	Female	Both sexes	Eastern U.S.A.* Both sexes
Sample Size	15	19	34	–
Wing Chord				
Mean	152.5	150.0	151.1	–
Range	145–161	143–157	143–161	129–157
Tail				
Mean	76.5	71.2	73.7	–
Range	71–91	66–78	66–91	70–88
Tarsus				
Mean	15.9	15.5	15.7	–
Range	14–18	13–18	13–18	11–16
Bill				
Mean	11.4	11.4	11.4	–
Range	10–12	10–13	10–13	11–13

* Data from Forbush (1929).

Nestlings had been individually marked on hatching. From about the 5th day onward, one or more nestlings had longer wings than the others. These larger nestlings were assumed to be males as adult and yearling males were found to be the same size, and were larger than females as shown in Table 2 and Bent (1942). Willson (1966) showed that the sex of nestling Yellow-headed Blackbirds (*Xanthocephalus xanthocephalus*) could be determined on the basis of weight, at six days of age. A comparison of the growth for the nests with three nestlings with those of five nestlings indicates no difference until day 17. Subsequently, the curve for five nestlings showed larger nestlings present. This could be explained by more males per brood in the nests with five young. It was observed that the appearance of the primary feather sheaths and later the primary feathers had no influence on the growth curves as shown in Figure 3. Various measurements of parent birds, were taken, according to Pettingill (1961), while banding Purple Martins in the same area in 1964. Results are presented in Table 2. There was no difference between adult and yearling males. Females had slightly shorter wing chords, tail lengths and tarsus lengths. The length of the bill was the same in both

TABLE 3

A COMPARISON OF PURPLE MARTIN PRODUCTIVITY AT EDMONTON, ALBERTA WITH THAT REPORTED AT THREE COLONIES IN THE UNITED STATES AS REPORTED BY ALLEN AND NICE (1952).

	Michigan	Missouri	Pennsylvania*	Alberta
Years of study	3	1	7	2
No. of nests	29	45	294	55
No. of eggs laid				
Total	143	220	1380?	262
Mean per nest	4.9	4.9	4.7?	4.8
Eggs hatched	119	129	1100?	198
Per cent	83.2	58.2	80.0?	76
Nestlings fledged				
Number	55	110	850?	185
Per cent	31.5	50.0	61.6?	70.7
Fledge per pair	1.9	2.4	2.9?	3.4

* The Pennsylvania figures are estimates.

sexes. A size comparison of the Edmonton birds to those in eastern North America indicated the northwestern ones are larger (Table 2).

The number of young martins fledged at Edmonton was greater than found in other studies, even though the clutch size was the same (Table 3). Martins studied at more southern latitudes were influenced by rain and cold weather which reduced their numbers. One period of bad weather at Edmonton occurred when most birds were incubating. Of the four nests with young at the time, all lost at least one chick and one lost three of five. I presume that if weather conditions during this study had been as detrimental as described in the reports from more southern areas, then martin productivity would have been substantially reduced.

Entrance-departure activity, together with observations, indicated that nestling feeding began in the early morning, continued at a steady rate all day, and fell off at or near sunset. There did not appear to be any major peaks or troughs in levels of activity. Once the adults begin feeding nestlings they apparently continue at about the same rate, whereas Lunk (1962) in a study of Rough-winged Swallows, reported a very marked spurt in feeding nestlings before dark. Allen and Nice (1952:635) had stated, "It seems evident that both age and number of young influence the rate of feeding although we are hampered by lack of exact information on both these points."

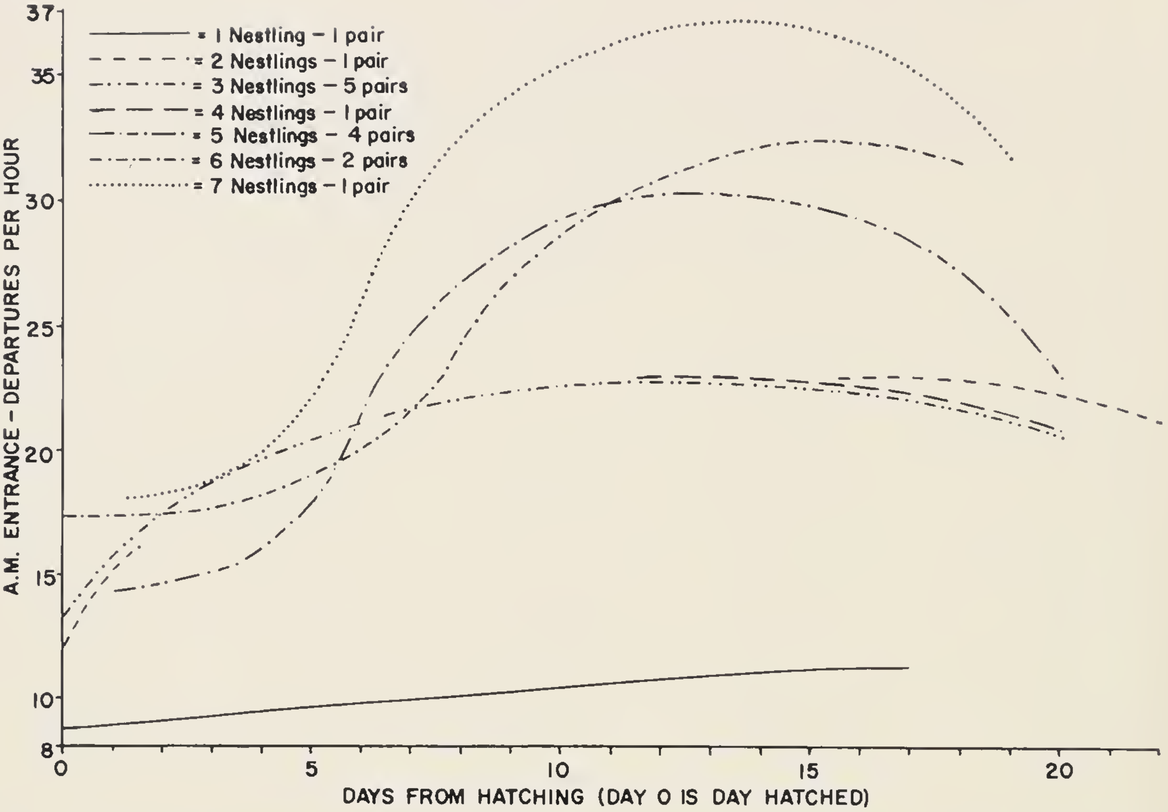

Fig. 4. Mean morning activity on a per hour basis for each day during the nestling stage for nests containing one to seven young. Curves were drawn by inspection and were prepared, ignoring data recorded on days with very cold, windy, rainy weather.

This speculation was investigated. It appears from Figure 4 that entrance-departure activity, presumably the rate of feeding, increased both with the age of young and the number per nest. The activity curve, for all broods with more than one nestling rose to a plateau at about day 10 and remained at this level until day 14, when activity began to decrease. An increase in number of trips per hour as the nestlings aged was similarly reported for other swallow species (Moreau, 1939, 1940; Purchon, 1948; Lunk, 1962).

The decrease in number of feeding trips per hour after day 14, coincided with observations of adults bringing to the young much larger insects, including Odonata and Lepidoptera of unknown species. Observations indicate that the number of trips with larger insects increased as the young become older. I postulate that parental feeding trips, hence, could be reduced and yet still provide the same amount of potential energy per nestling.

Various workers have reported that the number of feeding trips was greater in larger broods but not proportional to the brood size (Nice, 1943; Moreau. 1947; Lack, 1948, 1954; Gibb, 1955; Royama, 1966; Willson, 1966). My results agree with these findings (Fig. 4). Each young in larger broods presumably would not have received as much food as in smaller ones. Possibly the decrease in quantity of food brought per nestling in the larger broods may be compensated by heat conservation. Gibb (1955) suggested such a compensatory relationship in his study of Great Tits (*Parus major*). He mentioned that reduction of heat loss will reduce to some extent the demand for heat production and energy intake.

In both seasons, six young fledged from some nests. In 1966, two pairs each fledged seven young. Since a pair of martins can successfully fledge a larger number of chicks, I assume that those pairs feeding one, two, and three nestlings are not feeding at maximum rates. I suggest that martins would adapt to produce an ideal number of young, which can be fed at near maximum efficiency. If too many young are in the clutch, then according to Perrins (1965) the nestlings fledge underweight and die; if too few, maximum feeding rates are not approached and a loss of productivity occurs. I presume that the productivity of three to four per nest found in this study is the optimum number at this northern latitude. Two birds, each from a different 1966 nest of seven young, all of which were banded, returned, one in 1968 to the birth site and the other 23 miles southwest of the birth site in 1969, indicating that some of the nestlings from such large families will survive two and three years.

Yearling males were breeding for the first time. Data from three pairs of yearling birds obtained during three three-hour observation periods a week apart with young about one, two and then three weeks of age, indicated that the yearling males fed nestlings 45 per cent as often as did females at the same nest, whereas data from seven pairs with adult males, obtained at the same time and with young about the same age, indicated trips by adult males to the nest equalled those of the females at the same nest. Kendeigh (1952) reported similar results for one pair of adult martins.

Post-Breeding, Nest-Cavity Defense.—The post-breeding nest-cavity defense stage lasts from the time nestlings begin to fledge until birds depart on fall migration.

While studying martins in 1964 and later during this project, I noted these birds were quite active around the nest boxes shortly after young fledged. Allen and Nice (1952) in their detailed study do not mention such activity. Olmstead (1955:8) briefly discussed this stage: "After the young are fledged, adult males engage in short decisive flights and sing short bursts of song from the ledge of the box. A few mated pairs linger near the nest, but females and young are in the minority." Johnston and Hardy (1962) note groups of three or more individual martins participate as social units in investigating neighboring colonies in the spring and after breeding was complete. Based on data for 14 males, the final stage in the breeding cycle lasted 5.9 ± 4.6 days with a range of one to 19 days. Nearly all birds participating in this stage were yearling males. A detailed discussion of this stage will be published elsewhere.

SUMMARY

A study of Purple Martins was undertaken to determine the characteristics of this bird's breeding biology near the northern limits of its breeding range. Research was conducted during the summers of 1965 and 1966 in the vicinity of Edmonton, Alberta.

The breeding cycle was divided into seven stages. These stages and the mean duration of each were: arrival, nest-cavity defense and pair-bond formation—6.5 days; nest building—11.8 days; nest completion—3.2 days; laying—4.8 days; incubation—16.6 days; nestling—27.4 days; post-breeding defense of nest cavity—5.9 days. Clutches laid later in the season were smaller. The number of young fledged varied from one to seven with a mean of 3.4 for 55 nests. These breeding statistics are not significantly different from those reported by Allen and Nice (1952), except that incubation was longer, and fledging success greater at the latitude of Edmonton. During the nestling stage, activity at the nest entrance, presumably reflecting the rate of feeding of nestlings, increased to day 10, was maintained through day 13, and decreased after day 14. As brood size increased, the nest entrance and departure activity decreased per nestling. Males in adult plumage were observed to feed young at a rate similar to females, whereas males in first nuptial plumage fed young at half this rate. Males in first nuptial plumage were the main participants in the post-breeding defense of the nest-cavity.

ACKNOWLEDGMENTS

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THE OSTEOLOGY AND TAXONOMIC POSITION OF THE WHITE-BACKED DUCK, *THALASSORNIS LEUCONOTUS*

Robert J. Raikow

The White-backed Duck (*Thalassornis leuconotus*) of Africa and Madagascar is one of the least-studied members of the family Anatidae. There appears to be little detailed information as to its general behavior in nature, except that it is an inhabitant of quiet ponds, feeding both on the surface and by diving (Delacour, 1959). The food includes both plant and animal materials (Clancey, 1964). Until recently little was known about its structure and habits, but current studies suggest that its original classification was in error. Eyton (1838, not seen) allied it with the stifftail ducks, which are currently listed as the tribe Oxyurini of the subfamily Anatinae (Johnsgard, 1968). Verheyen (1955) classified the Anatidae on the basis of comparative osteology, but was unable to determine the relationships of *Thalassornis*, which he listed as Incertae Sedis, though possibly related to the stifftail genus *Oxyura*. Delacour and Mayr (1945) presented a thorough revision of the Anatidae in which they retained *Thalassornis* in the Oxyurini, but noted the resemblance of its call to that of *Dendrocygna*. Most recently Johnsgard (1967) argued that *Thalassornis* is not related to the Oxyurini at all, but instead bears a close affinity to the whistling ducks (*Dendrocygna*) of the subfamily Anserinae, and subsequently (1968) placed both genera in the tribe Dendrocygnini. This opinion is based upon several features, including the absence of stiffened rectrices and inflatable throat pouches, the reticulate tarsal pattern, the structure of the trachea, and numerous behavioral characters, including sexual, aggressive, and maintenance behavior patterns.

In this paper I will evaluate the skeleton of this species both from the standpoint of its taxonomic significance and its locomotor specializations. Together these should add to our understanding of the phylogenetic history of this little known form.

METHODS AND ACKNOWLEDGMENTS

I compared a skeleton of *Thalassornis leuconotus* with representatives of all three subfamilies of Anatidae, including *Anseranas semipalmata* (Anseranatinae); *Cygnus columbianus*, *Anser (Chen) caerulescens*, *Branta canadensis*, *Dendrocygna autumnalis*, *D. bicolor*, and *D. javanica* (Anserinae); and *Anas platyrhynchos*, *Heteronetta atricapilla*, *Oxyura jamaicensis*, and *Biziura lobata* (Anatinae). The last three species represent the tribe Oxyurini, with which *Thalassornis* was originally associated. All specimens except those listed below are from the collection of the Museum of Vertebrate Zoology, University of California, Berkeley. I am grateful to Dr. Richard L. Zusi of the United States

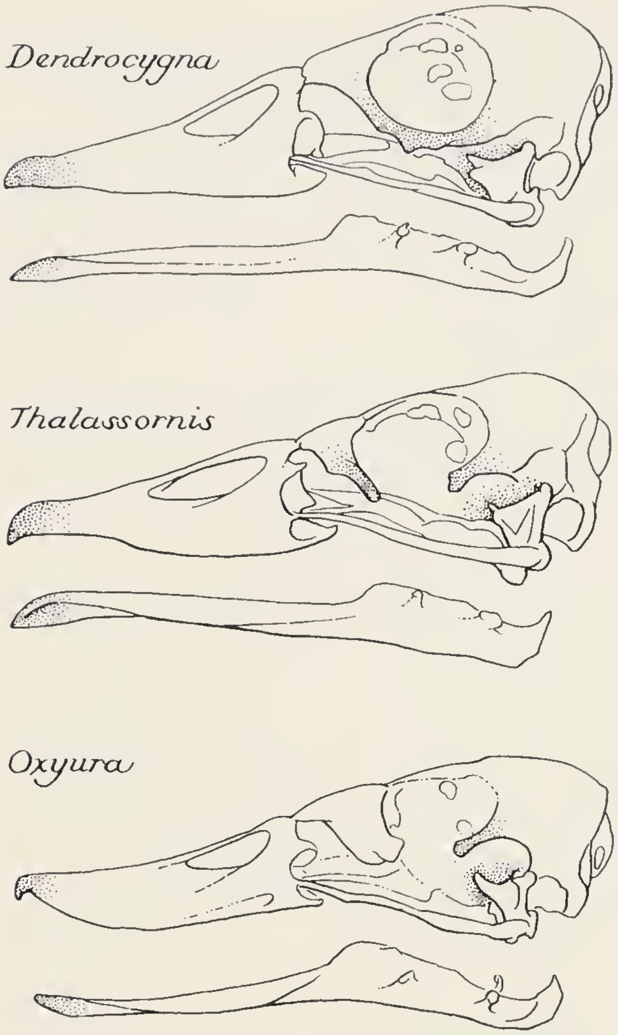

FIG. 1. Lateral views of the skulls of *Dendrocygna autumnalis*, *Thalassornis leuconotus*, and *Oxyura jamaicensis*. *Thalassornis* resembles *Dendrocygna* in the straight dorsal margin of the quadrate, the decurved mandibular symphysis, the straighter retroarticular process, and the more vertically oriented maxillae (not apparent in this view). It differs in lacking a complete suborbital bar. (Not to scale.)

National Museum for the loan of a skeleton of *Thalassornis* (U.S.N.M. 431502), and to Dr. Robert W. Storer of the University of Michigan Museum of Zoology for loaning me specimens of *Heteronetta*. The illustrations were drawn by Gene M. Christman.

THE SKULL

The most characteristic feature of the skull in *Dendrocygna* is that the foot of the lacrimal usually extends posteriorly to fuse with the postorbital process, forming a complete suborbital bar. This has otherwise been reported in the Anatidae only in some specimens of *Cereopsis* (Beddard, 1898:468). This fusion does not occur in *Thalassornis* (Fig. 1).

The quadrate of *Thalassornis* resembles that of *Dendrocygna* because its dorsolateral margin is straight, running from the otic process past the base

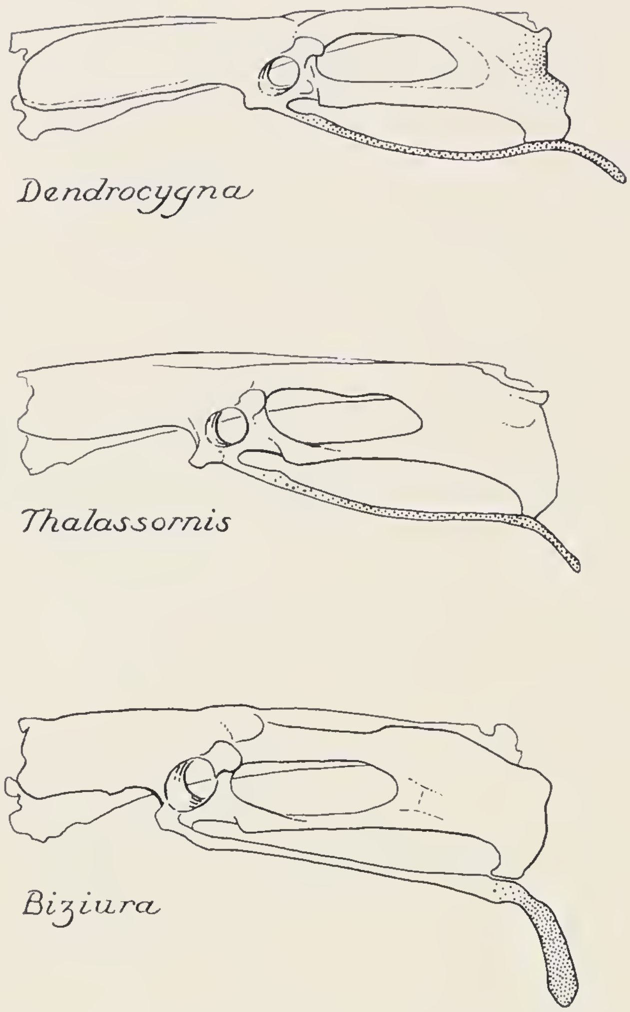

FIG. 2. Lateral views of the pelvic girdles in *Dendrocygna bicolor*, *Thalassornis leuconotus*, and *Biziura lobata*. *Thalassornis* resembles *Dendrocygna* in the form of the pubis, but otherwise is convergent to *Biziura*, especially in its relative proportions, which indicate a greater degree of adaptation for diving than in *Dendrocygna*. Further details are given in the text.

of the orbital process. In all other waterfowl examined this margin is concave, so that the orbital and otic processes are more distinctly set apart from the body of the quadrate.

The upper jaw of *Thalassornis* resembles that of *Dendrocygna* in that the maxillae are more vertically oriented than in the Oxyurini, where they diverge ventrally. Thus in *Dendrocygna* and *Thalassornis* the concave roof of the mouth is deeper than in stifftails.

The lower jaw of *Thalassornis* resembles that of *Dendrocygna* because the posterior edge of the retroarticular process is straight, while in the Oxyurini (except *Biziura*) it is rounded. Furthermore, in *Thalassornis* and *Dendrocygna* the mandibular symphysis is sharply decurved, while in the

Oxyurini it is not decurved at all (*Oxyura, Biziura*) or only slightly so (*Heteronetta*).

POSTCRANIAL SKELETON

The postcranial skeleton of waterfowl was studied by Woolfenden (1961) who included nearly all living genera, but not *Thalassornis*. In examining this genus I have used various criteria presented by Woolfenden by which the subfamilies and tribes of waterfowl may be distinguished. These criteria consist mainly of surface features and relative proportions of a number of bones, and I have chosen those which clearly distinguish the Oxyurini from *Dendrocygna*. Most require no explanation, and are listed in Table 1.

DISCUSSION

Woolfenden (1961:48) states that the coracoidal depression (Table 1, no. 14) will distinguish the coracoid of *Dendrocygna* from that of any other bird. A similar, but very shallow depression occurs also in *Thalassornis*, displacing the intermuscular line posteriorly exactly as in *Dendrocygna*, and indicating a relationship with that genus.

In general the postcranial skeleton of *Thalassornis* bears nearly as many similarities to that of the Oxyurini as to that of *Dendrocygna*. This could be interpreted as suggesting that the White-backed Duck is related to either one of these groups and convergent on the other. However, in view of the similarities of the quadrate and jaws, the findings of Johnsgard (cited above), and the presence of features highly characteristic of *Dendrocygna* (Table 1, nos. 14 and 30) according to the analysis of Woolfenden (1961), it seems most probable that *Thalassornis* is in fact a stifftail-like whistling duck.

This view is supported by the fact that many of the stifftail-like characters listed in Table 1 are part of an adaptive specialization for swimming and diving. Thus in *Thalassornis* the sternum is relatively wide (Table 1, no. 13). This is possibly associated with a widening of the body to make it more stable when swimming on the surface. The sternum is comparatively wide in *Biziura* and *Oxyura*, both excellent divers, but is relatively narrow in *Dendrocygna*. It is also narrow in *Heteronetta*, a less specialized diver. *Dendrocygna* spends much time out of the water, but the stifftails and *Thalassornis* typically rest on the water, being nearly helpless on land.

The pelvic proportions (Table 2), with an elongated postacetabular region and a general lateral compression, are similar to those associated with an abducted hind limb posture in *Oxyura* and *Biziura*. This posture is efficient for swimming, but the splayed, posteriorly placed feet makes walking difficult or impossible. The form of the cnemial crest (Table 1, no. 24) also appears convergent to the condition in these genera, where it is associated

TABLE 1

COMPARISON OF FEATURES OF THE POSTCRANIAL SKELETON OF *DENDROCYGNA*, *THALASSORNIS*, AND THE *OXYURINI*

Feature	*Dendrocygna*	*Thalassornis*	*Oxyurini*
Humerus			
1. Capital shaft ridge.	Prominent.	Prominent.	Less prominent.
2. Elevated area of pectoral attachment.	Circular.	Circular.	Elongate.
3. Pneumatic fossa.	Deep, with numerous foramina.	Shallow, with few or no foramina. Most resembles *Biziura*.	Shallow, with numerous foramina.
4. Scar of *M. latissimus dorsi posterioris*.	Mediad to outer edge of pectoral attachment.	In line with outer edge of pectoral attachment.	In line with outer edge of pectoral attachment.
5. Entepicondyle.	Relatively large.	Relatively large.	Relatively small.
Carpometacarpus			
6. Upper surface of metacarpal II.	Relatively flattened.	Relatively flattened.	Relatively rounded.
7. Extensor attachment.	Limited to tip of process of metacarpal I.	More limited, as in *Dendrocygna*.	Extends onto distal edge of process.
8. Shape of metacarpal II.	Incurved.	Incurved.	Not incurved.
9. External rim of carpal trochlea.	Slightly notched.	Slightly notched.	More deeply notched.
Sternum			
10. Sternal basin.	Deep.	Intermediate.	Shallow.
11. Pneumatic foramen.	Present.	Lacking.	Lacking or minute.
12. Ventral manubrial spine.	Lacking.	Lacking.	Present (except *Biziura*).
13. Relative width of sternum (medial width/length).	0.45.	0.65.	0.39 (*Heteronetta*); 0.58 (*Biziura*); 0.63 (*Oxyura*).
Coracoid			
14. Depression on ventral surface in angle between sternal facet and intermuscular line.	Deep.	Shallow.	Lacking.

TABLE 1 (Continued)

Feature	*Dendrocygna*	*Thalassornis*	*Oxyurini*
Furculum			
15. Coracoidal tuberosity.	Minute.	Minute.	Larger.
Pelvic Girdle (Fig. 2)			
16. Posterior end of ischium.	Extends considerably posterior to end of ilium.	Extends to about the same level as end of ilium.	Extends to about the same level as end of ilium.
17. Relative proportions.	Poorly specialized for diving.	Highly specialized for diving (see discussion).	Highly specialized for diving.
18. Body of pubis.	Concave dorsally.	Concave dorsally.	Straight or convex dorsally.
19. Postischiac pubis.	Short, weak, and more caudally directed.	Short, weak, intermediate in orientation (see Figure 2).	Longer, stouter, more ventrally directed.
Femur			
20. Anterior ridge of external condyle.	Elevated from trend of shaft.	Intermediate.	Not elevated.
21. Anterior surface of femur.	Concavity present two-thirds of way from proximal end.	Concavity as in *Dendrocygna.*	Concavity with a different terminal configuration.
22. Popliteal fossa.	Shallow.	Shallow.	Deep.
23. Anterior edge of trochanter.	Extends some distance anterior to head of femur.	Reduced.	Reduced.
Tibiotarsus			
24. Axis of inner cnemial crest.	Rotated sharply anterior to axis of shaft.	More nearly parallel to axis of shaft.	More nearly parallel to axis of shaft (except *Heteronetta*).
27. Orientation of inner cnemial crest.	Strongly directed laterally.	Only slightly directed laterally.	Only slightly directed laterally (except *Heteronetta*).
28. Depression between cnemial crests.	Relatively shallow.	Relatively deep.	Relatively deep (except *Heteronetta*).
29. Internal condyle.	In line with edge of shaft when viewed anteriorly.	Extends medially beyond shaft, resembling *Oxyura.*	Extends medially well beyond shaft.
Tarsometatarsus			
30. Trochlea for digit II.	Not grooved.	Intermediate. Shallow groove does not reach posterior face of trochlea.	Well developed groove all around articular surface of trochlea.

TABLE 2

RELATIVE PROPORTIONS OF THE PELVIC GIRDLE IN SEVEN SPECIES OF WATERFOWL (Mean Values × 100)

Species and number	Post-acetabular length (Total length)	Anterior iliac width (Total length)	Interacetabular width (Total length)	Posterior ischiac width (Total length)
Thalassornis leuconotus (1)	61	19	17	42
Dendrocygna bicolor (3)	54	24	20	41
D. autumnalis (3)	56	24	20	40
D. javanica (1)	53	24	20	34
Heteronetta atricapilla (3)	60	22	23	53
Oxyura jamaicensis (21)	61	20	20	62
Biziura lobata (8)	68	21	14	48

with specializations of the shank musculature. Further details of these functional specializations in the Oxyurini are discussed in Raikow (1970).

There is one feature in which an adaptive convergence with the stifftails has apparently not occurred. In the Oxyurini the tail, with its long, stiffened rectrices, is used as an underwater rudder. In *Thalassornis*, however, the tail is very short. Delacour (1959:252) reported that the short rectrices are stiffened, but Johnsgard (1968:81) claimed that they are unstiffened. In any event, the structure of the caudal skeleton and pelvis suggests that the tail is probably not used as a rudder in *Thalassornis*. The pygostyle is relatively smaller than in the stifftails. The Oxyurini are characterized by a long and sturdy postischiac pubis (Table 1, no. 19), the area of origin of certain well-developed caudal muscles. This bone is quite feeble in *Thalassornis*, closely resembling that of *Dendrocygna* (Fig. 2).

The evidence thus suggests that *Thalassornis* is an aberrant whistling duck more highly specialized for swimming and diving than *Dendrocygna*, and convergent in this adaptation to the stifftail ducks of the tribe Oxyurini. Whistling ducks are notable for the fact that they are not highly specialized for walking, swimming, or diving, but are rather generalized in their locomotor habits. Their actions underwater are apparently not extremely efficient. Frith (1967) says of *Dendrocygna arcuata*: "Although it secures much of its food underwater, its movements and swimming are clumsy." An underwater photograph of this species (Frith, 1967, opposite p. 74) shows that it swims with the legs greatly adducted, whereas the most specialized diving ducks, including the stifftails, utilize a highly abducted leg posture (Raikow, 1970). Whether the latter posture is also utilized by *Thalassornis* is not known, but its skeletal structure and inability to walk on land suggest that this is likely.

It thus appears that *Thalassornis* is the only highly specialized diving form known in the subfamily Anserinae. It may be a remnant of a lineage which diverged from the line leading to *Dendrocygna* before that genus achieved its present form. This is suggested by the absence of a suborbital bar and the presence of a rudimentary coracoid depression.

Since *Thalassornis* is the only known member of the Anserinae which has become highly specialized for diving, it is possible that more such types failed to develop because this adaptive zone was being actively entered by several groups of true ducks (Anatinae), which were perhaps better fitted to exploit this way of life.

SUMMARY

Recent studies of behavior and external anatomy suggest that the White-backed Duck (*Thalassornis leuconotus*) is related to the Dendrocygnini rather than to the Oxyurini as formerly suggested. Several features of the cranial and postcranial osteology support this theory, but other characteristics of the postcranial skeleton resemble the condition in the Oxyurini. Most of these can be interpreted as being parts of a general adaptive specialization for efficient aquatic locomotion, and it is suggested that the resemblance to the Oxyurini is therefore attributable to convergence.

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MUSEUM OF VERTEBRATE ZOOLOGY AND DEPARTMENT OF ZOOLOGY, UNIVERSITY OF CALIFORNIA, BERKELEY, CALIFORNIA, 20 NOVEMBER 1970.

MEASUREMENT OF SOCIAL ATTRACTIONS BETWEEN TROPICAL PASSERINE BIRDS

Charles F. Leck

Throughout the humid tropics groups of birds of several species are frequently encountered while they feed on fruit and nectar in large trees, or on insects among the canopy and forest floor. The social bonding of such flocks has been well described for insectivores (Moynihan, 1962; Willis, 1966) but the associations of fruit eaters have been much neglected. This paper presents a technique and preliminary results of a quantitative analysis of the social attractions of frugivorous birds in Panama.

METHODS

I selected two fruiting plants in the laboratory clearing of the Smithsonian Tropical Research Institute, Barro Colorado Island, Canal Zone. The plants were *Cecropia* sp. (a second-growth tree) and *Oryctanthus* sp. (a mistletoe shrub), both widespread in the neotropics and heavily exploited by a variety of birds. Each plant was observed for 100 hours at the end of the wet season, a non-breeding period. Census periods sampled the day as follows: 06:30–07:00, 07:30–12:00, and 12:30–17:30 (this temporal spread was designed to avoid bias related to species differences in activity patterns). During the observations I recorded the exact time of arrival of each individual bird that visited the food plant. Each bird was identified as a species or individual (40 birds of the area were color-banded).

RESULTS

At first a simple sequential analysis of the successive arrivals of all birds was used to determine bondings, on the assumption that if one species arrived at the tree after another species more frequently than can be attributed to chance, then the first bird is probably attracted to the second (such an assumption may be applied to both intra- and interspecific relationships). Data from both *Cecropia* (Table 1) and *Oryctanthus* (Table 2) showed that intraspecific attractions were dominant. Most of these were based on pair bonds, as analysed through records of color-banded birds. General intraspecific flocking of six to 10 individuals was important with the Plain-colored Tanager (scientific names in Appendix). Interspecific relationships were not easily revealed with this analysis because of the overriding effect of the intraspecific attractions and because the analysis used only a limited amount of the collected data. More information was incorporated by using the time interval (in minutes) between successive visits as an improved measure of attractive strength. That is, if one bird frequently followed another to a tree within one minute it was likely to have been more strongly attracted than if it usually arrived several minutes later. From this type of analysis for all visits to the plants (Figs. 1 and 2) it is again clear that intraspecific attrac-

Table 1

Predecessor-follower Records at *Cecropia* Tree in the Clearing at Barro Colorado Island, Fall, 1968.

	Predecessor					
Follower	Blue Tanager	Palm Tanager	Plain colored Tanager	Fulvous-vented Euphonia	Others	Totals
Blue Tanager	22*	10	7	5	14	58
Palm Tanager	9	88*	28	6	50	181
Plain-colored Tanager	16	26	191*	3	46	282
Fulvous-vented Euphonia	4	5	1	8*	9	27
Totals	51	129	227	22	119	548

For each predecessor-follower pair the actual number of observations is given. * = Statistically significant intraspecific attractions. Interspecific followings alone are significantly ($p < 0.05$) non-random, except after the Fulvous-vented Euphonia. ("Others" cannot be tested).

tions are stronger (i.e., usually involve shorter time intervals) than interspecific bonds. This technique can be further applied on an individual species basis, with the percentages of predecessor-follower visits that involve one minute or less between the arrival of the two birds (Table 3). The ability of this arbitrary time period to reveal attractions should be greater with shorter periods, and thus the use of the one minute interval criterion

Table 2

Predecessor-follower Records at *Oryctanthus* Plant in the Clearing of Barro Colorado Island, Fall, 1968.

	Predecessor						
Follower	Golden-masked Tanager	Sulphur-rumped Tanager	Paltry Tyrannulet	Ochre-bellied Flycatcher	Social Flycatcher	Others	Totals
Golden-masked Tanager	–	2	8	10	15	27	62
Sulphur-rumped Tanager	5	29*	5	20	6	33	98
Paltry Tyrannulet	6	7	7	17	13	38	88
Ochre-bellied Flycatcher	12	7	13	22	17	83	154
Social Flycatcher	6	10	8	12	40*	51	127
Totals	29	55	41	81	91	232	529

Legend as in Table 1, with significant ($p < 0.05$) intraspecific attractions indicated (*). Interspecific followings alone are non-random ($p < 0.10$) after the Sulphur-rumped Tanager, Paltry Tyrannulet, and Social Flycatcher. ("Others" cannot be tested).

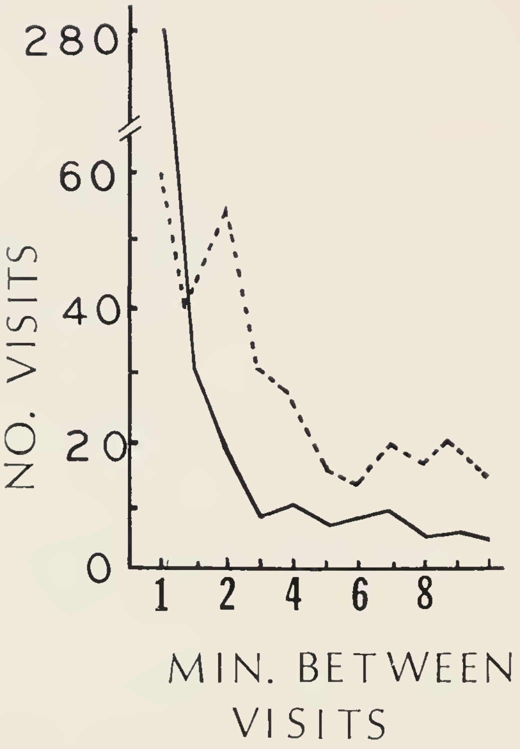

FIG. 1. Number of minutes between individual visits of the same species (solid line; n = 371) and of different species (dotted line; n = 308) to a *Cecropia* tree in the clearing at Barro Colorado Island, Sept.–Nov. 1968.

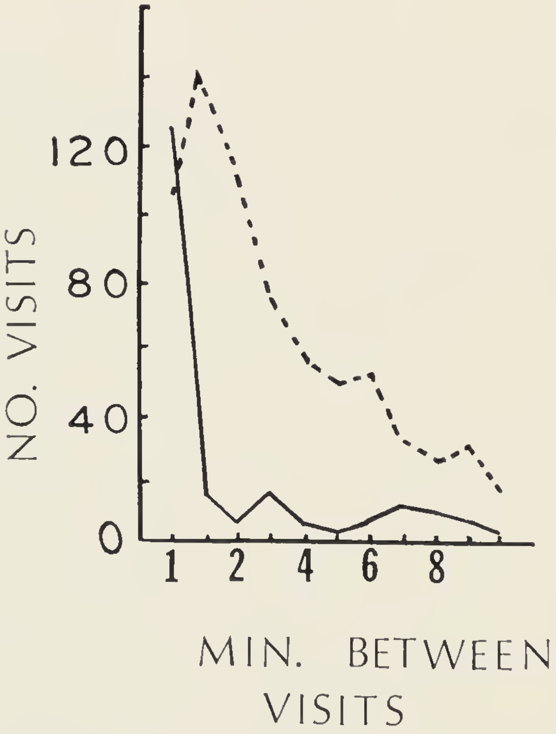

FIG. 2. Number of minutes between individual visits of the same species (solid line; n = 177) and of different species (dotted line; n = 686) to an *Oryctanthus* plant in the clearing at Barro Colorado Island, Sept.–Nov. 1968.

TABLE 3

PERCENTAGES OF FOLLOWING RECORDS OCCURRING WITHIN ONE MINUTE OF THE PREDECESSOR'S ARRIVAL.

	Predecessor				
Follower	Blue Tanager	Palm Tanager	Plain-colored Tanager	Fulvous-vented Euphonia	Others
Blue	91%	30%	57%	20%	14%
Tanager	(20,2)	(3,7)	(4,3)	(1,4)	(2,12)
Palm	56%	61%	46%	17%	18%
Tanager	(5,4)	(54,34)	(13,15)	(1,5)	(9,41)
Plain-colored	19%	35%	76%	33%	22%
Tanager	(3,13)	(9,17)	(145,46)	(1,2)	(10,36)
Fulvous-vented	0%	40%	100%	100%	11%
Euphonia	(0,4)	(2,3)	(1,0)	(8,0)	(1,8)

For each predecessor-follower pair there is in parenthesis the number of records with one minute or less between the two visits and the number with more than one minute between visits, and above these, the percentage of the total that is within the one minute category.

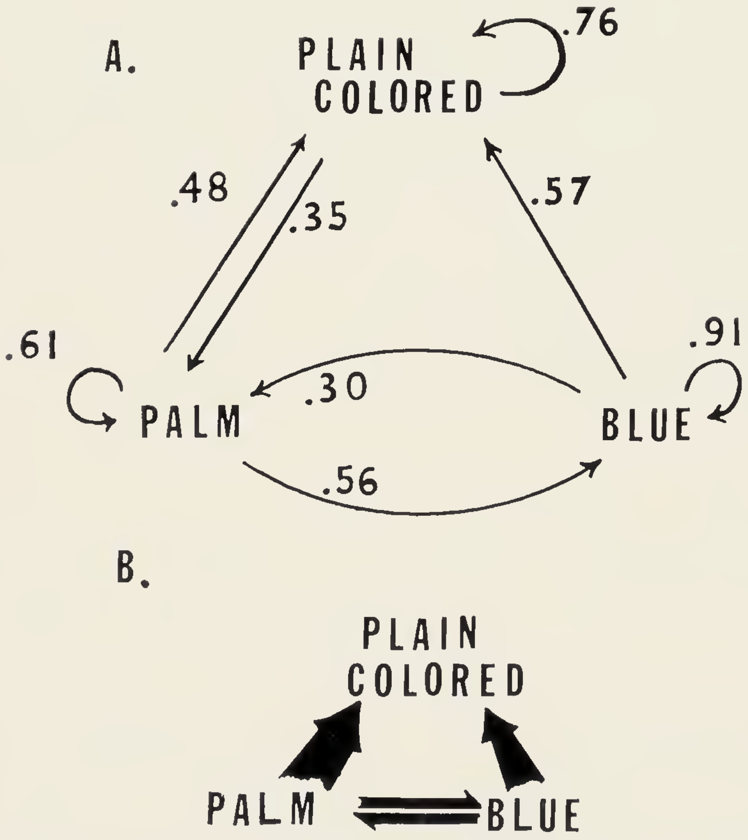

FIG. 3. Strengths of intra- and interspecific attractions of three tanagers at the clearing, Barro Colorado Island. Arrows point from the following (attracted) species to the predecessor. (A) Attractive strengths shown as the percentages of following species arrivals that occurred within one minute of the predecessor. (B) Attractive strengths shown by the relative widths of the arrows (from Moynihan, 1962, p. 65).

(the shortest possible with the data collected). The attractions may be easily diagramed to depict social organizations (Fig. 3A), and the results are seen to be similar to, but less subjective than those of Moynihan (1962) (Fig. 3B). This study also suggests mutual rather than one-way attractions between Palm and Plain-colored Tanagers. The primary contribution of this part of the study is its quantitative nature and its ability to reveal subtle relationships, providing an example of a field study of avian social structure with data adaptable to stochastic analysis.

In other parts of the study area (not reported here) intraspecific flocking of frugivores was common with the larger species (e.g., *Daptrius americanus, Crax* sp., *Penelope purpurascens, Amazona* sp., and *Ramphastos* sp.). Most of the species showing such gregarious behavior were highly vocal. probably to facilitate group cohesion.

DISCUSSION

As reported by Diamond and Terborgh (1967), the reduced interspecific bonding at fruit trees is in direct contrast to the strong social bonding reported for mixed-species flocks moving through the forest (Sedgwick. 1949; McClure, 1967). There are several possible reasons for these behavioral differences. Species feeding at a stationary food source such as a fruit tree would require less bonding to relocate the food easily than those species feeding at a moving food source, such as ant swarms (Willis, 1967). Second. while interspecific flocking at fruit trees might mainly provide increased awareness of predators, flocks moving through the forest could gain both this protection and an increased availability of food with the mutual flushing of insect prey (Moynihan, 1962). This latter point is probably very important in promoting the social cohesiveness of large mixed foraging flocks. the members of which are mainly insectivorous (Rand, 1954). Finally. competition may reduce social bonds at fruit trees where most species are frugivorous and take the same food, while such competition would probably be less important in mixed-species flocks, the members of which exploit a wide variety of foods through different behaviors (Diamond and Terborgh. 1967).

The methods of gathering data on social interaction at isolated food sources, as described in this report, offer several advantages: (1) an observer is able to take complete notes on the interactions at almost any single tree; (2) by taking notes at similar food sources it is possible to gather comparable data in different habitats, permitting a direct comparative study of social systems in different avian communities; and (3) individual plants which fruit continually provide unique opportunities for studies of seasonal changes in interspecific relationships (Leck, 1970).

SUMMARY

The social behavior of fruit-eating birds was studied in the Panama Canal Zone. Intraspecific attractions, usually pair bonds, dominated the interactions. Interspecific attractions were weak, in contrast to those reported for insectivorous species. The ecological reasons for this behavioral difference are considered.

The method described for gathering social data at single food resources is noted to be of value because of its quantitative nature and wide applicability.

ACKNOWLEDGMENTS

Residence at Barro Colorado Island during 1968–69 was made possible through the Smithsonian Tropical Research Institute (M. Moynihan, Director) and a Schuyler-Gage Fellowship (Cornell University). Transportation costs were generously covered by a Sigma Xi Grant-in-Aid of Research. Helpful ideas were provided by Juan Delius and Stephen T. Emlen.

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APPENDIX

Scientific names of species mentioned in the text and tables.

Social Flycatcher (*Myiozetetes similis*)
Paltry Tyrannulet (*Tyranniscus vilissimus*)
Ochre-bellied Flycatcher (*Pipromorpha oleaginea*)
Fulvous-vented Euphonia (*Euphonia fulvicrissa*)
Plain-colored Tanager (*Tangara inornata*)
Golden-masked Tanager (*Tangara larvata*)
Blue-gray Tanager (*Thraupis episcopus*)
Palm Tanager (*Thraupis palmarum*)

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THE BREEDING BIOLOGY OF BARN AND CLIFF SWALLOWS IN WEST VIRGINIA

David E. Samuel

Barn Swallows (*Hirundo rustica*) and Cliff Swallows (*Petrochelidon pyrrhonota*) both nest in parts of the eastern United States. The colonial Cliff Swallow nests under bridges or dams, on the outside of barns, and inside open sheds and barns. Barn Swallows nest inside such sheds and barns during the same time interval. Both build a mud nest, the Barn Swallow's cup-shaped and the Cliff Swallow's gourd shaped. Barn and Cliff Swallows are insectivorous, may feed in the same flock, perch together, and occasionally nest in the same building. Hybridization might be anticipated but only two instances have been reported (Mearns, 1902; Bent, 1942).

I wanted to determine: if temporal separation of breeding season occurred as suggested by Moody (1968); if spatial separation occurred at the nesting site; if there was feeding or perching stratification; and if distinct foraging areas existed.

METHODS

This study covered the summers of 1967 and 1968, and was made in 11 barns and five sheds near Bruceton Mills in Preston County, West Virginia. Visits were made to all barns at least every other day. Additional observations were made in four barns near Cranesville Swamp, Preston County, West Virginia, and in one barn in Jefferson County, Ohio. Cultivated fields and patches of hardwood forests made up all study areas. Temperature data were collected on the Bruceton Mills study area using a 7-day thermograph. Data for Cranesville Swamp were from the government station near Terra Alta. Birds were mist-netted, paint-marked, and sexed (Samuel, 1969*a* and 1971).

RESULTS

Arrival.—Barn Swallows arrived earlier than Cliff Swallows (Figs. 1 and 2). The arrival time varied for Barn and Cliff Swallows from barn to barn and year to year. For example, Barn Swallows arrived at different barns on study area A on 6 April, 16 April, 20 April, and 21 April in 1968. Both species arrived during or immediately after a few days of warm (usually 70°) weather (Fig. 3).

Three dead adult Barn Swallows were found during relatively cold weather (Fig. 3). Six of 10 birds present were marked at a barn on study area A during 20–25 April, 1967. By 28 April none were in the area, but only one was found dead. New arrivals moved into the same barn on 2–4 May and began nesting activities.

Estimated Nesting Populations.—All active nests were counted to estimate

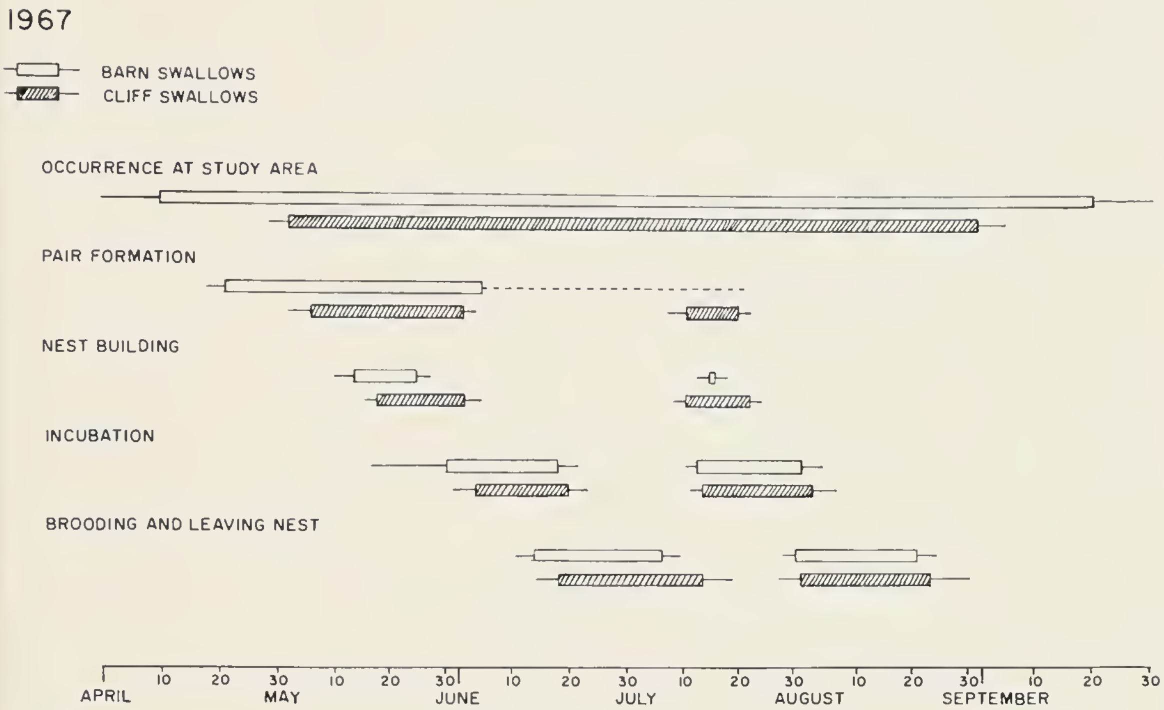

Fig. 1. Reproduction cycle of Barn and Cliff Swallows, 1967. Lines represent durations of activity in time; bars show peak periods of activity; dashed line shows uncertain dates. Sample sizes for Barn Swallows during the following periods are: nest building, 9 first clutch nests, 4 second clutch nests; incubation, 40 first clutches, 10 second clutches. Sample sizes for Cliff Swallows during the following periods are: nest building, 10 first clutch nests, 9 second clutch nests; incubation, 5 first clutches, 6 second clutches.

nesting populations. Barn Swallow nests used for first clutches totaled 58 in 1967 and 50 in 1968. As some birds laid a first clutch during the second clutch period, the population estimate for Barn Swallows was probably low.

Cliff Swallow counts included nests at least seven-eighths complete and totaled 40 in 1967 and 39 in 1968. Since Cliff Swallows sometimes build two to three nests per season, the population estimate may be high. If these variables were similar for both summers, the population was stable.

Nest-site Selection.—The essential features of the nesting sites of Cliff Swallows include: 1) open foraging areas, 2) vertical substrate with overhang for nest attachment, and 3) mud for nest construction (Emlen, 1954). This study revealed another requirement for a Cliff Swallow nesting in the interior of a barn: a sufficiently wide entrance. Most barns had wide entrances, but all were not open during successive years. Only two of nine Cliff Swallow nest sites had entrances less than 8 by 8 feet, and when such entrances were even partially closed, Cliff Swallows abandoned the nest. Barn Swallows under similar circumstances did not abandon their nests; they used any opening, large or small, for entrance. Otherwise, requirements for the nest site were similar for both species. Cliff Swallows and Barn Swallows nested

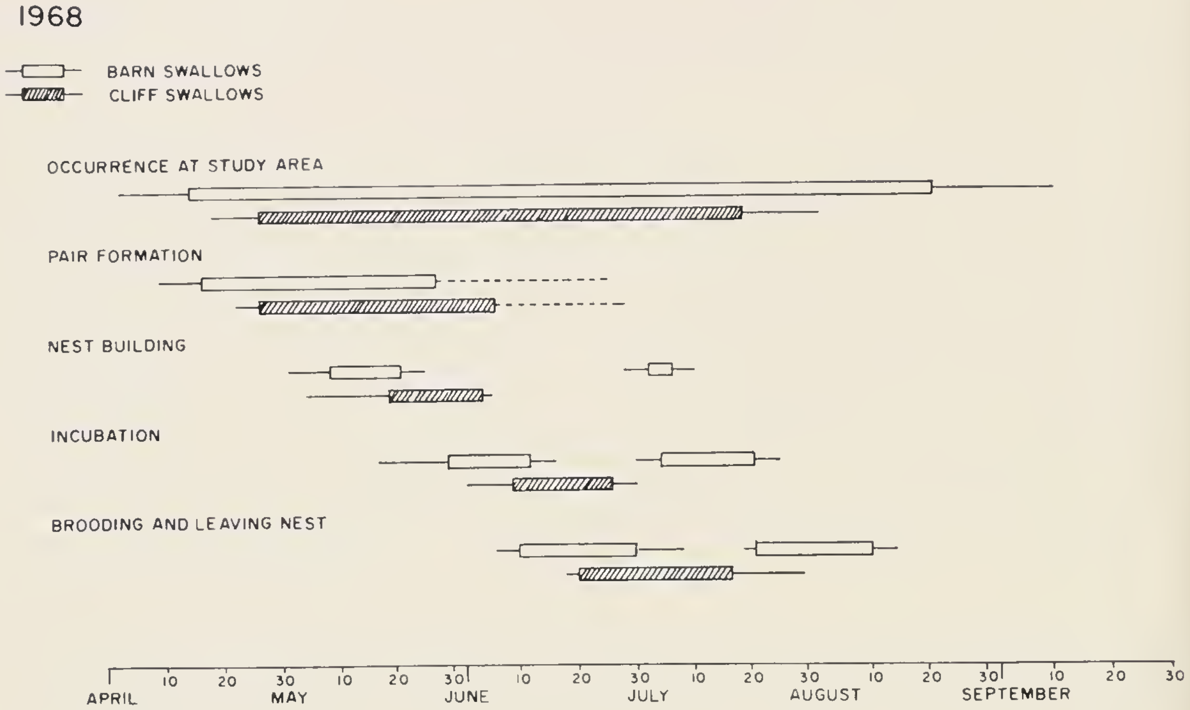

Fig. 2. Reproductive cycle of Barn and Cliff Swallows, 1968. Lines represent durations of activity in time; bars show peak periods of activity; dashed line shows uncertain dates. Sample sizes for Barn Swallows during the following periods are: nest building, 9 first clutch nests, 6 second clutch nests; incubation, 28 first clutches, 12 second clutches. Sample sizes for Cliff Swallows during the following periods are: nest building, 7 nests; incubation, 27 clutches.

together in numbers only once, but Cliff Swallow nest marks were found in 85 per cent of 32 barns and 18 sheds examined in Preston County.

Once a site was used, adults continued to return to the same building. Of the seven adults banded in 1967 and recaptured in 1968, all were retaken in the same barn. Two birds banded as nestlings in 1967 at barn 10 and shed b, returned in 1968 to barn 8. Groups of 10–30 juvenile Barn Swallows were commonly seen at the barns prior to the fall migration. I do not know whether their nest sites were selected then, or the next spring. No Cliff Swallows banded in 1967 were recaptured in 1968.

Pair Formation.—The breeding behaviors of the two species, particularly pair formation and copulation, were different. In March, 1968, Barn Swallows were observed in South Carolina and Georgia. Thirty-one of 33 were perched alone indicating non-pairing; however, most Barn Swallows on the study area were paired within 2 weeks after arrival. Pair formation took place on fences and lines located around the nesting area. Daily activities at barns were interrupted every 30–40 minutes by 10–15 minute periods of group feeding. Groups flew in and out of barns, fed, and perched. Paired birds were frequently challenged by unpaired birds; perching or flying between them.

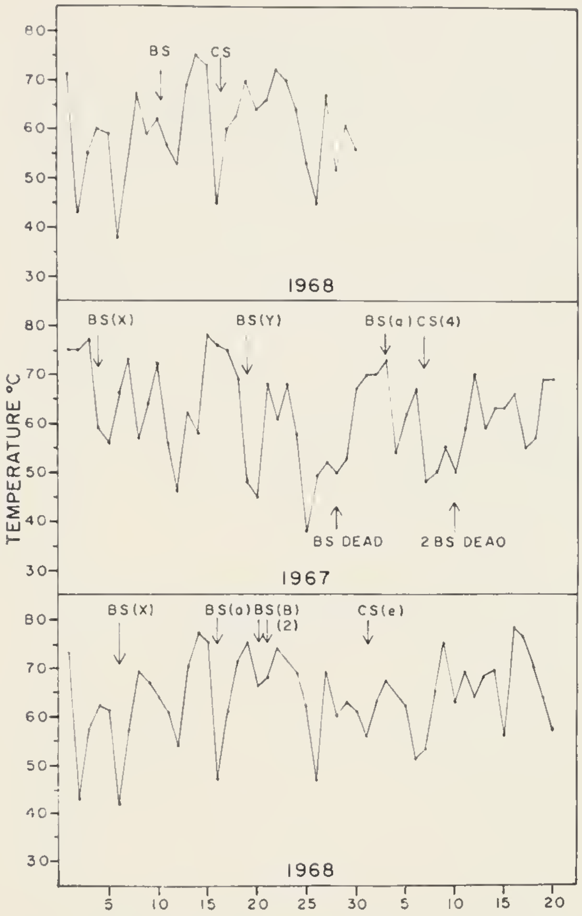

Fig. 3. Maximum daily temperatures and arrival times for Barn Swallows (BS) and Cliff Swallows (CS). At the top, data from one barn on area B for 1968 is shown, while the middle and bottom contain data collected on area A in 1967 and 1968. (X) and (Y) are barns near area A. (a), (e), (2), (4), and (8) are barns and sheds on area A.

Unpaired birds, however usually perched alone, and sang frequently, especially when other birds flew near. On cold days (35°–45°), Barn Swallows fed over ponds and did not return to the barns for 2–3 hour periods.

Cliff Swallow pair formation began upon arrival. It took place at or in the nest and in close proximity to other individuals, while pair formation of Barn Swallows did not. The behavior of Cliff Swallows was similar to that described by Emlen (1954). Pairing was also seen in three flocks of birds which arrived at the study area in July. One flock contained three marked females, of which two had had unsuccessful nests and one had successfully reared a brood at nearby barns. These birds did not have the same mates in the second pairing; all three participated in nest-building and one laid a second clutch.

Nest-building.—Barn Swallows build adherent or statant nests. The less common statant nests (Table 1, A and B) have an under support, while

TABLE 1

NEST OBSERVATIONS FOR BARN SWALLOWS AND CLIFF SWALLOWS ON ALL STUDY AREAS IN 1967 AND 1968.

	1967	1968	Totals
Barn Swallow			
A. Statant nests	32	12	44
B. Adherent nests	74	21	95
C. Nest used for both clutches	9	10	19
D. New nest for 2nd clutch	7	0	7
E. Swallows in 1968 reusing nests from 1967	—	35/62*	—
F. Swallows in 1968 using nests built previous to 1967, and unused in 1967	—	11	11
G. New nests in 1968	—	13	13
H. Nests used in 1967, not in 1968	27	—	27
Cliff Swallow			
a. Swallows in 1968 reusing nests from 1967	—	18/48**	—
b. New nests in 1968	—	25	25

* Birds reused 35 of 62 nests used in 1967.
** Birds reused 18 of 48 nests used in 1967.

adherent nests are attached only to vertical surfaces. Only the adherent gourd-shaped type of Cliff Swallow nest is found.

Barn Swallows were observed building nests on four occasions, and both sexes participated. Mud was gathered close to the barn, usually from wet areas trampled by livestock outside the entrances. Birds landed and, with wings folded in the normal position, collected mud in the beak. Both birds took turns about every 5 minutes adding mud to the nest. When the base was completed, birds perched on it to add more mud. Barn Swallows embedded horse hair, if available, into the nest as it was constructed. Feathers lined the nest and occasionally feathers were carried to the nest after eggs were laid. The presence of chicken feathers below indicated an active nest.

Only once were Barn Swallows and Cliff Swallows seen gathering mud together. Mud gathering was not a social activity in Barn Swallows. Nest building was an independent pair activity, and no mud was added to the nest of another pair.

Mud gathering by Cliff Swallows was a social activity and, once begun, was joined in by many birds. Mud was obtained up to 100 yards from the nest site, from farm ponds or rain puddles. Marked birds used different puddles or different places around a pond or puddle, and seldom returned to the same spot twice in succession. Birds from different farms (colonies) were never seen gathering mud together from the same place. Each farm usually had a nearby source of mud. Cliff Swallows fluttered their wings high above their backs as they pecked at the mud until a pellet was collected. Occasionally a bird swiped its bill upward, also, collecting mud on top of the beak. Unpaired birds might bring pellets to nests and paired birds with completed nests sometimes added to adjacent nests. Both members of a Cliff Swallow pair participated and exchanged places at the nest with each trip. Once incubation started, nest repairs were made by both sexes.

The structure and construction of the Cliff Swallow's nest was similar to that of the Barn Swallow until the roof was placed over the cup. Cliff Swallows lined the bottom of the nest with pieces of straw or hay, rather than with feathers. Barn Swallows did not lay eggs in unfinished nests but Cliff Swallows commonly did so.

Not all birds build new nests. Barn Swallows nesting on the study areas in 1968 reused 35 of 62 nests used in 1967 (Table 1E) and 11 pre-1967 nests (Table 1F). Most birds added mud to the nest rim and cup, so that the whole structure might reach a height of over 12 inches after years of use. Occasionally the greater portion of the old nest was rebuilt. Thirteen new Barn Swallow nests were built in 1968 (Table 1G).

Cliff Swallows reused old nests (Table 1a) or rebuilt nests entirely (Table 1b). Most Cliff Swallow nests were destroyed during the winter and had to be rebuilt. In 1968, more than one-half of all Cliff Swallows on the area nested in one barn where 1967 nests remained.

Barn Swallows rarely build nests within 5 feet of an entrance, but if so they may use old Cliff Swallow nest-marks as a base. However, 89 of 90 Cliff Swallow nests were built on one of three girders nearest the barn door.

Barn Swallows began nest building before Cliff Swallows (Fig. 1). The average building time for 18 adherent Barn Swallow nests was 6.4 days (range 3–10). Building time for 17 Cliff Swallow nests constructed during May and June averaged 13.0 days while 9 nests built during July for a second brood or by those unsuccessful at first nests took an average of 8.4 days to complete.

Incubation.—The eggs of both species were laid on consecutive days until clutch completion. Intermittent incubation began after two or three eggs were laid and became continuous the day before the last egg was laid. Incubation time was measured from the day the last egg was laid until the day the last young hatched. Incubation time for five Barn Swallow nests was 15 days and for seven Cliff Swallow nests was 15 days.

In most Barn Swallow nests where at least one member of the pair was marked and sexed, only the female incubated. However, male Barn Swallows assisted in incubation at four nests. Barn Swallow nest-attentiveness re-

TABLE 2

NEST ATTENTIVENESS OF BARN AND CLIFF SWALLOWS DURING INCUBATION.

		08:30–11:30		11:31–14:00		14:01–16:30	
	Days	Time	%	Time	%	Time	%
Barn Swallows	0–4	95	55.4	105	74.0	70	85.7
	5–9	84	47.2	98	63.2	91	38.0
	10–15	—	—	68	19.2*	135	14.7*
Cliff Swallows	0–4	—	—	40	95.0	40	100.0
	5–9	58	72.2	67	91.3	58	98.3
	10–15	104	73.1	—	—	—	—

Time = Total minutes of observation during this time period.
% = Percentage of time male or female was on the nest.
* Biased low as observations were made on day 15 at one nest when two of five eggs had hatched.

mained relatively stable during the incubation period, except for the morning period (Table 2).

Observations of 11 marked pairs showed that male Cliff Swallows incubated regularly. When a pair was observed 4 days after incubation began, the male entered the nest once and the female three times during a 40-minute period. On the fifth day, the male entered the nest four times and the female nine times during a 67-minute period. The birds usually exchanged places, with the male in the nest 63 of 80 minutes, the female only 42 of 80 minutes. Upon entering, the male moved into the lower part of the nest and assumed the same position as the female. During the incubation period with at least one member of a pair was usually incubating (Table 2).

Clutch Size and Hatching Success.—For Barn Swallows a first clutch of five eggs was most common while a second clutch of four was most common (Table 3, Fig. 4). More than six eggs per nest may indicate dual laying for Barn Swallows (Mason, 1953); however, seven eggs were found in three nests occupied by single females. From clutches of six eggs, 77 per cent of the eggs hatched; from clutches of five, 82 per cent; from clutches of four, 83 per cent; from clutches of three, 85 per cent; and from clutches of two, 87 per cent. Twenty-seven Barn Swallows of 33, that raised second broods, used old nests, though eight of these changed nests between clutches.

For Cliff Swallows a first clutch of four eggs was most common, while a second clutch of three was most common (Fig. 4).

Brooding and Nestling Mortality.—The period from hatching until leaving the nest averaged 20.7 days (range 18–27 days) for 10 Barn Swallow broods. The time from the first egg until the birds left the nest was 36–47 days. No difference was found for second broods.

TABLE 3

CLUTCH SIZE, EGG LOSS, NESTLING MORTALITY AND TOTAL MORTALITY FOR BARN AND CLIFF SWALLOWS, 1967 AND 1968.

Barn Swallows		Cliff Swallows	
First Clutch	N = 94	First Clutch	N = 35
Avg. Clutch Size = 430/94	4.57 ± 0.11	Avg. Clutch Size = 116/35	3.31 ± 0.30
Egg Loss = 72/430	16.7%	Egg Loss = 37/116	31.9%
Total Egg Loss = 91/564	16.1%	Total Egg Loss = 50/142	35.2%
Nestling Loss = 9/358	2.5%*	Nestling Loss = 2/79	2.5%*
First Clutch Mortality = 81/430	18.8%	First Clutch Mortality = 39/116	33.6%
Second Clutch	N = 33	Second Clutch	N = 9
Avg. Clutch Size = 134/33	4.06 ± 0.29	Avg. Clutch Size = 26/9	2.89 ± 0.15
Egg Loss = 19/134	14.2*	Egg Loss = 13/26	50.0%
Nestling Loss = 1/115	0.9%*	Nestling Loss = 7/13	53.8%
Second Clutch Mortality = 20/134	14.9%	Second Clutch Mortality = 20/26	76.9%
Total Mortality, Both Clutches = 101/564	17.9%	Total Mortality, Both Clutches = 59/142	41.5%

N = Sample size; average clutch size ± one standard deviation.
* This figure is lower than the real value because a few dead nestlings were probably not discovered.

The period from hatching until leaving the nest averaged 23.6 days for six Cliff Swallow broods. The total time from the first egg until the birds left the nest ranged from 38–48 days.

First-brood nestling mortality for Barn Swallows was 2.5 per cent, while second-brood nestling mortality was 0.9 per cent (Table 3). Cliff Swallow nestling mortality for first broods was also 2.5 per cent, but 53.8 per cent of the nestlings in second broods died. Total mortality for all Barn Swallow eggs laid was 17.9 per cent, compared to 41.5 per cent for Cliff Swallows.

Nest attentiveness in both species decreased as nestlings grew older. After 15 days, nestlings were brooded very little, especially on warm days. At night female Barn Swallows remained on the nest with the male perched beside it, while both the male and female Cliff Swallows remained in the nest.

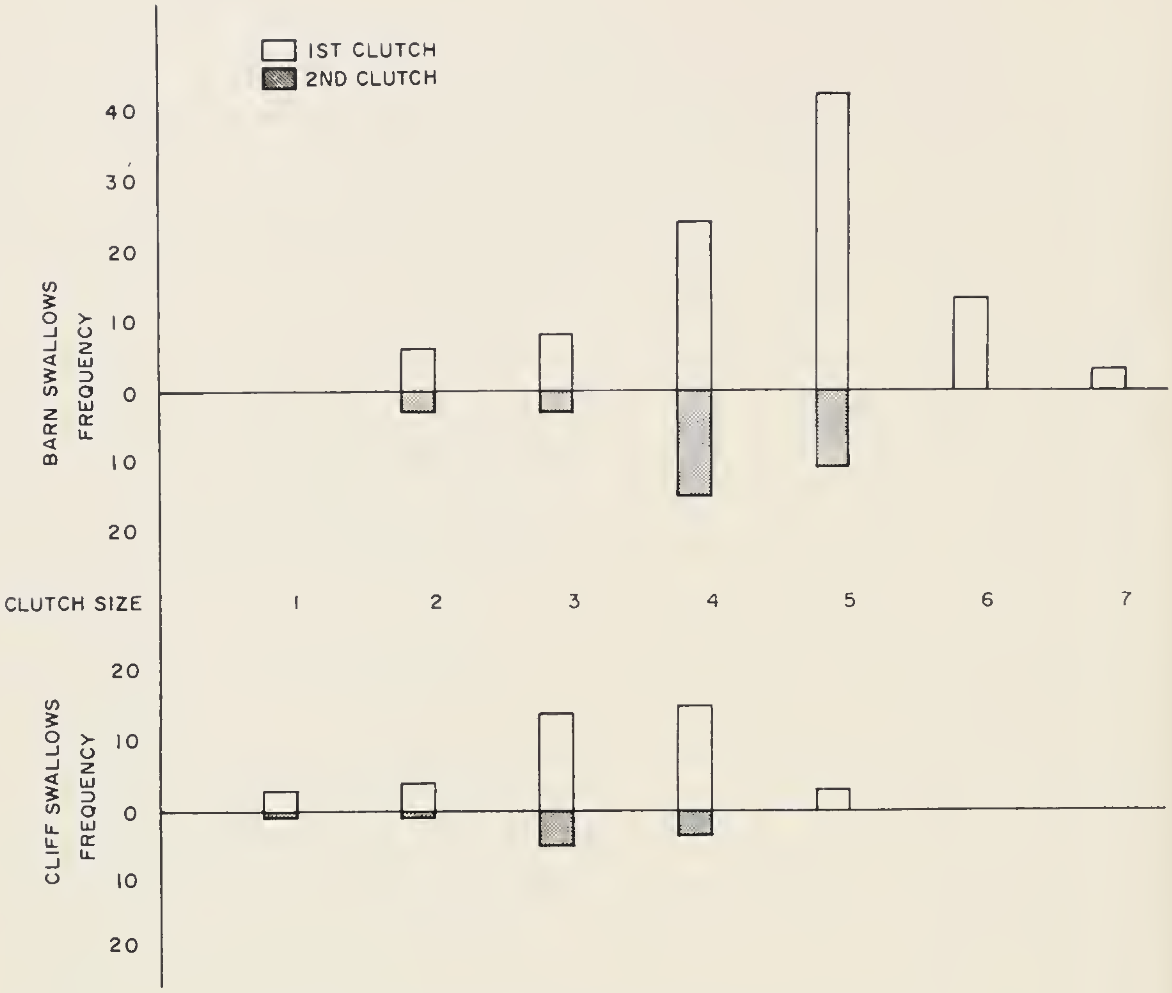

Fig. 4. Clutch sizes of Barn and Cliff Swallows.

Males of both species fed nestlings (Table 4). Male Barn Swallows fed nestlings as often as did females with the sexes exchanging places at the nest with each feeding. Cliff Swallows exchanged places also, and vocalizations announced each arrival and departure. Once nestlings could fly, they perched in family groups on telephone lines and fences. Adults fed the young on the wing and while perching beside them. Within a week, juveniles fed with the parents. Later, they joined adults in large feeding flocks.

Behavior Prior to Second Broods.—Barn Swallows which raised second broods exhibited courtship behavior. Courtship songs were heard, although pairs were established and appeared unchanged. After 29 May 1968, a Barn Swallow mount produced no copulation attempts as it had earlier in the year, indicating that the birds were paired. "Song flights" were seen between broods. These "flights" lasted 15–20 minutes and consisted of a flock of adult Barn Swallows from one barn flying quite high, chasing, and giving occasional songs. Juveniles were seen in such flocks. Between broods Barn

TABLE 4

FEEDING RATES FOR NESTLING BARN SWALLOWS AT FOUR NESTS AND CLIFF SWALLOWS AT THREE NESTS.

	Stage of Brooding	Time		Nest Visits
Barn Swallow				
	early	38	Male	10
			Female	9
	late	23	Male	11
			Female	11
	late	15	Male	9
			Female	4
	late	21	Male	9
			Female	6
Cliff Swallow				
	early	14	Male	20
			Female	12
	early	129	Male	20
			Female	12
	late	55	Male	15
			Female	18

Time = Total minutes of observation during brooding. Early brooding = 1–7 days, late brooding = 8–15 days. Nest visits = a feeding.

Swallows added small amounts of mud to the nest rim and more chicken feathers to the nest.

Cliff Swallow courtship behavior and associated vocalizations were evident between broods. A Cliff Swallow mount was ignored, indicating that pairs were intact.

Altered Activities.—Nest-building, incubation, and brooding activities were disrupted by milking activities at the farms. Some farmers milked before daylight, causing birds to leave the barn. Nest-building in Cliff Swallows began in most barns around mid-morning following perching activities. However, at one barn milking was delayed until mid-morning and nest-building was delayed until the noon period.

Evening milking was also disruptive for both species. Birds entered the barn at dusk; but, at the one barn where milking was delayed until dark, birds were forced to perch outside. Such interruptions altered activities, but did not cause nesting delays or abandonments.

TABLE 5

LIFE EQUATION OF 100 BARN SWALLOWS FOR A YEAR.

Time	Activities	Number of Barn Swallows	
		Young	Adults
Spring			
	(1) 50 males, 50 females		100
	(2) Females nest, avg. 4.57 eggs 50 × 4.57 = 228 eggs laid		
	(3) 16.7 per cent eggs do not hatch = 38 ∴ 228 – 38 = 190 eggs hatch		
Summer			
	(4) 2.5 per cent die before leaving nest = 5	185	
	(5) 35.2 per cent of 50 females lay a second clutch, avg. 4.06 18 × 4.06 = 73 eggs laid		
	(6) 14.2 per cent eggs do not hatch = 10 ∴ 73 – 10 = 63 eggs hatch		
	(7) 0.9 per cent die before leaving nest = 1	62	
	(8) Total number of young leaving the nest to migrate in the Fall	247	
	(9) Approximately 2 males and 2 females die during Spring and Summer		96
Fall-Winter			
	(10) An estimated 60 per cent of the adults die from time of migration South until they arrive in the Spring = 96 × 0.60 = 58		38
	(11) 74 per cent of 247 young die from Fall to Spring (Mason, 1953) = 185, 247 – 185 = 62		62
	(12) Spring population		100

Life Equations.—The life equations proposed for Barn and Cliff Swallows (Tables 5 and 6) assume a stable population. Almost certainly there are population fluctuations for these species from year to year, but these probably balance out for Barn Swallows. It is not known whether Cliff Swallow populations are stable or decreasing but the latter possibility exists.

Post-Brooding Activities.—Cliff Swallows left the area 2–4 weeks before Barn Swallows (Figs. 1 and 2). All of the Cliff Swallows in each barn departed simultaneously. However. Barn Swallow flocks moved through the area sporadically until late September. Their departure was not simultaneous and birds with young remained in the area until their nestlings became independent.

Nest Abandonment.—Samuel (1969*b*) described the factors causing nest

Table 6

Life Equation of 100 Cliff Swallows for a Year.

Time		Activities	Number of Cliff Swallows	
			Young	Adults
Spring				
	(1)	50 males, 50 females		100
	(2)	Females nest, avg. 3.31 eggs $50 \times 3.31 = 165$ eggs laid		
	(3)	31.9 per cent eggs do not hatch = 52 (See Samuel, 1969*b*) $\therefore 165 - 52 = 113$ eggs hatch		
Summer				
	(4)	2.5 per cent die before leaving nest = 3	110	
	(5)	26.7 per cent of 50 females lay a second clutch, avg. 2.89 $13 \times 2.89 = 38$ eggs laid		
	(6)	50 per cent eggs do not hatch = 19 (See Samuel, 1969*b*) $\therefore 38 - 19 = 19$ eggs hatch		
	(7)	53.8 per cent die before leaving nest = 10	9	
	(8)	Total number of young leaving the nest to migrate in the Fall	119	
	(9)	Approximately 2 males and 2 females die during Spring and Summer		96
Fall-Winter				
	(10)	An estimated 50 per cent of the adults die from time of migration South until they arrive in the Spring (Mayhew, 1958) $= 96 \times 0.50 = 48$		48
	(11)	An estimated 65 per cent of 119 young die from Fall to Spring = 77, $119 - 77 = 42$		42
	(12)	Spring population		100

abandonment in Cliff Swallows. These included barn alterations, House Sparrows (*Passer domesticus*), and fallen nests.

Barn alterations included "the closing of a door or window used as an entrance way, the placing of farm animals in an area beneath the nest, or any building or structural alteration near the nests."

Neither House Sparrows nor barn alterations caused disturbance to Barn Swallows, which entered the barns through small openings and continued nesting.

One pair of marked Barn Swallows that had begun building moved outside when cows were placed under the nest. This pair remained in the area of their nest for two days, but on the third day began a new nest in a nearby shed. They raised two broods here.

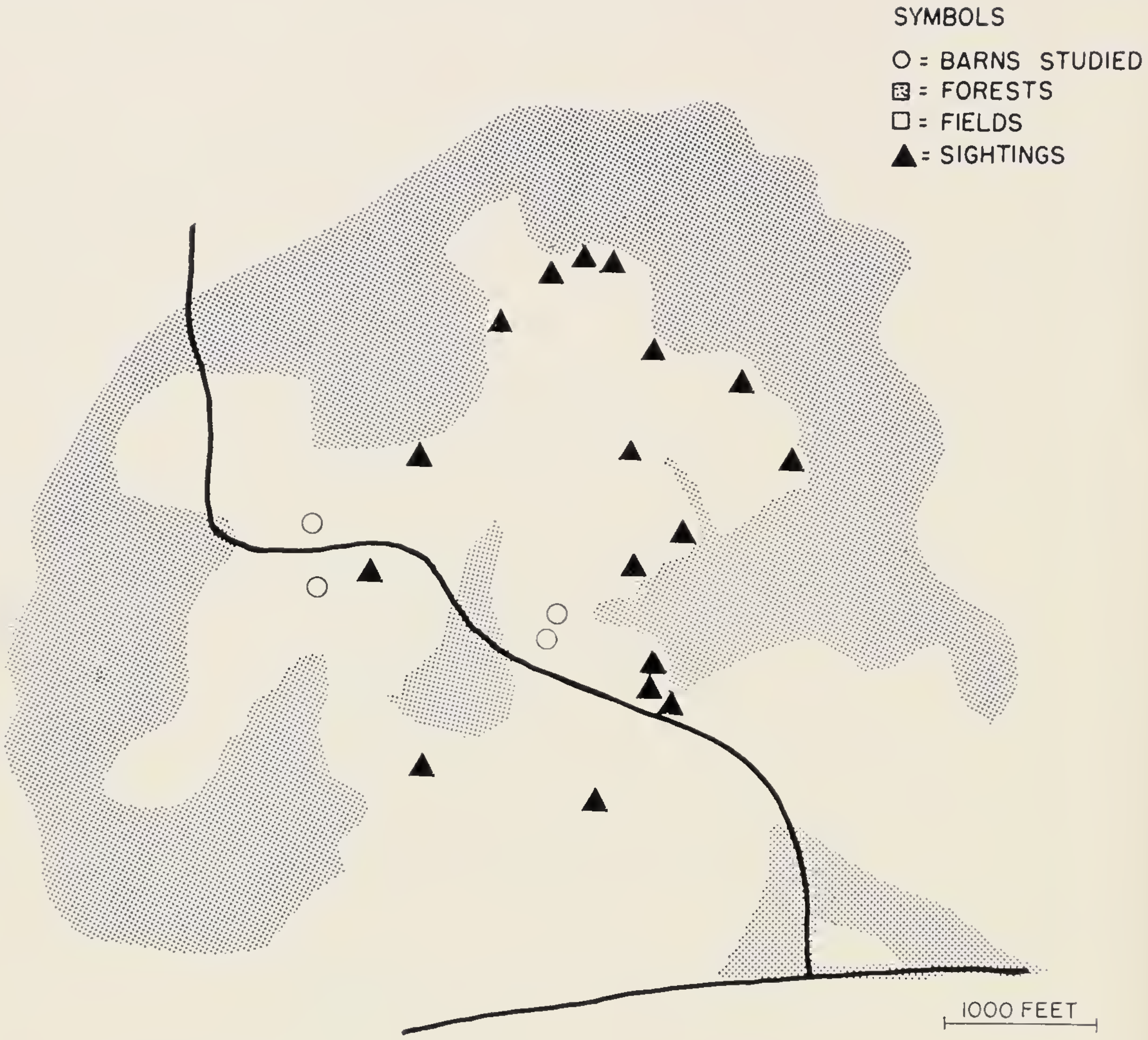

Fig. 5. Foraging area of a marked pair of Barn Swallows. Area is based on 17 sightings during one week. Birds rested in two barns in center.

Interspecific Relations.—I found nine Cliff Swallow nests built on top of Barn Swallow nests. Four of these were used by both species during one season, but no direct interactions between individuals were observed. Barn Swallows successfully reared broods before the arrival of the Cliff Swallows. Cliff Swallows disrupted normal nesting activities of only a few Barn Swallows.

Twice, Barn Swallows nested in incomplete and abandoned Cliff Swallow nests. On four occasions, Barn Swallows nested in old Barn Swallow nests previously used by Cliff Swallows, from which the tops had fallen away. Barn Swallows did not disturb Cliff Swallow nesting.

Four times Barn Swallows were seen flying into buildings where only Cliff Swallows nested; twice they were chased by Cliff Swallows and both times they left quietly. A Cliff Swallow was chased from a barn by a Barn Swallow on one occasion. No interactions were elicited by Barn Swallows flying under Cliff Swallow nests to reach their own nests. Both species were chased by House Sparrows using Cliff Swallow nests.

Feeding and Perching.—Where both swallow species occurred, they rarely fed and perched together. Cliff Swallows spent more time feeding above 100 feet, while Barn Swallows fed over ponds and fields. The feeding areas of the two species were thus vertically stratified and suggested a difference in diets.

Barn Swallows had smaller foraging areas (Fig. 5). Typically, the foraging range of Barn Swallows followed the borders of wooded areas within ¾ mile of the nest. The foraging areas of Cliff Swallows were larger, but no exact data were collected. Emlen (1952) reported Cliff Swallows foraging 2 miles from the colony site.

Cliff Swallows rarely perched on low barbed wire fences, as Barn Swallows regularly did. Conversely, no Barn Swallows perched on the 100-foot power lines used by Cliff Swallows. However, both perched on telephone lines of 30-foot height.

Both species fed and perched with other swallow species. During spring migration Barn Swallows associated with Tree Swallows (*Iridoprocne bicolor*). During nesting Barn Swallows and Rough-Winged Swallows (*Stelgidopteryx ruficollis*) were seen together around barns when the latter nested nearby. During spring migration Cliff Swallows perched or fed with Bank Swallows (*Riparia riparia*). Cliff Swallows displaced perching Bank Swallows on three occasions, but for the most part these two species appeared to be compatible.

DISCUSSION

The differences in arrival time between the two species may be a result of different migration routes. Lincoln (1950) postulated that Cliff Swallows migrate through Central America and Mexico and then into the United States, while the Barn Swallows apparently migrate across the Caribbean Sea to Florida and then north and west (Sprunt, 1954). These routes would explain the difference between the dates for West Virginia and those given by Moody (1968) for these species in the state of Washington, where the Cliff Swallow arrived before the Barn Swallow. The differences in arrival times might also be explained by differences in wintering areas.

Barn Swallow and Cliff Swallow arrival almost always followed a warm period. This is not surprising since arrival of most species of swallows is correlated with mean temperature or daily maximum temperature. Occasionally the earlier arriving Barn Swallow may suffer form late cold weather. Bell (1962) presents the interesting idea that first-year Barn Swallows arrived late and this may preserve the species in case of an early high mortality.

Overlap in breeding season occurred for these species in West Virginia.

Moody (1968) found little overlap in the breeding seasons of Barn and Cliff Swallows in Washington and postulated that this difference in timing evolved as a result of interspecific competition. My observations show that competition would not cause evolution of different nesting times. For example, little competition occurs during the initial phases of nest building. The mud-gathering habits of Barn and Cliff Swallows differ widely. Cliff Swallows always build near entrances while Barn Swallows build nests deeper within the barns. Occasionally Cliff Swallows built on top of an active Barn Swallow nest, but such competition was not serious and only involved nests located near an entrance, where Barn Swallows seldom built.

Moody (1968) observed Cliff Swallows in Washington building on Barn Swallow nests before the Barn Swallows arrived. He postulated that if Cliff Swallows continue to arrive first and construct their nests under the bridge (on Barn Swallow nests), the Barn Swallow may eventually be replaced at the colony site. However, since Barn and Cliff Swallows, in both Washington and West Virginia, build in slightly different areas of bridges and barns, such interactions are not due to competition but to population overflow and chance. Basic differences in the nest site selection make it doubtful that Cliff Swallows would thus replace Barn Swallows.

Competition for food could influence the evolution of non-overlapping nesting cycles but this was not observed. If food were a limiting factor, nestling mortality due to starvation would be expected, as would intraspecific competition. Neither was evident.

Barn Swallow pair formation took place on fences around the barn, and not in the area of the nest as with Cliff Swallows. Emlen (1954) previously described the first step in pair formation of Cliff Swallows as hovering of birds near the nests, and this continued from the earliest breeding activity until first nests were nearly completed. Hovering also occurred later in the form of "raiding behavior." Emlen (1952) believed that these raiding groups were composed of non-breeding birds after the destruction of their nests in a neighboring colony. A "raiding" flock arrived on the study area in July 1967, and exhibited pair formation behavior. This flock contained; a) 50–60 adults and 10–15 juveniles, b) a marked female which reared one brood at another barn and then built a nest at the new colony site, c) two marked females which had had unsuccessful nests at least twice previous to their arrival at this new colony. Thus, it appears that in the west raiding flocks are composed of non-breeders but in the east such "transient" groups are more heterogeneous.

I found only 35 per cent of the swallows raised second broods, and 27 of these 33 were from reused nests. It would appear that Barn Swallows which reuse or rebuild on old nests have a better chance to raise second broods. Bent

(1942) and McCann (1936) believed that Cliff Swallows raised two broods, while Buss (1942) stated that what appeared to be second broods were really re-nesting birds whose first nests were destroyed. A flock of birds which arrived at one shed on 10 July 1967, contained 3 re-nesting females and one of these raised a second brood.

The fledgling period of Cliff Swallows is 3 days longer than that of Barn Swallows. The Cliff Swallow nest is gourd-shaped and the entrance is a small hole. Lack (1968) suggested that hole-nesting Passerines have evolved longer fledgling periods, and can thus raise more young in a brood. Another interpretation of this longer fledgling period might be that swallows are similar to swifts; the species which feed higher above the ground find less food, producing a longer fledgling period (Lack, 1968).

The second clutch mortality of Cliff Swallows was 50.0 per cent; twice as great as first clutch mortality. High second brood mortality in Cliff Swallows was also reported by Foster (1968) in California where Cliff Swallows departed together as a colony and leave eggs and nestlings. This occurred at one barn during this study. Barn Swallows did not abandon nests until the breeding cycle was complete, regardless of when other pairs migrated.

The effect of the introduced House Sparrows on Cliff Swallow populations can only be surmised, without a long-term study. During this study I noted that House Sparrows caused many Cliff Swallows to abandon their nests (Samuel, 1969*b*).

Barn Swallows are much better adapted to nesting inside barns because farmers destroyed fewer of the less conspicuous nests, and closed doors did not cause nest abandonment. In view of their high mortality, one wonders why so many Cliff Swallows nest inside barns and sheds in the East rather than outside under eaves as they habitually do in Wisconsin (Aumann and Emlen. 1959). Forbush and May (1939) suggested that an increase in the number of painted barns in the east caused a decrease in Cliff Swallows because the nests would not adhere to the barns. This might cause birds to nest inside where unpainted substrates were available. Yet most barns in the midwest are painted and most swallows still nest under the eaves. There also may be some unknown relation between nesting inside and the low numbers of birds on the study area. Many colonies in the west and midwest contain hundreds of birds, and these birds usually nest outside.

SUMMARY

Barn and Cliff Swallows both may be found nesting inside the same, or neighboring barns or sheds in West Virginia. However, though apparently similar the two niches were found to be separable, and no competition was observed.

From arrival through nest building, differences in the breeding biology of these two species were found. Barn Swallows arrived in mid-April, while Cliff Swallows

arrived in late April or early May. Pair formation in both species occurred in different areas around the barns.

The requirements for a nesting situation are similar, except that Cliff Swallows entered only wide doors (8 × 8 feet) while Barn Swallows utilized any small opening as an entrance. Barn Swallows gathered mud near the barn entrances, while Cliff Swallows utilized the farm ponds and rain puddles where they occurred. Neither species traveled more than 100 yards to obtain mud.

Barn Swallows build adherent and statant nests on girders scattered throughout the barn. Cliff Swallows build gourd-shaped nests immediately inside the entrance. In 1968, Barn Swallows reused 35 of the 62 nests used in 1967. Most Cliff Swallow nests fell down or were removed by the farmer during the winter of 1967, and had to be rebuilt in 1968. The average building time for 18 adherent Barn Swallow nests was 6.4 days, while 17 Cliff Swallow nests took 13.0 days to build.

Incubation time for both species was 15 days, but other aspects of raising young differed. Male Cliff Swallows incubate more regularly than male Barn Swallows. First clutches of Barn Swallows averaged 4.6 eggs, while second clutches averaged 4.1 eggs. Total mortality for both clutches was 17.9 per cent. First clutches of Cliff Swallows averaged 3.31 eggs. Nine second clutches averaged 2.89 eggs, while total nest mortality was 41.5 per cent.

Barn alterations, i.e., closing doors after hay was brought in, etc., did not markedly affect Barn Swallow nesting, but caused abandonment of Cliff Swallow nests. House Sparrows did not interfere with Barn Swallow nests, but caused high Cliff Swallow nest losses.

Basic differences occurred in feeding and perching for these species. Cliff Swallows fed at a higher altitude and foraged as much as two miles from the nest site, while Barn Swallows fed lower and seldom more than one-half mile from the nest site. Barn Swallows commonly perched on low fences, while Cliff Swallows were seen perched on higher power lines.

ACKNOWLEDGMENTS

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Dr. W. N. Bradshaw guided the research and edited the manuscript. Dr. R. L. Smith and J. W. Thomas also provided editorial advice.

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GENERAL NOTES

Some observations on the behavior of Whistling Herons.—Recent discussions of the taxonomic position of the Whistling Heron (*Syrigma sibilatrix*) have been hampered somewhat by lack of a complete knowledge of the bird's behavior (Bock, Amer. Mus. Novit., no. 1779, 1956; Humphrey and Parkes, Proc. Internatl. Ornithol. Congr., 13:84–90, 1963). The following fragmentary observations, which were made in Corrientes Province, Argentina, during August–September 1969 while I was there studying storks, are offered to help fill that gap. To date relatively little information has been published on the behavior of *Syrigma* (cf. Short, Wilson Bull., 81:330–331, 1969).

Flight.—In contrast to other herons, which have a slow wing-beat and deep wing-strokes, the Whistling Heron flies with short, stiff, and relatively rapid wing-beats. The characteristic flight makes the species recognizable at long distances. At first glance or at a distance, the flight is more reminiscent of a large lapwing or plover than a heron. On the only occasion that I timed the flight of a *Syrigma*, it was flapping at a rate of 273 per minute. This rate is rather fast compared to the rates I have measured in other (slightly larger) species of herons: *Ardea melanocephala* (Kenya: 1 record) = 162/min; *Ardea purpurea* (India: 1 record) = 148/min; *Egretta intermedia* (India: 11 records) = 196/min.

Whistling Herons that I observed usually flew with the neck only partially retracted and not with the head pulled all the way back onto the shoulders as do most other herons. Furthermore, the birds frequently extended their neck fully forward in flight and uttered a series of melodious whistles (see below). During aerial calling, the flapping rate increased and the amplitude of the wing-strokes decreased, with the wings hardly going above the level of the back on their up-stroke.

Vocalizations.—Both the common and scientific names of the Whistling Heron derive from the bird's commonest call: a clear, loud, melodious whistle, about 1–1.5 sec long and often repeated in a series of 2–5 calls *ca.* 0.5 sec apart (cf. Friedmann and Smith, Proc. U.S. Natl. Mus., 100:411–538, 1950). This whistle is given either while the bird is perched or in flight; the performing bird usually extends its neck fully with each call or series of calls and holds its bill widely open.

A second call that I heard was a more heron-like guttural croak, which, however, was much higher-pitched and with a more sibilant quality than the comparable calls I have heard in other herons.

A third call, which I heard only during a ritualized display at a feeding area (see below), was a high-pitched, flatulent, and rasping buzz about 1 sec in duration, uttered forcefully at the peak of the display.

Ritualized displays.—As described above, during the whistling vocalizations either perched or in flight the neck is usually extended fully. On one occasion I saw several Whistling Herons perched within the canopy of a small forest bordering a pond. One bird stood on a limb, extended its neck fully upward about 30° in front of vertical, pointed its bill up in line with the neck, and gave a series of 4–5 whistles 1–1.5 sec long and about 0.5 sec apart. The bill was gaped open continuously during the series of vocalizations.

On 16 August 1969 I saw three *Syrigma* fly in and land in shallow water at the edge of an extensive marsh. One was giving the melodious whistle as it landed. After landing, the three walked about for a few minutes. Then one bird approached to within several meters of another and quickly adopted an oblique posture, with body, neck, and bill on a line and pointed down about 20° below the horizontal, so that the tip of the bill nearly touched the surface of the water. As the bird stretched forward, it gave the flatulent buzz described above. This display was repeated several times by the same bird; the other two stood quietly and appeared to be watching.

At the "Estancia Tres Marias," just south of Corrientes City, I observed an apparent courtship display on 15 September 1969. A pair of *Syrigma* walked rapidly side by side at the edge of a garden with closely-clipped grass. Both held all their head-plumes and upper-neck feathers strongly erected and their bills high, just above the horizontal. Every four to five steps one bird (which I took to be the male) bowed forward until its bill almost touched the ground; then it stood erect once more and continued marching alongside the other bird. During the bow, the pace of both birds slowed but did not stop. Occasionally one or the other of the displaying birds raised its head until the bill was about 60° above the horizontal, gaped the bill widely, and uttered 2–4 whistling notes. Another pair of Whistling Herons was performing similar displays about 15 m away. After displaying for about 5 min, both birds of the pair flew off together.

The latter display may be related to the one described by Short (loc. cit.). Like that author, I am unable to comment on the significance of these observations, other than to say that the behavior of *Syrigma* appears quite unlike that of any other heron that I have observed, including *Nycticorax*. I agree with Humphrey and Parkes (loc. cit.) that the present behavioral evidence suggests that *Syrigma* is not closely related to *Nycticorax* and should not be included in that genus, as was suggested by Bock (loc. cit.). Further conclusions on the taxonomic relationships of *Syrigma* must await a thorough study of the ethology and ecology of the species. Such a study would seem highly feasible in northeastern Argentina, where the bird is abundant and easily observed.

These observations were made under a research grant from the National Geographic Society, and this paper was written while I was a Chapman Research Fellow at the American Museum of Natural History. I thank Dr. A. J. Meyerriecks for comments on the manuscript.—M. P. Kahl, *American Museum of Natural History, New York, 3 November 1970.*

Nestling mortality in a Texas heronry.—Nesting success studies of colonial birds are hampered by the unmeasured effect of the investigator on the colony. Dusi and Dusi (Wilson Bull., 80:458–466, 1968) state that their presence in a heronry may have affected breeding success, but given no measurement of this affect. The following study was an attempt to quantify the effect of frequent nest checking on reproductive success in a Texas heronry.

The study was conducted during the summer, 1970, at a 50-acre lake on the Rooke Ranch, Refugio County, Texas. The colony consisted of an estimated 6,582 birds, 91 per cent of which were Cattle Egrets (*Bubulcus ibis*). The remaining 9 per cent were: 175 Little Blue Herons (*Florida caerulea*), 150 Snowy Egrets (*Leucophoyx thula*), 100 Louisiana Herons (*Hydranassa tricolor*), 50 Roseate Spoonbills (*Ajaia ajaja*), 40 Black-crowned Night Herons (*Nycticorax nycticorax*), 35 Anhingas (*Anhinga anhinga*), 20 American Egrets (*Casmerodius albus*), 6 Great Blue Herons (*Ardea herodias*), and 6 White Ibises (*Eudocimus albus*). About 200 Boat-tailed Grackles (*Cassidix mexicanus*) were also present.

The heronry was situated in about five acres of dead huisache (*Acacia farnesiana*) trees at the southeast edge of the lake. Water depth at the colony varied from two to three feet, and most nests were 18 to 48 inches above water. Two study sites, each 100 yards by 15 yards, were selected in the heronry. The sites were 75 yards apart, a distance sufficient to prevent disturbance to one site while the other was being checked. The

TABLE 1

CHANGES IN NUMBER OF EGGS AND NESTLINGS

	Site I (77 nests visited at 2-day interval)			Site II (100 nests visited at 8-day interval)		
Date	Eggs	Nestlings	Loss per 8-day interval	Eggs	Nestlings	Loss per 8-day interval
6 July	223	0	0	278	0	0
14 July	90	115	17	105	163	10
22 July	19	180	6	14	229	25
30 July	3	163	33	1	177	65

sites, equidistant from shoreline, were similar in nest density, species composition, and general appearance.

On 6 July, 164 Cattle Egret, 5 Louisiana Heron, 2 Snowy Egret, 3 Black-crowned Night Heron, and 2 Little Blue Heron nests with eggs were marked. Within eight days approximately 60 per cent of the eggs had hatched. From 6 July until 3 August when the nests were destroyed by Hurricane Celia, nestling development was noted at one site every two days and at the other site every eight days. Nest checking was made by a single individual wading at the site. No other known human activity occurred at the colony. Since the only apparent difference between the sites was that one received four times more visits than the other, a difference in nestling mortality should indicate the effect of frequent nest checking. Table 1 shows the changes that took place in the number of eggs and nestlings during the study period.

At the beginning of the study period the area visited at two-day intervals (Site I), had an average of 2.9 eggs per nest and Site II (visited at eight-day intervals) had 2.78 eggs per nest. This difference in the average number of eggs per nest in the two sites was not significant at the 99 per cent confidence interval when the sample means were compared by a *t*-test using pooled variance ($t = .270$, $df = 175$).

At the end of the observation period Site I had been observed 16 times and Site II had been visited four times. The nests in Site I now had 2.12 birds per nest and Site II, 1.77 per nest. Using the same test as above the difference is significant at the 99 per cent confidence interval ($t = 2.96$, $df = 175$). The importance of this difference is more apparent than real because the primary loss of young during the last eight-day interval was through fledging and not mortality.

The nests that were more frequently visited were at least as successful as those infrequently observed, indicating that human visitation is not necessarily detrimental during the later stages of reproduction.

Dusi and Dusi (Wilson Bull., 82:458–460. 1970) reported that of 126 eggs in 50 nests at a Houston County, Alabama heronry, only 18 (14.8 per cent) hatched and produced fledglings. In our study at least 340 of 501 eggs (67.9 per cent) in 177 nests hatched and were near fledging when the heronry was virtually destroyed by Hurricane Celia on 3 August 1970. It appears that, in the absence of such a catastrophic event, reproductive success in Cattle Egrets can be very high.

We wish to express our gratitude to Dr. Clarence Cottam and Mr. Caleb Glazner of the Welder Wildlife Foundation, Sinton, Texas, and Mr. and Mrs. Frank B. Rooke, Jr.,

Woodsboro, Texas, for their support and cooperation.—David K. Goering, *Department of Zoology, University of Arkansas, Fayetteville, Arkansas (Present address: Department of Biology, Cottey College, Nevada, Missouri 64772)* and Ronald Cherry, *Department of Zoology, University of Illinois, Urbana, Illinois 61801, 2 October 1970.*

Collisions with wires—a source of anatid mortality.—As harvest demands upon waterfowl increase and their habitats diminish in quantity and quality, reduction of non-hunting mortality warrants increased emphasis. The authors' observations on the northern prairie breeding grounds suggest that anatid strikes of wires (fence, communications, and power) occur commonly, but go largely unnoticed and unreported.

Hochbaum observed and photographed a full-grown juvenile, female Pintail (*Anas acuta*) impaled on a strand of barbed wire on 15 August 1966, in the Portage la Prairie, Manitoba, Community Pasture (Fig. 1a). The bird flew from a roadside ditch and caught a barb, pointing against the direction of flight, in the skin on the top of the head. The bird's momentum swung it up and over the fence so it was impaled once more. Cornwell observed in August of 1966 an adult drake Blue-winged Teal (*Anas discors*) similarly impaled on the top strand of a barbed wire about three miles east of Woodworth, North Dakota. The drake was caught by the skin on the dorsal aspect of the neck and suffered a broken neck. There was no sign of an immediate wetland area. Charles Dane (pers. comm.) told us of a nesting, Blue-winged Teal female that appeared to have caught itself near the vent on a barbed wire near the nest site. The fence was electrified and the hen was long enough to reach from wire to wire. There was no reason to believe the bird had not been accidentally impaled. Jack C. Shaver (pers. comm.) told us of a drake Pintail flying into telephone wires and wrapping itself by the neck around two wires in July, 1948, 5 miles east of Saskatoon, Saskatchewan (Fig. 1b).

Stout (The nature and pattern of non-hunting mortality in fledged North American waterfowl. Unpubl. M.S. thesis, Virginia Polytech. Inst., pp. 77–81, 91–93) in a monumental, but unpublished, study of non-hunting mortality in waterfowl, reported 1,487

Fig. 1a. Female Pintail in southern Manitoba.
Fig. 1b. Male Pintail in southern Saskatchewan.

deaths from striking telephone and power lines, and 20 from striking fences and buildings in his survey covering a period of about 10 years. He suggests that: puddle ducks are most often involved in such wire strikes, males may be more vulnerable than females (perhaps, in part, because of the "reckless" nature of pursuit flights), and the greatest incidence of strikes is during migration.

No-longer-needed barbed wire fences should be removed from the publicly-owned waterfowl production marshes; and, when overhead lines become a frequent local source of mortality, they should be placed underground or moved. The practice of running fences and lines through marshes should be reevaluated and other alternatives considered.

These measures would bear a substantial esthetic bonus in that the natural beauty of our wetlands would be enhanced while at the same time husbanding the waterfowl resource.—George Cornwell, *School of Forestry, University of Florida, Gainesville, Florida 32601* and H. Albert Hochbaum, *Delta Waterfowl Research Station, Delta, Manitoba. 7 November 1970.*

The Ruddy Turnstone as an egg predator.—The Ruddy Turnstone (*Arenaria interpres*) is well known as an opportunistic feeder, as evidenced by a multiplicity of published notes on unusual food items. That eggs of other birds are not a major element in the normal diet of this species is suggested by their omission from the accounts of the turnstone in most standard reference works. Those few that do mention egg-eating (such as Palmer, in Shorebirds of North America, 1967:259) have apparently derived all of their information from Wetmore (in Bent, U.S. Natl. Mus. Bull. 146:288, 1929) and Bergman (Acta Zool. Fennica, 47:32–33, 1946). Crossin and Huber have recently published an additional observation of this behavior (Condor, 72:372–373, 1970).

All of these reports involve the Old World subspecies *A. i. interpres.* Bergman's is the most detailed description of egg-eating, and forms a part of a general study of the turnstone on its breeding grounds on the coast of Finland. Eggs eaten there included those of several species of gulls and terns, ducks, and other turnstones. The other two reports originated in the islands of the Pacific. Wetmore saw turnstones eating eggs of Sooty and Gray-backed Terns (*Sterna fuscata* and *S. lunata*) on Laysan Island in 1923, and the predation described by Crossin and Huber took place in 1969 on Eniwetok Atoll, Marshall Islands, the victims being Sooty Terns.

In the present note we report two additional observations of egg-eating by turnstones, the first instances of this behavior in the New World subspecies *A. i. morinella.* We will also point out variations in the behavior of the turnstones and of their victims.

John C. Ogden, Research Biologist at Everglades National Park, was kind enough to send us his notes from the Dry Tortugas, Florida. Participators in the Sooty Tern banding project there had noticed numerous punctured eggs in tern nests, especially along the perimeter of the colony, at the head of the beaches, some 4 to 10 yards above high water line. Turnstones had been suspected as likely culprits, as they had often been seen running among setting terns at the beach heads. Predation by turnstones was confirmed by Mr. Ogden in late April and late May 1969, when, during a number of 10–20 minute observation periods, he watched turnstones in the act of puncturing Sooty Tern eggs.

Our own observations took place during the last week of May 1970, when small numbers of turnstones were seen feeding along the shore of Great Gull Island, off the northeastern tip of Long Island, New York. At about the same time, broken eggs had been found in 23 nests of the island's large colony of Common Terns (*Sterna hirundo*). Most of the eggs were split in half, with little of the contents left in the shell when they were found. With few exceptions, the nests where broken eggs were found were thought previously to have been deserted or to be incomplete clutches. At about 19:30 EDT on 30 May, as we were observing Common Tern nests from a building used as a blind, Poole noticed one turnstone making its way through the colony, foraging in typical style by probing under and turning small stones and concrete chips. A few moments later we noticed the turnstone with a tern egg shell in its bill. We watched the bird feeding on the remains of the egg's contents, and then left the blind to inspect the nest. The three eggs therein had been split apart and the contents cleaned out, matching the broken eggs we had found earlier.

We returned to the blind the following evening, 31 May, joined by Helen Hays. At about 19:15, a turnstone landed in front of the blind and began foraging. Miss Hays, who was familiar with the locations of the previously destroyed nests, pointed out to us that the turnstone's movements did not appear to be random foraging. On the contrary, it seemed to be following a definite itinerary, running directly to and pausing at four nest sites in succession where broken eggs had been found earlier in the week. We regard this as circumstantial evidence that the turnstone had been responsible for the original breaking of the eggs, although we actually witnessed only the eating from an already broken shell. Only a single turnstone was seen feeding on eggs on each of the two evenings. A turnstone collected by Parkes along the beach on the morning of 31 May had only insect remains and sand in its stomach.

The egg-opening techniques of turnstones as thus far reported have been quite varied. Those seen by Wetmore were taking advantage of the disturbance caused by the presence of humans walking through the tern colony, following 15 or 20 feet behind the men. They "ran quickly about driving their bills into the eggs without the slightest hesitation, breaking open the side widely and feeding eagerly on the contents, sometimes two or three gathering for an instant to demolish one egg and then with this half consumed running on to attack another."

The only turnstones that have been reported to attack a nest attended by a parent bird were those seen by Crossin and Huber, who witnessed only a single actual egg-breaking. They watched several turnstones harrying an incubating Sooty Tern; each time the tern lunged at one of the marauders, the others would dash in and peck at an egg. Although a ¾ inch hole was pecked in one egg, the tern finally succeeded in making the turnstones give up their attempts at its nest.

On Great Gull Island, as mentioned earlier, most or all of the destroyed nests had been deserted, so the turnstones could proceed in a more leisurely fashion than where terns actively defended their nests. Here the tern eggs had been relatively neatly split in two, the turnstone then drinking the contents from the inside of the shell-halves.

The turnstones observed by Bergman in Finland had quite a different technique in eating undefended eggs. "As soon as they spotted an egg, they picked a hole in it, and sucked the contents as carefully as possible, whereupon they turned it over with quick head movements in order to pick another hole in the shell. In this way, once, all three eggs of a tern were emptied in twelve minutes" (Bergman, op. cit.:32–33, translation by Parkes).

In the Dry Tortugas, too, the turnstones confined their attentions to deserted or temporarily unguarded nests; Ogden never saw one attempt to puncture an egg in an attended nest. Here, however, at least those turnstones that were closely observed were feeding on embryos rather than on the liquid contents of eggs as elsewhere. According to Ogden (in litt.), when a turnstone finds an unguarded egg, it "quickly punctures it with 2–3 hard jabs with its bill, takes hold of the embryo, and pulls it out and eats it.

With one exception, all of the eggs I watched being punctured were relatively fresh and therefore contained small embryos rather quickly extracted. At one egg a turnstone had some difficulty pulling some solid material out through the puncture, which allowed time for a second turnstone to run from 20 yards away, but the second bird almost as quickly ran on after a brief poke at the egg still being worked on by the first turnstone."

The reaction of nearby terns to turnstones is variable, but is relatively mild at most. Our experience on Great Gull Island agreed with that of Wetmore in that the terns did not appear to recognize the turnstone as a predator, neither conspicuously avoiding it or attacking it, although it sometimes passed within inches of incubating terns. Crossin and Huber found that the turnstones on Eniwetok were pecked at as they passed, especially by terns that were incubating; this matches Ogden's observations in the Dry Tortugas. Bergman (op. cit.:110 ff.) comments at length about the proximity of turnstone nests to those of gulls and terns, so it is not surprising that the Finnish terns did not seem to regard turnstones as potential predators. No observer has reported the aerial "mobbing" of turnstones by terns; on Great Gull Island this behavior may be elicited by both predatory (e.g., Blue Jays, hawks) and non-predatory (e.g., Mourning Doves) birds passing over the colony.

Egg-eating by turnstones appears to be an uncommon behavior. Crossin and Huber observed migrant and wintering turnstones in the central Pacific for several years, but had seen only this single instance of egg predation, which apparently involved only five individuals. As stated above, our 1970 observation on Great Gull Island involved only a single turnstone. Although Wetmore did not specify numbers, his observations appear to have been based on many turnstones. Ogden (in litt.) says that "the number of turnstones actually puncturing eggs is small; at least no more than 5–10 may be seen around the total perimeter of the colony of an estimated 80,000 nesting Sooties on any one day. I judge the egg puncturing practice to occur daily during the late March–May incubation period, and that many hundred eggs are destroyed among the relatively small number of Sooties which nest immediately below the vegetation line at the beach head." This concept of a small number of individuals destroying a formidable number of eggs accords with Bergman's findings; he stresses several times that only a few turnstones become what he calls "egg specialists." In fact, he points out that in his study area robbing of tern nests was confined to turnstones nesting on small, isolated, rocky islands. He postulates that the difficulty of foraging in the immediate vicinity of such nests, and the sterility of these wave-washed rocks, had led these few turnstones to investigate abnormal food sources, even including eggs of neighboring turnstones.

In view of the abundance of the New World race of turnstone as a migrant along the Atlantic Coast of the United States at a time when terns and other ground-nesting birds are breeding, it seems remarkable that the Dry Tortugas and Great Gull Island incidents appear to be the first reported cases of egg-eating by turnstones in North America. Many tern colonies, like these two, have been under close surveillance for years. It will be of no little interest to see whether there are increasing reports of egg-eating by turnstones in such well-studied colonies, suggesting that we may be witnessing the spread of a new behavior pattern.

We are indebted to John C. Ogden for permission to utilize his Dry Tortugas data, to Helen Hays for assistance in the field and in the preparation of this note, and to Joseph R. Jehl, Jr., and Mary H. Clench for critically reading an earlier version of the manuscript.—Kenneth C. Parkes, *Carnegie Museum, Pittsburgh, Pennsylvania 15213,* Alan Poole, *Salisbury, Vermont 05769,* and Helen Lapham, *American Museum of Natural History, New York, New York 10024, 23 April 1971* (originally submitted 19 November 1970).

First Puerto Rican record of the Antillean Palm Swift.—The Antillean Palm Swift (*Tachornis phoenicobia*) is an endemic Antillean species that ranges from Cuba and the Isle of Pines eastward to Jamaica and Hispaniola and its southern islands of Beata and Ile-a-Vache (Bond, Birds of the West Indies, 1961). It is common and widespread within its range and normally occurs at low elevations. Although it is found on three of the Greater Antilles, including several offshore islands, it has never been reported from Mona Island (Bond, Notulae Naturae, 176:1–10, 1946; Barnes, Auk, 63: 318–327, 1946) or from Puerto Rico (Danforth, Los Pajaros de Puerto Rico, 1936; Bond, 1961; Leopold, Univ. Puerto Rico Agr. Exp. Sta. Bull., 168:1–119, 1963; Biaggi, Las Aves de Puerto Rico, 1970), islands lying, respectively, 50 and 110 km east of its range in the Dominican Republic.

At 14:30 on 12 July 1969 I saw a single Antillean Palm Swift flying over the coast in Guánica Forest, southwestern Puerto Rico, at a point approximately 38 km east of Cabo Rojo, the southwesternmost point on the island. With me at the time were Mr. and Mrs. Del Buerge, who are also quite familiar with Puerto Rican birds. The sighting was made by the three of us with 7 × 35, 7 × 50, and 10 × 40 binoculars. We were located on the edge of a cliff that dropped vertically 10 m to the sea below, and were watching Caribbean Martins (*Progne dominicensis*) and Cave Swallows (*Petrochelidon fulva*) flying to and from a large cave in which the martins were nesting. Flying in association with them was the palm swift. For two minutes the swift flew in wide circles over the water below, approaching us at times to within 15 to 20 m before arcing inland above us and out of view. Thus we had the opportunity to see well both its dorsal and ventral surfaces, and to compare its size with the two swallows. The swift was smaller than either the martin or the Cave Swallow, and clearly showed the following marks: wings, crown, and tail, including undertail coverts, black; tail slightly notched; rump with a large white patch; underparts white, with a clear black horizontal band between the throat and the belly. We could not discern a thin black line from the lower flanks to the vent, but did notice that the area appeared dark.

The Antillean Palm Swift is so strikingly marked and of such small size that it is not easily confused with any other Caribbean swift. Other black and white swifts, such as the White-throated Swift (*Aeronautes saxatalis*) and the Lesser Swallow-tailed Swift (*Panyptila cayennensis*), are larger and differently marked, and have not been reported in the northeastern Caribbean. I have seen them both within their ranges, and know *Tachornis* from both Jamaica and Haiti, and am thus convinced that the bird sighted at Guánica was *Tachornis*: it thus represents the first record of this species for Puerto Rico.

Since *Tachornis* is a lowland swift and occurs in numbers only 110 km from Puerto Rico, it is perhaps surprising that it has not been sighted previously on the island. Such a water barrier should theoretically pose little problem to a strong-flying species with a range spanning several major and minor islands. It is possible that it occurs infrequently and has been overlooked in the past.

This sighting raises interesting questions in zoogeography and ecology: Why does only one species of swift occur regularly in Puerto Rico? Cuba, Jamaica, and Hispaniola, the three other Greater Antillean islands, each have three swifts (*Tachornis*, *Cypseloides niger*, and *Streptoprocne zonaris*). Moreover, six of the Lesser Antillean islands, all much smaller than Puerto Rico, each have two swifts. One large species (*Cypseloides niger*) occurs as a summer resident on each of the six islands, and one small species of South American origin occurs as a year-round resident on each, as follows: Guadeloupe, Dominica, Martinique, and St. Lucia (*Chaetura martinica*); St. Vincent (*Chaetura brachyura*); and Grenada (*Chaetura cinereiventris*) (Bond, Wilson Bull., 60:207–229, 1948). In Puerto Rico only *Cypseloides niger* occurs; it is primarily a summer resident, being very rare in winter (Leopold, op. cit.; personal observation). Thus Puerto Rico is the only major island in the West Indies that lacks a substantial year-round swift population. Puerto Rico's location near the terminus of the normal routes of dispersion from either South, Central, or North America (see Lanyon, Bull. Amer. Mus. Nat. Hist. 136: 329–370, 1967) has certainly reduced the numbers of birds reaching it. Although Bond (1948, op. cit.) suggests that the dry islands of the northern Lesser Antilles, which are too small to maintain swifts, cannot act as stepping stones for the northward dispersal of these birds, one specimen of *Chaetura brachyura* exists from St. Croix (Leopold, op. cit.). Thus occasional dispersal may occur from the east. The present sighting documents dispersion from the west, and suggests that some ecological limitation may exist in addition to the island's isolation. Throughout its range *Tachornis* is closely associated with Royal Palms (*Roystonea* spp.), and an endemic species (*R. borinquena*) is widely distributed in Puerto Rico. Although it would appear to offer similar ecological conditions, important differences between this and other species could pass unnoticed. Unfortunately ecological studies of *Tachornis* and the other West Indian swifts are particularly lacking, so I can only speculate at this point that Puerto Rico lacks suitable ecological conditions for the birds once they do arrive.

I thank James Bond for his comments on the manuscript.—CAMERON B. KEPLER, *Patuxent Wildlife Research Center, Puerto Rico Field Station, P.O. Box 442, Palmer, Puerto Rico 00721, 31 October 1970.*

Some spatial and temporal dimensions of kingbird foraging-flights.—The Eastern Kingbird (*Tyrannus tyrannus*) characteristically feeds on flying insects, and remains perched until a potential prey is sighted. In the late summer and winter berries are added to the diet, but they too are taken in flight. This note describes some of the dimensions of foraging-flights in relation to prey categories. Birds were observed on open-habitat study plots in the southwest corner of Middlesex County, New Jersey, during July, 1970.

Only flights associated with feeding or attempted prey capture were considered (eliminating territorial pursuits, escapes, and flights related to maintenance behaviors). Foraging-flights were noted to comprise two distance sets—those greater than 40 feet (hereafter termed "Long Flights") and those less than 30 feet ("Short Flights"). All but a few of the 300 recorded flights could be assigned to one of the sets. A stopwatch analysis showed the Short Flight ($n = 11$, $\bar{x} = 2.82$, $s = 1.17$) to be less than 5 seconds in duration and the Long Flight ($n = 11$, $\bar{x} = 10.02$, $s = 3.39$) to be greater than 5 seconds. Further, Short Flights would end at the original (same) perch or a new perch with similar frequencies ($n = 51$ and $n = 69$ respectively, from a sample of 120), but Long Flights greatly increased the adoption of new perches ($n = 68$ from a sample of 75). The feeding behaviors associated with different flight characteristics are described below. It will be seen that these foraging patterns can reflect relative prey sizes and distributions.

New Perch-Long Flight.—Most commonly it appeared that this flight pattern resulted from the pursuit of larger insects. The large prey size permitted distant sighting, and made the pursuit energetically worthwhile. After the capture there was not sufficient advantage in returning to the original perch. The pattern was also noted when adult birds made a capture and then continued in flight to their young (which were still being fed). Less frequently, the pattern occurred as a bird continued to pursue a missed prey, or made multiple captures on a single flight.

New Perch–Short Flight.—This pattern was usually associated with pursuit of small insects that were not immediately caught. The temporal delay leads the bird away from the original perch and although a distance of less than 30 feet is involved, it can be efficient to select a new perch.

Same Perch–Long Flight.—All such combinations resulted from multiple captures, where the bird apparently sighted successive prey with each capture in an area of high prey density. One gains the impression that the bird has undertaken a short sally with "planned" perch return, but that the sally becomes elongated with the opportunistic pursuit of the second (and sometimes third) prey. In spite of the distance thus covered, the Same Perch is assumed, perhaps because of original short-sally intentions or because the bird is in the same immediate region, for which the original perch is optimal. (One almost *vertical* Long Flight did have its last capture near the original perch.)

Same Perch–Short Flight.—This pattern was commonly observed with the capture of small insects near the original perch. An immediate capture thus permitted easy return to the perch that might be particularly favorable (e.g., located in the shade). Larger insects were not involved because their greater size and speed lead to long pursuits. Also, this was the pattern of foraging associated with taking fruit. Immature and adult birds fed at elderberry (*Sambucus canadensis*) and the fruits of nightshade (*Solanum dulcamara*), with brief hoverings in the Short Flights to pluck the berries. The immature birds were particularly frequent at the plants (taking up to eight berries per minute), probably because of the combination of inexperience in flight and the fact that fruits are much easier prey than insects. As reported by Morehouse and Brewer (Auk, 85:44–54, 1968), fruits can sometimes be important even to nestling kingbirds.

The immature birds were repeatedly chased from the fruiting shrubs by a Mockingbird (*Mimus polyglottos*). Of course the latter species frequently established interspecific territories about food sources, reducing the feeding efficiency of other birds by vigorous supplanting attacks.

In summary, the dimensions of foraging-flights can provide a potential ecological index of the dispersion and abundance of different prey categories. Short Flights are associated with small insects while Long Flights usually reflect larger prey. Same Perch returns can be indicative of favorable locations (e.g., with high prey density), while repeated New Perch flights may suggest more widely distributed prey. A measure of changes in foraging patterns with different habitats or seasons might thus provide interesting information on the concomitant changes in prey size and availabilities. The method would also be worthwhile for studies on a comparative basis within Tyrannidae. As a brief example it is noted that the Same Perch–Long Flight, while rare in the Kingbird, is the most common foraging-flight pattern (pers. obs.) of the Olive-sided Flycatcher (*Nuttallornis borealis*), which takes large insects and has strict perch preferences.

Technical problems associated with this method include extraneously induced variations in foraging patterns. The variations or perturbations may result, for example, from intraspecific social relationships, avoidance of predator exposure, or thermal considerations. Such influences should be acknowledged although their importance is probably limited to unusual situations. A more significant variable may be the habitat's density of "suitable" perches. This density can be estimated in future work by simply recording the total number of perches used for each study area.—Charles F. Leck, *Department of Zoology, Rutgers University, New Brunswick, New Jersey 08903, 2 October 1970.*

Great Crested Flycatcher observed copulating with an immature Eastern Bluebird.—On 11 June 1970, I was observing breeding birds in a second-growth cove hardwood forest along Abram's Creek in Cade's Cove, Great Smoky Mountains National Park, Blount County, Tennessee. The calls of a Great Crested Flycatcher (*Myiarchus crinitus*) attracted my attention to a small deciduous grove bounded on one side by a grazed pasture. Within the stand the flycatcher was calling repeatedly. Several small passerines were moving through the trees including a family of Eastern Bluebirds (*Sialia sialis*) consisting of the two adults and three grown young-of-the-year in the spot-breasted juvenal plumage. The family was moving slowly with the parents searching ahead for food and returning to feed the begging fledglings that followed. As the bluebirds moved across a small open area beneath the canopy a Great Crested Flycatcher flew down from a treetop perch and hovered facing one of the juveniles for a few seconds. The young bluebird assumed the begging-feeding posture with fluttering wings whereupon the flycatcher moved from his hovering position in front of the young bird to its back. The flycatcher then proceeded to copulate with the juvenile bluebird. This the flycatcher accomplished by standing on the bluebird's back while keeping balanced with fluttering wings. This attempt lasted one to three seconds whereupon the flycatcher returned to a higher perch and resumed calling. The young bluebird remained almost motionless for approximately a minute before flying to rejoin the family group.—FRED J. ALSOP III, *Department of Zoology and Etymology, University of Tennessee, Knoxville, 37916 11 September 1970.*

Adaptive behavior of tits which have lost one eye.—I have systematically observed the behavior of two tits each of which had lost one eye, a Carolina Chickadee (*Parus carolinensis*) and a Tufted Titmouse (*P. bicolor*). The case histories are as follows.

On 6 July 1969, when I brought food to a feeder at my house in southern Maryland, a Carolina Chickadee with dishevelled feathers attracted my attention. It appeared that the left eye with a portion of skin and feathers was missing. The wound extended from the left ear to the bill, exposing the bone of the upper mandible. However, the bird was able to eat. It alighted on my hand to take a crumb of walnut. (All the tits that live on my wooded tract had been trained to alight on my hand.) As if aware of his defect, the male chickadee devoted much time to examining the surrounding area with his only eye. The head was usually moving from one side to the other, but more often to the left so that, in forward motion, the right eye could control the front of the bird. Sometimes the chickadee even performed several counterclockwise spins, especially when taking part in the lively chatter and sportive exercises of the flock of tits.

The right eye has become more extroverted due to its intensified use. This adaptive modification, combined with rapid swings of head and body, has evidently led to an increase in the efficiency of the remaining eye. In addition, the physical defect has brought about an extremely swift reaction to unusual sounds, notably to the opening of the camera shutter which is accompanied by a click. To arrest the bird in the lens field, the clicking sound had to be eliminated.

The Tufted Titmouse (Fig. 1) lost its eye sometime in December 1969. It had no other injury, and the defect was brought to my attention by a peculiar behavior of the bird. In contrast to the one-eyed chickadee, the Tufted Titmouse avoided superfluous motions. After each change of perch, the bird sat motionless for a while. The flight of the titmouse was slowed down and almost noiseless as the bird kept its feathers fluffed when moving around.

FIG. 1. The one-eyed Tufted Titmouse picks up a crumb of nut.

These characteristics of behavior seem to depend on the relatively larger size and weight of body. The Tufted Titmouse cannot stop the inertia of motion so quickly as the Carolina Chickadee. More time and braking power are needed to either stop the motion or change its direction. Therefore the position of obstacles in the direction of movement should be accurately perceived from a greater distance than in the case of the Carolina Chickadee. This is hardly possible with one eye. To improve maneuverability in brushy habitat, the velocity of movement has to be reduced by fluffing the feathers. An additional gain for the titmouse is a silent owly flight which may increase its chances of survival.

The one-eyed Tufted Titmouse is a female. Both she and the chickadee were mated in the following spring and successfully raised their broods.—MARTIN A. SLESSERS, *Route 4, Box 146, Brandywine, Maryland 20613, 21 August 1970.*

Range extension of the Golden-crowned Kinglet in New York.—The Golden-crowned Kinglet (*Regulus satrapa*) has been found in New York state during the breeding season in a number of isolated locations outside of its usual breeding areas in the Adirondack and Catskill Mountains. There are a few such records in the late 19th and early 20th centuries, but since about 1949 the species has been discovered in summer in more new places. These occurrences have been largely coincident with the maturation of artificially planted spruce stands in the state.

During the past several years, particularly in the breeding seasons of 1969 and 1970,

FIG. 1. Golden-crowned Kinglet breeding distribution in New York state showing isolated breeding locations examined by the author (black ovals) and reported by others (crosses) in relation to the species' general breeding range in the Adirondack and Catskill Mountains (slanted dashes).

I investigated spruce plantations mostly in state reforestation areas through southern New York west of the Catskills and found kinglets in 46 separate stands situated in 35 disjunct localities. Examination of state Division of Lands and Forests aerial photographs and data and selection of plantations of proper age with trees at least 15 cm DBH led in the field almost invariably to those containing kinglets.

Evidence of nesting in the plantations I checked has so far consisted in the observance of family groups and fledged young birds being fed in June and July. Kinglets have now been recorded in some tracts during several consecutive breeding seasons and I believe that they breed each year in most of the plantations I investigated. A few stands are known not to have contained kinglets regularly; several localities found by others have been cedar, balsam or spruce bogs and cemeteries with scattered large spruces. Kinglets have not established themselves permanently in the latter sites.

The map (Fig. 1) shows that the isolated kinglet breeding localities are scattered about the state; they cover an area which represents a large portion of the bird's eastern continental range. The siting of most of them is determined by the location of reforested tracts established about 35 to 40 years ago. The disjunction of these new populations is similar to that existing in parts of the Adirondacks and Catskills and especially to that found southward in the Appalachians.

The Golden-crowned Kinglet is known to nest in pine, fir, spruce, and hemlock woods or groves in pure or sometimes mixed stands, occasionally with deciduous trees present, as well as in tamarack, spruce, balsam and cedar bogs (Bent, U.S. Natl. Mus. Bull., 196, 1949), but in the new places it is confined almost entirely to spruce in usually tall, dense stands. Most of these lie from 1200 to 2400 feet above sea level in the state's hilly, stream-dissected uplands in areas originally occupied by native deciduous or mixed forest and subsequently farm fields and orchards. Stands containing breeding kinglets were planted mostly from 1931 to 1936. Spruces in them usually vary from about 10 to 20 m in height, the trees forming a closed layer at middle levels. Exceptions to this height are the 25 to over 30 m tall spruces in Letchworth State Park and near Margaretville at the edge of the Catskills, which were planted over 50 years ago. Spruce stands range in area from two to about 60 acres; most are less than 30 and almost half of those in which I found kinglets are less than 10 acres in extent. They usually consist of pure Norway spruce (*Picea abies*), or white spruce (*Picea glauca*), but sometimes contain both species with the former predominating. In at least two places kinglets have been discovered in mixed red pine (*Pinus resinosa*)-spruce stands, and in two localities in banded spruce-pine plantings with bands 10 and 20 m wide.

Only once did I find kinglets in a recently thinned plantation where alternate rows of spruces had been removed for pulpwood and lower branches of the remaining trees trimmed. Such forestry practices are carried out in many stands and the trees that are left usually attain a closed condition after some years. This closed layer is most suitable for kinglets. It prevents sunlight from penetrating the lowest level so that frequently it is rather dark within the stand. The resulting shade is conducive to slightly cooler temperatures and more moisture than exist in surrounding pine and deciduous forest. Mosses, lichens, fungi, and mushrooms respond in abundance to these conditions. Some unthinned, unpruned, almost impenetrable stands may be more suitable than old thinned ones for kinglet colonization if trees are sufficiently mature.

Most plantations contain from one to three pairs of kinglets each, a breeding density per acre that differs considerably among the stands owing to their wide variation in area. Breeding density in the new localities averages somewhat less than that determined by breeding censuses in spruce habitat in several places at slightly higher latitudes within the species' eastern range. It is considerably lower in general than densities found in some high altitude Appalachian native coniferous and mixed forests where as high as one pair per two acres has been reported. Sparse density might be expected in these new, relatively small and isolated tracts where initial establishment and perhaps the subsequent annual repopulation of breeding individuals may be derived from scattered migrants or a wandering late winter flock. Although kinglets occasionally enter pine plantations and native deciduous forest bordering the spruce tracts, they seldom stray far from the dense spruces.

Other breeding birds characteristic of these spruce plantations are Blackburnian, Black-throated Green, and Magnolia Warblers, Black-capped Chickadee, and Slate-colored Junco. Red-breasted Nuthatch and Myrtle Warbler have been found in them more frequently in recent years, and it appears that these two species are also undergoing some range expansion in New York in response to this new habitat.

I think that at this latitude elevation is not a significant factor affecting kinglet presence in the new localities. The mere existence of suitable habitat with its structural and microclimatic conditions appears to be the major, if not only, requisite for kinglet colonization. Breeding kinglets in the Adirondacks, at only a slightly higher latitude than these new areas, occur through a wide range of elevations, some at considerably lower as well as higher altitudes than the new populations. The fact that kinglets do not breed lower than about 3000 feet in the Catskills is probably attributable only to the absence of suitable habitat there below that height. Farther south, in the Pocono Mountains of Pennsylvania, they nest as low as 1700 feet elevation. Altitude and related climatic conditions probably become more significant as influence factors in the disjunct populations of the Appalachians from West Virginia to North Carolina. There they usually occur from about 3000 feet elevation at generally increasing altitudes toward the south (G. A. Hall, in litt.).

Todd (Bird of western Pennsylvania, 1940) remarks on the absence (there is an old reference to the species being a "rare" or "casual" breeder near DuBois) of resident kinglets in the western Pennsylvania Canadian Zone despite the existence of some suitable habitat. Apparently they have not spread to these western areas because I have not been able to learn of any recent definite breeding locations in the state outside of the Poconos and North Mountain in its northeastern portion. Lycoming County and Warren in the central and northwestern parts are mentioned as breeding localities in the literature without supporting evidence. The diminution of native conifers by cutting and fire could be one factor which has affected kinglet breeding in Pennsylvania. Also, the lack of any extensive reforestation with spruces is one possible reason why kinglets have not colonized new localities as they have in New York.

There are probably several more breeding populations of kinglets in New York spruce plantations that have not yet been discovered; I did not check all possible habitat in some reforestation areas. A number of plantations that I examined were not suitable for kinglets either because of age or tree density and species composition, but some of the younger stands are potential future habitat when they attain sufficient size. If forest practices and commercial use permit enough spruce plantations suitable for kinglets to remain, the range extension outlined here will probably persist indefinitely.

I thank the many persons who provided assistance and information, and I am also indebted to New York State Department of Lands and Forests officials for aid, particularly, P. Carter, W. C. Craig, E. A. Karsch, R. Pigman, and G. H. Smith.—ROBERT F. ANDRLE, *Buffalo Museum of Science, Buffalo, New York, 6 November 1970.*

Starling feeds young Robins.—A female Robin (*Turdus migratorius*) built a nest in the crotch of a Hicks upright yew about fifteen feet from the ground. The yew was situated in a grove of evergreens on a property just off Highway 13 in Delaware, and the nest could be clearly seen from a second-story window of the house on the property. The female Robin laid and hatched two eggs. She was seen feeding the young and removing excrement from the nest until 27 May 1970. The male was not seen at the nest.

On 26 May a Starling (*Sturnus vulgaris*) appeared at the nest, and began feeding the young and removing excrement. The female Robin continued feeding and caring for the young along with the Starling. On 28 May the Robin stopped caring for the young, apparently driven away by the Starling.

On 29 May I saw the Starling feed the two young several times. We could not always discern what the Starling was carrying, but frequently we saw insects in its bill. The female Robin did not approach the nest, but three times I saw what appeared to be a Starling chasing a Robin around the roof above us. At this date the young Robins were beating their wings and creeping onto the edge of the nest.

Early on the morning of 30 May, the Starling again fed the young in the nest. A short time later one young left the nest. Thereafter there was much excitement and calling from two Robins on the roof. The second young left the nest in the late afternoon. We could not locate either of the young in the dense undergrowth, and it is not known whether the Starling continued feeding or whether the Robins took over the care of the young.

Logan (Auk, 68:516–517, 1951) has described the feeding of young Robins by a male Cardinal (*Richmondena cardinalis*) at least a day before its own young hatched, and twelve days after the robins had left their nest. Jewett (in Bent, U.S. Natl. Mus. Bull., 196:1949) has also recorded a Swainson's Thrush (*Hylocichla ustulata*) feeding nestling Robins whose parents were present. In the numerous instances of interspecific helpers at the nest summarized by Skutch (Condor, 63:98–226, 1961), the participation of a hole-nesting helper at the open nest of another species seems to be quite rare.—KATHLEEN GREEN SKELTON HERBERT, *R. D. 2, Middletown, Delaware 19709, 21 August 1970.*

An aberrant incubation stimulus.—A thermistor telethermometer probe, inserted into the nest of a Cardinal (*Richmondena cardinalis*), may have functioned as an incubation stimulus for the nesting female. A standard white-tipped, round telethermometer probe was inserted through the bottom of the empty nest and extended 2.3 cm above the nest floor. It is doubtful that the probe was in direct contact with the median apterium of the bird because the probe registered temperatures from 28–30°C, which are lower than would be expected under direct contact.

The probe was inserted on 26 April 1969. A single egg was found under the incubating female on the evening of 4 May, at which time the egg was removed. The bird continued to incubate in the absence of eggs until the probe was removed on 23 May. After the removal of the probe, the bird was seen only once at the nest, which then was abandoned. The length of observed incubation for this bird was 27 days, the normal incubation period being 12 to 13 days.

This may support the view (McClure, Auk, 62:270–272, 1945) that for some birds the "feel" of the egg or other object alone may evoke the incubation behavior. Prolonged incubation of infertile eggs (Berger, Condor, 15:151, 1953; Jickling, Jack-Pine Warbler, 18:114–115, 1940; Peterle, Wilson Bull., 65:119, 1953) has been reported for several species, but this is the first case known to the author where this behavior apparently was elicited by an object (4 mm × 4 mm) considerably smaller than the species' own eggs (25.3 mm × 18.2 mm).—JOHN R. HALDEMAN, *Department of Zoology, University of Arkansas, Fayetteville, Arkansas 75701, 31 October 1970.*

Bull snake and Common Grackles.—About a dozen pairs of Common Grackles (*Quiscalus quiscula*) nest each spring in the willows along Little Dry Creek near my home in Arapahoe County, Colorado. One huge tree has 10 branches going abruptly upward from the main trunk, and in this tree a pair of grackles built a nest completely concealed by heavy foliage about 15 feet from the ground. I had watched the birds carrying material and consequently knew its location, though it was not visible from below.

On the afternoon of 8 June 1970 I saw a five-foot bullsnake (*Pituophis*) at the base of the tree; it paused momentarily and then started up the rough bark of the trunk—and unerringly headed along the branch holding the nest—bombed by the pair of grackles and at least eight others from nearby. Half of the snake disappeared into the leaves at the nest site, leaving a loop below, and with a long pole I tried to dislodge the reptile. The head appeared and the snake disgorged the yolk and white of an egg, apparently retaining the crushed shell. The animal fell to the ground and was mobbed by the irate birds as it headed into long grass.

We know, of course, that bullsnakes regularly rob nests. Through the years we have observed them taking eggs of ducks and other ground nesting species at Mile High Duck Club, and I have seen snakes high in towering cottonwoods in nests of Great Blue Herons (*Ardea herodias*) though without at the time giving a thought as to how the reptiles locate eggs in out-of-the-way places.

Seeing the bullsnake ascend without hesitation the one correct branch of 10 of the willow intrigued me. Was it mere happenstance, or do reptiles have an innate something which enables them to located food?—Robert J. Niedrach, *The Denver Museum of Natural History, Denver, Colorado, 12 June 1970.*

INFORMATION WANTED

Several hundred mounted Mexican bird specimens, many of them from the vicinity of Ciudad Victoria, Tamaulipas, have been housed at the University of Oklahoma Museum of Zoology since my coming to Norman in the fall of 1952. Since some of the specimens had, according to the museum's old catalogue, been collected by Charles D. Bunker, I continued to assume that all had been taken by him, or possibly by one of his field assistants. According to Margaret Morse Nice (Birds of Oklahoma, 1931, p. 43), Bunker was a "taxidermist at the University of Oklahoma" from 1901 to 1903. The Mexican specimens referred to were taken in 1910 and 1911, years during which Edwin D. Crabb "collected and mounted various birds" near Yukon, Canadian County, Oklahoma (Nice, op. cit., p. 44). Crabb may also have collected birds in Mexico in 1910 and 1911, for all I have thus far been able to find out. However, according to the museum's old catalogue none of the Mexican specimens referred to was taken by Crabb, a few were taken by Bunker, and no collector's name is given for most of them. One specimen, a Stygian Owl (*Asio stygius*), taken 22 April 1911 at or near Ciudad Victoria, is of special interest since it may well represent the only record of *A. stygius* for the whole of northeastern Mexico. My friend Alexander Wetmore is confident that Bunker could not have been in Mexico in April of 1911. I have written Crabb, addressing the letters to the University of Colorado in Boulder, but the letters have been returned to me unopened. Will anyone having information as to who might have collected all these Tamaulipan specimens in 1910 and 1911 please write me?—George M. Sutton, *University of Oklahoma, Norman, Oklahoma 73069.*

ORNITHOLOGICAL NEWS

Dr. H. Lewis Batts, Jr., Past-president of the Wilson Society, and former Editor of the Bulletin was awarded an Honorary Degree of Doctor of Science by the Western Michigan University on 17 April 1971. Dr. Batts was honored for his leadership in the founding and developing of the Kalamazoo Nature Center.

The John Burroughs Medal for excellence in natural history writing was awarded to John K. Terres for his book, "From Laurel Hill to Siler's Bog" on the occasion of the Fiftieth Anniversary of the John Burroughs Association.

The National Geographic Society has published a species index for the complete Bent "Life Histories of North American Birds." In addition to the technical name and the usually accepted common name, many colloquial names have been included. The index is available from the Society.

Ernest P. Edwards is working on a compilation to be known as "Workbook of the Birds of the World" which will include a full listing of all known species giving technical name, a suggested vernacular name, and brief information about the distribution. At present a mimeographed rough draft is available for the sub-passerines ($4.50) and the section on passerines will be available soon. Persons interested in obtaining one of these rough drafts or in getting more information about the project should contact Dr. Edwards. (Sweetbriar, Virginia, 24595.)

The Eastern Bird Banding Association is again sponsoring a $250 grant for an undergraduate or graduate student for research in ornithology. The work, to be considered, must involve bird banding as a part of the research or thesis; the college or university must be within the United States. Those interested in applying should write to: Dr. W. D. Merritt, Chairman, Riverview Road, Rexford, New York 12148. The deadline for receipt of completed applications is March 20, 1972.

FROM THE A.O.U.

At the annual meeting of the A.O.U. at Seattle, Washington on 30 August the following officers were elected.

President: Robert W. Storer
First Vice-President: Joseph J. Hickey
Second Vice-President: George A. Bartholomew, Jr.
Secretary: Richard C. Banks
Treasurer: Burt L. Monroe, Jr.
Editor: Oliver L. Austin, Jr.

The Brewster Medal was awarded to Charles G. Sibley for his studies in the application of electrophoresis to avian systematics.

ORNITHOLOGICAL LITERATURE

Species Taxa of North American Birds, A Contribution to Comparative Systematics. By Ernst Mayr and Lester L. Short. Publications of the Nuttall Ornithological Club, No. 9, 1970: 6 × 9 in., 127 pp., 8 tables. $4.00.

For those who have thought that the taxonomy of North American birds was complete with the 1957 edition of the A.O.U. Check-list, or who had hoped that the nomenclature was now stable and could be used as an authoritative basis for all sorts of faunal and ecological listings in which stability of scientific names is desired, this book will be a shock. As the authors have demonstrated, the systematics of North American birds, although relatively well known, is far from a closed book. The biological species concept has resulted in the need for re-evaluation and a new classification approach to show the current thinking on relationships of taxa.

The new approach to the classification and nomenclature of North American birds is quite different from that of any of the several editions of the A.O.U. Check-list, although it is based on the taxa of the fifth edition (1957) of this publication. The main thrust of the Mayr-Short effort is toward showing relationships rather than differences in populations while the latter has been a more important objective of most classifications in the past. The objective of showing relationships is accomplished by not recognizing weakly differentiated geographical races by name; by combining what have been considered closely related but distinct species into polytypic species; by the use of the concept of the superspecies for those populations that are not quite closely enough related to combine in polytypic species; by recognizing "species groups" which are still less closely related but not sufficiently so for classification as distinct genera; and by making the genera more inclusive. Particular attention is paid by the authors to showing relationships of North American taxa to those of other continents by bringing them into the same groupings when this is considered justified.

Emphasis on the biological species concept as a basis for the proposed arrangement is considered by the authors to give a more meaningful classification. This concept, that "a population belongs to a given species when not isolated from it by intrinsic reproductive barriers," although not new to American systematic ornithology, is stressed more in the present paper and in most cases has resulted in recognizing more comprehensive polytypic species. Examples are uniting in single species, the Great Blue Heron (*Ardea herodias*) of America and the Gray Heron (*A. cinerea*) of the Old World; the various flickers, *Colaptes auratus*, *cafer*, *chrysoides*, *mexicanus*, and *chrysocaulosus*; and the temperate and tropical American House Wrens, *Troglodytes aedon*, *brunneicollis*, and *musculus*. In a few cases, this concept has separated what were considered single species into two separate species. The Traill's and Alder Flycatchers (*Empidonax traillii*) and (*E. alnorum*), and the Pacific and Arctic Loons (*Gavia pacifica*) and (*G. arctica*) are examples of this.

There are many instances in which North American species are grouped in superspecies, sometimes combining North American taxa with those in distant parts of the world. Following the practice of Amadon, brackets around the species name indicates this relationship. Some examples of well-known American species which have been combined with others into superspecies are: the Least and Hammond's Flycatchers, *Empidonax* [*minimus*] *minimus* and *E.* [*minimus*] *hammondii*; the martins, *Progne* [*subis*] *subis*. *P.* [*subis*] *chalybea*, *P.* [*subis*] *dominicensis*, and *P.* [*subis*] *modesta*; and the Barn Swallows, *Hirundo* [*rustica*] *rustica*, *H.* [*rustica*] *tahitica*, *H.* [*rustica*] *angolensis*, and *H.* [*rustica*] *lucida*.

The species of birds breeding in North America are listed by family groups in the first section of the book in the form of a table. By use of symbols in columns following the species name, it is indicated whether they are monotypic species, uncomplicated polytypic species, strongly differentiated polytypic species, members of superspecies, or members of species groups. A final column shows other taxa to which the listed species are related and, by symbols, how they are related. This table includes a remarkable amount of information in relatively little space. Taxonomic comments explaining the basis for the proposed arrangement appear in separate sections of the book.

Polymorphism is not considered by the authors to be a problem in understanding speciation of North American birds today as it was in former generations. The most confusing species are those that have an entire population of one morph while another population may have either another morph or both together, such as the Great Blue (Great White) Heron, the Snow (Blue) Goose, and the Common (Black-eared) Bushtit. These are considered good examples of elucidation by the biological species concept.

Phenotypic similarity resulting in sibling species is thought by the authors to be less common in birds than other groups of animals because the intraspecific recognition signals of birds (coloration, calls and songs) are perceptible by the same sense organs in man as in birds (eye and ear) as distinct from chemical signals common in mammals and insects. Those bird species that are difficult to separate morphologically are chiefly in the tyrant flycatcher and swift families although the Semipalmated and Western Sandpipers are considered as possibly qualifying as sympatric sibling species.

The subject of hybridization is discussed in considerable detail because of its obvious significance in determining the relationships as either distinct species, polytypic species or superspecies. As pointed out by the authors, there is room for considerable difference of opinion and need for much more study of the significance of such hybridization in classification. There are many borderline situations as would be expected in a concept based on evolutionary changes. The authors mention 19 situations involving 16 species where hybridization is considered sufficient (existence of a hybrid zone) to classify the taxa as elements of polytypic species. These include, among others: the Mallard, Mexican, and Mottled Ducks; the Tufted and Black-crested Titmice; the Myrtle and Audubon's Warblers; the Baltimore and Bullock's Orioles; the Gray-crowned and Black Rosy Finches: and the Slate-colored, Oregon, and Gray-headed Juncos. Also considered conspecific, although hybridization is limited or uncertain, are seven groups including: Atlantic and Black Brant; Common and Green-winged Teal; Common and Northwestern Crows; and Mourning and MacGillivray's Warblers. On the other hand, there are zones of overlap and extensive hybridization in five situations where the taxa are considered as separate species, although members of the same superspecies. These are the Mallard and Black Ducks, Herring and Glaucous-winged Gulls, Blue-winged and Golden-winged Warblers, Black-headed and Rose-breasted Grosbeaks, and Indigo and Lazuli Buntings. Thirteen other situations with more limited hybridization in contact or overlap zones which are considered as distinct species are listed, including one group the A.O.U. Check-list considers conspecific—the Yellow-bellied, Red-naped, and Red-breasted Sapsuckers.

Of the 607 species of birds breeding in North America, as recognized in the present work, 389 are polytypic. Within these 389 polytypic species, no less than 315 North American subspecies were described initially as full species. This shows the extent to which subsequent study has demonstrated the relationships between bird taxa and the usefulness of the trinominal subspecies designation in showing these relationships as well as differences.

The number of species endemic to North America, as defined by the authors, is relatively small (31.2 per cent). The more northerly species and marine birds tend to range into Asia and the more southerly species range into Mexico, Central America, and the West Indies.

The "species group" is a category inserted between the superspecies and the genus, and at the same time, considerable combination of different genera into more inclusive ones is advocated. In the present work, this has progressed to the point that 79 genera recognized in the 1931 A.O.U. Check-list are combined with other genera in that list. How the species group category differs from a finely differentiated genus or subgenus, which might be made to conform to the same group of species, is not clear.

The classification proposed by Mayr and Short is the result of analysis and interpretation of biological speciation information from a large number of cited publications. This guide to the pertinent and widely dispersed literature on the modern systematics of North American birds is a valuable contribution to ornithology. The present book should be a stimulus to other investigators to make thorough biological analyses of the groups of birds with which they are familiar and to either support or refute the conclusions of the present authors. The arrangement presented here would seem to offer an excellent starting point for a new and critical look at the classification of North American birds.—JOHN W. ALDRICH.

BIRDS OF THE CHURCHILL REGION, MANITOBA. By Joseph R. Jehl, Jr. and Blanche A. Smith. Special Publication No. 1 of the Manitoba Museum of Man and Nature, 190 Rupert Avenue, Winnipeg 2, Manitoba, Canada, 1970: 6 × 9 in., 87 pp., 13 figures, 3 maps, paper cover. $2.50.

Since the railroad to the port of Churchill, Manitoba, first opened up a portion of the Hudson Bay lowlands and tundra to ornithologists, the birds of the Churchill region have been extensively studied and enjoyed by professional and amateur ornithologists alike. From these studies, an ever expanding body of knowledge of the avifauna of the region has been built up, culminating, first, in the important monograph "The Birds of Churchill, Manitoba," published in 1934 by Percy A. Taverner and George M. Sutton (Ann. Carnegie Mus., 23). Since the publication of this widely cited early work, and undoubtedly in no small measure as a result of it, ornithological interest in the region has continued to develop, with a corresponding accumulation of knowledge. The collaboration of Dr. Joseph R. Jehl, Jr. and Mrs. Blanche A. Smith in gathering together this recent material and combining it with their own extensive observations in an updated account of the birds of the Churchill region is therefore a most welcome contribution at this time.

Introduced by Robert W. Nero as a book that hopefully will "encourage further recognition of the value of the unique habitat" of the Churchill region, the book provides a useful modern description of the area, along with an important section dealing with recent changes in the environment. Two pages devoted to "Birding at Churchill" provide an additional feature for the field ornithologist. An appendix listing the available data for clutch sizes of some 47 species at Churchill is a useful addition. With respect to their main objective of updating the earlier (1934) work of Taverner and Sutton, the authors have drawn heavily on their own extensive knowledge of the area, and have added relevant observations, both published and unpublished, from many other biologists and ornithologists. A direct comparison with the study of Taverner and Sutton (1934) indicates a considerable body of new material, as exemplified by the inclusion of 67 new entries in the species accounts, bringing the number of species reported from the region to a total of 209. The emphasis by Jehl and Smith on the more recent studies is also reflected in the literature cited, of which almost 90 per cent of the 93 references listed bear dates after 1934.

It would perhaps be difficult for any single observer to assess and comment on the observations presented for all of the 209 species treated in the species accounts. For those species that I have had the opportunity to study, however, I find the material presented by Jehl and Smith to be accurate, discerning, and in general quite useful. For example, in the account of the Arctic Tern (*Sterna paradisaea*), three paragraphs are devoted to feeding and nesting habits in relation to habitat and ice conditions on Hudson Bay and on the many small fresh-water ponds frequented by this species. These early spring observations, often unavailable to the many ornithologists who visit the area later in the season, are a valuable contribution. One is often left wishing that more observations of this type could have been incorporated for more of the species discussed. In other instances, however, there is an unfortunate absence of exact figures and dates, which tends somewhat to reduce the usefulness of the observations. In the account of the Oldsquaw (*Clangula hyemalis*), for example, we find the statement (pp. 29–30) that "nesting usually begins about 20 June, but completed clutches have been found as early as June (Grinnell and Palmer, 1941: 48)." Examination of the original paper cited (Canadian Field-Nat., 55: 47–54, 1941), provides the additional useful information that a clutch was in fact completed by as early as 12 June. These, clearly, are relatively minor criticisms when seen in the context of the book as a whole, more apt to be of concern to an occasional biologist investigating a particular species than to the ornithologist interested in a general account of the birds in the Churchill region.

The format of this first Special Publication of the Manitoba Museum of Man and Nature is in general attractive, perhaps the most striking and pleasing aspect being Mrs. Smith's remarkably fine color photograph of the rock and tundra habitat at Churchill that is reproduced on the cover, front and back. The text, printed on glossy paper, is clear throughout, as are Jehl's 13 black and white photographs of selected birds and habitats. Unfortunately, the binding is weak. Minor inconsistencies also appear in the text, for example, the absence of "a" or "b" to distinguish between two of Jehl's own 1968 publications (p. 75). Somewhat more significant are occasional inconsistencies between references mentioned in the text and those listed in the literature cited section. For example, Wynne-Edwards (1935), cited on p. 70, does not appear in the literature cited. On the other hand, the excellent paper by F. Cooke, dealing with the Snow Geese of La Pérouse Bay (Ontario Naturalist, 1969 (4): 16–19) is listed in the literature cited section, but I failed to find mention of it in the text, and it does not appear where it might be most expected, under the description of *Chen caerulescens*, on page 25. These inconsistencies, although unnecessary, are fortunately rare, and do not detract significantly from the overall attractiveness and usefulness of the publication.

In sum, there can be little doubt that Jehl and Smith have done an entirely credible and useful work. With the current environmental crises threatening many avian habitats, particularly those of the fragile arctic regions, it seems imperative that a greater understanding and appreciation of these areas be attained without delay so that enlightened preservation and survival measures can be taken when needed. It is to be expected that books such as "Birds of the Churchill Region, Manitoba," will go far towards providing the necessary background knowledge and impetus to meet these challenges.—ROGER M. EVANS.

A GUIDE TO THE BIRDS OF SOUTH AMERICA. By Rodolphe Meyer de Schauensee. Livingston Publ. Co., Wynnewood, Penna., 1970: 9 × 6 in., xiv + 470 pp., 50 pls. by E. L. Poole and J. R. Quinn, and 22 bl. and wh. drawings by G. M. Sutton. $20.00. (Three pages of "Further Addenda and Corrigenda" attached).

Never before has there been available a concise, illustrated guide to the birds of South America combining descriptions of *all* species in one volume. The need for such a guide book increased considerably during recent years when previously remote rainforest streams, pampa plains, and Andes cordilleras were placed within easy reach of the modern jet traveler. Meyer de Schauensee's meticulously prepared new book goes far to satisfy both professional scientists and amateurs alike.

A brief introductory section explains altitudinal zones in the mountains and the habitat terms used in the text. Descriptions of a total of 2853(!) species are given on only 427 pages of text, and 73 casual, accidental, doubtful, and introduced species are listed in an Appendix. The short but mostly adequate description of each species (and subspecies where recognizable in the field) is followed by an outline of the range and an indication of the preferred habitat. Notes on behavior or voice are not included (not known in many cases) but a brief biological account precedes each family section. Elimination keys and illustrations serve as an aid in species identification. These novel keys (used by the author also in his book, "The Birds of Colombia," 1964) lead to species groups with certain common characters and are very useful in the field, although difficulties are to be expected in large families. About 680 species (24 per cent of the total bird fauna) are illustrated on 31 color plates, 19 black and white plates (conveniently bound together in the center of the book) and 22 text figures. The plates are the work of J. R. Quinn (30 plates) and E. L. Poole (20 plates: these also appeared in the author's previous volume on Colombia). Although occasionally reproduced somewhat pale, the plates are appealing to the eye; they are mostly adequate as an identification tool except perhaps plate 13 or those 7 plates which show only the heads of 141 species (I doubt their usefulness in the field). The ink drawings by G. M. Sutton are of the usual excellence. High reproduction cost probably precluded adding more plates and three-quarters of the species described in the text are left unillustrated.

The nomenclature and systematic arrangement follow mostly the author's useful list, "The Species of Birds of South America" (1966), written in collaboration with E. Eisenmann. Deviations include the following cases: The family "Conopophagidae" has been dissolved and *Conopophaga* included with the Formicariidae and *Corythopis* with the Tyrannidae (following the proposal by Ames et al., Postilla, 114: 1–32, 1968). Several genera previously placed in the Cotingidae have now been transferred to the Tyrannidae, although the author had recommended in 1966 "to leave the family [Cotingidae] in its traditional arrangement awaiting a complete study." The resulting wide separation of the close relatives *Rhytipterna* (included in the Tyrannidae) and *Lipaugus* (left in the Cotingidae) seems very unsatisfactory. Inspection of Ames' recently published work (Peabody Mus. Nat. Hist. Bull., 37: 160–161, 1971) reveals that the syringeal structure of *Lipaugus* may indeed be similar to that of *Rhytipterna*, although further examination of additional material is needed.

I list below a few suggestions and minor corrections (mainly concerning details of distribution) which might be taken into consideration in preparing a second edition of the guide book: *Picumnus subtilis* Stager (Contrib. Sci. 153, 1968) from eastern Peru apparently has been overlooked. The habitat of *Laterallus viridis* is not like that of the other species of the genus but thickly overgrown wasteland far from swamps and marshes (Haverschmidt "Birds of Surinam," 1968, p. 89). *Trogon comptus* has been collected in western Ecuador (Gyldenstolpe, Ark. Zool., 2: 91, 1951). The record of *Galbula pastazae* from the lower Rio Purus, Brazil (Todd, Ann. Carnegie Mus., 30: 9, 1943) is not valid as it is based on a female of *G. cyanescens* (pers. examination). *Baillonius bailloni* occurs at Puerto Bertoni in easternmost Paraguay (Laubmann, Vögel, Paraguay) as well as in Misiones Province, northern Argentina (Olrog, Op. Lill. 9, 1963; Eckelberry, Wilson Bull., 76, 1964). *Rhamphastos brevis* does *not* occur in eastern Panama; because of its croaking voice, bill shape, and small size I consider this species as a member of the *R. vitellinus-culminatus* group and unrelated to the larger forms *R. swainsonii-ambiguus* with a yelping voice. The toucan shown opposite the title page is identified on page 182 as the red-billed *Ramphastos tucanus*, although it looks to me more like the black-billed *R. cuvieri* (which de Schauensee keeps specifically distinct). *Celeus grammicus* has not been recorded from the Guianas. *Certhiaxis mustelina* occurs in Amazonas Department, Colombia (Olivares, Caldasia, 10: 50, 1967). The occurrence of the southeast Brazilian *Iodopleura pipra* in Guyana is at least questionable. White-rumped populations of this species may have inhabited or still inhabit Minas Gerais, Brazil, whence no specimens are presently available (Camargo et al., Pap. Av. São Paulo 16: 1964). The types of *I. p. leucopygia* (supposedly from "British Guiana") may have had a similar fate as those two skins of another strictly southeast Brazilian species, *Cotinga maculata*, in the collections of the American Museum of Natural History that are also labelled "Demerara," Guyana, which is obviously incorrect. *Attila torridus* has been recorded from Colombia (Nariño; Blake, Lozania, 11, 1959). One of the probable parent species of the hybrid form *Pteroglossus* "*olallae*" is *P. bitorquatus* (instead of *P. torquatus*, see p. 432). It would be desirable to indicate the questionable status of *Fulica* "*ardesiaca*," *Anodorhynchus* "*leari*," *Ramphastos* "*aurantiirostris*" and perhaps *Pipra* "*obscura*" which are included as good species in the text.

The book under review hopefully will encourage work on South American birds at the species level. To further enhance its usefulness as a research tool it would be helpful in future editions to have the species grouped, where feasible, in superspecies even if only on a tentative basis. This would bring out parapatric or allopatric distribution patterns of closely related forms and, with appropriate remarks in the Introduction as to the need for information on the interrelationship of known or supposed members of superspecies, would guide readers to interesting research problems. Any short term visitor to South America can make substantial contributions to the knowledge of Neotropical birds at the species level if he chooses the right species in the right area. Grouping of the species into superspecies would also bring out more clearly the poorly understood fact that a comparatively large number of species replace each other geographically in a uniform environment, presumably as a result of ecologic competition. Such a grouping in zoogeographic species would also help to see the South American bird fauna in more proper proportions compared to the bird faunas of other continents.

The guide book is well produced and clearly printed. Although insufficient and partly inadequate illustrations render field identification of certain passerine groups quite difficult, both professional ornithologists and amateurs will be grateful to the author for having undertaken the immense task of compiling this meticulous and up-to-date guide to the birds of South America.—Jürgen Haffer.

Roberts Birds of South Africa, 3rd edition. Edited by G. R. McLachlan and R. Liversidge. John Voelker Bird Book Fund and the Central News Agency Ltd., Cape Town, 1970: 8¾ × 6 in., xxxii + 643 pp., 56 col. pl., 2 end piece maps. R6.75 (= $9.45).

This third edition of Austin Roberts' classic "Birds of South Africa" is essentially an updating of the second edition (1957). To quote the editors (p. xv) "The third revision provides mainly additions and corrections in distribution, although breeding seasons, incubation and nestling periods, and even new races, are all added. Several species new to our sub-region are also added. The authors wish to draw attention to the fact that changes in distribution do not necessarily imply that the bird populations have changed."

The original plates from the first edition (1940), and therefore the original numbering and order of species, are still used. Since Austin Roberts had his own original ideas on classification, this leads to some unfamiliar families and placements of species. Attention is called to most of the anomalies either in the common names of the birds or in the text, and they detract very little from the usefulness of the book. The text has been entirely reset with new paragraph headings—Identification, Distribution, Habits, Food, Voice, Breeding—making the included information more readily accessible. The distribution maps, which were an innovation of the second edition, have been carefully revised, and are much more trustworthy than the written ranges. The main omission that I noticed was the failure to make use of the information on intra-African migration that has been brought out by the active South African banding program.

It is difficult for us to realize the impact and influence that "Roberts Birds of South Africa" has had on bird study in southern Africa. "South Africa," to Roberts, was that area to the south of the Cunene and Zambesi rivers, and when I was travelling in Rhodesia and Botswana 10 years ago there was hardly a home that I stopped in that did not have a well-worn copy in evidence. Over 60,000 copies of the first two editions were sold, which, in an area with an English speaking population of only 4,000,000, is the equivalent of 2,700,000 copies in the United States. Although other bird books are now becoming available for the same area, Roberts will always be a necessity, if for no other reason than that his names are now the universal vernacular names for the region.—MELVIN A. TRAYLOR

ANIMALS IN MIGRATION. By Robert T. Orr. Macmillan, New York, 1970: 7 × 9½ in., 15 + 303 pp. $12.50.

In 1956 the Macmillan Company published in the Collier Books series a paperback, "The Great Migrations of Animals," by Georges Blond. In this book Blond as a writer and not as a scientist treated in an exciting and often dramatic manner the migrations and journeys of locusts, salmon, eels, geese, buffaloes, and lemmings. His book was both pleasurable and insightful. After a period of fourteen years the same publisher has put out another book on the migration of animals, but this time the author is a scientist and his stated purpose in writing the book is to gather together under one cover the basic principles and recent discoveries in animal migration. Orr directs his book to mammalogists, ornithologists, herpetologists, ichthyologists, entomologists, and zoologists specializing in invertebrates. He feels there is a separation of those studying migration because they tend to stay within their own field of study and restrict their activities to those animals with which they are most familiar. I think Orr is underestimating the serious students of migration.

Most previous books on migration have been rather comprehensive accounts dealing with a particular group of organisms (e. g., insects, fish, birds), and Orr's attempt to amalgamate these works and arrive at the fundamental principles governing migration in a book of approximately 300 pages is only partially successful.

The book suffers in a number of places from an incomplete coverage of the literature and an inadequate reading of the literature covered, which in turn weakens the author's attempt to elaborate basic principles. For example, in his discussion of the influence of wind on bird migration (p. 50), Orr concludes that south winds in the autumn direct migration to the north in the southern United States, but at more northern latitudes southerly winds cause grounding and a cessation of migration temporarily. Orr overlooked an important paper by Drury and Nisbet (1964) where they pointed out that northeasterly autumnal movements of landbirds in New England occur with following winds throughout the fall. On the same page Orr states that Lowery and Newman (1966) found that stable air aloft may be requisite for heavy autumnal migrations, but in Lowery and Newman's paper they found this to be the case in only one of four nights studied.

Although the bibliography has 349 references, several statements are made in the book without supporting citations. On page 60 Orr says that males of the Long-billed Marsh Wren (*Telmatodytes palustris*) arrive on the breeding grounds ten days or so before the females, and during this interval they spend much of their time building dummy nests. This is important information and should have been documented. Mention is made of occasional nocturnal migrations in butterflies, but unfortunately no references are given to permit the interested reader to delve further into the matter. Orr claims that the Eastern Kingbird (*Tyrannus tyrannus*) is a diurnal migrant, again without documentation, but Stoddard and Norris (1967) have recovered the bodies of 23 individuals of this species that collided during nocturnal migration with a TV-tower in northwestern Florida. The same number of Great Crested Flycatchers (*Myiarchus crinitus*) were picked up by Stoddard and Norris during the same period of time, and this species is commonly accepted as a nocturnal migrant (see illustration on page 71 in Fisher and Peterson, "The World of Birds," 1964).

In the center of the book there are 19 color photographs on eight pages. The reason for their inclusion in a book of this nature is puzzling. They have undoubtedly increased the cost without adding very much to the book. Moreover, the subject matter of six of the color plates is duplicated in the black and white photographs scattered throughout the text (i. e., color photographs 1, 2, 5, 6, 11, 12, are very similar to the black and white photographs on pages 91, 94, 200, 136, 150, and 151, respectively). Migration maps are numerous in the text, but no graphs or tables are presented. The index is wrong in several places. For example, according to the index the term *Zugunruhe* (migratory restlessness in caged migrants) is first used on page 39, but the term actually first appears in the text on page 71, and its usage there is misleading.

The sections on the migrations and movements of mammals are good, and this is clearly where Orr has made his greatest contributions. The book's format is attractive and will undoubtedly appeal to the interested non-professional, but there is almost too much factual material for this readership. Professionals not seriously interested in migration will probably read the book and enjoy it, but serious students of animal migrations should probably save their $12.50.—SIDNEY A. GAUTHREAUX, JR.

STUDIES IN THE LIFE HISTORY OF THE SCARLET TANAGER, *PIRANGA OLIVACEA*. By Kenneth W. Prescott. New Jersey State Museum Investigations No. 2, 1965: x + 159 pp., 2 pls., 15 figs., 12 tables. $2.50.

This work represents a major contribution to our knowledge of the Scarlet Tanager, one of the most widely known American songbirds. The tanager's arboreal habits and perhaps a scarcity of numbers probably explain why, previous to Prescott's work, comparatively less was known about it than about other familiar passerines. The style in which this study is presented makes it quite readable, although it is perhaps uncritical and vaguely anthropomorphic in some cases. The book is well organized, and along with two fine colorprints of young tanagers by George Miksch Sutton, it makes a neat, attractive volume.

Most of the work was done in southern Michigan in 1947, 1948, and 1949. Males first arrive in early to mid-May and soon begin to sing from conspicuous perches in the tops of large trees. Females arrive several days later and, Prescott suggests, initially locate the males visually as the latter are easily seen on their tree top perches. After the females arrive, singing is no longer done from such high perches and its intensity decreases. To my mind, at least, this evidence raises the question of whether high visibility leading to a rapid acquirement of a mate is the primary selective pressure responsible for the spectacular plumage of the male Scarlet Tanager or whether some other factor such as a species isolating mechanism is more important. Nest construction is done entirely by the female although the male may influence her in the choice of site. Comprehensive descriptive data on the nest site are presented and indicate that nests are usually placed at openings in the forest.

Incubation rhythm and the factors that influence it are dealt with at some length. Data on clutch size and/or success rate, are presented for only 17 nests. The small number of nests studied is, I feel, the major shortcoming of the entire study. Information on other important aspects of nesting, such as feeding the young and nest sanitation, is also presented.

General behavioral aspects including vocalizations and preening are described in varying detail. One significant point apparently unrecognized prior to this work is that most if not all female tanagers sing during the breeding season. The female's song is similar to the male's, and antiphonal singing occasionally occurs. A comprehensive section deals with other vertebrates found in the tanagers' territory and the interactions, if any, that Prescott observed.

This study contains much significant information on parasitism by Brown-headed Cowbirds (*Molothrus ater*). Eleven of 14 (79 per cent) nests studied by Prescott contained cowbird eggs. Almost as many cowbirds (seven) fledged from successful nests with known contents as did tanagers (eight). The detrimental effects of cowbird parasitism are clear, and apparently are due largely to egg removal by adult cowbirds and/or decreased egg production by the female tanagers. Prescott suggests that if tanagers desert their nests in response to cowbird parasitism, this should be considered a detrimental consequence. I believe it is more meaningful to consider nest desertion as an adaptive response to cowbird parasitism because it gives the birds an opportunity to undertake another and possibly unparasitized attempt at breeding. During his studies, Prescott was fortunate enough to witness a female cowbird in the act of parasitizing a nest. To my knowledge, this observation is unique in that the cowbird removed a tanager egg within seconds of depositing her own egg. Other workers (Hann, Wilson Bull., 53: 211–221, 1941 and Mayfield, The Kirtland's Warbler, Cranbrook Inst. Sci., Bloomfield Hills, Michigan, 1960) have found that host eggs are removed either the day before, several hours after, or the day after the cowbird egg is deposited.

Occasional aspects of this work are marred by uncritical methods and deductions. The statements that the singing rate of the male falls off when the females arrive and that in general, singing rate is constant throughout the day would be more valuable if they were backed up with quantitative data. Prescott states that the cowbird is recognized as an enemy since tanagers usually attack female cowbirds which enter their territory. Yet instances of invading cowbirds not being attacked are noted, as are cases of attacks by the tanagers upon nonparasitic birds such as the Catbird (*Dumetella carolinensis*) and the Veery (*Hylocichla fuscescens*). In an interesting section on predation of tanager nests by Common Crows (*Corvus brachyrhynchos*) Prescott states that crows employ two different methods to hunt tanager nests. However, it is by no means certain that the activities Prescott observed the crows engaging in were designed to reveal the locations of nests.

One of the most valuable assets of this work is the large number of interesting, anecdotal types of observations. Nest predation is a significant phenomenon yet is rarely witnessed. Prescott describes four instances in which he observed nests being preyed upon. The selective advantage of keeping females from copulating with other males is an often cited function of territorality. Prescott describes a relevant observation in which a strange male invaded a territory, copulated with the female, and then was chased off by the resident male as soon as the latter appeared on the scene. Probably most persons interested in avian breeding ecology and behavior will find specific observations such as these, which are of value to their own special interests. Thus, besides being a source of significant information on Scarlet Tanagers and Brown-headed Cowbirds, this study contains much additional material of value to ornithologists.—STEPHEN I. ROTHSTEIN.

THE RANDOM HOUSE BOOK OF BIRDS. By Elizabeth S. Austin and Oliver L. Austin, Jr. Illustrated by Richard E. Amundsen. Random House, 1970: 8¼ × 11¼ in., 131 pp., many color paintings. $4.95.

A pleasant family reference book, "Birds" is made up of alphabetically listed descriptions of birds (such as, in the D's, Dippers, Dodos, Domestic Birds), interspersed with a few general headings (for example: Feathers, Voice, Waterfowl). All the bird families of North America are included as are the most interesting or popular birds of the rest of the world. The illustrations, which unfortunately do not include all the species described in the text, are generally quite nice; there is, however, an extremely odd Great Blue Heron. A good deal of information, all carefully indexed, is available here to the grade four through junior high students, who will perhaps be the book's chief readers. This would be a good book for school libraries as well as for families.—SALLY LAUGHLIN.

FLASHING WINGS. THE DRAMA OF BIRD FLIGHT. By John K. Terres. Doubleday and Co., Inc., New York, 1968: 9½ × 6½ in., xiv + 177 pp., 15 illus. by Robert Hines. $4.95.

This interesting and informative book opens and closes with the story of Mr. Terres's pet Peregrine Falcon, Princess. The chapters in between deal with such topics as How a Bird Flies, Soaring and Gliding Flight, Eagles Over Hawk Mountain, Hovering Flight, Dangers of Bird Flight, and so on.

On this framework is built a rambling presentation of a great variety of anecdotes and observations by the author and many other students of birds. The author is enthusiastic and interested in his subject, and he conveys much delight in the accomplishments of birds.

The name of Crawford H. Greenewalt is consistently mis-spelled "Greenawalt."

"Flashing Wings" could serve as something of an encyclopedia of popular material on bird flight and some other facets of bird life.—ERNEST P. EDWARDS.

PUBLICATION NOTES AND NOTICES

Ornis Scandinavica: Scandinavian Journal of Ornithology. Edited by Anders Enemar. Published twice yearly by Universitetsforlag, P. O. Box 307, Blindern, Oslo 3, Norway. American office: P. O. Box 142, Boston, Mass. 02113. Subscription price per volume, including postage, $8.35.

Published for the Scandinavian Ornithologists' Union, primarily to make the research results of Scandinavian ornithologists known internationally. The first issue appeared in 1970.

Fauna: the Zoological Magazine. Edited by R. Mark Ryan. Published six times per year by Fauna Press, Inc., P. O. Box 895, Rancho Mirage, California 92270. Subscription price per year: $9.00 in the U.S. and Canada, $11.00 elsewhere. Single copies $2.00 each.

A "Scientific American" for zoologists. If teaching and research biologists are finding it impossible to keep abreast of their journals, one wonders how they'll find time for this one. Many will find it worth the effort. The first issue (January/February 1971) contains articles on a variety of animals, written in authoritative yet readable style, and extremely well illustrated. Abstracts of several discoveries of less complexity, prepared from current technical journals are presented in the section "Advances in Zoology." Thumbnail reviews of many new books with an indication of the general level of readership for each are given in "Zoologists Library." An attractive, well-prepared magazine for serious amateurs and professionals.—P. S.

Annual Review of Ecology and Systematics. Edited by Richard F. Johnston, Peter W. Frank, and Charles D. Michener. Annual Review, Inc., Palo Alto, Calif., 1971: 6¼ × 9 in., ix + 406 pp. $10.00.

The 15 papers in this new review are diverse in subject, yet they illustrate the interdependence of ecology and systematics. The editors intend "to cover the important and vigorous topics and to generate interest in reviewing fields in which a potential for major advance seems to exist." This first volume contains no papers about birds, yet ornithologists may be interested in R. C. Lewontin's "The Units of Selection," David L. Hull's "Contemporary Systematic Philosophies," and Malcolm Hadley's "The Ecology of Tropical Savannas." The writing is pitched for advanced students and professionls in biology. Reprints of individual articles can be purchased at the rate of $1.00 each from the publisher, a boon to students and teachers.—P.S.

Check-list of the Birds of New Mexico. By John P. Hubbard. New Mexico Ornithological Society Publication No. 3, 1970: 6 × 9 in., paper covered, 108 pp., 3 maps. $2.50. Order from the New Mexico Ornithological Society, P. O. Box 277, Cedar Crest, N.M. 87008.

Distribution and seasonal status are described for each of 476 species which have been recorded or reported in New Mexico. Several symbols and typefaces are used as shorthand devices, enabling the author to convey much information in short paragraphs. Observations are documented and sight records have been evaluated as to their reliability. Maps on the covers show geographic features and localities.—P.S.

PROCEEDINGS OF THE FIFTY-SECOND ANNUAL MEETING

JEFF SWINEBROAD, SECRETARY

The Fifty-second Annual Meeting of the Wilson Ornithological Society was held 22–25 April 1971 on Dauphin Island, Alabama. The Sponsor was the Alabama Ornithological Society.

The meeting started on Friday with a welcome by Dr. Wilson Gaillard, Chairman of the Local Committee on Arrangements, and a response by William W. H. Gunn, President of the Wilson Ornithological Society.

Papers sessions were held Friday and Saturday. On Saturday, there was a special symposium, Bird Migration in the Region of the Gulf of Mexico, arranged by Kenneth C. Parkes and chaired by George H. Lowery, Jr.

Thursday evening there was a reception in old Fort Gaines on Dauphin Island. A seafood fry was held Friday evening and the Annual Banquet was on Saturday evening.

On early Friday and Saturday morning short field trips were conducted to local areas. On Sunday longer field trips were conducted to various areas in the region.

The recipients of prizes were announced at the Annual Banquet as follows:

Fuertes Award (for pre-doctoral research): Flash Gibson, Oregon State University—A behavioral-energetic study of the American Avocet.

Nice Award (for research by a non-professional): T. A. Beckett, III, Charleston, South Carolina: The Red-cockaded Woodpecker in South Carolina.

Edwards Prize (for best paper in the Wilson Bulletin previous year):

First Prize: William J. Maher—The Pomerine Jaeger as a Brown Lemming predator in northern Alaska.

Second Prize: John P. Ryder—A possible factor in the evolution of clutch size in Ross' Goose.

Wilson Prize (for best paper by a student or non-professional presented at the Annual Meeting): Kenneth P. Able—The flight directions of autumn nocturnal migrants on the Louisiana Gulf Coast.

FIRST BUSINESS MEETING

The first business meeting, held Friday morning, was presided over by President Gunn. The minutes of the previous business meetings as included in the Proceedings of the Fifty-first Annual Meeting in the Bulletin were approved as published.

The President appointed the following temporary Committees:

Resolutions: Harold F. Mayfield (Chairman), John T. Emlen, Jr., Lawrence H. Walkinshaw.

Wilson Prize: Helmut C. Mueller (Chairman), Robert D. Burns.

Auditing: C. Chandler Ross (previously appointed).

The President announced those previously appointed to the Nominating Committee were: Phillips B. Street (Chairman), C. Chandler Ross, and O. S. Pettingill, Jr.

The Secretary reported on the highlights of the meeting of the Executive Council of the Society.

(1) The Council received and approved reports of the Secretary, Treasurer, Editor, Program Chairman (Second Vice President), Trustees Committee, Research Committee, Membership Committee (First Vice President), Student Membership Committee, and

Endowment Committee. There was no report from the Library Committee or the Conservation Committee at this time.

(2) The Council accepted the recommendations of the Research Committee for the recipients of the Fuertes and Nice Awards as indicated in the beginning of these Proceedings, and from the Edwards Prize Committee for the recipients of those prizes as similarly indicated. The Edwards Prize Committee was: Douglas A. Lancaster, Kenneth C. Parkes, and George A. Hall.

(3) George A. Hall was unanimously re-elected Editor of the Wilson Bulletin.

(4) The Membership Committee reported 97 new members and 95 new life members. The latter increase was largely due to the work of the late Aaron Bagg in conjunction with personal letters to the members from President Gunn.

(5) The Council accepted an invitation from the Delaware Valley Ornithological Club to hold the 1972 meeting, 15–18 June in Cape May, New Jersey.

The Treasurer summarized his report which is included here for the record.

Report of the Treasurer for 1970

General Fund

Balance as shown by last report 31 December 1969			$5,322.21
RECEIPTS			
Membership Dues			
Active for 1970	$ 6,958.18		
Active for 1971	4,367.00		
Total Active		$11,325.18	
Sustaining for 1970	840.00		
Sustaining for 1971	195.00		
Total Sustaining		1,035.00	
Subscriptions to The Wilson Bulletin			
For 1970	1,524.25		
For 1971	2,871.00		
Total Subscriptions		4.395.25	
Sales of back issues of The Wilson Bulletin		402.73	
Interest and dividends on savings & investments		3,608.83	
Royalties from microfilming back issues of The Wilson Bulletin		74.25	
Total Receipts		20,841.24	
DISBURSEMENTS			
The Wilson Bulletin (Printing & Engraving)	13,349.05		
Less contributions from authors	764.00		
Printing & Engraving Expense		12,585.05	
The Wilson Bulletin (Mailing & Service)		1,594.62	
Editor's Expense		155.25	
Secretary's Expense		30.71	
Treasurer's Expense		763.17	
Foreign discount, bank charges and transfer fees		29.30	
Annual Meeting Expense		323.65	
Committee Expense		314.42	
President's Expense		318.02	

Transfer to Research and Paper Awards	238.00	
Total Disbursements	16,352.19	
Excess of Receipts over Disbursements for Year 1970		4,489.05

GENERAL CASH FUND

Checking Account	5,379.77
Savings Account	4,431.49
Balance in National City Bank, Cleveland, Ohio 31 December 1970	$9,811.26

JOSSELYN VAN TYNE MEMORIAL LIBRARY BOOK FUND

Balance as shown by last report 31 December 1969	$ 128.15
RECEIPTS	
Sale of duplicates and gifts	85.50
Total Balance and Receipts	213.65
DISBURSEMENTS	
Purchase of Books	42.42
Balance in National City Bank, Cleveland, Ohio 31 December 1970	$ 171.23

LOUIS AGASSIZ FUERTES RESEARCH FUND, MARGARET MORSE NICE FUND, AND ANNUAL MEETING PAPER AWARD

Balance as shown by last report dated 31 December 1969		$ 103.00
RECEIPTS		
Contributions		263.00
Transfer from General Fund		238.00
Total		604.00
DISBURSEMENTS		
Award to Thomas C. Dunstan	$ 200.00	
Award to Ronald M. Case	100.00	
Award to Louis H. Kermott, III	100.00	
Award to Alan F. Posey	100.00	
Total		500.00
Balance in National City Bank, Cleveland, Ohio, 31 December 1970		$ 104.00

SPECIAL FUND ACCOUNTS

Balance as shown by last report 31 December 1969		$ 105.00
RECEIPTS		149.50
Prepaid Student Dues	0.00	
Advanced Renewals	80.50	
Discount due Agencies	14.00	
Non-endowment receipts	55.00	
Total		254.50
DISBURSEMENTS		55.00
Balance in National City Bank, Cleveland, Ohio, 31 December 1970		199.50

ENDOWMENT FUND

Balance in Endowment Fund Savings Account as shown by last report dated 31 December 1969		$5,037.00
RECEIPTS		
Life Membership Payments	6,615.50	
Patronship Payments	600.00	
Total Receipts		7,215.50
DISBURSEMENTS		0.00
Balance in Endowment Fund Saving Account National City Bank, Cleveland, Ohio, 31 December 1970		$12,252.50
Securities Owned (listed at closing prices 31 December 1970)		
United States Government bonds	9,946.87	
Canadian Provincial bonds	4,000.00	
Corporate bonds	3,750.00	
Convertible corporate bonds	3,650.00	
Convertible preferred stocks	24,383.50	
Common stocks	15,913.75	
Investment trusts	7,880.70	
		$69,524.82
Total Endowment Fund 31 December 1970		$81,777.32

In addition to the annual financial report, other activities of the Treasurer can be condensed in the matters that follow.

The membership list was prepared in June for publication intended for the September Wilson Bulletin which did not materialize. The list was updated for the December issue.

Because of the Tax Reform Act, it was necessary for the Treasurer to file Form 4653, Notification Concerning Foundation Status, with the Internal Revenue Service. Notice was received, thereafter, that the Society is classified as an organization that is not a private foundation as defined in section 509(a) of the Internal Revenue code.

Returns for Organizations Exempt from Income Tax have also been revised for those filing under Sec. 501(c)(3) and these are being studied so returns can be filed by the May 15 deadline.

An expansion of the accounting methods was introduced so that a better perspective between calendar year results and the operational year performance can be seen. The new billing system from Allen Press went into effect which can create some difficulties in keeping good continuity with the accounts as now established.

The Endowment Fund and the Student Membership drives were productive and added additional loads in the way of acknowledgments to each person responding. Also delinquent members and subscribers accounted for approximately 500 additional mailings as second notices and billings.

Operational Income for 1971

Income for 1971 from:	
Active membership	$ 9,842.00
Sustaining membership	705.00
Subscriptions	4,493.47
Total Actual Receipts	$15,040.47

Projected dividends and interest	3,600.00
Miscellaneous income	550.00
Total Expectation	$19,190.47

Respectfully submitted
WILLIAM A. KLAMM, *Treasurer*

Also, for the record, here are summaries of other reports presented at the Council Meeting:

Student Membership—The Committee received 81 nominations for Student Memberships. These have been followed up with invitations to join the Society. Names of interested high school students have been solicited (Dr. Douglas James is on sabbatical, in his absence Jerome Wenger prepared the Committee report).

Editor's Report (George A. Hall)—Volume 82 (1970) consisted of 486 pages and included 36 papers, 44 notes, 18 book reviews, and the index. The Membership List was issued as a separate. As of this meeting there is no backlog. Papers appearing in the June issue will have been on hand from 8–15 months, while papers in the September issue will have had a 5–16 month publication delay. As usual the members of the Editorial Board have been outstanding in their help, which is hereby acknowledged. Many other ornithologists reviewed papers and without exception they performed a good and rapid job.

Secretary's Report—The volume of correspondence outside that of the business matters of the Society was low indicating a quiet year. The new scheme for meeting arrangements proceeded well. The Second-Vice President, Kenneth C. Parkes, arranged the papers session and the Local Committee made final additions and printed the program. The Secretary served as liaison and central clearing house to both.

The President made a special report on the results of the questionnaire circulated to the members of the Society. So far over 600 responses have been received indicating the great vitality of the Society. Many volunteered to serve on the various committees of the Society; for example, 231 on the Conservation Committee alone, 261 on the Council. About 50 per cent of those responding recommended the Society increase its efforts in the area of environmental problems and several mentioned particularly the problems of rare and endangered species. About 50 per cent of those responding, either by lack of comment or positive statement recommended no changes in the Society.

The Auditing Committee's report was presented to those in attendance at the business meeting as follows: I have verified the 1970 Annual Report of the Treasurer of the Wilson Ornithological Society with the books and am satisfied that it accurately represents the very excellent condition of the financial affairs of the Society. William A. Klamm is to be congratulated on the way he is fulfilling the position of the Treasurer —C. Chandler Ross, Auditor. The report was accepted by the members present.

SECOND BUSINESS MEETING

President Gunn presided over the second business meeting Saturday afternoon. Harold Mayfield read the following resolution:

WHEREAS the Wilson Ornithological Society was in its Fifty-second Annual Meeting at Dauphin Island, Alabama, THEREFORE BE IT RESOLVED that the Society express its warmest appreciation for the gracious hospitality of the Alabama Ornithological Society and particularly the members of the Local Committee on Arrangements who made the meeting possible by providing for papers sessions, lodgings, and field trips in this beautiful and historic part of the South.

The resolutions were approved without a dissenting vote by members in attendance at the meeting.

The proposed new members of the Wilson Society as posted were elected unanimously.

The report of the Nominating Committee was presented by Phillips B. Street: President, Pershing B. Hofslund; First Vice President, Kenneth C. Parkes; Second Vice President, Andrew J. Berger; Secretary, James Tate, Jr.; Treasurer, William A. Klamm; Elected Member of the Council, Robert D. Burns.

The slate was elected and the Secretary was directed to cast a unanimous ballot.

There being no further business the meeting was adjourned.

PAPERS SESSIONS

Richeboug G. McWilliams, University of South Alabama, *An Introduction to Dauphin Island.*

Marjory Bartlett Sanger, Winter Park, Florida, *William Bartram in Alabama. The First American Ornithologist Visits Mobile Bay.*

John P. Hubbard, Delaware Museum of Natural History, *Events of the Tertiary Period and the Avifauna of the Lower Southeastern States.*

Henry M. Stevenson, Florida State University, *The Recent History of Bachman's Warbler.*

Susan C. White, University of South Florida, *Nesting Success in a Florida Population of the Eastern Bluebird.*

Stephen G. Martin, Colorado State University, *Adaptive Solutions to Potential Reproductive Miscarries in Polygynous Bobolinks.*

Roger J. Lederer, University of Illinois, *Feeding Behavior and Ecology of Some Tyrannid Species.*

Darrel Bateman, Macon Junior College, and Julian L. Dusi, Auburn University, *Movements of Cattle Egrets and White Ibises in Relation to the Nesting Colony.*

Emil K. Urban, University of Miami and Haile Selassie I University, *Breeding Attempts and Success of* Threskiornis aethiopica *at Lake Shala, Ethiopia.*

Oscar T. Owre, University of Miami, *Observations on the Aquatic Avifauna of Lake Rudolf, Kenya.*

James A. Kushlan, University of Miami, *Bird Predation and the Ecology of an Alligator Pond.*

Julian L. Dusi and Rosemary T. Dusi, Auburn University, *Age and Sex Determination in the Cattle Egret.*

Robert B. Hamilton, Northwestern State University of Iowa, *Sexual Dimorphism of the North American Recurvirostridae.*

Lawrence H. Walkinshaw, Lake Wales, Florida, *A Twelve-year Study of Nesting Sandhill Cranes on the Phyllis Haehnle Memorial Sanctuary.*

Harvey I. Fisher, Southern Illinois University, *Pesticides in North Pacific Albatrosses.*

Sheila Conant, University of Oklahoma, *The Vocal Repertoire of Captive Hand-raised Blue Jays.*

Vivian Telford Anderson, Utah State University, *The "Critical Period" for Song Learning in the Black-capped Chickadee.*

Symposium: Bird Migration in the Region of the Gulf of Mexico,
George H. Lowery, Jr., Presiding.

George H. Lowery, Jr., Louisiana State University, *Introduction to the Symposium.*

Robert J. Newman and George H. Lowery, Jr., Louisiana State University, *The Intradiel Timing of the Spring Passage of Birds over the Coasts of Honduras and the Yucatan Peninsula.*

Henry M. Stevenson, Florida State University, *Occurrence of Migrants on Islands off Apalachicola, Florida, during Good Flying Weather.*

Sidney A. Gauthreaux, Jr., Clemson University, *Behavioral Responses of Migrating Birds to Daylight and Darkness on the Northern Coast of the Gulf of Mexico in Southern Louisiana.*

James J. Hebrard, Clemson University, *Nightly Departures from the Louisiana Coast.*

William B. Robertson, Jr. and John C. Ogden, Everglades National Park, *Migration Patterns in Southern Florida, the Keys and the West Indies.*

Robert W. Dickerman, Cornell University Medical College, and Allan R. Phillips, Universidad Nacional Autonoma de Mexico, *Migration Patterns along the Caribbean Slope of Mexico.*

Kenneth P. Able, University of Georgia, *The Flight Directions of Autumn Nocturnal Migrants on the Louisiana Gulf Coast.*

William H. Buskirk, University of California at Davis, *The Autumnal Arrival of Transgulf Migrants in Yucatan.*

George H. Lowery, Jr., Summary of the Symposium.

W. John Richardson, Cornell University, *Patterns of Autumn Migration in Southeastern Canada: A Radar Study.*

Helmut C. Mueller, University of North Carolina, *Diurnal Movements of Nocturnal Migrants.*

Edwin O. Willis, Oberlin College, *Disappearances of Certain Ant-following and Other Birds from Barro Colorado Island, a Tropical Reserve.*

Yoshika Oniki Willis, Oberlin College, *The Slaty Antshrike, A Successful Bird of Barro Colorado Island.*

Alexander Cruz, University of Florida, *Ecological Relationships of Pigeons and Doves (Columbidae) of Jamaica.*

Harold F. Mayfield, Waterville, Ohio, *Birds Taken by Indians at the Western End of Lake Erie before the White Man.*

Michael W. Roberts, James E. Wright, and Jerome A. Jackson, Mississippi State University, *Food Habits of the Marsh Hawk in East-central Mississippi.*

Roger L. Kroodsma, Union University, *Species-recognition Behavior of Territorial Male Rose-breasted and Black-headed Grosbeaks.*

Alison R. Carleton, University of Miami, *Studies on a Population of the Red-whiskered Bulbul,* Pycnonotus jocosus *(Linneaus), in Dade County, Florida.*

Jerome A. Jackson, Mississippi State University, *A Comparison of Some Aspects of the Breeding Biology of Red-bellied and Red-headed Woodpeckers.*

ATTENDANCE

One hundred ninety seven members and guests were registered. Thirty six states, one Canadian province, the Bahamas, and Portugal were represented.

From ALABAMA: 47—*Auburn*, Julian L. Dusi, Rosemary Dusi, Robert J. Waters;

Birmingham, Gussie Arnett, Mrs. Worth Arnett, J. Russell Bailey, Jr., Naomi Barks, Andrew K. Bates, Raymond D. Bates, Walter F. Coxe, Dan C. Holliman, Thomas A. Imhof, Helen Kittinger, Wilma J. Lindberg, Mrs. W. H. Persons, Mr. and Mrs. Robert R. Reid, Jr., Gretchen M. Schmalz, Mrs. D. O. Wright; *Dauphin Island*, Mrs. Henry K. Toenes; *Fairhope*, Mrs. Thomas R. Horne; *Gadsden*, Blanche E. Dean; *Marion*, Mr. and Mrs. Argyle; *Mobile*, Ernest Cleverdon, Marion Cleverdon, Ben B. Coffey, Jr., Lula C. Coffey, J. L. Dorn, Mary A. Gaillard, Wilson Gaillard, Arthur Garrett, Nancy N. Garrett, Mrs. Sybil Hanks, Margaret Miller, Alwilda Mitchell, Louise L. McKinstry, William Tonsmeire; *Montevallo*, E. B. Bledge; *Montgomery*, Jim Keller, Mr. and Mrs. Cecil Loftin; *Theodore*, Mrs. Iness C. Brande; *Tuscaloosa*, James C. Thompson, Faith Traylor, Tim Traylor.

From ARIZONA: 3—*El Dorado*, Mrs. W. Milton Brown; *Scottsdale*, Betty Carnes, Herbert Carnes.

From ARKANSAS: 6—*Arkadelphia*, Helen Parker, Max Parker; *El Dorado*, H. H. Shugart, K. L. Shugart; *Pine Bluff*, Thomas Fote, Jane E. Stern.

From COLORADO: 2—*Fort Collins*, Peter Hall, Stephen Martin.

From CONNECTICUT: 1—*Sharon*, John M. Anderson.

From DELAWARE: 1—*Newark*, John P. Hubbard.

From DISTRICT OF COLUMBIA: 3—W. Todd Furniss, Mr. and Mrs. Edwin T. McKnight.

From FLORIDA: 24—*Fort Lauderdale*, Marie Evadne Thompson; *Fort Walton Beach*, Dot Bates, Howard Bates; *Gainesville*, Kenneth Campbell, Alexander Cruz, Gilbert Crosby; *Homestead*, John C. Ogden, William B. Robertson; *Jacksonville*, Noel C. Wamer; *Lake Wales*, L. H. Walkinshaw; *Miami*, Alison R. Carleton, James A. Kushlan, Marilyn Kushlan, Oscar T. Owre, Emil K. Urban; *Panama City*, Lila Crew; *Pinellas Park*, Carrie F. David; *Tallahassee*, W. Wilson Baker, Robert L. Crawford, H. M. Stevenson; *Tampa*, Ralph W. Schreiber, Susan C. White; *Winter Park*, Marjory Bartlett Sanger; *Zephyrhills*, Perna M. Stine.

From GEORGIA: 6—*Athens*, Kenneth P. Able; *Atlanta*, Robert Manns, Richard S. Parks; *Columbus*, Dr. and Mrs. Berenson; *Macon*, Darrel L. Bateman.

From HAWAII: 1—*Honolulu*, Andrew J. Berger.

From ILLINOIS: 8—*Blue Island*, Karl E. Bartel; *Carbondale*, Harvey Fisher, Mildred Fisher; *Momence*, Mr. and Mrs. William T. Lory; *Rantoul*, Roger J. Lederer; *Urbana*, Brian W. Cain; *Villa Park*, Paul Schulze.

From INDIANA: 5—*Indianapolis*, Henry C. West, Wilma J. West; *Richmond*, Janet Snow, Mabelle Snow; *West Terre Haute*, Mrs. James H. Nason.

From IOWA: 2—*Cedar Rapids*, Dr. and Mrs. Robert Vane.

From KANSAS: 2—*Topeka*, Orville O. Rice; *Valley Center*, Robert C. Beason.

From KENTUCKY: 6—*Anchorage*, Dr. and Mrs. Burt L. Monroe, Jr.; *Louisville*, Mr. and Mrs. Leonard C. Brecher, Anne Stamm, Frederick Stamm.

From LOUISIANA: 17—*Alexandria*, Mr. and Mrs. Skivett Stuart; *Baton Rouge*, Dr. and Mrs. George H. Lowery, Robert J. Newman, Marcella Newman, Doug Pratt; *Bogalusa*, Mr. and Mrs. Raiford L. Hommes; *Lafayette*, Grace Eyster, Marshall B. Eyster; *Natchitoches*, Robert B. Hamilton; *New Orleans*, Consuela Bongiorno, Salvatore Bongiorno, Donald Norman, Dallas Ward; *Shreveport*, Horace H. Jeter.

From MARYLAND: 5—*Columbia*, Larry L. Hood; *Ellicott City*, Ted Van Velzen;

Frostburg, Mrs. Gordon C. Taylor; *Gaithersburg*, Jeff Swinebroad; *Towson*, Mrs. R. D. Cole.

From MASSACHUSETTS: 1—*Manomet*, Kathleen S. Anderson.

From MICHIGAN: 6—*Bloomfield Hills*, Alice Kelley, Neil Kelley; *Kalamazoo*, Helen E. Burrell; *Lansing*, George Divoky; *Mt. Pleasant*, Hal Mahan; *Okemos*, Bertram G. Murray, Jr.

From MISSISSIPPI: 17—*Gulfport*, Mr. and Mrs. Hal C. Cleveland, Bedford F. Flord, Ethel Flord; *Jackson*, Christine Berry, Mary J. Berry, Mrs. Arnold Ritchie, William H. Tucotte; *Natchez*, Mr. and Mrs. Orrick Metcalfe; *Oxford*, Marvin Davis, *Starkville*, Gordon Williams, Mike Roberts, James E. Wright; *State College*, Elsie Croft, Jerome Jackson, Christina Lusk.

From MISSOURI: 2—*Puxico*, Leigh H. Frederickson, George W. Hartman.

From NEW JERSEY: 5—*Cape May Point*, Ernest E. Choate; *Hightstown*, Dr. and Mrs. William E. Parker; *Tenafly*, Dr. and Mrs. Dean Amadon.

From NEW YORK: 8—*Dryden*, James W. Grier; *Irvington*, Mary LeCroy; *Ithaca*, W. John Richardson, James Tate, Jr.; *Mamaroneck*, Robert Arbib; *New York*, Robert W. Dickerman; *Rochester*, Allan Klonick, Sandy Klonick.

From NORTH CAROLINA: 1—*Chapel Hill*, Helmut C. Mueller.

From OHIO: 14—*Ashtabula*, Howard E. Blakeslee; *Bowling Green*, Elden W. Martin; *Columbus*, Charles B. Wheeler; *Dayton*, Elspeth F. McCallum; *East Liverpool*, Mr. and Mrs. John T. Laitsch; *Gambier*, Robert D. Burns; *Holland*, John McCormick; *Lakewood*, Naney R. Klamm, William A. Klamm; *Oberlin*, Edwin O. Willis, Yoshika O. Willis; *Waterville*, Harold Mayfield, Virginia Mayfield.

From OKLAHOMA: 1—*Norman*, Sheila Conant.

From PENNSYLVANIA: 6—*Ambler*, Albert J. Williams; *Chester Springs*, Mr. and Mrs. Phillips B. Street; *Philadelphia*, C. Chandler Ross; *Pittsburgh*, Kenneth C. Parkes; *West Chester*, Frank B. Moody.

From SOUTH CAROLINA: 9—*Charleston*, Dennis M. Forsythe; *Chester*, Mrs. Walker Atkinson, Mrs. Mabel M. Carter, Mrs. Catherine T. Moore, Mrs. W. S. Robinson, Mrs. W. C. Stone; *Clemson*, Sidney Gauthreaux, Jr., James J. Hebrard, Georgeann Schmalz.

From SOUTH DAKOTA: 2—*Rapid City*, Gertrude Bachmann, Violet L. Brodsky.

From TENNESSEE: 6—*Bolivar*, P. Bollman; *Jackson*, Roger L. Kroodsma; *Maryville*, Ralph J. Zaenglein; *Memphis*, Wendell L. Whittemore; *Nashville*, Mike Bierly, Mrs. Katherine A. Goodpasture.

From TEXAS: 2—*Fort Worth*, Olan W. Dillon; *San Antonio*, Charles R. Bender.

From UTAH: 1—*Logan*, Vivian T. Anderson.

From VIRGINIA: 6—*Arlington*, Lawrence V. Compton; *Manassas*, Roxie C. Laybourne; *Williamsburg*, Mr. and Mrs. Paul S. Baker, Mitchell A. Byrd, Robert S. Kennedy.

From WEST VIRGINIA: 3—*Inwood*, Clark Miller; *Morgantown*, George A. Hall, Tanya Hall.

From WISCONSIN: 5—*Madison*, George Allez, John T. Emlen, Virginia M. Emlen; *Milwaukee*, Daniel D. Berger; *Viroqua*, Margarette E. Morse.

From BAHAMAS: 1—*Andros*, Andrew Paterson.

From ONTARIO: 6—*Hamilton*, Erie W. Bastin; *Toronto*, Rosemary Gaymer, Christopher Gunn, William W. H. Gunn; *Sudbury*, Millicent Lowe, Ross Lowe.

From PORTUGAL; Ernest Chenery.

Address Unknown: Gairly Chandler, Dr. and Mrs. D. A. McDonald.

STUDY PROJECTS

Colored Gull Study

California, Franklin's, and Ring-billed Gulls are being individually marked near Calgary, Alberta, Canada, as part of a three year study of their local movements. All marked gulls have had four colored jesses attached to their legs in the following manner: two jesses per leg, one above and one below the tibia-tarsus joint on each leg. Black, blue, green, orange, white, and yellow jesses are being used. In addition, portions of the gull's plumage may be dyed green, orange or red. This marking program will be continued through the 1972 season.

Reports of sight records of these marked gulls would be greatly appreciated. Please include date, time and location of sighting, color and location of plumage dye and color and location of each jess.

Reports should be sent to D. Vaughn Weseloh, Dept. of Biology, University of Calgary, Calgary 44, Alberta, Canada.

Great Blue Heron Survey

At the top of the aquatic food-chain, the Great Blue Heron may well be an important indicator species. The Laboratory of Ornithology is planning a nation-wide survey of this species.

The first step will be to compile an inventory of heronries. To this end, we appeal to all readers with knowledge on this point to write to us. Information may be recent or old; detailed or sketchy. Even "I remember seeing a heronry as a boy" is helpful if the site is remembered well enough to locate on a topographic map.

We hope that this inventory will contain the exact locality of the heronry, a general description of the site, and as much history as possible. We hope that this stage of the program can be completed by the winter so that arrangements can be made for census work in the 1972 breeding season.—David B. Peakall, Laboratory of Ornithology, Cornell University.

Purple Martin Survey

The Purple Martin that nests in bird apartment houses in our back yards and gardens once nested exclusively in natural cavities—now it nests almost exclusively in man-made bird houses. Because of our ability to rapidly change the environment, it is particularly important that we watch wildlife populations for changes that might be due to our upsetting the balance of nature. Like the canary in a coal mine, changes in Purple Martin populations might serve as an indicator that something is wrong in our environment. While our long range goal is to monitor population levels of Purple Martins over a period of many years, our short term goals are: 1) to learn more about the breeding biology of this species (for example, can the Purple Martin raise more than one brood a year in the south?); 2) to learn more about the relationship between Purple Martins and their nest hole competitors (for example, Starlings, House Sparrows, Tree Swallows, Flying Squirrels); 3) to learn more about the migration of this species and the factors influencing the arrival and departure of the birds. All persons maintaining martin boxes are urged to respond to the questionnaire which may be obtained from the Laboratory of Ornithology, or from Dr. Jerome A. Jackson, P. O. Drawer Z, Department of Zoology, Mississippi State University, State College, Mississippi 39762.

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CONTENTS

General Notes

Blue Jay X Steller's Jay *(Cyanocitta cristata x Cyanocitta stelleri)* hybrid.
Photo by Pat Wheat.

HYBRID JAYS IN COLORADO

OLWEN WILLIAMS AND PAT WHEAT

PITELKA, Selander, and del Toro (1956) described a hybrid between the White-tipped Brown Jay (*Psilorhinus mexicanus*) and the Magpie Jay (*Calocitta formosa*) observed and collected in western Chiapas, Mexico. To our knowledge, no other hybrid jay has been reported in North America (Cockrum, 1952); hence the recent appearance in Boulder, Colorado, of hybrid individuals identifiable as *Cyanocitta cristata* × *C. stelleri* or as backcrosses between such a hybrid and a Steller's Jay is an unusual event.

The first hybrid to be seen appeared on 3 September 1969 at a feeder at the residence of the junior author in Boulder, approximately one mile east of the lower edge of the ponderosa pine forests covering the hogbacks immediately west of the city. On 30 September 1969, at a bird-banding station about two blocks distant, the hybrid was captured, measured, banded, photographed, and released by Professor and Mrs. John Hough. However, by 2 October it was clear that there were four hybrid individuals visiting the Wheat's feeder. The banded bird was not seen after 7 October, but the others used the feeder regularly throughout the winter and the 1970 breeding season in the company of Steller's Jays.

DESCRIPTION OF THE HYBRIDS

The hybrid individuals appeared intermediate between the two parental species in body size, length of bill, length of crest, and color (Fig. 1). In each case, the forehead was deep blue with a heavy black line extending over the top of the bill and with two thin tapering white lines extending from the bill to the base of the crest which resembled, in attitude and shape, that of a young Steller's Jay. The deep blue crest was streaked with light blue. Extensive white patches, strongly outlined in black, appeared above and below the eyes. The lores were black and a heavy black line extended back through the eyes. The chin and throat were bluish white, and a heavy black nuchal band encircled the neck. The underparts were blue becoming lighter posteriorly, while the back and rump were medium blue with a lavender cast. Wings and tail were blue. The secondaries were barred with black; the greater wing coverts were barred and variably white-tipped. The rectrices were likewise barred with black, and all but the inner central feathers were conspicuously white-tipped; however, the white areas were seen only when the tail was spread. Careful scrutiny of the birds during the winter months revealed that the variations in the amount of white in the wings provided color patterns sufficiently different to allow observers to distinguish one bird from another.

BEHAVIOR OF THE HYBRIDS

In general, the behavior of the hybrids was indistinguishable from that of the Steller's Jays visiting the feeder. Using criteria similar to those em-

Fig. 1. A. Hybrid Jay. B. Blue Jay. C. Steller's Jay.

ployed by Brown (1963) in his study of social organization of Steller's Jays, we judged the hybrids to be socially dominant over both parental species. Although they were seldom overtly aggressive toward the Steller's Jays, the hybrids consistently supplanted the latter at the peanut dispenser. They were more actively aggressive toward Blue Jays; on one occasion, in October, a hybrid drove a Blue Jay out of the yard.

PROBABLE BACKCROSSES

Courtship among the Steller's Jays began in February 1970. Occasionally, hybrid birds were seen participating in courtship activities, but until 6 August 1970 we were unable to obtain evidence that any of them had obtained mates and nested. On this date, three young jays, beginning post-juvenal molt, appeared with an adult Steller's Jay at the feeding station. The four were obviously a family group. Unlike young Steller's Jays which have sooty heads and crests unmarked with white, these new birds possessed gray-blue heads with a faint blackish band across the throat. Backs, rumps, and underparts were also gray-blue. A few of their greater wing coverts were barely tipped with white; variable amounts of white showed in their secondaries. All but their central rectrices were tipped with white but less extensively so than in the hybrids of the previous season. By mid-August these birds were showing large, crescent-shaped patches of white above their eyes, but the feathers of their chins and throats were deep blue with no suggestion of the nuchal band clearly evident in the old hybrids. Because no Blue Jays had been seen in the neighborhood since early June, we concluded that these young birds were offspring of a backcross between one of the original hybrids and a Steller's Jay.

VOCALIZATIONS

Initial assessment of the vocalizations of the Blue Jays, Steller's Jays, and hybrids at the feeding station indicated that the latter produced calls approximating those of both parental species and an additional unique call. We, therefore, proceeded to record and compare some of the calls by means of sound spectrograms. The Steller's Jays, visiting the feeding station regularly and in relatively large number throughout the year, produced six or seven distinct calls in addition to their quiet conversational notes. In contrast, the Blue Jays, infrequently visiting the feeder in the early fall, made only their typical *jay* alarm calls and a *peedly-ink* call which may be the one verbalized by Hardy (1961) as *wheedle-eee* expressing anxiety or suppressed excitement. At one time or another, the hybrids were heard producing all of the vocalizations of the Steller's Jays but with slight tonal differences verified by the sonagrams of these calls. Surprisingly, the hybrids used Blue Jay calls more frequently than Steller's calls, although, from October to April, as far as we could ascertain, they had no contact with Blue Jays; none were in the neighborhood. Likewise, the backcross hybrids used the Steller's rasping alarm or assembly calls but, more frequently, the Blue Jay *jay* and *peedly-ink* calls.

DISCUSSION

The Steller's Jay is a common resident throughout the mountain forests of Colorado. Its greatest abundance is in the ponderosa pine zone of the lower montane forest climax (Bailey and Niedrach, 1965) and probably has been so for a very long time. In contrast, the Blue Jay is a relative newcomer along the foothills of the Rockies in Colorado. Beidleman (1951) suggested that the species was uncommon in the state during the first half of this century. The birds began to appear regularly in Boulder and nearby communities in small numbers in the mid-fifties and in increasing numbers in the 1960's. In 1968 a pair of Blue Jays nested in the University Hill section of

Boulder thus, for the first time in this area, bringing breeding Blue Jays in close proximity to nesting Steller's Jays. Strange-looking jays. possibly hybrids, have been reported from at least one other community along the foothills, but the report has not been verified.

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DEPARTMENT OF BIOLOGY, UNIVERSITY OF COLORADO, BOULDER, COLORADO 80302 AND 1515 BASELINE ROAD, BOULDER, COLORADO 80302. 6 NOVEMBER 1970.

PARENTAL CARE AND NESTING IN THE RUFOUS-THROATED ANTBIRD, *GYMNOPITHYS RUFIGULA*, IN AMAPÁ, BRAZIL

Yoshika Oniki

On 26 April 1968, while studying ant-following birds at Serra do Navio (0° 55′ N, 52° 01′ W), Amapá, Brazil, I found a nest of a Rufous-throated Antbird (*Gymnopithys rufigula*) with two nestlings about 2 or 3 days old. I watched the care of the young from a blind built with palm leaves and set about 8 m from the nest for a total of 67 hours and 10 minutes until 8 May 1968, when the young left the nest. Afterward I occasionally watched the parents feeding the young near an ant swarm about 100 m from the nest. Willis (1967) suggested that the Bicolored Antbird (*Gymnopithys bicolor*) and the White-cheeked Antbird (*Gymnopithys leucaspis*) may be conspecific with the Rufous-throated Antbird because the three species have similar calls and behavior. This report gives data on brooding and growth of young Rufous-throated Antbirds for comparison with data from Van Tyne (1944), Willis (op. cit., 82 ff.), and Skutch (1969) for nesting Bicolored Antbirds.

The nest I found was in a site similar to that of a nest with eggs described by Beebe, Hartley, and Howes (1917) from Guyana. The Guyana nest was in a low cavity in a sapling. The Amapá nest was cup-shaped, 5 cm deep, at 48 cm up in the cavity of a rotten 102 cm stump. The stump had a wide opening on the west side from the top down to the upper edge of the nest. The internal diameter of the nest was 5.5 cm and the external diameter was about 8 cm. It was 150–200 m off the road, in a depressed area of the forest where water probably flows nearby during heavy rains. The large surrounding trees shaded it nearly all day. The nest was made of short pieces of dead palm leaves (*Astrocaryum* sp.) and the scanty lining was of finer and thinner material.

The nest sites and nests of Rufous-throated Antbirds seem very similar to sites and nests of Bicolored Antbirds (Willis, op. cit.: 82–83). Willis (pers. comm.) found one nest of White-cheeked Antbirds on 20 November 1965 at Yaapi (2° 52′ S, 77° 56′ W), eastern Ecuador. The nest cup, 0.3 m down in the hollow cavity of a 0.4 m stub and made of strips of palm leaves, was similar to those of Bicolored and Rufous-throated Antbirds. There was one egg, and on 23 November 2 eggs, very heavily streaked with purplish brown.

Feeding the Young.—The parent Rufous-throated Antbirds were similar in color, although the male seemed slightly larger than the female. Females have concealed buffy dorsal patches and males have concealed white dorsal patches,

TABLE 1

FEEDING RATES AT A NEST OF RUFOUS-THROATED ANTBIRDS

Date	Time	Approx. age	Feedings per hour
26 April	11:40–18:30	2–3 days	1.4
27	07:15–18:30	3–4	1.5
28	09:45–10:00	4–5	–
29	11:30–18:30	5–6	1.4
30	06:00–09:05, 12:00–18:30	6–7	3.3, 1.2
1 May	08:45–18:30	7–8	4.4
2	07:45–10:00, 14:00–18:30	8–9	3.5, 2.5
3	08:00–08:40, 16:35–18:30	9–10	1.0
6	08:00–18:30	12–13	1.8
7	06:00–08:40, 20:30	13–14	1.3

but the parents never displayed these patches at the nests. The only way I could tell that two birds were feeding the young was that one of the birds had two tail feathers growing (feather number 1 on the left center was three-fourths, of the full length and feather number 1 on the right center was one-half). This was the bird that brooded all night, so it probably was the female. Skutch (op. cit.: 294) reports that among antbirds only females incubate at night. The presumed male made 74 (63 per cent) of the 117 feedings for which I could identify the parent, the presumed female only 43 (37 per cent).

Willis (op. cit.: 84) reports that Bicolored Antbirds carry food obtained near swarms of army ants to young. Rufous-throated Antbirds brought food from ant swarms, but also captured food near the nest occasionally.

The parents attended the nest from the opening on the west of the stump, using two or three depressions as perches and seldom other possible perches. Food items were difficult to see, so that only large items were identified. Among large items fed the young were small lizards, cockroaches, and grasshoppers. After long but not loud calls (probably "faint-songs," according to Willis, op. cit.: 14–15), the parent came rapidly to the nest and, perching vertically or horizontally, fed the young. During feeding the tail was spread and flicked regularly. Often the parent probed repeatedly inside the nest, as reported by Haverschmidt (1953:249) for Black-crested Antshrikes, (*Sakesphorus canadensis*).

The number of feedings per hour averaged 1.4 to 1.5 until the young were 5–6 days old. The rate then increased in the morning to 3.3 to 4.4 per hour until the young were 8–9 days old, and decreased again to 1.0 to 1.8 until the birds were 13–14 days old. Young between 6 and 9 days old were fed

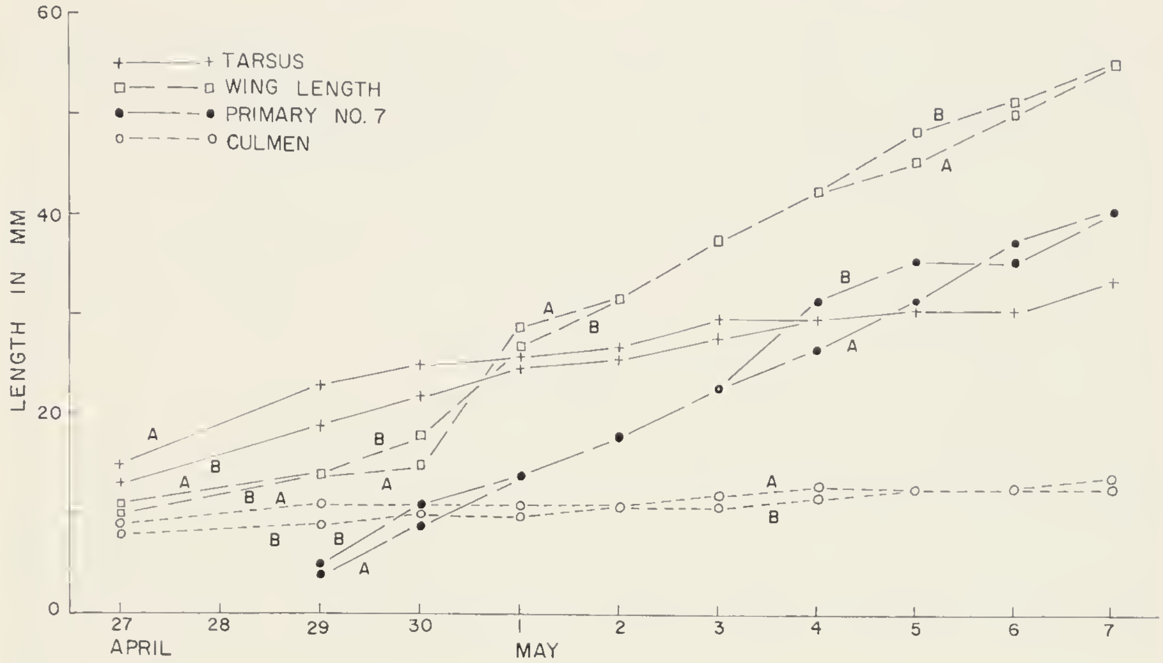

FIG. 1. Growth of two nestling Rufous-throated Antbirds at Serra do Navio, Amapá.

more in the morning than in the afternoon, when the number of feedings averaged 1.2–2.5 per hour (Table 1).

The parent ate fecal sacs before brooding when the young were small. Fecal sacs were carried away for the first time on 27 April; 3 May and thereafter fecal sacs were always carried away. Ratios of fecal sacs eaten/fecal sacs carried away were 5/0 on 26 April, 6/1 on 27 April, 4/3 on 29 April, 5/6 on 30 April, 4/5 on 1 May, 4/6 on 2 May, and 0/13 on 3–7 May.

Brooding.—Young were brooded after many feedings until 30 April, when they were 6–7 days old. Brooding was less common 1 May and rare on 2 May: no daytime brooding was noted on 3–7 May. However, the female slept on the nest at night until the night of 7–8 May.

The longest session on the nest was 104 minutes on the afternoon of 29 April and the shortest was one minute on 1 May. There were many short sessions of brooding.

Young.—When I found them, the young Rufous-throated Antbirds were naked and had dark pinkish bodies; eyes and viscera were visible through the transparent skin. The eyes were closed. The gape angles were white and the gapes orange. They were cool, unable to regulate their body temperatures, and called weakly when handled.

When the right leg of one of the young was marked with a white thread, each parent tried to take the thread out as it perched not on the rim of the nest but inside it. The thread stayed on, however, allowing me to distinguish the two young.

Figure 1 shows growth of the tarsus, beak, wing, and primary number 7 for the two young. The wing feathers grew at a faster rate than the beak or tarsus. The two young birds grew at about the same rate.

When the young were 3 or 4 days old (27 April), the pinfeathers of the wing were growing and there were dark spots on other pterylae. The egg teeth were still present. When they were 5–6 days old, 29 April, they had the eyes slightly open; there were feathers appearing on dorsal and ventral pterylae, each crural pteryla had 13 feathers and each scapular pteryla about 24 feathers, and wing feathers were growing. On 30 April, the feathers of the upper ventral pteryla were gray, while those of the lower ventral one were brown. There was one red, tiny mite on the breast of one young.

On 7 May at 08:00, when they were 13–14 days old, the young had brownish-gray irises, yellowish-white gape angles, and blackish bare skin around the eyes. The tail feathers measured 14 mm. They were unable to fly, but one hopped out of the nest and hop-fluttered away quickly. After some minutes of chasing I returned it to the nest. At 13:00 only one young was in the nest. At night, at 20:30, the remaining young was alone in the nest and had the head hidden under the breast and all the body feathers very fluffed. The next morning at 08:00 it was not in the nest.

Breeding Season and Molt.—Nests of Rufous-throated Antbirds have been recorded in late April, late June (Beebe et al., 1917) and late December (G. K. Cherrie took a male, American Museum of Natural History No. 491279, from a nest with two eggs at Ipousin, Cayenne). A brown young out of the nest less than a month was collected at Caño Seco, Mt. Duida, Venezuela, on 16 December 1928 (AMNH No. 273332). Young were out of the nest at Nappi Creek in Guyana in December and January (E. O. Willis, pers. comm.). Most records are in the respective rainy seasons at these localities, as for the related Bicolored Antbird in Panamá, but the Nappi records suggest nesting well into the dry season.

The seasons of molt are not well defined, judging from specimens in the American Museum. Scattered Rufous-throated Antbirds are in wing molt in every month collected, with the highest percentages in October to January (14 out of 35). Thus, the Rufous-throated Antbird seems to be nesting at the seasons in which it molts. According to E. O. Willis, Bicolored Antbirds often molt during nesting.

DISCUSSION

Gymnopithys rufigula has nesting habits very like those of *Gymnopithys bicolor*, which gives additional weight to suggestions (Willis, op. cit.: 2–3) that they may be conspecific. However, antbirds are not very diverse in nesting habits (Skutch, op. cit.: 293–5), so that the evidence for conspecificity is still not conclusive.

Molting at the time of nesting, and nesting almost all year, is recorded also for Barred Antshrikes (*Thamnophilus doliatus*) on Trinidad (Snow and Snow, 1964). Perhaps these birds of the tropical forest undergrowth do not show the tendency for molt to follow or precede the nesting season noted for many northern birds.

ACKNOWLEDGMENTS

I appreciate the hospitality of the ICOMI (Indústria e Comércio de Minérios S.A.) as well as the facilities provided for my field study. I thank the Frank M. Chapman Memorial Fund and IPEAN (Instituto de Pesquisas e Experimentação Agropecuárias do Norte) for supporting my trip to Serra do Navio, and Dr. Dean Amadon and the American Museum of Natural History for the use of specimens. Dr. Philip S. Humphrey gave helpful advice for field work and for the manuscript. Dr. E. O. Willis was very helpful with the manuscript and kindly provided me with unpublished data for comparison of nesting habits. Writing was completed under his NSF Grant GB-21442.

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SOME NEW PERSPECTIVES ON THE BREEDING ECOLOGY OF COMMON GRACKLES

ANTHONY J. ERSKINE

The Common Grackle (*Quiscalus quiscula*) is a conspicuous bird, abundant through much of eastern North America. Bent and Gross (*in* Bent, 1958) have described the general features of its ecology. Their account was necessarily based upon scattered observations and local studies. Recent standardized methods of data collection by volunteers, particularly roadside breeding-bird counts and nest record card programs, should permit fuller perspectives of some aspects of Grackle ecology. This paper is an attempt to explore some possibilities of data collected by these new methods, using chiefly material from Canada.

MATERIALS AND METHODS

The cooperative Breeding Bird Survey (Robbins and Van Velzen, 1967. 1969) was started in Maryland in 1965, and first included all of the continental United States in 1968. All Canadian provinces except Newfoundland were included in the 1968 and 1969 surveys (Erskine, 1970), but coverage was neither complete nor uniform in the four western provinces and in the northern parts of Ontario and Quebec. This survey uses a standard procedure and a random sampling plan to make roadside counts on a single day in June each year. I have examined the data for individual surveys in Canada; in the United States the mean numbers of birds per survey in each state as given by Robbins and Van Velzen (1967, Table 2; 1969, Tables 2–4) were used.

Data on individual bird nests are entered on nest record cards, which are assembled in central files at the end of each breeding season (Mayer-Gross, 1970). The cards vary somewhat in design between regions, but nearly all request data on precise location, habitat, nest site and construction, and the numbers of eggs or young present on each visit, with other pertinent information. Data from the Grackle cards in the files of the Maritimes, Ontario, and Prairie Nest Record Schemes were used in this study; the Newfoundland, Quebec, and Pacific Nest Record Schemes contained too few Grackle records to warrant analysis at this time. I had contributed all except five of the 199 Grackle records from Cape Breton Island, Nova Scotia, in the Maritimes file; these provided a convenient sample which could be compared with data from other areas.

DISTRIBUTION

The A.O.U. Check-list (1957) and Bent (1958) indicate that the breeding range of the Common Grackle includes most of North America east of the Rocky Mountains and south of the tundra. The distribution in Canada extends far into the boreal forest, particularly in the northwest where it reaches Great Slave Lake (Godfrey, 1966). These accounts are based upon specific breeding localities, but they do not attempt to suggest the relative importance of different parts of the range.

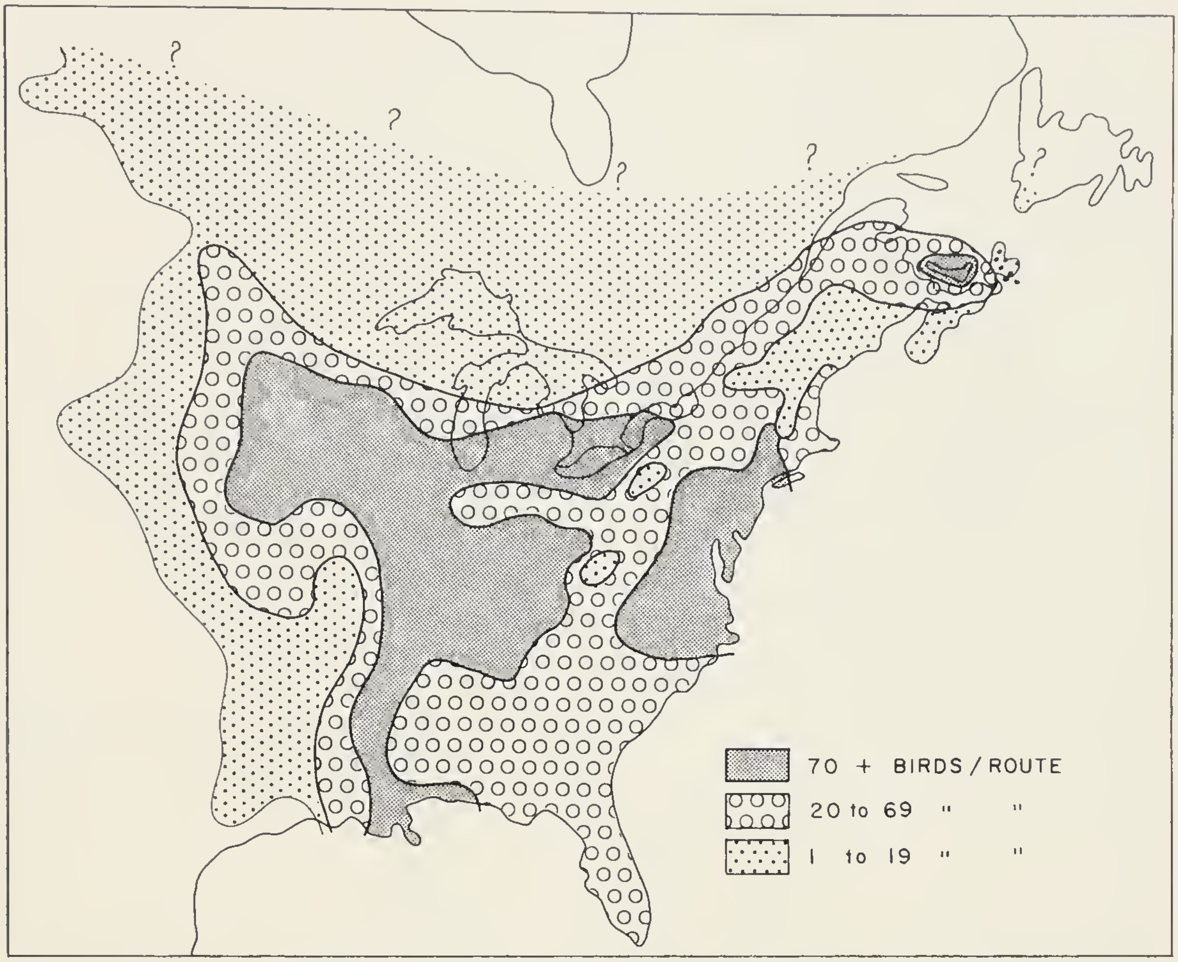

Fig. 1. Principal range of Common Grackle. Northern outline based upon Godfrey (1966); density indices generalized from figures provided by Migratory Bird Populations Station, Laurel, Maryland.

The cooperative Breeding Bird Survey does not provide actual proof of breeding, but it does provide standardized indices of grackle numbers during the breeding season through most of their range. The mean numbers of Common Grackles noted per survey in each state and province are plotted in Figure 1, using the data for 1968–70 obtained from the Migratory Bird Population Station. Figure 1 shows that the A.O.U. Check-list (1957) and Godfrey (1966) place far too much emphasis on the peripheral records. The vast northwestern extension of the range is very sparsely populated with Grackles, whose main range lies largely east of 100° W and south of 48° N. The highest densities are between 35° and 43° N, along the Atlantic and in the Mississippi valley. Numbers generally thin out towards the limits of the range, but there is a remarkable concentration of Grackles in the Maritimes, particularly on Prince Edward Island (Fig. 2).

Nest record cards contain the same kinds of data used in compiling the

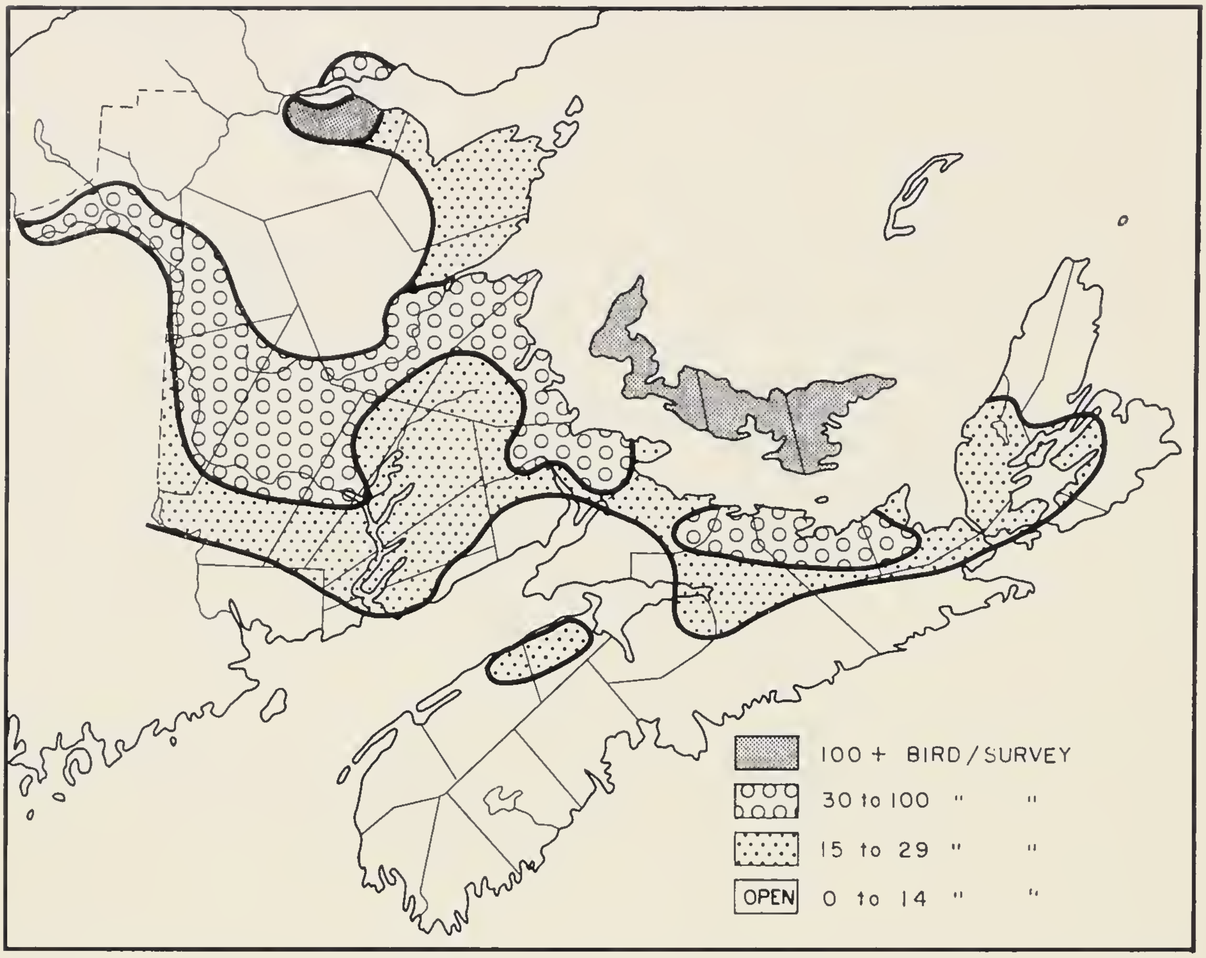

FIG. 2. Common Grackle density indices in the Maritime Provinces, from breeding bird survey data, 1966–70.

ranges in the A.O.U. Check-list (1957) and Godfrey (1966). Future compilations of this kind will be based to a great extent on nest record cards, which are, for common species, much more numerous than published breeding records. Through 1969, the Canadian nest record files contained over 1,700 records of Common Grackle nests.

However, even a cursory plotting of the distribution of nest record cards for a species shows that they are less valuable for distributional studies than might be expected. Nest records are provided by volunteer observers working chiefly near their homes, and frequently revisiting the same areas—or even the same sites—each year. A concentration of nest records represents a concentration of effort by one or more observers much more faithfully than it does local abundance of the species involved. The numbers of Grackle nest record cards for the Maritimes are presented by counties (Fig. 3) for comparison with the Breeding Bird Survey results (Fig. 2). The high density in western and central Prince Edward Island, and the low density along all the

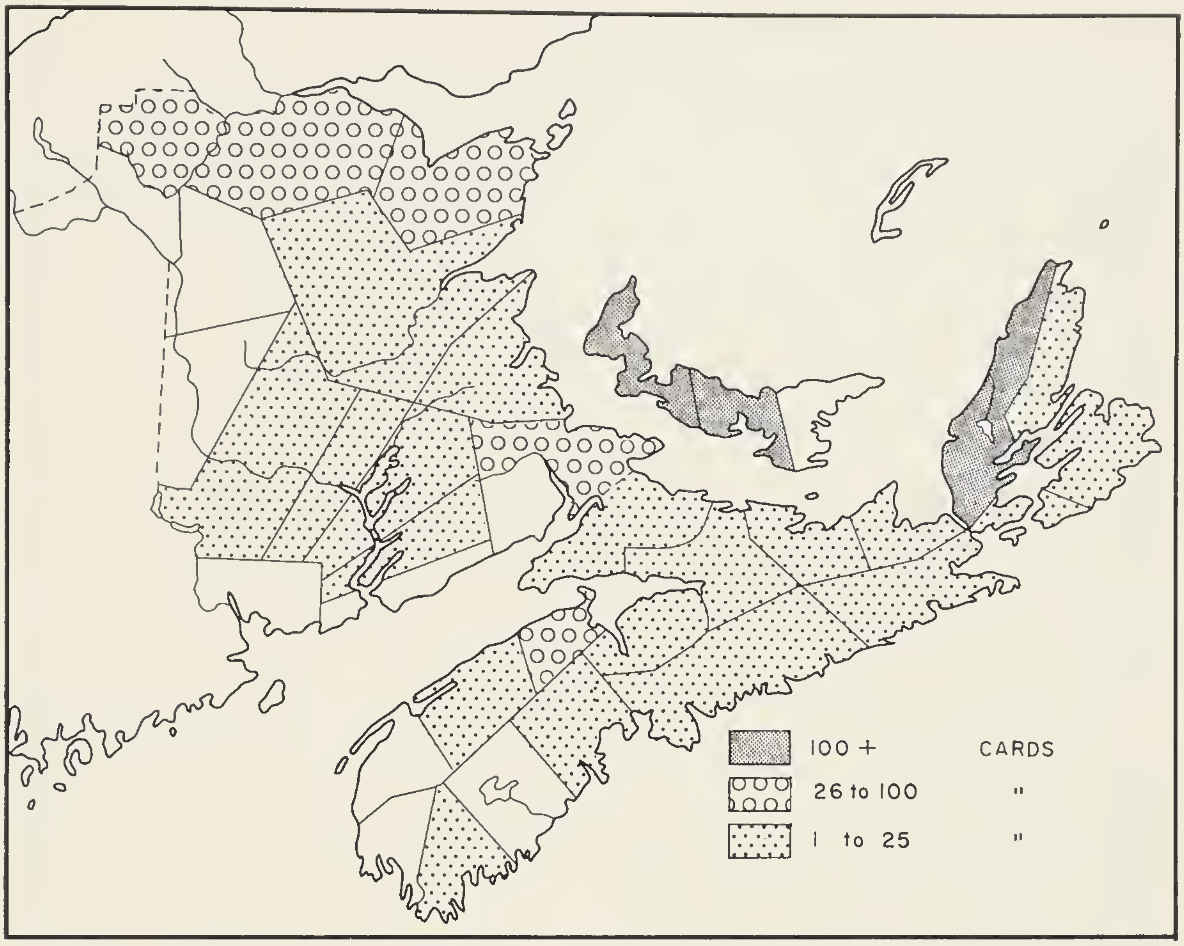

FIG. 3. Numbers of nest record cards of Common Grackles, by county, in the Maritime Provinces, 1960–68.

Atlantic slope of Nova Scotia show up in both kinds of data. But nest records for the St. John valley in New Brunswick are obviously absent because no one spent much time searching for nests there; the totals for southeastern New Brunswick and western Cape Breton Island are high because of enthusiastic nest hunting. Such efforts have inflated a rather average density and given a quite distorted picture.

On the prairies, where the Breeding Bird Survey coverage was incomplete, the Grackle nest records help to fill in the picture. But these too are scarce. Nest records suggest that Grackles are found west to Calgary and Stettler, Alberta, and north to Battleford, Saskatchewan. Only single records, from the Lesser Slave Lake region of Alberta and from near Fort Smith, Northwest Territories, confirm the existence of the extended ranges shown in distributional summaries. In this attempt to correlate Grackle distribution with environment and with ranges of potentially competing species, the peripheral ranges can be largely ignored, since the local situations on which they depend will not show up in a broad-scale study.

HABITAT AND NEST SITE SELECTION

Nest record cards are biased sources of information on habitats and nest sites, just as they are as sources for distributional data. Observers tend to return to the same locations, habitats, and nest sites each year. After finding a species in a particular situation, they tend to look for other nests in similar habitats or sites in the same area. The habitats and sites in which nests can most easily be found will always be over-represented in these nest samples: the bias may be illustrated with data from the Maritimes.

I observed over 190 Grackle nestings in eastern Nova Scotia from 1960 to 1968. More than 95 per cent of these were close to water; however, this was chiefly because they were found during work on mergansers and other ducks, which was necessarily done in riparian situations. Only 15 per cent of over 360 nests on Prince Edward Island, found in 1963 to 1968, were stated to be near water. The observers there had looked for nests chiefly in the farming country around their homes.

Actually, about 95 per cent of the Grackle nest sites on Cape Breton Island were within one-half mile of fields (often old or abandoned fields), and most were much closer than this. But this information is drawn from my knowledge of the surrounding areas. The entries on the nest record cards usually refer only to the habitat(s) within 200 yards of the nests: thus, farmland was mentioned on only about one-quarter of the cards from Cape Breton, appreciably less than on the Nova Scotia mainland, in New Brunswick, or on Prince Edward Island.

I have seen Grackles foraging, and occasionally nesting, near open areas other than farmland—in marshes and even sphagnum bogs. Gross (*in* Bent, 1958) gave many examples of them feeding along shores, and Wiens (1965) and Snelling (1968) studied a Grackle population nesting in a cattail marsh. Probably this adaptability to alternative feeding areas has permitted the Common Grackle to breed locally far into the boreal forest, but its low densities there suggest poorer feeding opportunities than in open, arable lands.

Although Grackles often nest in abandoned farm buildings, the species is not one that typically associates with man's dwellings, as does the Starling (*Sturnus vulgaris*). On Cape Breton Island, only one nest could have been termed "in a farmyard." Concentrations close to villages were always in poorly accessible or inconspicuous places, such as flooded alder swamps or the girders of railway bridges. Unlike the cavity nests of Starlings, the large, untidy nests of Grackles are obvious and vulnerable to small boys, so nesting in urban areas obviously depends on whether suitably inaccessible nest sites exist. Grackles which nest in city parks (cf. Petersen and Young, 1950) and in city gardens usually build high in ornamental conifers or in vines on the sides of buildings.

My Cape Breton data on Grackle nest sites required editing to minimize duplication between years, as some areas were visited annually. I have summarized below the maximum number of nests found in any one year in a particular kind of site in a given locality, rather than the total of all nests found over the years. Such selective treatment of the data from nest record cards is seldom feasible (cf. von Haartman, 1969).

Nests:	in shrubs or small trees (under 15 feet tall) (alder 33, hawthorn 13, willow 9, others 10)	65
	in trees or tree stubs	7
	in abandoned buildings (mostly old barns)	13
	in bridges (both road and railway)	32

The highest proportions of nest sites were in alder swamps (28 per cent) and in bridges (27 per cent), because my work was along rivers. The nests studied on Prince Edward Island by M. Thomas included a much larger proportion in old farm buildings, while those studied by B. and K. Pigot were largely in conifer windbreaks. We would need larger and more evenly distributed samples than are now available to use these cards to describe quantitatively Grackle habitats or nest sites. Anyone attempting to use the data on nest record cards for these purposes should especially note the sites visited in several successive years, as these can introduce serious bias when samples are contributed by a relatively small observer corps.

LAYING DATES OF GRACKLES

Published laying dates for Grackles are few. Bent (1958) gave egg dates only. If many records were available from one state, we might assume that the earliest and latest dates approached the actual span from earliest laying to latest hatching; however, with small samples this is not likely to be true. The safest thing one can do with such records is to assign them to the midpoint of the egg period (laying + incubation = ca. 16 days). Three detailed studies of Grackles have been made at the University of Wisconsin (Petersen and Young, 1950; Wiens, 1965; Snelling, 1968), but I was unable to derive accurate laying dates from the graphical presentation in the two later papers. Records from Bent (1958) and Petersen and Young (1950) are presented in Figure 4.

I have followed Myres' (1955) method, with some minor modifications set out by Snow (unpubl. outline, British Trust for Ornithology, 1967), to calculate laying dates from nest record cards. An important feature of their method is that each calculated laying date is assigned a degree of accuracy

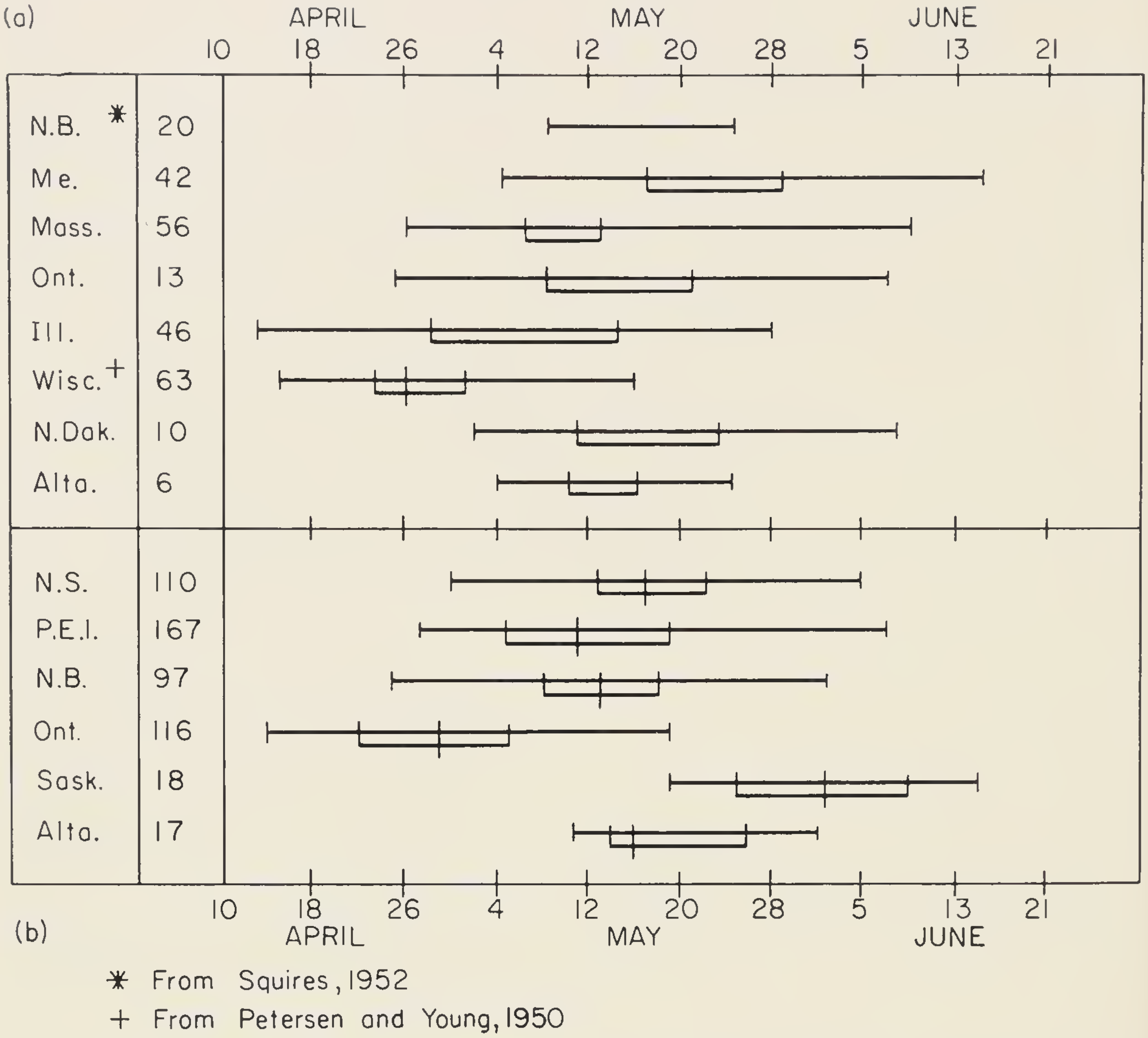

FIG. 4. Laying dates of Common Grackles from literature and nest record cards, with median dates and interquartile ranges where available. Assumed second nestings excluded. (a) Published records from Bent (1958) except as shown; all ± 8 days except Wisc. (± 0–2 days). (b) From nest record cards; all ± 0–2 days. Sample size in second column.

depending on the span of possible dates within which it falls. A nest found and revisited during laying can be back-dated to an accuracy of ± 1 day or better. Nests with apparently complete clutches or with unaged nestlings can only be back-dated to the mid-points of the incubation or nestling stages; these periods are each about 12 days long, so the calculated date has an accuracy of ± 6 days. In this study, only nests dated to an accuracy of ± 0–2 days were used, but in studies involving smaller numbers of nests it may be desirable to use less precise records as well. Composite laying dates for the Maritime Provinces, Ontario, Saskatchewan, and Alberta are presented in Figure 4, with those from the literature. The Maritimes nest records were sufficiently numerous that they were subdivided for further examination into six groups, namely: eastern (E-NS) and western (W-NS) Nova Scotia, eastern (E-PEI) and western (W-PEI) Prince Edward Island, and northern (N-NB) and southern (S-NB) New Brunswick.

CLUTCH SIZE

There are few detailed accounts of Grackle clutch sizes. Bent and Gross (*in* Bent, 1958) stated that four and five egg sets were usual, and six not especially rare; three was apparently less common than six, since Bent did not mention it for the southern races. Petersen and Young (1950) gave exact data from a three-year study in Wisconsin: 3 (3), 4 (9), 5 (36), 6 (6), 7 (1), for a mean of 4.87. Wiens (1965) gave a mean of 4.4 eggs per clutch, with no details, from a different habitat in the same area of Wisconsin. It is not clear how many of these values involved clutches counted on more than one visit (cf. Snow, 1955*a*), but those of Petersen and Young and of Wiens presumably did.

A recent paper (Willson et al., 1971), presents additional data on clutch size from central Illinois, a high density part of the range (see Fig. 1). Their data confirm the larger clutch size (mean 4.9 eggs) reported from the middle of the continent by Petersen and Young (1950), and they cite further references (not examined) to large mean clutches (4.7 eggs) in Kentucky and Kansas. The data they cited from Long and Long (1968), refer to clutches examined on two dates late in the nesting season; these should not be considered comparable to other samples taken over the entire season.

In my samples all nests containing only one or two eggs were omitted as being incomplete, although three nests had checked counts of two egg sets. Two of these were not found until midway through incubation; the third was not checked for 10 days during incubation, and it also showed an abnormally long period between the start of laying and the hatching, a likely sign of disturbance. In these nests additional eggs could have been laid and subsequently lost.

Some of the nest record samples included too few checked counts (i.e. counted on two or more visits) to be very helpful. Checked clutches consistently averaged larger than unchecked but apparently complete ($\geqslant 3$ eggs) ones, the ratio of unchecked/checked being 0.98. The means and samples are given in Table 1.

In all Canadian samples of 10 or more clutches, except those from N-NB and checked clutches from S-NB, five was the most frequent clutch, four prevailing in the exceptions. But only in E-PEI (both checked and unchecked samples) was six the most frequent clutch after five and four; elsewhere three was commoner than six.

TABLE 1

CHECKED AND UNCHECKED CLUTCH SIZES OF COMMON GRACKLES, BASED ON NEST RECORDS IN CANADIAN PROGRAMS

Area	No. of eggs	Checked clutches		Unchecked clutches	
		No. of clutches	Mean clutch	No. of clutches	Mean clutch
E-NS	6	–)		3)	
	5	3)	5.00	49)	4.37
	4	–)		41)	
	3	–)		15)	
W-NS	6	–)		–)	
	5	7)	4.70	13)	4.35
	4	3)		5)	
	3	–)		5)	
E-PEI	6	2)		10)	
	5	15)	4.76	33)	4.70
	4	8)		21)	
	3	–)		5)	
W-PEI	6	1)		2)	
	5	22)	4.49	44)	4.31
	4	14)		33)	
	3	4)		18)	
S-NB	7	–)		1)	
	6	1)		3)	
	5	6)	4.44	25)	4.32
	4	8)		19)	
	3	1)		14)	
N-NB	6	1)		1)	
	5	4)	4.33	15)	4.23
	4	9)		25)	
	3	1)		6)	
Ontario	6	–)		1)	
	5	24)	4.36	37)	4.30
	4	23)		24)	
	3	5)		15)	
Saskatchewan	6	–)		2)	
	5	3)	4.33	2)	4.33
	4	2)		2)	
	3	1)		3)	
Alberta	6	4)		1)	
	5	5)	5.00	1)	4.67
	4	4)		2)	
	3	–)		–)	

BREEDING SUCCESS

The only published data on breeding success of Grackles are those of the Wisconsin studies, and Snelling (1968) believed that his activities (study of food brought to nestlings) had had a markedly adverse effect on reproductive success. Only one-fifth (18–21 per cent) of the grackle cards recorded nests found before incubation began, and less than half of these (5–9 per cent of total) were followed through to success or failure (cf. Snow, 1955*b*) Mayfield's (1961) method would permit use of more records, but it is unlikely that a meaningful analysis of Grackle breeding success based on nest record cards can be attempted until more records are available.

DISCUSSION

Distribution and Habitat.—The distribution of Grackles in the Maritimes (Fig. 2) agrees fairly well with that of agriculture. The highest densities occur on Prince Edward Island, which has 55 per cent of its area in cleared agricultural land. The highest densities in New Brunswick are in the potato-growing areas along the St. John valley and in more localized farming areas on the east and north coasts. But the main agricultural area in Nova Scotia, the Annapolis valley, seems to support relatively low Grackle densities, certainly less than in poorer farming areas on the north shore and western Cape Breton Island. The low densities in the Annapolis valley may reflect the more prosperous farming, with larger fields, fewer hedgerows, and fewer abandoned buildings for nest sites; the Bobolink (*Dolichonyx oryzivorus*), whose distribution in the Maritimes closely parallels that of the grackle but which nests on the ground in grassy fields, reaches its highest densities in the Annapolis valley. Much of the Maritimes was apparently settled by grackles only during the past 50 to 100 years (Godfrey, 1954, 1958; Tufts, 1962: Ouellet, 1969). Present distribution and densities there are possibly the temporary result of formerly more extensive agricultural settlement; as the many farms abandoned since the early 1900's revert to forest, the habitat becomes at first favorable but ultimately unsuitable for grackles.

The correlation between the Grackle's range and that of agriculture probably holds elsewhere in eastern Canada. Densities of Grackles certainly decrease rapidly as one moves north from the main farming areas of southern Quebec and Ontario. However, grackles virtually disappear (Fig. 1) in the northern grain-growing regions and on the dry prairies along the eastern flank of the Rockies, presumably owing to scarcity of elevated nest sites in these treeless regions.

If we consider only the main ranges of each species (Fig. 5), we find that the birds at present divided among the genera *Quiscalus*, *Euphagus*, and *Cas-*

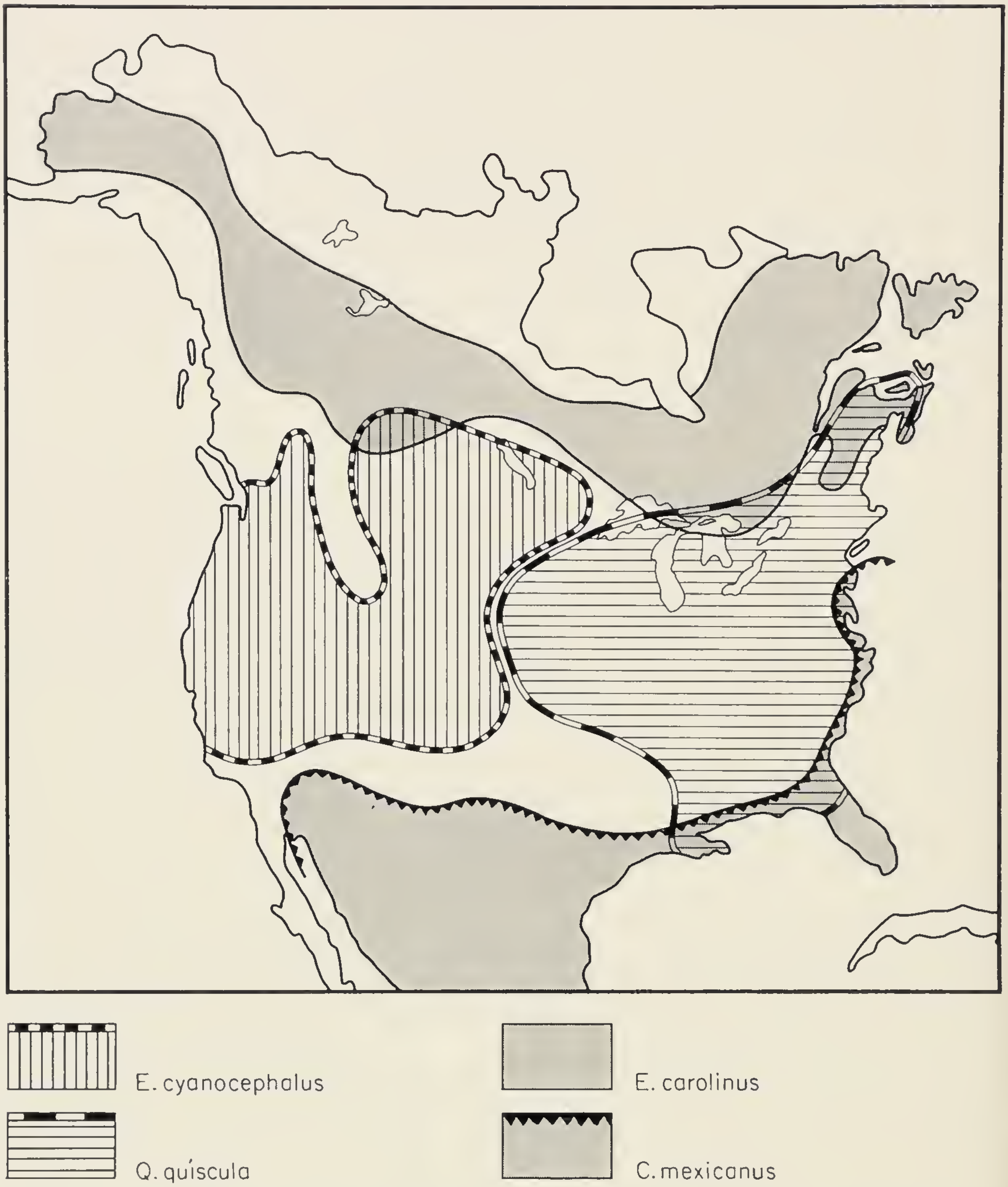

FIG. 5. Ranges of some North American blackbirds (*Quiscalus* and related species), from A.O.U. Check-list (1957) and for *Q. quiscula* and *E. cyanocephalus* only) from Breeding Bird Survey data.

sidix are nearly exclusive. Furthermore, their main ranges (omitting peripheral records) coincide closely with those of the greatest concentrations of species in the bird faunas to which each belongs (Udvardy, 1963). The Rusty Blackbird (*Euphagus carolinus*), of the taiga group of the Boreal Forest Fauna, spans the northern conifer forests from Newfoundland to Alaska. The

Brewer's Blackbird (*E. cyanocephalus*), of the Western Woodland-edge Fauna, occupies dry, open country from the Pacific to the eastern edge of the short-grass prairie. The Common Grackle, of the forest-edge group of the Deciduous Forest Fauna, extends from the less dry, eastern prairies to the Atlantic, south of the Boreal Forest. The larger grackles (*Cassidix major* and *C. mexicanus*), of the Tropical South American Fauna, occupy Mexico and Florida and coastal areas from Texas to New Jersey. All of these are basically species that forage in open country but nest in somewhat elevated sites, in woody or herbaceous vegetation. Although the Brewer's Blackbird nests on the ground in some areas, I believe that this is a secondary adaptation in a more typically tree- or bush-nesting species. Selander (1965), merged *Cassidix* with *Quiscalus.* Any future revision of this genus should also consider the species now set apart in *Euphagus*, which are similar in morphology as well as complimentary in distribution. Between them, these species occupy most open country habitats in North America except for the tundra and the southwestern deserts.

Except for the Rusty Blackbird, the northernmost of the group, these blackbirds co-exist throughout most of their ranges with one or several other Icterid species. The other species are also open country foragers, but they nest characteristically in marshes or on the ground. The more adaptable species may also use the nesting habitats of other species, resulting in competition. The most common comparison involving the Common Grackle has been with the Red-winged Blackbird (*Agelaius phoeniceus*), the typical marsh-nesting Icterid of eastern North America. These two are the most common and familiar blackbirds throughout the east, but their nesting habitats are largely segregated.

Wiens (1965) and Snelling (1968) studied Grackles nesting in a cattail marsh with Redwings. They concluded that the Grackles adjusted their behavior to minimize conflict with the highly territorial Redwings, and that the two species had almost complete temporal nesting separation, the Grackles nesting nearly two weeks earlier. The latter may be the factor that permitted the Grackles to invade this, to them, atypical habitat. Marsh-nesting by Grackles is known, on a local scale, in other areas. On Cape Breton Island, I found a few Grackle nests in sweet gale bushes in a shrubby marsh largely occupied by Redwings, and Redwings also nest sparsely in sweet gale clumps along the edges and in openings in alder swamps where Grackles nest commonly.

Many studies of competition between blackbird species have centered on the marsh-nesting species, particularly the Red-winged vs. Yellow-headed (*X. xanthocephalus*) Blackbirds (e.g. Willson & Orians, 1963), and the Red-winged vs. Tricolored (*A. tricolor*) Blackbirds (e.g. Lack and Emlen, 1939).

The Yellowhead is the dominant blackbird where it occurs in western marshes, as it readily supplants the Redwing. The Breeding Bird Survey (Robbins and Van Velzen, 1969) suggests that the Yellowhead is nowhere nearly as common as the Redwing. While this is probably correct on any but a local scale, the density of the Yellowhead is likely to be underestimated, as its habitat—deep, permanent marshes (Willson, 1966)—is poorly sampled by this roadside survey technique. Orians (1966) has shown that the Yellowhead is largely confined to the more fertile marshes, while the Redwing occupies the marsh edges and the less fertile areas.

In the west, Redwings frequently nest in willows and other tall marsh shrubs, the kind of habitat where one expects Grackles in the northeast. This habitat is available in the west because the Brewer's Blackbird, in other respects the western geographic replacement of the Common Grackle, usually prefers drier habitats (cf. Orians and Horn, 1969). The Brewer's Blackbird also nests on the ground in treeless areas, something which is unknown in the Grackle. This ground-nesting adaptation apparently places the Brewer's in competition with the Bobolink. The latter co-exists widely with the Grackle, but occurs very sparsely in the range of the Brewer's Blackbird. Bent (1958) quoted Roberts and Schorger on the (partial) replacement of Bobolinks by Brewer's Blackbirds in Minnesota and Wisconsin in the early decades of this century, but the evidence of the Breeding Bird Survey is that the Bobolink is still much more numerous in these states. Habitats frequented by the Common Grackle and other Icterid species with which it comes in contact are diagrammed in Figure 6.

Habitats, food, and social systems all enter into blackbird competition. Broadly, the trend is from densely colonial, marsh-nesting species at one extreme, to solitary, scrub-nesting species at the other. The most highly colonial species (*A. tricolor*) is monogamous, as are the solitary species (*E. carolinus* and *Q. quiscula*) at the other extreme; in between there are various degrees of polygyny. Recent studies (e.g. Horn, 1968) have shown that colonial nesting is adaptive where food sources are unevenly distributed, whereas solitary nesting is favored where the food supply is stable and uniformly distributed. The latter is true especially if grouped nests become unusually vulnerable to predation, as with ground-nesting species in grassland. But it would also apply to species using infertile habitats such as the spruce bogs frequented by Rusty Blackbirds. The Common Grackle is at most loosely colonial (Lack, 1968) would term it "grouped nesting" rather than truly colonial behavior). There are no useful data on whether the Grackle is more or less colonial in the different parts of its range; in fact, there seem to be no major studies from the areas where it is most common! My own data from Cape Breton suggested that clumped nesting was the most common organization, but this

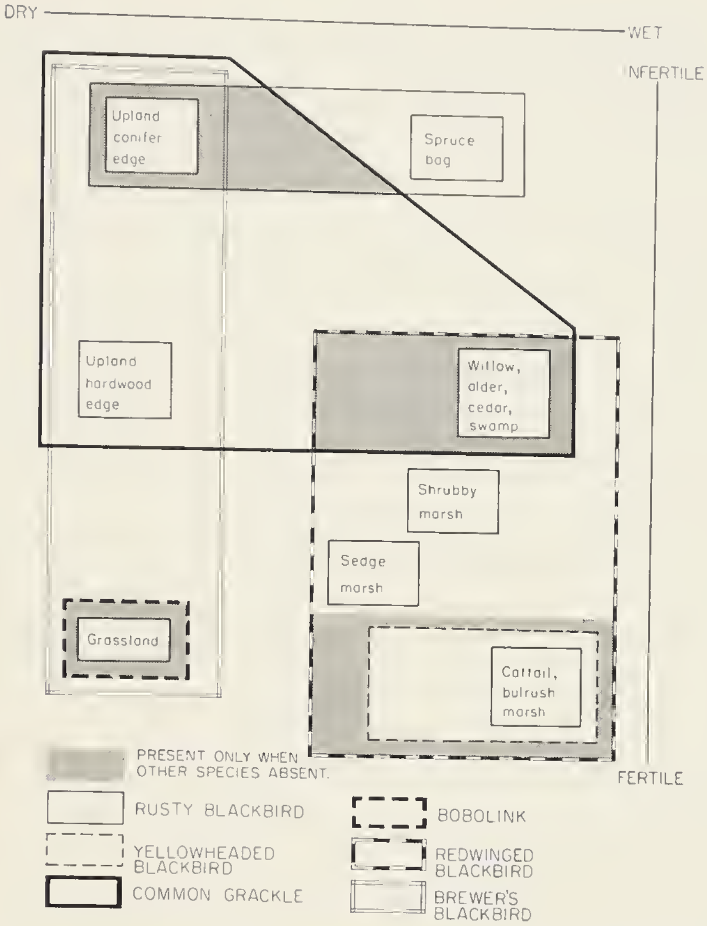

Fig. 6. Habitats used for nesting by grackles and other Icterids.

could be solely because clumped nests are much easier to find than solitary ones. Except in bridges, nests were usually more than 15 feet apart, particularly in the more extensive swamps where alternative nest supports were readily available.

The social organization of the Grackle involves minimal territorial defense (Ficken, 1963; Wiens, 1965), in contrast with the noisy and energetic defense of nest territories of marsh-nesting blackbirds. But the Brewer's Blackbird (Williams, 1952) is not conspicuously territorial, and the promiscuous or polygynous *Cassidix* grackles defend only the nest rather than an area around it (Skutch, *in* Bent, 1958). I am left with the feeling that the Common Grackle differs rather little in social organization from the other scrub-nesting icterids, but that it is quite strictly monogamous in the northern parts of its range. Comparisons between Grackle and Rusty and between Grackle and Brewer's Blackbirds, along the lines of those described by Wiens (1965) and Snelling (1968), would be extremely interesting. Although these species do exist in the same general areas, my own impression (Erskine, 1968) is that they never nest together in the same habitat. It is likely that their requirements are so similar that no two of these species can occur together without one gradually displacing the other. But we badly need comprehensive studies of the breeding biology of Common Grackles near the center of their range where they are most numerous.

Laying Dates.—The start of laying in the Maritimes is well correlated with local temperatures (Canada, Department of Transport, 1961–68) in any area and year. Within each year, the start of laying seems to follow a rise in daily mean temperature above 42° F (6° C) by five to seven days. This relationship (e.g. Fig. 7a) resembles that found by Nice (1937) for the Song Sparrow (*Melospiza melodia*), except that the usually earlier laying dates of the sparrow were accompanied by a considerably higher temperature threshold.

The only sample within which the relationship between temperature and laying date is anomalous is that from E-PEI (Fig. 7b). There the interval between temperature rise above 42° F and onset of laying was shorter than five days in all years for which nine or more accurate dates were available. This could be explained if the temperature around the nesting site was (say) 2–3° F higher than at the station (Charlottetown CDA) at which weather records were taken. There is no evidence that the nesting locality was actually warmer, but this nest sample was the only one in which nests in dense conifers predominated. The micro-habitat provided by this substrate may be sufficiently warmer and better insulated than other nesting sites that a lower temperature threshold is tolerable there (cf. Horvath, 1964).

There is no correlation between median laying dates and monthly mean temperatures, probably because in the Maritimes the critical period for the start of ovulation falls sometimes in late April and sometimes in early May. Probably one could demonstrate correlation of laying dates with 10-day or weekly means of daily temperatures, but the correlation with the daily temperatures is likely to be more useful.

Clutch Size.—The clutch size frequencies reported by Bent and Gross are too general to be very helpful. In combination with the data of Petersen and Young (1950) and those from the nest record cards (Table 1), they suggest that the clutch size decreases slightly from south to north, with five and six egg sets becoming scarcer and three and four more frequent. But we obviously need far more data from the center of the species' range before this can be taken as proved. Present data are not sufficient to show whether clutch size differs between habitats in any one area, as occurs in some species (cf. Lack, 1966—Table 25).

Clutch size varied inversely with laying dates in most parts of the Maritimes. This could not be verified from data on individual clutches, since too few records gave both an accurate laying date and a checked clutch size. There was fair correlation (Fig. 8) between mean clutch size and median laying

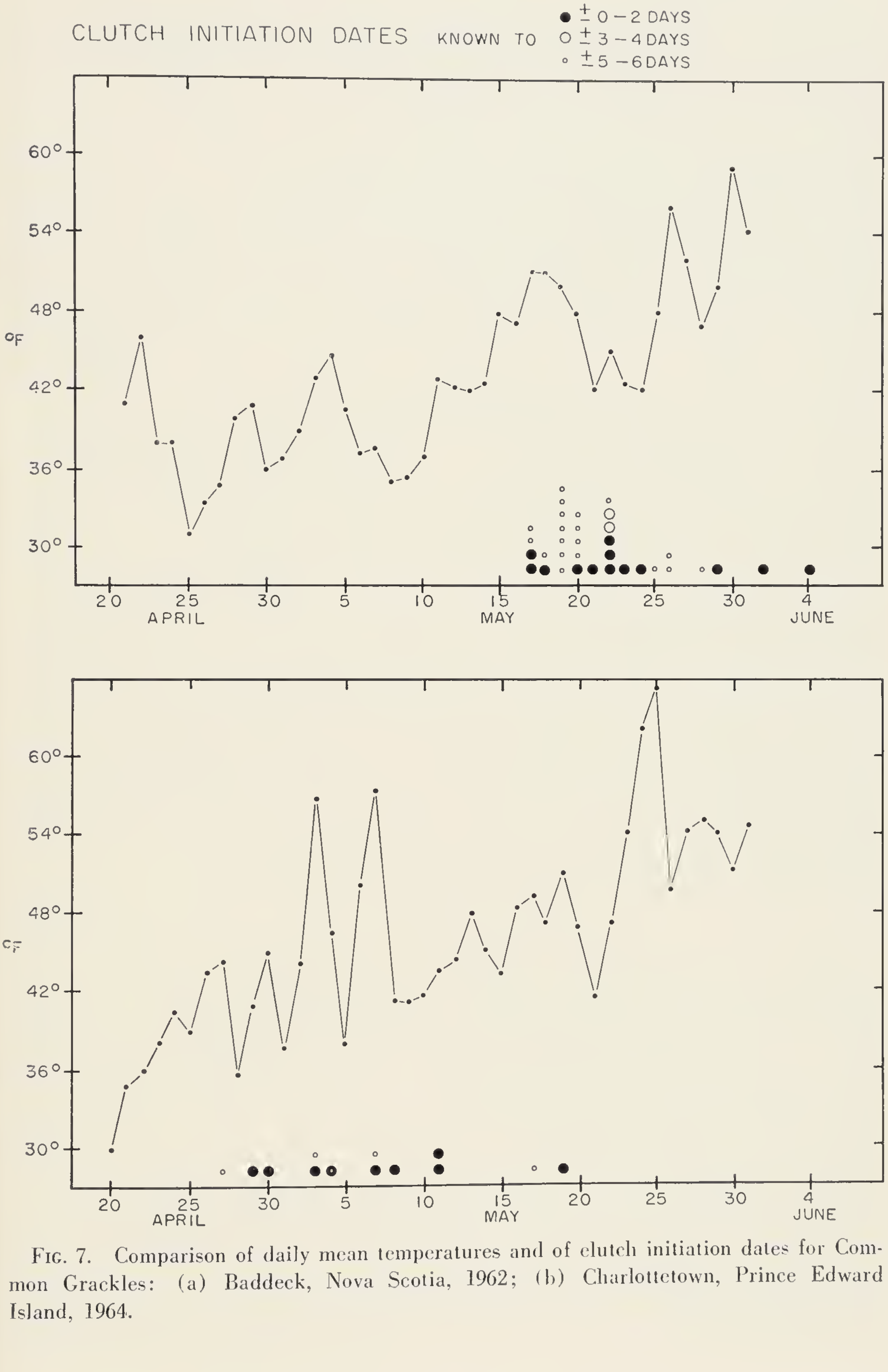

Fig. 7. Comparison of daily mean temperatures and of clutch initiation dates for Common Grackles: (a) Baddeck, Nova Scotia, 1962; (b) Charlottetown, Prince Edward Island, 1964.

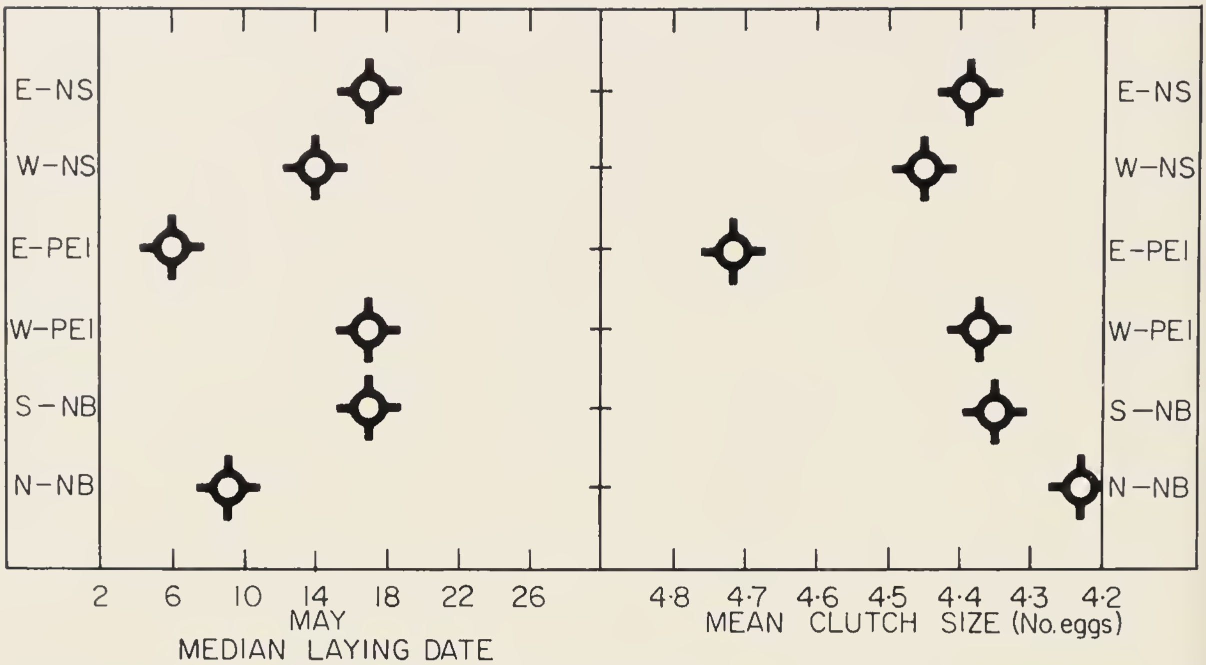

FIG. 8. Comparison of median clutch initiation dates and of mean clutch size of Common Grackles in various parts of the Maritime Provinces, 1960–68.

date in Nova Scotia, Prince Edward Island, and S-NB, but the relationship did not apply in N-NB. The very early laying dates found in E-PEI were accompanied by a high frequency of six egg sets and an overall high clutch size. But the early laying dates in N-NB, which were well correlated with temperatures in the warm springs of 1964 and 1968, were accompanied by the lowest mean clutch size of any area in the Maritimes. The N-NB sample is from about 100 miles farther north than any other Maritimes sample, but all of the Maritimes samples are about equally near to the limits of the species' distribution. I cannot at present explain this discrepancy.

SUMMARY

In this paper data collected in the cooperative Breeding Bird Survey and in nest record programs are used to obtain new perspectives on the breeding biology of the Common Grackle. Much of the range outlined in recent handbooks, especially in the north and west, is seen to be populated very sparsely—or perhaps very locally—by Grackles. The main range coincides well with agricultural areas and other open habitats where there are elevated sites (trees, bushes, buildings) for nests. The main range is mutually exclusive with those of the other blackbirds now placed in the genera *Euphagus* and *Cassidix*.

Nest record cards are shown to be quite biased as samples for data on distribution, breeding habitat, and nest site. Data on laying dates and clutch size are more satisfactory, provided they are interpreted carefully. The start of laying is generally well correlated with temperature, and the clutch size is usually (but not always) correlated with laying date. There is a suggestion that nests in dense conifers are started earlier and at lower temperatures than those in less protected sites. The clutch size may decrease slightly from south to north, but there are insufficient published data from the central and south-

ern parts of the main range to establish this at present. Data on reproductive success are generally meager, and this subject was not explored further.

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CANADIAN WILDLIFE SERVICE, OTTAWA, ONTARIO, CANADA. 10 MAY 1971.

SIZE, MIGRATION PATTERN, AND STRUCTURE OF FALL AND EARLY WINTER BLACKBIRD AND STARLING POPULATIONS IN WESTERN OKLAHOMA

STEPHEN V. GODDARD

EVERY fall thousands of blackbirds and Starlings migrate into Oklahoma from their northern breeding areas. Populations of these birds have been increasing rapidly and reportedly are causing severe crop depredations in Custer County in western Oklahoma. Accurate records of the size of the population and its structure are not available. There are some records for the area around the Washita National Wildlife Refuge. Congregations of Brewer's Blackbirds (*Euphagus cyanocephalus*) and Brown-headed Cowbirds (*Molothrus ater*) began using the area shortly after the construction of Foss Reservoir and the establishment of the refuge on the northern one-third of the lake in 1961. The peak blackbird population that year was estimated at 100,000 individuals (Washita National Wildlife Refuge, Narrative Reports).

The 1962 fall population was greater than that for the previous year. Flocks of Yellow-headed Blackbirds (*Xanthocephalus xanthocephalus*) visited the refuge during the early part of the fall. The wintering blackbird flock consisted of Red-winged Blackbirds (*Agelaius phoeniceus*), Brewer's Blackbirds, and Brown-headed Cowbirds.

During 1963, upwards of 200,000 blackbirds caused serious damage to refuge sorghum fields. These birds left the area during the latter part of December (Washita National Wildlife Refuge, Narrative Report).

With this background information, a study was conducted during the fall and early winter periods of 1964–65 and 1965–66 with the following objectives: 1) Determine the size of the fall and winter blackbird and Starling population in the area; 2) ascertain the migration pattern of these birds; and 3) determine the species, age, and sex structure of the fall population; and 4) ascertain the relationship of the population buildup with actual crop depredations.

DESCRIPTION OF STUDY AREA

The 130 square-mile study area was located in the western third of Custer County, Oklahoma and included the Washita National Wildlife Refuge and the land adjacent to the Foss Reservoir.

The area's rolling topography was interlaced with gullies and ravines. The most abundant grasses in the area were sand bluestem (*Andropogon hallii*), little bluestem (*Andropogon scoparius*), Indian grass (*Sorghastrum nutans*), silver bluestem (*Andropogon saccharoides*) and Johnson grass. Much of the upland area had been overgrazed, and in these situations broomweed (*Gutierrezia dracunculoides*) had taken over.

The Washita River runs through the western edge of the area, while Barnitz Creek traverses the northeast section. Valleys formed by these streams are more fertile than the uplands. Consequently, most of the farming activity is centered here and in the bottomlands of other smaller waterways. Usually the uplands were used for cattle grazing. The major crops are cotton (*Hibiscus herbaceum*), grain sorghum, and wheat (*Triticum aestivum*).

Three large blackbird and Starling (*Sturnus vulgaris*) roosts in cattails (*Typha* sp.) were located off the refuge in the northern part of the study area. These roosts were on ponds that had surface areas of 33 (Ring's Pond), 26 (Ray's Pond), and 20 (Hughes Pond) acres respectively. The cattails grew around the edges and occurred in thick stands in the shallow water portions.

Much of the work was conducted on the Washita Refuge which contains 8,200 acres, of which approximately 3,400 acres will be under water when the reservoir reaches maximum pool elevations. Gently rolling bottomlands make up another 2,600 acres and 2,200 acres are uplands. About 2,500 acres are being cultivated to provide feeding areas for migrating waterfowl. In 1965, 969 acres were planted in wheat, 659 acres in grain sorghum, 319 acres in corn (*Zea mays*) and 216 acres in barley (*Hordeum vulgare*). The remaining acreage was in alfalfa (*Medicago sativa*) or was left fallow.

Cattails and western salt cedar (*Tamarix gallica*) have become established in the shallow water portions and along the lake shoreline. Dense stands of Johnson grass grew along the banks of the Washita River, which transected most of the refuge. These stands extended out for about 200 yards in some places. The grass was especially thick on the river's delta. Tall dense stands occurred along the banks of all the watercourses and in most of the low situations where water collected. These areas were used by roosting blackbirds.

PROCEDURE

Field observations were conducted throughout two study periods, 24 August to 6 January in 1964–65 and from 1 September to 20 January in 1965–66. The information collected dealt primarily with Redwings, cowbirds, and Starlings. Data pertinent to Common Grackles (*Quiscalus quiscula*), Brewer's Blackbirds, and Rusty Blackbirds (*Euphagus carolinus*) were also included.

Blackbird populations were best estimated by counting birds flying to and from roosts. Roost counts were initiated two hours before sunset during the September through November period of 1964. For the remainder of the first study period, counts were begun one hour before sunset. This was due to birds coming in later in the day to the roost as the days became shorter.

During the second year, evening counts were begun one and one-half hours before sunset from September through November and from one hour before sunset in late December and January. The observer remained in the area until about 30 minutes after sunset.

Morning counts extended from 45 minutes to one hour before sunrise until the last bird had left the roost.

Road censuses were made on 22 December, 1965, and on 4 January, 1966, to determine the relative density of blackbirds on the refuge and on adjacent lands. A 100-mile route was marked off on a map of the study area and a random starting point selected. The census was started at 10:00 and terminated 15:00. Only blackbirds and Starlings in odd mile segments and within 100 yards of the road were tabulated.

An attempt was made to determine the population of local blackbirds as contrasted to

TABLE 1

BLACKBIRD AND STARLING POPULATION ESTIMATES BY WEEKLY PERIODS 1964–65, 1965–66

Month and week		1964–65	1965–66
August	4	10,000	2,000
September	1	10,000	3,100
	2	10,000	3,000
	3	10,000	6,400
	4	15,000	8,000
October	1	15,000	7,500
	2	500	17,000
	3	3,000	35,000
	4	40,000	40,000
November	1	140,000	50,000
	2	250,000	160,000
	3	200,000	270,000
	4	100,000	345,000
December	1	100,000	420,000
	2	80,000	862,000
	3	80,000	913,000
	4	80,000	621,000
January	1	15,000	591,000
	2	—	238,000
	3	—	161,000
	4	—	90,000
February	1	—	50,000
	2	—	50,000
	3	—	10,000
	4	—	5,000

migrants. Throughout the study periods, data were collected on the rate of population movement into and away from the area and on the age and sex structure of the population.

Banding was carried out in an endeavor to determine the major breeding and wintering areas of the birds and the age and sex composition of the flock. The modified Australian crow trap (U.S.F. & W.S., 1965) and mist nets (Low, 1957) were the means by which birds were captured. Redwings were sexed and aged in accordance with criteria presented by Packard (1936) and DeGrazio (1964). Cowbirds were aged by the method described by Selander and Giller (1960). Kessel's (1951) technique was used to determine the age and sex of Starlings.

TABLE 2

BLACKBIRD POPULATIONS ON THE WASHITA NATIONAL WILDLIFE REFUGE FEB.–AUG. 1965, FEB.–APRIL, 1966

Month and week		1965	1966
February	3	—	10,000
	4	2,000	5,000
March	1	3,000	5,000
	2	3,000	3,000
	3	2,000	2,000
	4	2,000	100
April	1	5,000	50
	2	—	200
	3	—	1,000
	4	—	200
May	1	200	—
	2	100	—
	3	75	—
	4	100	—
June	1	120	—
	2	100	—
	3	75	—
	4	80	—
July	1	85	—
	2	200	—
	3	275	—
	4	300	—
August	1	500	—
	2	1,200	—
	3	1,500	—
	4	2,000	—

RESULTS

Population Size.—Blackbird population estimates for weekly periods during the fall and early winter for the two years are presented in Table 1. The population was approximately 10,000 birds when the study was initiated in 1964. The number increased to 15,000 by the end of September. By the middle of October, the blackbird population had declined to a low of 500 birds. The population increased after 15 October and reached 40,000 by the end of the month. A peak population of 250,000 birds occurred during the second week of November. The population started to decline the next week and had dropped to 15,000 birds by 6 January, 1965.

TABLE 3

SPECIES COMPOSITION OF THE BLACKBIRD AND STARLING POPULATION 1964–1965

Date	Red-winged Blackbirds		Brown-headed Cowbirds		Starlings		Other Blackbirds	
	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
Aug. 4	4,000	40.0	4,500	45.0	—	—	1,500	15.0
Sept. 1	4,500	45.0	4,500	45.0	—	—	1,000	10.0
2	4,500	45.0	5,200	52.0	—	—	300	3.0
3	3,400	34.0	6,380	63.8	140	1.4	80	0.8
4	2,160	14.4	12,700	84.6	100	0.6	40	0.3
Oct. 1	2,400	16.0	12,450	83.0	100	0.6	50	0.4
2	100	20.0	380	78.0	—	—	20	4.0
3	660	22.0	2,250	75.0	—	—	90	3.0
4	3,000	7.5	36,800	92.0	—	—	200	0.5
Nov. 1	33,600	24.0	82,600	59.0	24,000	17.0	—	—
2	100,000	40.0	100,000	40.0	50,000	20.0	—	—
3	90,000	45.0	60,000	30.0	50,000	25.0	—	—
4	40,000	40.0	30,000	30.0	30,000	30.0	—	—
Dec. 1	40,000	40.0	30,000	30.0	30,000	30.0	—	—
2	32,000	40.0	20,000	25.0	28,400	35.0	—	—
3	32,000	40.0	20,000	25.0	28,400	35.0	—	—
4	32,000	40.0	20,000	25.0	28,400	35.0	—	—
Jan. 1	6,000	40.0	1,500	10.0	7,500	50.0	—	—
Total	430,320	37.1	449,260	38.7	277,040	23.9	3,580	0.3

In the second year, a population of 3,100 blackbirds was using the area by 1 September. The population steadily increased until it reached a peak of over 900,000 birds during the third week of December, then began to decrease the following week. On 20 January, 1966, the population was 160,000 birds. Follow-up observations indicated that the population had declined to 5.000 by the end of February.

Blackbird population estimates from road censuses were 301.000 and 315,000 for 22 December and 4 January, respectively. These figures were 48 and 53 per cent of the population estimated from roost counts. The density of blackbirds on the refuge obtained from the census data was 28.5 and 93.5 times as great as the density of blackbirds off the refuge for the two days. The average density for the two days was 3.7 birds/acre for the entire study area. Tremendous concentrations took place at the various roosts where densities of 44,700 (Ring's Pond, 1964), 70,400 (Ring's Pond. 1965). and 99,700 birds/acre (Ray's Pond, 1965) were observed.

TABLE 4

SPECIES COMPOSITION OF THE BLACKBIRD AND STARLING POPULATION 1965–1966

Month and Week	Red-winged Blackbirds		Brown-headed Cowbirds		Starlings		Other Blackbirds	
	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
Aug. 4	1,100	55.0	300	15.0	—	—	600	30.0
Sept. 1	1,705	55.0	465	15.0	—	—	930	30.0
2	1,710	57.0	300	10.0	—	—	1,000	33.0
3	3,900	61.0	500	8.0	—	—	2,000	31.0
4	3,600	45.0	2,000	25.0	—	—	2,400	30.0
Oct. 1	3,800	51.0	2,200	29.0	—	—	1,500	20.0
2	6,400	38.0	9,300	55.0	600	3.0	700	4.0
3	3,850	11.0	30,800	85.0	350	1.0	800	2.0
4	7,200	18.0	32,000	80.0	—	—	1,200	7.0
Nov. 1	13,500	27.0	31,000	62.0	1,500	3.0	4,000	8.0
2	105,000	66.0	39,000	24.0	3,200	2.0	12,800	8.0
3	210,000	78.0	44,000	16.0	8,000	3.0	8,000	3.0
4	241,000	70.0	44,850	13.0	58,650	17.0	—	—
Dec. 1	273,000	65.0	46,200	11.0	100,000	24.0	—	—
2	578,000	67.0	113,000	12.0	171,000	21.0	—	—
3	547,000	60.0	92,000	10.0	274,000	30.0	—	—
4	323,000	52.0	25,000	4.0	273,000	44.0	—	—
Jan. 1	284,000	48.0	23,000	4.0	284,000	48.0	—	—
2	189,000	80.0	28,000	12.0	21,000	8.0	—	—
3	128,000	80.0	20,000	12.0	13,000	8.0	—	—
4	72,000	80.0	10,800	12.0	7,200	8.0	—	—
Total	2,996,765	61.9	594,715	12.3	1,215,500	25.1	35,930	0.7

Migration Patterns.—The summer pattern is not known for 1964, but a population of 10,000 birds was present on 1 September of that year. The population remained relatively stable for five weeks and then most of the birds left. They could not be located during the day or at any of the roosts. Blackbirds began moving into the area during the third week of October and the migration peak occurred during the second week of November. Large numbers of the birds migrated through during the next two weeks. From the last week of November until the end of December, the population was relatively stable. A large movement of birds from the area took place during the first week of January in 1965. Additional small movements out of the area occurred until only 2,000 birds were present by the end of February.

The numbers in the spring migration, which took place during the first part of April, were considerably less than in the fall (Table 2). After this move-

TABLE 5

REDWING SEX RATIOS AND PERCENTAGE OF MALES OBTAINED FROM FIELD COUNTS 1964–65, 1965–1966

Month	Males		Males/Female	
	1964	1965	1964	1965
September	220	569	2.3	0.6
October	128	224	0.7	0.2
November	1,230	1,298	4.5	0.8
December	1,510	3,254	4.1	1.0
January	—	1,712	—	1.5
Total	3,088	7,057	3.4	0.9

ment, the population dwindled to about 100 resident birds. The population had increased to 300 by the second week of July. This increase was probably due to young birds and to post-nesting flocking. Another increase took place the first week of August which was attributed to birds raised in the immediate area moving onto the refuge. Blackbirds continued to move in and population increased slowly to 8,000 by the end of September. By the second week of October, large numbers of birds were migrating into the area and 40,000 birds were present by the end of the month. The migration tempo picked up tremendously from the second week of November until the third week of December as about 860,000 birds were added to the population. This build-up was only transitory and birds began moving out the next week (190,000). Large movements out of the area continued until the first of February. There was no definite spring migration in 1966. It appeared the population simply declined until the first week of May when 200 birds or local nesters were present. A small movement of birds did take place during the third week of April.

Population Structure.—Cowbirds made up 38.7 per cent of the population the first year (Table 3). Redwings and Starlings made up 37.1 and 23.9 per cent respectively of the total population. Cowbirds were the earliest migrants but peak numbers of all three species occurred during the second week of November. Cowbirds were the first to leave followed by Redwings and Starlings. The latter two species made up 90 per cent of the total population the first week of January.

The large population increase the second year was primarily due to the tremendous increase in the numbers of Redwings and Starlings (Table 4). There was also a smaller increase in the cowbird population. Redwings made up 61.9 per cent of the total population. Starlings and cowbirds com-

TABLE 6

SEX RATIOS OF BLACKBIRDS AND STARLINGS BANDED ON THE WASHITA NATIONAL WILDLIFE REFUGE 1964–65, 1965–66

	Oct.	Nov.	Dec.	Jan.	Total
Redwings					
Sample Size					
1964	—	37	221	30	288
1965	—	8	11	11	30
Males/Females					
1964	—	8.2	43.2	—	31.1
1965	—	0.0	10.0	4.5	1.7
Cowbirds					
Sample Size					
1964	—	203	717	69	989
1965	36	49	314	202	601
Males/Females					
1964	—	0.9	1.9	2.6	1.6
1965	0.3	0.8	1.8	3.2	1.8
Starlings					
Sample Size					
1964	—	—	197	26	223
1965	—	—	—	—	—
Males/Females					
1964	—	—	1.9	4.2	2.1
1965	—	—	—	—	—

prised 25.1 and 12.3 per cent respectively of the total. Cowbirds again were the earliest migrants followed by Redwings. However, peak populations for both species occurred the second week of December. The Starling population did not peak until a month later. Again Starlings and Redwings made up about 90 per cent of the population the first week of January. More Starlings and cowbirds moved out during the next three weeks so that the population consisted of 80 per cent Redwings by the end of the month.

Sex-ratio (males/female) counts of Redwings at various places in the study area generally followed the same trend both years but not to the same degree. During the first year, September sex ratios were 2.3 (Table 5). The number of females increased and the ratio declined to 0.7 in October. The November sex ratio increased to 4.5 and then declined slightly in December to 4.1 while the population remained relatively constant.

During 1965, the September sex ratio was 0.6. The number of females again

Table 7

Age Ratios of Blackbirds and Starlings Banded on the Washita National Wildlife Refuge 1964–65, 1965–66

	Oct.	Nov.	Dec.	Jan.	Total
Redwings					
Sample Size					
1964	—	37	221	30	288
1965	—	8	11	11	30
Immatures/Adult					
1964	—	8.2	1.1	0.2	1.1
1965	—	0.6	1.8	1.2	1.1
Cowbirds					
Sample Size					
1964	—	203	717	69	989
1965	36	49	314	202	601
Immatures/Adult					
1964	—	3.2	1.2	0.6	1.3
1965	1.8	1.7	2.7	1.2	1.9
Starlings					
Sample Size					
1964	—	—	197	26	223
1965	—	—	—	—	—
Immatures/Adult					
1964	—	—	1.8	0.7	1.6
1965	—	—	—	—	—

increased in October and the sex ratio declined to 0.2. With a larger influx of males in November, it increased to 0.8. The sex ratio continued to increase in December to 1.0 and increased again in January to 1.5.

During the first year, 1,555 birds were banded. The species composition was 291 Redwings, 1,003 cowbirds, 253 Starlings, and eight grackles (Table 6).

Sex ratios for the three major species of banded birds increased from November to January. The greatest change occurred in the sex ratio for Redwings. Field counts indicated that male Redwings were trapped in a larger proportion than they occurred in the population.

The banded sample in 1965 of 636 birds consisted of 30 Redwings, 601 cowbirds, four Brewer's Blackbirds, and one Starling. The number of Redwings banded the second year was too small to justify any conclusions concerning the population. The proportion of male cowbirds increased from October through January. The October sex ratio of 0.3 was evidence that female cowbirds predominated. The proportion of males increased in November to 0.8 and increased further to 1.8 and 3.2 in December and January respectively.

Age ratios (immatures/adult) of birds banded in 1964 declined for all three species from November to January (Table 7). The pattern was slightly different the second year. The highest age ratios were obtained from birds banded in November. After this it appeared the age ratio declined as birds moved out of the area.

DISCUSSION

The population peak of 900,000 birds in 1965 was more than three and one-half times that observed the first year. For seven weeks, the 1965 population was equal to or greater than the peak population observed in 1964. Several factors may have accounted for the much larger numbers in 1965. The weather was extremely mild during late summer and fall. This milder weather may have slowed migration and allowed birds to build-up and not migrate through the area. Evidence for this was that the population peak occurred five weeks later. There was a tremendous increase in the numbers of Redwings (about seven times) and Starlings (approximately five times). Also, the larger population coincided with the trend of increased blackbird populations every year since the refuge was established.

Populations based on two road-census samples both gave about the same percentage (one-half) of the population estimates based on roost counts. indicating that road censuses may be useful for obtaining a population index. A road census has already been developed for censusing breeding Redwings (Hewitt, 1967). Population estimates based on roost counts included birds feeding outside the area (especially Starlings) which flew in at night to roost. These birds would not be included in the road census and thus resulted in a lower population estimate.

The road-census data indicated a greater density of blackbirds on the refuge than on the rest of the study area. The refuge appeared to be a congregation point for feeding (due to grain sorghum planted for waterfowl) even though most of the blackbirds roosted off the refuge. Greater densities of birds occurred on the refuge in January as food became less available off the refuge.

Some blackbird movement into the study area had taken place by 1 September both years. The early September population was larger than could reasonably be attributed to reproduction by resident birds. Goddard and Board (1967) reported that the average Redwing reproduction in north central Oklahoma was 2.5 young per pair. It would have taken 1,800 and 680 nesting Redwings in 1964 and 1965 respectively to produce the late August populations. It was unlikely that this many birds were present due to the low nesting populations observed on the area in the springs of 1965 and 1966. A reasonable estimate of the resident breeding population and their young would be about 1,000 birds.

Sex-ratio data obtained from field counts and banding demonstrated similar movement patterns. In both years, a decline in the proportion of males in October coincided with a blackbird movement into the area. This suggested the early build up was largely composed of females. The greater proportion of male Redwings and cowbirds in November of both years implied that most birds moving into the area during this month were males.

In 1964, many females were in the large movement out of the area the last two weeks of November. Since the population was composed primarily of immatures at this time, the largest proportion of the birds were presumed to be immature males. The sex ratio of banded Redwings and cowbirds increased during December and the age ratio declined. This suggested that the large segment of the population which left during November was composed of immatures and adult females.

A higher proportion of male cowbirds and Starlings was present in January. These data combined with age ratios that declined for all three species, indicated again that immatures and adult females made up most of the birds which left during December and the first part of January.

During the second year, the age ratio of cowbirds in November remained almost constant with that for October which suggested that flocks moving into the area during this time had about the same age composition as the population already present. The similarity may have been due to small sample size or perhaps to greater trapping vulnerability of immatures. Generally, the proportion of males increased from November to January. The population peak in November seemed to be due to a large number of males moving into the area.

The proportion of males increased again in December and January. The December age ratio indicated that the population peak which occurred during the third week of December contained large numbers of immatures. A substantial movement out of the area took place over the next three weeks. The movement consisted largely of adult females and immature males and females. Evidence of this was the increased number of adult males in the December and January samples and the decreased proportions of the other age and sex classes.

Approximately 65 and 71 per cent of the grain sorghum in the damage-evaluation fields was eaten by blackbirds and Starlings in 1964 and 1965 respectively. Using these data, and expanding it for the entire refuge, the losses were $6,500 and $10,700 in the two years. Loss of a large amount of the refuge's sorghum crop to the blackbirds and Starlings was presumed to have been responsible for the daily feeding flights of waterfowl off the refuge in late 1964 and early 1965. These flights exposed the ducks to additional hunting pressure. At least four farmers are known to have lost most of their 1964 sorghum crop. This was due to late rains which delayed the harvest until large numbers of blackbirds were present. Normally the harvest is completed by the end of October before the large build-up of blackbirds. Warmer weather delayed the migration the second year and little damage off the refuge was reported. The loss of sorghum and subsequent reduction in waterfowl use of the refuge were related to the size and duration of use by the blackbird and Starling populations.

SUMMARY

A study of the population size, migration pattern, and structure of blackbird and Starling populations was carried out during the fall and early winter of 1964 and 1965 in western Oklahoma. In 1964, the peak population of 250,000 birds was observed in the second week of November. The peak the second year was 900,000 and occurred during the third week of December. Greater densities of birds were observed in January on the refuge portion of the study area. Possible reasons for the increased population the second year and greater densities on the refuge are discussed.

The relationship between migration patterns the two years and the species, age, and sex composition of the populations are also discussed.

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SEASONAL CHANGE IN THE BREEDING BEHAVIOR OF THE MALE RED-WINGED BLACKBIRD

Frank W. Peek

Changes in behavior in response to changing conditions in the breeding situation have been demonstrated for a number of species. For species in which both sexes are directly involved in rearing the young, the changing features of the nest situation, such as the appearance of eggs or the hatching of young, have been shown to play a critical role in pacing behavioral change in both sexes (Lehrman, 1961; and Emlen and Miller, 1969). In species such as the Red-winged Blackbird (*Agelaius phoeniceus*), in which the breeding behavior of the sexes differs markedly, these factors probably pace the behavior of the female since she builds the nest, incubates, and cares for the nestlings. The male Redwing, however, is largely concerned with territorial defense during the breeding period and with rare exceptions is not directly involved in nest building, incubation, or feeding nestlings (Allen, 1914; Beer and Tibbits, 1950; and Orians, 1961). In the present report I present data which show that seasonal changes in the male's behavior occur and that these changes are correlated with seasonal changes in the difficulty he experiences in maintaining territory.

METHODS

The study was conducted on a small (16.5 acre) fresh-water marsh located near State College, Pennsylvania. The marsh was bounded on two sides by small creeks which served as the primary sources of ground water. The remaining side was bounded by dense bush oak and maple woods. The dominant vegetation was cattail (*Typha* sp.) in the wetter portions of the marsh and sedge (*Carex* sp.) in the dryer portions. The Redwing population on the marsh was isolated by hills and extensive cultivated areas.

I carried out the study through four complete breeding cycles (1966–1969). As many males as possible were captured using mist nets and Potter traps baited with corn. All captured birds were individually marked with leg bands of colored plastic tape. Territorial boundaries were determined by plotting the movements of each male on field maps followed by drawing an envelope around the outermost points.

Throughout one breeding season routine observations were made between the hours of 06:00 and 11:00 EST, on seven marked territorial males. I watched each bird for one or two periods of approximately one and a half hours in each of seven consecutive ten-day periods. The following data were recorded: the frequency of songs and calls; the frequency and durations of the periods when the male was on territory, off territory, on the ground on territory, perched on territory, and flying on territory; and the frequency and durations of all trespasses by conspecific males on the observed territory. Detailed data on the events and dates of the breeding seasons, presented in detail elsewhere (Peek, 1969), formed the basis for dividing the breeding season into functional periods (Fig. 4). Dates of the various events reported here agree well with those reported for the same

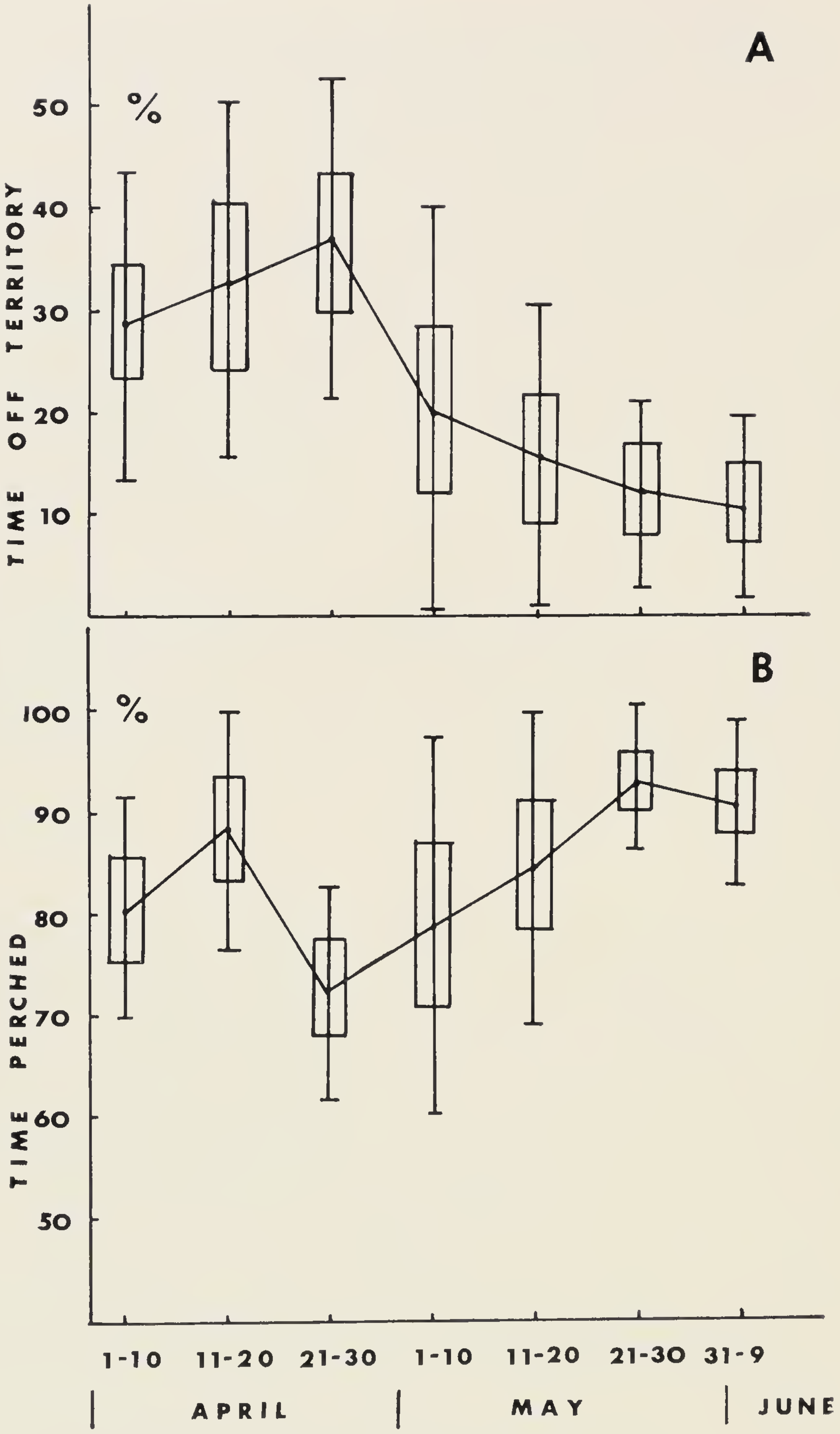

FIG. 1. A. Percentage of observation period the territorial male was off his territory. B. Percentage of time on territory that the territorial male was perched. Observation: between 06:00 and 11:00. Dots represent means; rectangles indicate mean ± one standard error; brackets denote 95 per cent confidence intervals.

species in New York (Allen, 1914) and Wisconsin (Beer and Tibbits, 1950; and Nero, 1956*a*).

Three experimental manipulations of the population were made:

(1) Thirty-five territorial males were removed from their territories over the four breeding seasons at times distributed throughout each season. The date of removal was recorded and the identity of the new territory owner was determined.

(2) Twenty-three territorial males were surgically muted (by cutting the hypoglossal nerves controlling the syrinx) at times distributed throughout two breeding seasons. Immediately after the operation the muted birds were released upon their territories and their behavior as well as the behavior of conspecific males toward them and their territories was observed to determine the effect of their being unable to vocalize upon their ability to hold territory. The details of this and the following epaulet-coloration experiment are reported elsewhere (Peek, in press).

(3) The red epaulets of 17 territorial males were colored black (using Nyanzol B dye) or white (by feather clipping) at times distributed throughout two breeding seasons. The behavior of these birds as well as the behavior of conspecific males toward them and their territories was observed to determine the effect of reducing the effectiveness of their display upon their ability to hold territory.

The 95 per cent confidence limits were calculated from "*t*" values with the appropriate degrees of freedom.

RESULTS

Seasonal Activity of Normal Territorial Males.—A number of the activities of territorial males showed seasonal differences. Males tended to spend progressively more time off of the territory during April and spend progressively less time off territory during the remainder of the season (Fig. 1A). During the last 20 days of the season, males spent significantly ($P < 0.05$) less time off territory than during the last 10 days of April. During the course of 58 observation periods (mean duration 78.4 ± 3.3 minutes) the males were on territory an average of 73 per cent of the time (mean duration 57.4 ± 2.9 minutes). While on territory, males alternated between periods of perching and periods on the ground. While perched, the males spent most of their time singing and the rest preening or resting quietly. The mean percentage of the total time on territory that males spent perched decreased during the last of April and then gradually increased throughout the remainder of the season (Fig. 1B). Since little time was spent in flight, the difference between the percentage of time perched and 100 approximates the time the males were on the ground in the territory (primarily feeding).

Advertising song, which apparently functions in territory defense (Orians and Christman, 1968; and Peek, in press), was given throughout the breeding season. There was no significant change in the number of song bouts during the breeding season (mean 4.0 bouts per hour). The number of songs per bout (Fig. 2A) and the number of songs per unit time (Fig. 2B) both decreased significantly ($P < 0.05$) as the breeding season progressed. The song

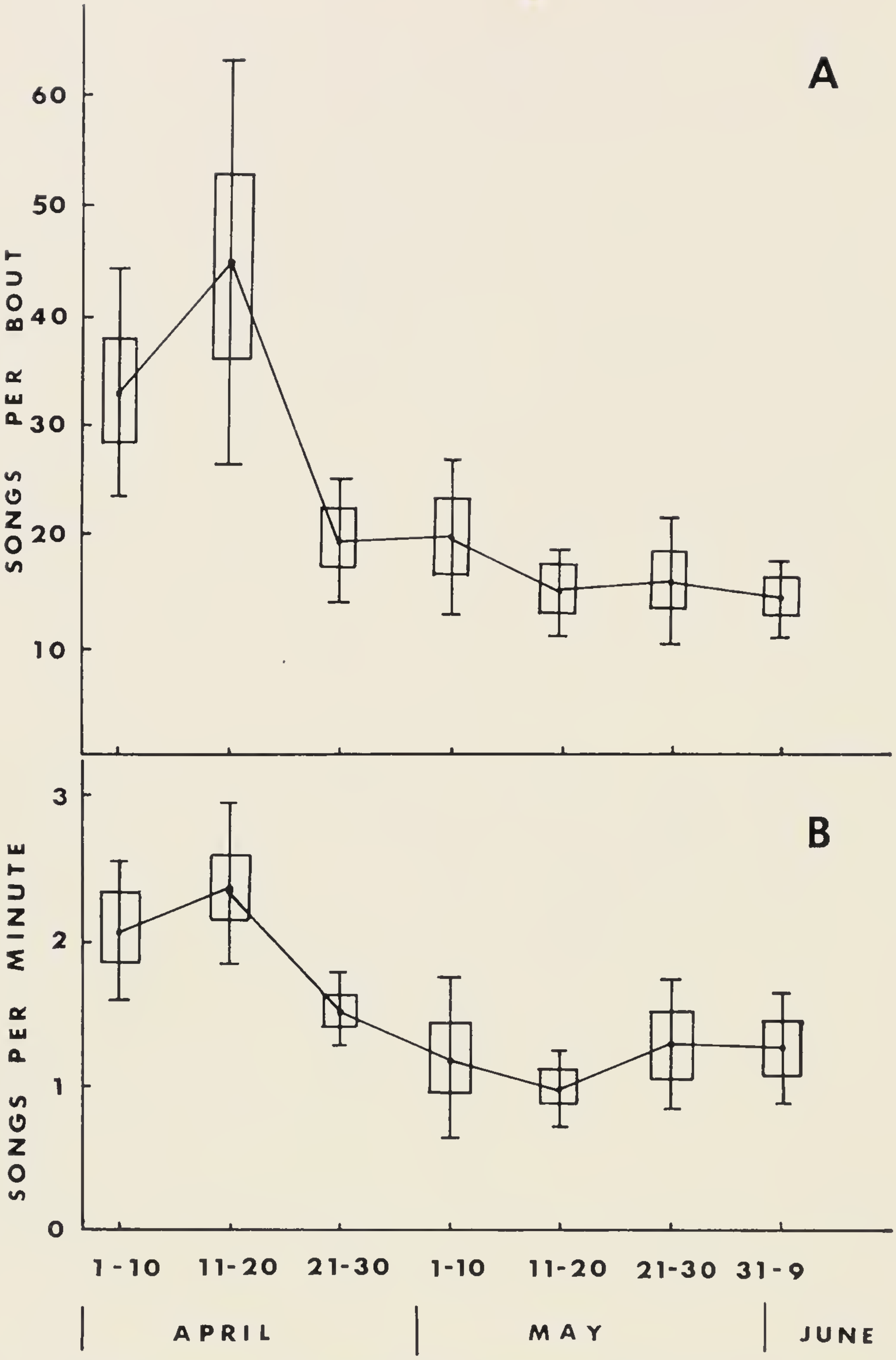

FIG. 2. A. Songs per bout of singing per territorial male. B. Songs per minute per territorial male. Observations between 06:00 and 11:00. Dots represent means; rectangles indicate mean ± one standard error; brackets denote 95 per cent confidence intervals. A bout of song was defined as a group of consecutive songs, none of which was given more than 2.5 minutes apart.

rates reported here agree well with those reported for birds in the same marsh for the period 1 May–10 June 1960 (Vandenbergh and Davis, 1962). Allen (1914) reports for nearby Ithaca, New York, that Redwing song and display reach a peak about one week after the arrival of the resident females and that after mating occurs song gradually diminishes. The seasonal trend in song frequency reported by Beer and Tibbits (1950) for the Redwing in Wisconsin is very similar to that reported here (Fig. 2). The song frequencies. however, were all much higher than those reported here (their peak song rate in April was approximately nine per minute and by late May was still three per minute).

The greatest variation in the number of songs per bout occurred early in the breeding season when males gave as many as 179 or as few as four songs per bout in the course of one observation period. The variation in number of songs per bout as well as the total number of songs decreased throughout the remainder of the season. During the last 10-day period the greatest range of songs per bout during one observation period was from 35 to four. Song was most often given by perched males but was occasionally given on the wing. Seasonal changes in the frequency of the Song-spread display parallel the seasonal changes reported for song frequency (Fig. 2) since song is frequently accompanied by the Song-spread display.

Seasonal Change in Trespassing by Conspecific Males upon Occupied Territory.—The mean rate of trespassing by conspecific males upon occupied territories reached a peak of more than two per hour during the second 10 days of April (Fig. 3). From this peak the mean number of trespasses decreased significantly ($P < 0.05$) by the first 10 days of May. Trespassing remained at approximately the same low level throughout the remainder of the breeding season. A large proportion of the trespasses recorded during the last two 10-day periods was due to intrusions by immature males (62 per cent and 75 per cent, respectively). Territorial males generally paid little attention to these immature males. To my knowledge the only comparable data available on rates of trespassing are those of Patterson (1965) who reported rates of 30 trespasses per hour for the colonial nesting Black-headed Gull (*Larus ridibundus*). The situation reported here is quite different from that in a gull colony possibly because of differences in the nesting densities of the two species.

Seasonal Change in Occupation of Vacated Territories.—During the premating portion of the season (from territory establishment until the last of April) vacated areas were quickly occupied by previously unestablished males (Table 1). During the remainder of the breeding season (the post-mating portion) neighboring males expanded their territories to include any vacated areas. Territories vacated late in the breeding season sometimes remained vacant. Other research on the same species suggests a similar pattern, though

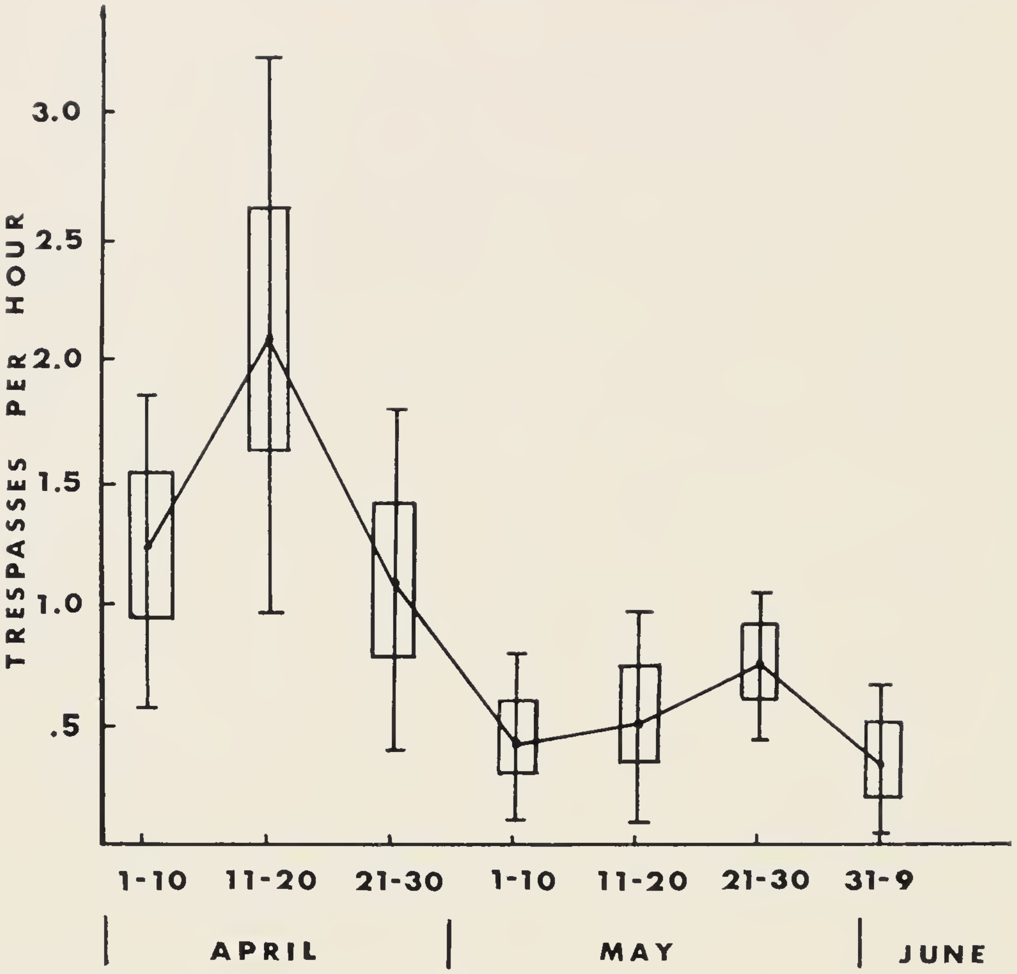

Fig. 3. Trespasses per hour by conspecific males upon occupied territories. Observations between 06:00 and 11:00. Dots represent means; rectangles indicate mean ± one standard error; brackets denote 95 per cent confidence intervals.

most removals reported fall within the pre-mating period as defined here. In a study of this species in Wisconsin, Nero (1956*b*) reported 12 instances in which previously occupied territory was taken oven wholly or partially by another male. In their study of a Redwing population in Wisconsin, Beer and Tibbits (1950. p. 66) found that , “If in the pre-nesting season a male is removed from his territory it is immediately taken over by either the adjoining males or a new male. Later in the season this is usually not the case.” In removal experiments on the Redwing in California, (Orians 1961, Table 10) the number of replacements after successive removals declined throughout the breeding season. First year males which do not normally hold territories did so after removals late in the season.

In the present study vacated territories were rapidly occupied during the pre-mating portion of the breeding season. Frequent trespassing generally occurred shortly after a resident male was removed from his territory. For example, on 18 April between 08:00 and 09:00, 51 trespasses were recorded

TABLE 1

NUMBERS OF TERRITORIES VACATED (N) AND THEN OCCUPIED BY UNESTABLISHED MALES (UM) OR NEIGHBORING MALES (NM) DURING DIFFERENT PERIODS OF THE BREEDING SEASON

	Period of Breeding Season								
	Pre-mating 26 March—21 April occupied by			Mating—Post-mating 27 April—22 May occupied by			Terminal 5 June—12 June occupied by		
	N	UM	NM	N	UM	NM	N	UM	NM
1966	1	1	0	1	0	1	0	–	–
1967	4	4	0	8	0	8	2	0	0
1968	6	6	0	3	0	3	1	0	0
1969	8	7	1[a]	1	0	1	0	–	–
Totals	19	18	1	13	0	13	3[b]	0	0

[a] Vacated territory occupied by neighbor on 18 April.
[b] No males occupied these vacated territories.

on the territory of a male removed an hour earlier. The duration of individual trespasses was less than two minutes at this time. By the end of the three hours one previously unestablished male had succeeded in establishing himself on the territory and was successfully chasing off the now relatively few trespassers. During the post-mating period vacated territories were occupied more slowly. For example, on 14 May between 08:15 and 10:45 no trespassers were observed on the territory of a male removed approximately an hour earlier. At 10:45 one neighboring male entered the territory and remained for ten minutes. During the remainder of that day and most of the following day, he gradually increased the frequency and durations of his visits to the vacated territory and eventually occupied it.

Seasonal Change in the Ability of Muted and Epaulet-colored Males to Maintain Territory.—Males muted prior to 28 April consistently left their territories (Fig. 4). Three of the four birds muted during the transition period between 28 April and 1 May left their territories. Nine of the 10 birds muted after 2 May retained their territories. Though the territories of birds muted prior to 28 April were carefully watched (in some cases continuously for three days), no birds were seen to return to their territories. The failure of these birds to retain territories was probably a result of the rapid occupation of temporarily vacated territories by other males during this portion of the breeding season. The rate of trespassing upon the territories of three muted males (mean 1.9 trespasses per hour) during the transition period was significantly greater ($P < 0.05$) than that on the territories or normal males (mean 0.9 trespasses per hour).

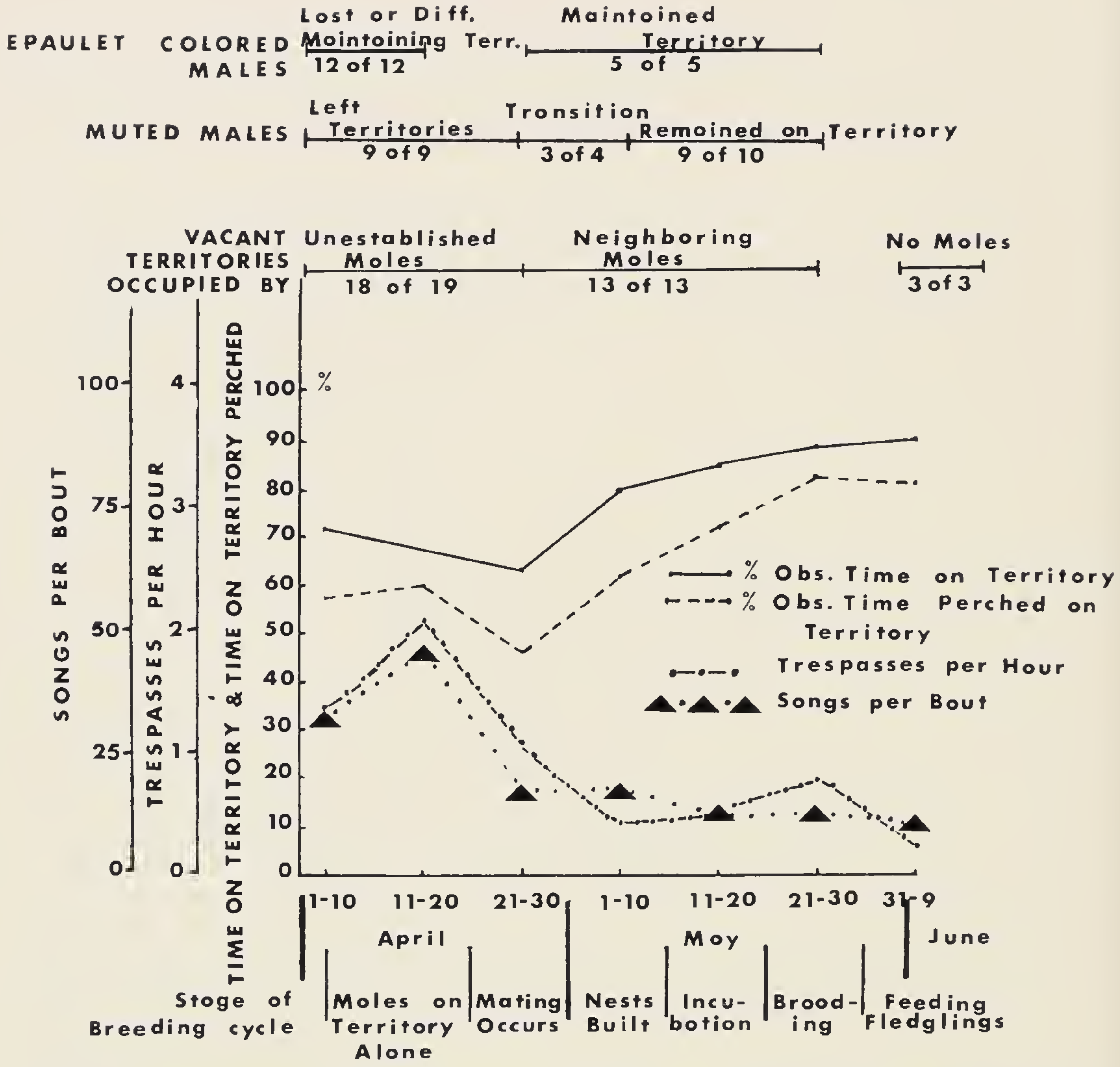

FIG. 4. Summary diagram of changes in the major aspects of the breeding behavior of the Red-winged Blackbird thoughout a breeding season.

Males whose epaulets were altered before they had acquired mates (pre-mating period) lost all or part of their territories (Fig. 4). Trespass occurred at a significantly ($P < 0.05$) greater rate (mean 5.8 trespasses per hour) on the territories of experimental males than on the territories of normals (mean 0.9 trespasses per hour). Males whose epaulets were colored during the mating and post-mating period maintained all of their former territories, and one even enlarged its territory when an adjacent one was vacated.

Thus, muted and epaulet-colored males were either unable to maintain territory or had great difficulty in doing so during the period when territories are presumably being parceled out (the pre-mating period) but maintained their territories after this time (the post-mating period).

DISCUSSION

The principal findings of this study are summarized in Figure 4. Apparently a major shift occurred in many aspects of the breeding biology of the Red-winged Blackbird around the time of pair formation. This shift provided a basis for dividing the breeding season into two periods: (1) pre-mating and (2) post-mating.

The pre-mating period was a time when many aspects of intraspecific territoriality were at peak levels and spacing of the population was undoubtedly achieved. Throughout most of this period the territorial males spent approximately 75 per cent of their time on territory and were perched and generally singing an average of 80 per cent of this time. Song was given at peak rates during this period. Since intruding males were usually responded to with the Song-spread display, the peak in the trespassing rate at this time was paralleled by a corresponding peak in Song-spread display frequency. Competition for vacated territories was keen during the pre-mating period since all vacated space was rapidly occupied by unestablished males from some "free floating" surplus population. Later only neighboring males occupied vacated territories suggesting that unestablished birds had either left the marsh or for some reason no longer occupied available territory. Unestablished males accounted for much of the trespassing recorded during the pre-mating period, and their disappearance undoubtedly accounted for much of the decline observed in the trespassing rate. The competition for space was also reflected in the results of the muting and epaulet-coloration experiments which demonstrated that experimental males had more difficulty maintaining their territories during this period than did their normal neighbors.

During the post-mating period territorial behavior declined. Song, for example, was given at significantly lower rates. This decline in singing was paralleled by a decline in trespassing rates and the disappearance of the population of unestablished males. At this stage only neighboring males occupied vacated territory. Muted and epaulet-colored males were able to maintain their territories during this period indicating that vocalization and display of epaulets were no longer as vital to territory maintenance. Some of the data suggest that behavior associated with nest defense became more prominent during the post-mating period. Males spent progressively more time on territory and spent it perched in prominent places about the territory. Males were very sensitive to any disturbance; for example, a human being entering a territory evoked alarm calls at rates that sometimes exceeded 1000 per hour for periods of time in excess of an hour.

These results suggest that the role of the male Redwing changes as the breeding season progresses. Early in the season the emphasis is on intraspecific territory defense to achieve spacing of the breeding population; later the emphasis shifts to interspecific defense and protection of the female, nest, and young. On the basis of studies of this species in Wisconsin, Beer and Tibbits (1950, p. 66) come to a similar conclusion, placing the occurrence of the shift around the start of egg laying. There is good evidence for a seasonal decline in behavior commonly associated with territoriality for the Black-capped Chickadee (*Parus atricapillus*) (Stefanski, 1967) (Dixon and Stefanski, 1970). In this species song functions solely in territorial contexts and not in the attraction of mates; therefore, the decline in singing during nest-building cannot be interpreted as indicating that mate attraction has ceased. I am not sure to what extent song in the Redwing functions in attracting mates and thus would be expected to decline at the time of mating. There are, however, a number of reasons (more fully presented elsewhere, Peek, in press) for believing song is importantly involved in territorial defense: (1) Muted males experience difficulty in maintaining territory and song appears to be the only vocalization which could play a major role in this respect; (2) song is given primarily only during the period that territory is maintained; and (3) song is given more frequently when trespassing rates are highest and decreases with decreasing trespassing rates.

During the post-mating portion of the breeding season the males apparently play a significant role in defending the territory against intrusion by other species. The presence of a human being on a territory containing an active nest evokes a strong response from the male (repeated diving upon the intruder and alarm calling at high rates with little decrement of the response over time). Allen (1914) noted that the male always shows great concern when the nest is approached. During the first portion of the season before the females have arrived, the territorial males seem much less concerned with human beings on territory; unfortunately no quantitative data is available to compare male responsiveness to a standard stimulus (e.g. a human being on territory) throughout the breeding season.

Preliminary data on the flushing response of nesting females of muted and normal males suggests that the alarm calls of the male function to alert the female of approaching danger. It was possible to approach the nest of a female on a muted male's territory much closer without flushing her than the nest of a female on a normal male's territory.

Many of the male Redwing's vocalizations are alarm calls, all of which are given frequently during the post-mating period. Of the nine vocalizations recorded during the course of the present study, six were clearly given in response to other species (especially the observer) intruding on the territory (these six vocalizations accounted for 63 per cent of the total of 16,015 vocalizations I recorded). Orians and Christman (1968) list 18 vocalizations given by the male Redwing; nine of these, accounting for 59 per cent of the total of 7,200 vocalizations they recorded, were described as being given in response to intrusion by other species. Their data show that the female Redwing gives only four of the nine alarm calls listed for the male, further suggesting a specialized role for the male in guarding against interspecific intrusion upon the territory. Finally, I found that at this time the male spends more time on territory perched in prominent places presumably surveying his territory during the post-mating period and spends less time singing (Fig. 4). Clearly more quantitative data are needed to define the male's role in interspecific territory defense at all stages of the breeding season.

The presence of a population of unestablished males appears to be an important factor affecting the breeding behavior of the male Redwing. The existence of surplus populations of unestablished males during the breeding season is well-known for many birds (Hensley and Cope, 1951 and Stewart and Aldrich, 1951). Stewart and Aldrich noted that in those species just beginning their breeding cycle during the period of shooting, there were large differences in the numbers of males collected as compared to the number of females collected (as high as 15 males to one female). Approximately equal numbers of both sexes were collected from those species that were well into their breeding cycles during the shooting period. Thus, surplus males were available to occupy territory only during part of the breeding season. Holmes (1966) found that in the Dunlin (*Erolia alpina*) the territories of birds removed during the period of arrival on the breeding grounds were rapidly filled by new birds, but that later in the season they remained vacant even though territorial activity continued through this period.

One explanation for the failure of unestablished male Redwings to occupy vacated territories after the mating period to the extent they did prior to mating may be that most of them leave the breeding grounds around the time mating occurs. Beer and Tibbits (1950: 16) favor this explanation; they found that with the arrival of females (middle of April) excess males unable to obtain territories crowded into the marsh only to disappear later (the end of April). In an island population of Song Sparrows (*Melospiza melodia*) Tompa (1962) found an excess of 55 birds during the period of mating and final spacing. These exccss birds definitely left the island when nesting began.

An alternative explanation is that excess birds remain in the area but are no longer disposed to trespass and occupy territory. In the present study three muted males who lost their territories later returned to them. None of these three marked birds was seen in the intervening period (over a month and a half in one case). This demonstrates that excess birds may well be in an area and not be detected by an observer constantly in that area. The fact that all of these birds reappeared on the same day that their former territories were vacated suggests that they had been around the mash and were aware of the situation on it. Studies using improved biotelemetry techniques might eventually supply answers to present questions on surplus populations.

SUMMARY

Seasonal changes were found in a number of aspects of the breeding biology related to territory of the Red-winged Blackbird. There was a significant decrease in the frequency of male song, male Song-spread displays and in trespassing upon occupied territories at the time mating occurred. This shift in behavior was paralleled by a decrease in the difficulty with which behaviorally impaired males (muted or epaulet-colored) maintained their territories as the season advanced. Experiments of systematically removing birds from their territories suggest that the surplus population of males which was present on the marsh prior to the occurrence of mating disappeared after mating. It was concluded that prior to mating many aspects of territoriality were at peak levels, that spacing of the population was probably achieved at this time, and that the population or surplus males was a crucial factor at this time. After mating, many aspects of territorial behavior decreased in frequency and the surplus male population disappeared. During the post-mating portion of the breeding cycle males appeared to be primarily involved in defense of the female, eggs, and young from predation.

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SOME PATTERNS OF WOODCOCK ACTIVITIES ON MAINE SUMMER FIELDS

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American Woodcock (*Philohela minor*) wintering in Louisiana have long been known to concentrate at night in certain fields (Glasgow, 1958). During the fall, Pettingill (1936) noted woodcock flying at dusk into fields at Cape May, New Jersey. Not until the studies of Sheldon (1961) in Massachusetts were woodcock reported entering fields after sunset during summer months. Summer utilization of fields has since been found to occur over much of the species' breeding range, including West Virginia (Kletzly and Rieffenberger, 1967), New Brunswick (J. C. Baird and T. G. Dilworth, pers. comm.), and Wisconsin (L. E. Gregg, pers. comm.). Such widespread observations suggest that usage of clearings during summer nights is a characteristic behavior pattern of the species.

The activities of woodcock using these fields have not been well documented, although Sheldon (1961, 1967) presented some relevant information. The present paper results from a study undertaken in Maine during the summers of 1968 and 1969. Specifically, it documents the initiation, magnitude, and termination of summer field usage; timing of crepuscular flights; movements of birds between fields; and the age and sex composition of woodcock captured on Maine summer fields. While this paper does not specifically describe what woodcock do on fields at night, the data presented should be useful to persons desiring to locate and band woodcock on nocturnal fields.

METHODS

The fields studied were located in, or near, southern Penobscot County in central Maine. I made observations in 14 fields, with two of these, Rebel Hill and Sunkhaze, selected for intensive investigation. The areas studied were abandoned farm fields having a vegetative cover of grasses, hawkweeds (*Hieracium* spp.), and various species of woody plants, including meadow-sweet (*Spiraea latifolia*) and sweet-fern (*Comptonia peregrina*).

Rebel Hill and Sunkhaze, 5.0 and 4.5 hectares in size, were each visited at least two evenings a week during the spring of 1968 to determine when woodcock first remained on the fields throughout the night. Both fields were systematically searched after dusk at least once a week throughout the summer and fall by one to four, but generally two, observers walking parallel transects 4 to 7 meters apart. The locations of woodcock flushed were plotted on maps to document the distribution and number of birds found. Each observer carried a spotlight and 12 volt battery; some woodcock were captured with a long-handle net. Although only a small percentage of the woodcock found were captured and banded, these birds provided information on movements between fields. An account of the night-lighting technique is given by Rieffenberger and Kletzly (1967). Some birds were also captured in mist-nets while flying into fields, a method described by Sheldon (1960).

Observations of woodcock flying into fields during evenings were made in 1968 and 1969; morning observations of birds leaving fields were made in 1969. Crepuscular flights were observed at least once a week from July through October. The majority of these observations were made at Sunkhaze although evening flights were watched at 13 other fields; data on morning flights were recorded at four fields. The midpoint of an evening or morning flight was defined as the median between the time when woodcock were first and last seen flying over, alighting on, or departing from a field. Seasonal changes in the timing of crepuscular flights were studied by plotting midpoints of evening flights against time of sunset (EST) and midpoints of morning flights against time of sunrise. Midpoints were used in order to reduce the effect of an exceptionally late or early bird on the timing of an individual flight. Sunset and sunrise times came from the 1968 and 1969 editions of "The World Almanac."

In this paper, repeats are defined as woodcock recaptured between one and 150 days after initial banding (the length of the summer banding period); returns are banded birds that survived at least one winter before being recaptured by the same bander.

The age and sex composition of woodcock captured by personnel of the U. S. Bureau of Sport Fisheries and Wildlife was examined for the years 1968, 1969, and 1970. The age-sex information from central and southern Maine consisted of woodcock caught for the first time. However, as a relatively large percentage of the adults captured on the Moosehorn National Wildlife Refuge were banded in previous summers, it was necessary to include returns in the eastern Maine data. This paper includes only known age woodcock caught on Maine summer fields during June through September. The age and sex of these birds were determined by the methods described by Martin (1964). When age data were tabulated, subadults (second year birds) and adults (after second year) were combined as adults (after hatching year).

RESULTS

Seasonal activity pattern.—Woodcock established two singing grounds on Rebel Hill and five on Sunkhaze in the spring of 1968. The break between courtship activities and nighttime usage of fields by numbers of non-performing woodcock was indistinct. During the transition period, non-performing woodcock were associated with some of the courting birds but the significance of these associations is unknown. In 1968, numbers of woodcock first remained on fields throughout the night in the second week of June, when evening courtship flights were sporadic and nearly over for the season.

The number of woodcock flushed from the study fields varied between nights (Fig. 1). The average number of woodcock flushed per search from Rebel Hill was 8.4 (range: 3–16) in 1968 and 3.6 (1–9) in 1969; the corresponding figures for Sunkhaze were 10.5 (0–34) and 5.7 (1–13).

The number of woodcock found on nocturnal fields decreased in late October and birds were absent during the first week of November (Fig. 1).

Crepuscular activity pattern.—Although the majority of woodcock entered fields by flying, it is believed that a few birds walked from adjacent covers. Woodcock were found on fields throughout the night regardless of weather. Both early and late in the season a few woodcock left fields immediately, or

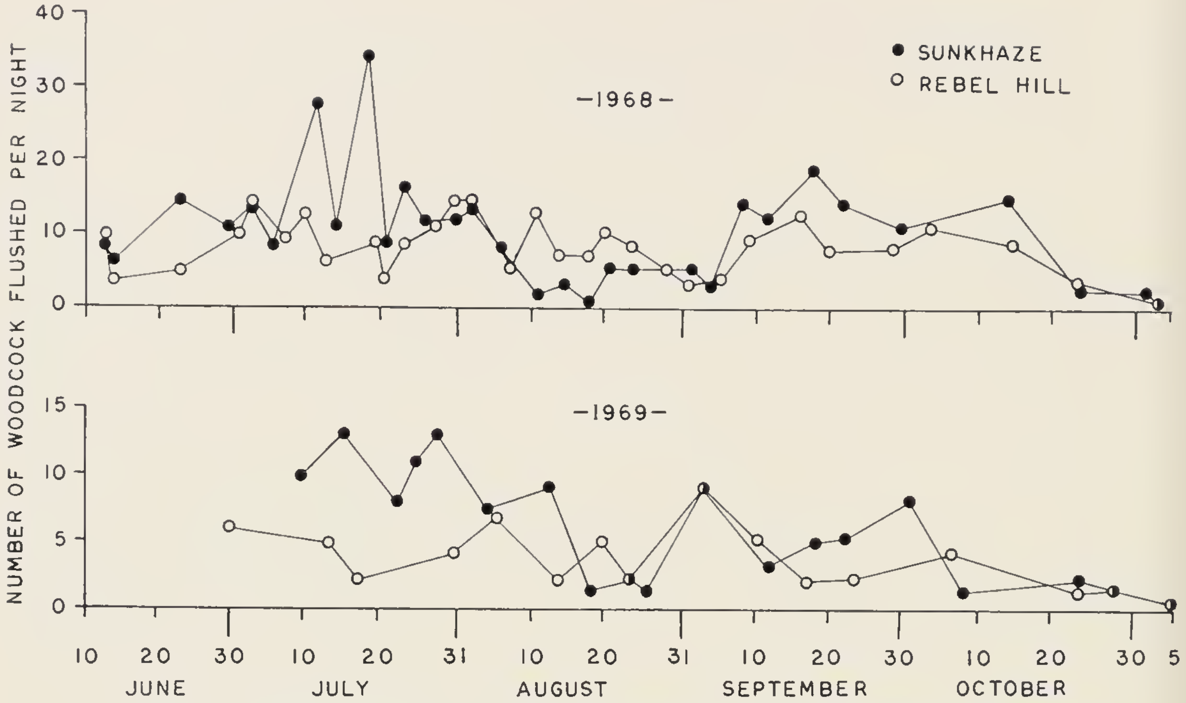

Fig. 1. Seasonal usage of summer fields by woodcock, 1968 and 1969.

within a few minutes after alighting. It could not be determined whether these birds landed in another section of the field, a different field, or returned to their diurnal covers. Woodcock commonly performed "courtship" flights over fields, both when entering in the evening and leaving in the morning (see Sheldon, 1961). During 47 evenings, semi-courtship flights were heard during six evenings (13 per cent); "courtship" flights were also noted during two of 18 mornings (11 per cent). In addition, woodcock sometimes gave the *peent* call after alighting or just prior to leaving fields. During 47 evenings and 18 mornings, *peents* were heard during six evenings and two mornings (13 per cent and 11 per cent). *Peents* and semi-courtship flights did not necessarily occur during the same flight periods. However, both types of behavior appeared to occur with approximately the same frequency during the crepuscular periods throughout the summer. One morning, calls resembling distorted *peents* were also heard. These may have been the "cat wheeze" call believed to be made by females (Sheldon. 1961).

The timing of crepuscular flights at Sunkhaze appeared identical to that on other. less intensively studied, fields and thus flight data taken at all 14 summer fields were combined. Forty-seven evening flights. each involving more than one woodcock, averaged 13.6 ± 0.9 ($\bar{X} \pm$ S.E.) minutes in length, while 18 morning flights averaged 14.5 ± 1.2 minutes in duration (Table 1). Thus. when entering and leaving summer fields, woodcock were active for relatively short and similar periods of time.

TABLE 1

BEGINNING AND ENDING OF CREPUSCULAR FLIGHTS OF WOODCOCK AS RELATED TO SUNSET, SUNRISE, AND CLOUD COVER

	Total Overcast $\bar{X} \pm$ S.E. (n)	Clear $\bar{X} \pm$ S.E. (n)	All Cloud Conditions $\bar{X} \pm$ S.E. (n)
Evening Flights (1968 & 1969)			
Minutes Between Sunset and Start of Flight	22.9 ± 1.8 (10)	26.8 ± 1.0 (27)	26.0 ± 0.8 (47)
Minutes Between Sunset and End of Flight	36.3 ± 2.5 (10)	40.2 ± 1.7 (27)	39.6 ± 1.3 (47)
Total Length of Evening Flight	13.4 ± 2.2 (10)	13.4 ± 1.2 (27)	13.6 ± 0.9 (47)
Morning Flights (1969)			
Minutes Between Start of Flight and Sunrise	47.2 ± 5.6 (5)	50.7 ± 3.4 (10)	47.9 ± 2.5 (18)
Minutes Between End of Flight and Sunrise	33.0 ± 4.6 (5)	35.4 ± 2.3 (10)	33.4 ± 1.9 (18)
Total Length of Morning Flight	14.2 ± 3.3 (5)	15.3 ± 1.5 (10)	14.5 ± 1.2 (18)

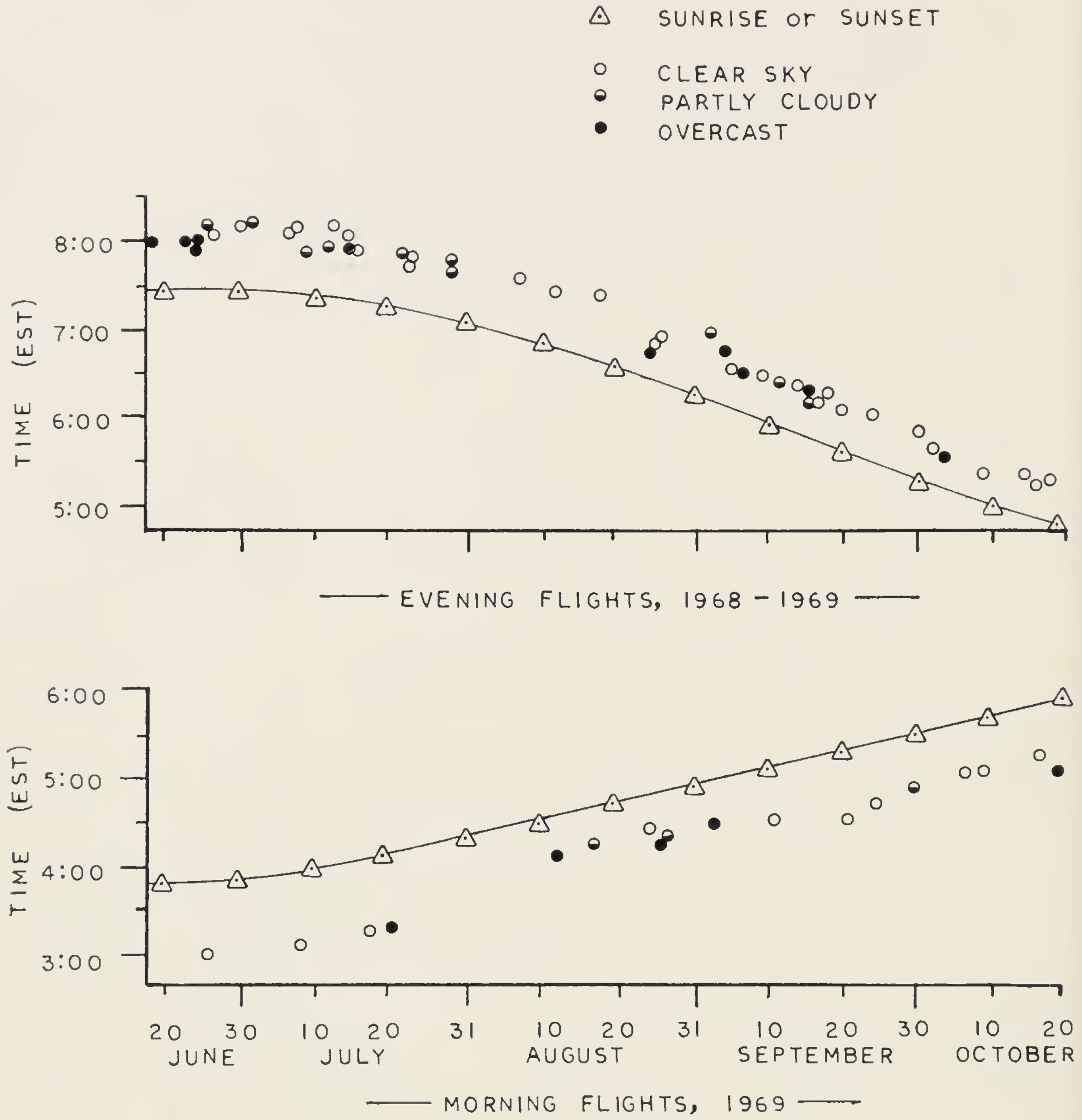

Fig. 2. Midpoints of woodcock crepuscular flights as related to sunset and sunrise.

The relationship between evening flights and sunset, and morning flights and sunrise, suggests that light intensity is the triggering stimulus (Fig. 2). The average times that flights into fields began and ended were later on clear than on totally overcast evenings (Table 1). Similarly, average times that flights from fields commenced and terminated were earlier on clear than on totally overcast mornings (Table 1). However, neither of these differences was statistically significant (*t*-test, $p > 0.05$).

Movements and distribution.—During 1968 banding operations in central Maine, one return and 28 repeats were caught. Of these, only four birds were recaptured as repeats on a field other than where banded. The distance between fields of initial and subsequent capture averaged 2.2 (0.8–4.8) kilome-

TABLE 2

PERCENTAGE (SAMPLE SIZE) AGE-SEX COMPOSITION OF WOODCOCK CAPTURED ON MAINE SUMMER FIELDS ACCORDING TO LOCATIONS AND YEARS, 1968–1970

Geographic Location	Year of Capture	Age-Sex Classes[1]				Totals
		HY		AHY		
		Male	Female	Male	Female	
Eastern Maine[2]	1968	49 (61)	23 (29)	13 (16)	15 (18)	100 (124)
(Moosehorn National	1969	44 (98)	29 (65)	14 (32)	13 (28)	100 (223)
Wildlife Refuge)	1970	37 (40)	33 (36)	12 (13)	18 (20)	100 (109)
Central Maine	1968	—	—	—	—	—
(Penobscot River	1969	39 (101)	28 (74)	11 (29)	22 (58)	100 (262)
Valley)	1970	40 (109)	30 (79)	12 (33)	18 (47)	100 (268)
Southern Maine	1968	—	—	—	—	—
(Sheepscot Lake	1969	—	—	—	—	—
Region)	1970	29 (72)	30 (74)	18 (44)	23 (56)	100 (246)
Combined:	1968–70	39 (481)	29 (357)	14 (167)	18 (227)	100 (1.232)

[1] HY = hatching year; AHY = after hatching year (includes SY and ASY birds).
[2] Includes returns.

ters. In 1970, five returns and eight repeats were captured in central Maine. All returns were recaptured on the same fields of initial banding; although these data are limited, they are significant since they indicate migrational homing tendencies. Of the eight repeats, one was retaken on a field adjacent to where the bird was caught. Although movements of woodcock between summer fields did occur, the majority of repeats were taken on the same field where originally banded. Thus, these data suggest that flights to and from summer fields were essentially local movements.

Woodcock were not flushed from all portions of summer fields with equal frequency. When used and unused parts of fields were compared, it became apparent that areas of low ground vegetation interspersed with taller cover were used more frequently and heavily than unbroken stands of tall, densely growing ground cover.

Age-sex composition.—The age-sex composition of 1,232 woodcock captured on Maine summer fields varied between locations, and between years within locations (Table 2). The overall age composition was 68 per cent immatures and 32 per cent adults. Hatching year males were caught more commonly on summer fields than hatching year females (39 vs. 29 per cent), while in the older class females were slightly more abundant than males (18 vs. 14 per cent) (Table 2).

The age-sex composition also varied between methods of capture (Table 3). Of the 296 birds mist-netted, 78 per cent were immatures while 22 per cent were adult; of the 936 woodcock which were captured by night-lighting, 64 per cent were immatures and 36 per cent were adults. On a percentage basis, both methods captured more immature males than immature females and more adult females than adult males (Table 3).

DISCUSSION

The hatching peak for woodcock in eastern Maine occurs in mid-May (Mendall and Aldous, 1943). At the age of three to four weeks, young woodcock apparently can fly as well as adults (Pettingill, 1936; Mendall and Aldous, 1943). Thus, the initiation of summer field usage in mid-June apparently coincides with the time most young birds would reach full flight capabilities.

Much of the information on seasonal patterns was based on the assumption that counts of flushed woodcock gave a reasonable estimate of the number of birds present. Many variables undoubtedly influenced the reliability of these estimates. On rainy nights, birds flushed less readily than on clear nights. Thus, fields had to be searched more thoroughly during or shortly after a rain. It was possible for flushed birds to alight in an unsearched section of the field and be counted a second time in that area. Thus, flushed woodcock

TABLE 3

PERCENTAGE (SAMPLE SIZE) AGE-SEX COMPOSITION OF WOODCOCK CAPTURED ON MAINE SUMMER FIELDS ACCORDING TO CAPTURE METHODS AND LOCATIONS, 1968–1970

Method of Capture	Age-Sex Classes[1]				Totals
	HY		AHY		
	Male	Female	Male	Female	
Mist-netted					
Eastern[2]	40 (65)	37 (61)	12 (20)	11 (17)	100 (163)
Central	48 (59)	31 (38)	8 (10)	13 (16)	100 (123)
Southern	60 (6)	10 (1)	10 (1)	20 (2)	100 (10)
Combined:	44 (130)	34 (100)	10 (31)	12 (35)	100 (296)
Night-lighted					
Eastern[2]	46 (134)	23 (69)	14 (41)	17 (49)	100 (293)
Central	37 (151)	28 (115)	13 (52)	22 (89)	100 (407)
Southern	28 (66)	31 (73)	18 (43)	23 (54)	100 (236)
Combined:	37 (351)	27 (257)	15 (136)	21 (192)	100 (936)

[1] HY = hatching year; AHY = after hatching year (includes SY and ASY birds).
[2] Includes returns.

were followed with spotlights, and each bird which appeared to have landed in an unsearched portion of a field was not counted when reflushed.

Disturbance caused by investigators searching a summer field probably influenced the number of woodcock using it. Sheldon (1961) believed that continuous mist-netting reduced the number of woodcock flying into summer fields. Glasgow (1958) noted a sharp decline in the number of birds using winter fields which were night-lighted more than twice a week. Weather, soil moisture, vegetative cover, and other unmeasured variables may also cause nightly and seasonal fluctuations in the number of woodcock using fields.

Sheldon (1961) reported that evening flights seldom exceeded 15 minutes. Glasgow (1958) observed that about 50 per cent of the birds arrived on winter fields within a 10 to 15 minute period. The present study, which found that the average length of evening flights was approximately 14 minutes, is in close agreement with these past investigations.

Sheldon (1961) found that woodcock began flying into summer fields one-half hour after sunset at the same light intensity that evening courtship commenced in the spring. Working on winter fields, Glasgow (1958) also found birds arriving about 30 minutes after sunset. In the present study the start of evening flights averaged approximately 26 minutes after sunset while the beginning of morning flights averaged about 48 minutes before sunrise. While illumination measurements were not taken, it is possible that the same

TABLE 4

PERCENTAGE (SAMPLE SIZE) AGE-SEX COMPOSITION OF WOODCOCK SHOT IN MAINE DURING THE FALL AS INDICATED BY THE WING SURVEY, 1967–1969

Hunting Season	Age-Sex Classes[1]				Totals
	HY		AHY		
	Male	Female	Male	Female	
1967[2]	24.3 (536)	22.2 (491)	23.2 (513)	30.3 (668)	100 (2,208)
1968[3]	25.7 (836)	27.2 (886)	20.6 (671)	26.5 (860)	100 (3,253)
1969[4]	25.1 (823)	23.4 (767)	21.7 (710)	29.8 (975)	100 (3,275)
Combined:	25.1 (2,195)	24.5 (2,144)	21.7 (1,894)	28.7 (2,503)	100 (8,736)

[1] HY = hatching year; AHY = after hatching year.
[2] Data from Clark, 1969.
[3] Data from Clark, 1970.
[4] Data from Clark, 1971.

light intensity triggered both evening and morning flights. The actual illumination in a forested situation 26 minutes after sunset (evening flight) could be equivalent to that of an open field 48 minutes before sunrise (morning flight). However, this is only speculation and further study is suggested.

Glasgow (1958) found that woodcock frequented particular areas on many Louisiana winter fields. Ensminger (1954) concluded that the vegetation on winter fields, and not the abundance of earthworms, controlled the choice of feeding sites. Sheldon (1961) noted "favorite alighting places" on three of four summer fields in Massachusetts. Similar observations made during the present study indicated that woodcock preferred small pockets of short vegetation surrounded by taller cover. Areas of fields with many such pockets were generally the most heavily utilized portions of fields.

While much remains to be learned about the distances woodcock move from diurnal covers to fields, data from recaptured birds indicated that these movements were local. A similar conclusion was reached by Sheldon (1961). The regularity with which individual woodcock use specific fields was not ascertained because of the disturbance caused by banding operations. and because only a small percentage of the birds present on fields were captured.

Is the age composition of woodcock using summer fields typical of the population as a whole? The answer to this question can be explored by comparing the age structure of woodcock caught on summer fields to that of the fall harvest. A sample of 8,736 woodcock shot in Maine during the 1967–69 hunting seasons consisted of 50 per cent immatures and 50 per cent adults (Table 4). The 1,232 woodcock captured during the summers of 1968–70 on nocturnal fields consisted of 68 per cent immatures and 32 per cent adults (Table 2). In relation to the whole population, these percentages suggest that Maine summer fields were used by a higher proportion of immatures than adults. However, these figures must be viewed cautiously since the difference between summer and fall age compositions could be due to the banding and/or wing survey data not accurately reflecting the age structures of the populations sampled. For example, immatures might have been easier to capture on fields than adults; this would tend to inflate the percentage of hatching year birds caught in relation to adults. On the other hand, immatures of many game bird species are more vulnerable to shooting than adults. Thus, the age structure indicated by the wing survey probably consisted of more immatures than what actually existed in the total population. This bias would not be serious in that it would tend to increase the already apparent difference in the age structure of the summer and fall samples. In addition to the problem of representative sampling, there might also have been differential mortality between age classes which occurred between summer and fall. A major age related difference in the summer mortality rates, and/or differential vulnerability to capture or hunting, could account for the differences in Tables 2 and 4.

What of the sex structure of the population using summer fields? The ratio of immature males to immature females shot in the fall was 1.02:1 (Table 4). In contrast, Table 2 shows a ratio of 1.35:1 immature males to immature females captured on summer fields. Similar calculations indicated little difference existed in the ratio of adult males to adult females (captured = 0.74:1, Table 2; shot = 0.76:1, Table 4). Unfortunately, interpretation of these ratios is difficult since the limitations which applied to the age data may also apply here.

Sheldon (1961, 1967) believed that summer fields were used mainly for feeding. His conclusion was based on an analysis of 15 stomachs from woodcock which were captured while entering, or shortly after alighting on, summer fields in Massachusetts. In contrast, Krohn (1970) concluded that Maine summer fields were not used primarily for feeding. Comparisons between the weights of stomach contents from 16 birds mist-netted before landing on fields, to weights of stomach contents from 44 woodcock collected on fields at various times of the night, showed that woodcock fed heavily prior to entering fields. However, no evidence was found to indicate that substantial amounts of food were eaten by birds remaining on fields throughout the night.

This report describes general aspects of summer field usage, and makes no attempt to explain why woodcock use fields at night. Specific activities of individual birds, such as frequency of field usage or movements on fields, were not studied. Data such as these, being more explicit than those reported here, might indicate why woodcock move at dusk from forest covers to various types of openings. Telemetry investigations presently being conducted in Maine and Minnesota will undoubtedly provide a more precise understanding of woodcock activities on summer fields. In turn, these data may help to clarify why woodcock spend summer and early fall nights in clearings.

SUMMARY

Certain aspects of woodcock usage of summer fields were studied in Maine. Findings were as follows:

1. On two study fields in 1968, numbers of woodcock first began spending nights in the fields during the second week of June. During 1968 and 1969, the number of birds flushed from the fields varied greatly between nights. Use of fields continued into the first week of November.
2. Woodcock started flying into summer fields approximately 26 minutes after sunset. Unless disturbed, birds remained on fields throughout the night and started departing for diurnal covers about 48 minutes before sunrise. The duration of evening and morning flight periods averaged 13 to 15 minutes.
3. Woodcock did not necessarily use the same field throughout the summer. Five of the 36 birds taken as repeats were caught on fields other than where originally banded. However, it was believed that flights to and from fields were essentially local movements.
4. Vegetation appeared to have been a critical factor influencing the distribution of woodcock in fields. Areas of low ground cover interspersed with taller and denser cover were used most frequently.
5. Immatures, especially immature males, were the predominant age-sex class captured on Maine summer fields. The question of whether the age-sex composition of birds using summer fields is atypical of the total woodcock population requires additional study.

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THE NESTING, REPRODUCTIVE PERFORMANCE, AND CHLORINATED HYDROCARBON RESIDUES IN THE RED-TAILED HAWK AND GREAT HORNED OWL IN SOUTH-CENTRAL MONTANA

JOHN C. SEIDENSTICKER IV AND HARRY V. REYNOLDS III

IN this paper, we describe the nesting, reproductive performance, and chlorinated hydrocarban residues, and evaluate current population status of the Red-tailed Hawk (*Buteo jamaicensis*) and Great Horned Owl (*Bubo virginianus*) in south-central Montana. We conducted the field work during June and July, 1966, and March-July, 1967, incidental to but as background information for studies of the response of juvenile Red-tailed Hawks and Golden Eagles (*Aquila chrysaetos*) to DDT in their diet (Seidensticker, 1968) and the population status of the Golden Eagle (Reynolds, 1969).

THE STUDY AREA

The topography of northern Park, western Sweetgrass, and southern Meagher Counties, Montana, where we conducted this study, is characterized by river flood plains, gentle transitional foothills, and timbered mountain slopes. An alpine zone occurs at the highest elevations. Elevations range from 10,00 feet in the Bridger, Gallatin, Crazy, and Absaroka Mountain Ranges, which border the area, to 4,000 feet along the Yellowstone, Boulder, and Shields Rivers.

Cottonwood trees (*Populus* spp.) and willows (*Salix* spp.) dominate vegetation on the river and creek flood plains at the lower elevations where we concentrated our search for hawk and owl nests.

METHODS

We located hawk and owl nests using the procedure outlined by Craighead and Craighead (1956:196–199).

To obtain tissue for analysis of chlorinated hydrocarbon insecticide residues, we used a biopsy technique (Seidensticker, 1970*a*) or sacrificed the bird. Each egg that we analyzed came from a different nest. We placed large tissue samples and eggs in separate double polyethylene bags; small samples (collected via biopsy) were placed in clean, screw-top, five ml vials. We stored all samples in a freezer. The WARF Institute, Inc., Madison, Wisconsin, analyzed tissues and eggs with a gas chromatograph following the procedure outlined by the U.S. Food and Drug Administration (USFDA, 1964).

Samples from one Great Horned Owl egg and one Red-tailed Hawk egg were re-extracted, cleaned up, and hydrolyzed (treated with alcoholic KOH) to check for polychlorinated biphenyls (Risebrough et al., 1969; Anderson et al., 1969).

D. W. Anderson of the University of Wisconsin measured and weighed the hawk and owl eggshells using the procedures described by Hickey and Anderson (1968).

NESTING AND REPRODUCTIVE PERFORMANCE

Breeding Season.—Our observations indicated that the Red-tailed Hawk is at least partially migratory but the Great Horned Owl is not.

In 1967, the first Red-tailed Hawk on the study area was observed on 24 March and the first territorial selection probably began near the end of March. Laying dates recorded in 1967 ranged from 11 April to 8 May (median 24 April): hatching dates ranged from 18 May to 10 June (median 29 May); brood departure dates ranged from 26 June to 13 July (median 4 July). The total breeding season spanned about 105 days.

In 1967, based on the earliest observed hatching date, the first selection of territory by Great Horned Owls began during mid-February, the first egg hatched on 29 March, and the last brood fledged on 20 June. The breeding season in 1967 was about 125 days. The breeding season started about 10 days earlier and ended about two weeks later than the 1947 breeding season reported by Craighead and Craighead (1956) for the Great Horned Owl in Wyoming.

Nest Location and Density.—Of 55 nests used by Red-tailed Hawks located during the two years of study, we found 41 (74 per cent) in cottonwood trees, four in Douglas firs (*Pseudosuga menziesii*), three on cliffs, three in dead snags, two in quaking aspen (*Populus tremuloides*), one in an Engelmann spruce (*Picea engelmanni*), and one in a limber pine (*Pinus flexilis*). Cottonwoods were the only common tall trees growing on the river and creek flood plains where most of the nests were found.

Of 10 nests that the Red-tailed Hawks had used in 1966, hawks occupied four in 1967.

We made no effort to locate every nest in the study area, but we did search intensively in five different areas where, we believe, we located all hawk nests. Distances between adjacent nests ranged from 3.1 miles to 0.2 mile and averaged 1.3 miles.

We located 15 active Great Horned Owl nests and found 13 (86 per cent) of the nests in cottonwood trees, one in a Douglas fir and one on a cliff. Eight owls nested in abandoned hawk (*Buteo*) nests, four in abandoned Black-billed Magpie (*Pica pica*) nests, one in an abandoned Golden Eagle eyrie, one in an abandoned Common Crow nest (*Corvus brachyrhynchos*), and one on a cliff.

In 1967 owls occupied two of 10 nests used by Red-tailed Hawks in 1966. On 10 April 1967, we found a Great Horned Owl incubating two eggs in an old hawk nest. When we checked this nest again on 11 May, we found a female Red-tailed Hawk incubating two eggs.

Without obtaining absolute quantitative data or nesting densities, we found

TABLE 1

CAUSES OF 16 RED-TAILED HAWK NEST FAILURES IN SOUTH-CENTRAL MONTANA, 1966 AND 1967

	Before or during incubation		Nestling Period		
Cause of failures	Known	Probable	Known	Probable	Total
Man	2	4	1	–	7
Great Horned Owl	–	2	1	1	4
Disease	–	–	2	–	2
Wind	–	–	1	1	2
Common Crow	1	–	–	–	1
Total	3	6	5	2	16

a Red-tailed Hawk to Great Horned Owl nest ratio of 3:1 which is equivalent to that found by Craighead and Craighead (1956) in Jackson Hole, Wyoming.

Nesting Success.—We recorded the success or failure of 54 of the 55 nests of Red-tailed Hawks that we found. No young were fledged from 27 (50 per cent) of the nests; of the 27 nest failures, 15 (59 per cent) occurred before or during the incubation period while seven (22 per cent) occurred during the nestling period. We could not determine when five of the nest failures occurred.

From both direct and indirect evidence, we were able to determine the cause or probable cause of 16 of the 27 nest failures that were recorded (Table 1). As investigators, we caused the failure of one nest during the nestling stage. After we climbed to two nests, the hawks deserted them, and it is possible that we were responsible. These failures are listed as man-caused in Table 1. Other man-related causes listed in Table 1 included the shooting of adult hawks and taking eggs. Of the 11 nests that failed and were not listed in Table 1, we climbed into six. Other investigators have reported that many times Red-tailed Hawks desert if they are disturbed by climbing into the nest prior to or early in the incubation period (Fitch et al., 1946; Luttich et al., 1971). We do not believe that investigator influence was a principal cause of nest failures not listed in Table 1. We purposely avoided climbing into nests early in the incubation period but in two cases when we misjudged and climbed to nests that contained one egg, two eggs were present in both nests at a later time.

Red-tailed Hawks that nested close to Great Horned Owl nests were not successful in fledging young. This phenomenon was reported and discussed by Craighead and Craighead (1956), Hager (1957), and Luttich et al. (1971).

TABLE 2

PRODUCTIVITY IN ACTIVE AND SUCCESSFUL NESTS OF RED-TAILED HAWKS AND GREAT HORNED OWLS IN SOUTH-CENTRAL MONTANA, 1966 AND 1967

Number per nest	Red-tailed Hawk		Great Horned Owl	
	Nests studied	Mean ± SE	Nests studied	Mean ± SE
Eggs in complete clutches	22	2.9 ± 0.1	6	2.2 ± 0.2
Newly hatched young	15	2.6 ± 0.2	6	2.2 ± 0.2
Large downy young	12	2.2 ± 0.2	9	1.9 ± 0.2
Fledglings	15	1.7 ± 0.2	6	1.8 ± 0.2

Young fledged from seven (64 per cent) of the 11 Great Horned Owl nests in which we were able to determine success or failure. Man (other than the investigators) caused at least two of the four nesting failures.

Clutch Size and Egg Hatchability.—Minimum egg counts at 22 Red-tailed Hawk nests averaged 2.9 (Table 2): 4 nests with two eggs; 15 with three; and 3 with four. Minimum egg counts at six Great Horned Owl nests averaged 2.2 (Table 2): five nests with two eggs and one with three.

We found four addled eggs in Red-tailed Hawk nests with no nest containing more than one and no addled eggs in Great Horned Owl nests in which young hatched successfully. There was little difference in the average clutch size and the average brood size of newly hatched Red-tailed Hawks: there was no difference between average clutch size and average brood size of newly hatched young Great Horned Owls (Table 2). This indicated to us that egg hatchability was good for both species in nests that produced young.

Nestling Survival in Successful Nests.—Although nestling Red-tails died in nests which were successful, we have limited data on these deaths (Table 2). In two nests the youngest of three nestlings disappeared, and in two nests the youngest of two nestlings disappeared. One nestling with a swollen eye fledged. The blood sucking dipterous larva of *Protocallophora* sp. (identified for us by Dr. C. B. Philip) infected almost all hawk nestlings, but we could attribute no mortality to these larvae.

We have no data on nestling mortality in successful Great Horned Owl nests.

Reproductive Success and Population Status.—Henny and Wight (in press), using band recoveries, unpublished nesting records, and a structural model that permitted the use of mortality and recruitment rates to determine the status and trend of a population, found that between 1.33 and 1.38 Red-tails must be fledged per nesting attempt to maintain a stable population. They found that Red-tailed Hawks above 42°N latitude on the average fledged

1.84 young per successful nest. This figure approximates the 1.7 ± 0.2 young fledged per successful nest which was recorded in this study. If 1.84 young are produced per successful nest the nesting success must be 71–74 per cent to maintain a stable population. The 50 per cent nesting success we recorded, and hence the lower number of young fledged per nesting attempt (0.9) in our study, is clearly below that which is necessary to maintain a stable population based on the mortality rate calculated from banding recoveries.

Henny and Wight (in press) reported that the Red-tailed Hawk population in the United States appeared to be maintaining itself. Post-World War II counts of migrating Red-tailed Hawks flying over Hawk Mountain showed a decline from Pre-World War II levels, but they have remained constant at a lower level (Spofford, 1969). From the data available, it appears that the Red-tailed Hawk population over North America as a whole has remained stable.

Stewart's (1969) life table constructed from banding data shows that the mortality rate of Great Horned Owls (32 per cent) is less than that reported for the Red-tailed Hawk (35 and 42 per cent). Thus, fewer young need be produced to maintain a stable population and the 1.2 owls fledged per nesting attempt recorded in this study may be adequate.

CHLORINATED HYDROCARBON RESIDUES AND EGGSHELL MEASUREMENTS

Insecticide Residues.—All raptor tissue and egg samples analyzed bore measurable levels of DDE, DDT, DDD, and dieldrin (Table 3), and all samples except those taken from nestling and fledgling Red-tailed Hawks contained heptachlor epoxide. DDE was the most abundant residue in all samples, but these data (Table 3) indicate a generally low level of contamination from an acute-toxicity point of view. The sublethal effects of these levels are not certain.

Breast muscles taken from newly hatched nestling and fledgling Red-tails show no build-up of residues (Table 3). Fledglings were taken from the same nest from which nestlings were taken.

Residues in tissue taken via biopsy from Red-tails were higher than the residues found in whole pectoralis muscles taken from hawks of the same age (Table 3). Seidensticker (1970*a*) showed that samples taken via biopsy tend to give more variable results than whole muscles, probably because of the variable amounts of adipose tissue that are taken with muscle tissue in the biopsy.

We found (Table 3) that the viable eggs of hawks and owls have similar relatively low residue levels, and this may indicate a general low residue level in the fat of adult female hawks and owls (Anderson et al., 1969). We do not

Table 3

Chlorinated Hydrocarbon Insecticide Residues in Red-Tailed Hawk and Great Horned Owl Tissue and Eggs, South-Central Montana, 1967

		Residues in ppm wet wt							
		DDE		DDT + DDD		Dieldrin		Heptachlor epoxide	
	N	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Red-tailed Hawk									
Viable eggs	2	0.92	0.24– 1.60	0.05	0.03–0.06	0.30	0.16–0.44	0.16	0.09–0.24
Nonviable eggs	3	4.19	1.08–10.30	0.48	0.04–1.33	0.39	0.23–0.63	0.51	0.30–0.80
Nestlings (whole pectoralis muscle)	2	1.26	0.43– 2.10	0.14	0.09–0.20	0.12	0.05–0.19	0.02	0 –0.04
Fledgling									
Whole pectoralis muscle	2	0.87	0.49– 1.25	0.10	0.10	0.09	0.02–0.16	0	—
Biopsy (muscle and fat)	5	3.17	1.27– 6.87	1.33	0.40–2.30	0.38	0.10–1.40	0	—
Great Horned Owl									
Viable eggs	3	0.74	0.36– 1.13	0.07	0.02–0.22	0.16	0.11–0.24	0.11	0.02–0.23
Adult (whole pectoralis muscle & fat)	1	7.33	—	1.86	—	0.15	—	0.19	—

know why one hawk egg (nonviable) contained levels so much higher than the others. It weighed about the same as the viable hawk eggs, so the high residue level did not result from desiccation. In some instances birds acquire egg residues before they arrive on the breeding grounds (Anderson et al., 1969) and this egg may represent exposure in a dissimilar non-breeding area for the migratory Red-tailed Hawk.

Polychlorinated Biphenyls.—We conducted this study before the discovery of polychlorinated biphenyls (PCB) in the tissue of North American wildlife and the possibility of PCB interference with the determination of other residues. Anderson et al. (1969) and Risebrough et al. (1969) showed that PCB compounds affect analysis for DDT and DDD and that PCB residues may be mistakenly identified at DDT and DDD. In Table 4 we show the residues present in samples taken from one hawk and one owl before and after hydrolysis. The values obtained from these two samples indicated that there were low levels of PCBs present and little or no DDD or DDT present.

TABLE 4

RESIDUE LEVELS OF DDE, DDD, DDT, AND PCB IN HYDROLYZED AND NON-HYDROLYZED EGGS, SOUTH-CENTRAL MONTANA, 1967

	Residues in ppm wet wt.	
	Great Horned Owl egg	Red-tailed Hawk egg
DDE		
Non-hydrolyzed	0.630	1.240
Hydrolyzed	0.590	1.250
DDD		
Non-hydrolyzed	0.027	0.017
Hydrolyzed	0.021	0.017
Actual ppm	<0.010	<0.010
DDT		
Non-hydrolyzed	0.031	0.021
Hydrolyzed	0.031	0.022
Actual ppm	<0.010	<0.010
Est. PCBs	0.210	0.250

PCB levels in our samples are of the same general magnitude as those found in eggs of the Golden Eagle (0.23 ppm wet weight), Sparrow Hawk (*Falco sparverius*) (0.09), Pigeon Hawk (*Falco columbarius*) (0.39), Barn Owl (*Tyto alba*) (0.47 and 0.66) but far below the level found in a Peregrine Falcon (*Falco peregrinus*) egg (10.21), reported by Risebrough et al. (1968). In Britain, 0– < 1 and 0 residue levels were found in 5 Buzzard (*Buteo buteo*) and 20 Golden Eagle eggs respectively (Prestt et al., 1970).

The available evidence indicates that, like the chlorinated hydrocarbon pesticides, PCBs are persistent, accumulate in the body fat of animals, and are widespread in the environment. While PCBs apparently have a low avian toxicity, they are similar to dieldrin in their ability to induce hepatic enzymes that alter hormone concentrations. Thus, PCB could be a component cause of the breeding failure observed in some raptor populations (Risebrough et al., 1968; Prestt et al., 1970).

Eggshells.—The declining populations of raptoral birds in Great Britain (Ratcliffe, 1967) and North America (Hickey and Anderson, 1968) have produced thin-shelled eggs. Correlative evidence suggested that DDE inhibits calcium metabolism which results in eggshell thinning. Controlled experiments have confirmed this correlation (Porter and Wiemeyer, 1969; Peakall, 1970).

In Table 5 we compare weight and thickness of Great Horned Owl and Red-

TABLE 5

WEIGHT AND THICKNESS OF GREAT HORNED OWL AND RED-TAILED HAWK EGGSHELLS FROM 1967, COMPARED WITH PRE-1946 MUSEUM SPECIMENS FROM THE SAME GENERAL AREA[a]

		Thickness (mm)			Weight (g)		
Species	Period	No.	Mean ± SE (range)	Per cent change	No.	Mean ± SE (range)	Per cent change
Great Horned Owl	Pre-1946	65	0.3622 ± 0.0048	—	65	4.834 ± 0.064	—
Great Horned Owl	1967	3	0.3866 (0.37–0.41)	+6.7	3	5.353 (5.05–5.57)	+10.8
Red-tailed Hawk	Pre-1946	57	0.4286 ± 0.0052	—	97	6.108 ± 0.077	—
Red-tailed Hawk	1967	5	0.3850 (0.37–0.40)	–10.9	5	5.344 (5.18–5.47)	–12.5

[a] Pre-1946 data were provided by D. W. Anderson and J. J. Hickey, University of Wisconsin.

tailed Hawk eggshells with the same measurements taken from eggshells collected in the same general area prior to 1946 (pre-DDT). The Great Horned Owl eggshells show a slight increase but the Red-tailed Hawk eggshells show a decrease. Hickey and Anderson (1968) found that the weight of Red-tailed Hawk and Great Horned Owl eggshells in California increased slightly in recent years. In a more recent analysis, these workers (Anderson and Hickey, in press) reported that some Red-tailed Hawk eggshell samples show a decrease in thickness and weight from pre-DDT days with the largest decrease shown by our Montana sample.

DISCUSSION AND CONCLUSIONS

Hickey and Roelle (1969) and Peakall (1970) reported that the recent reproductive failures of raptor populations included some or all of the following symptoms: (1) abnormally late breeding, (2) failure to lay eggs, (3) reduced clutch size, (4) failure to re-lay after the loss of an initial clutch of eggs, (5) thinner eggshells, (6) egg breakage and eating, (7) increased embryonic mortality, and (8) increased nestling mortality. These have been termed the *raptor-pesticide syndrome* by Peakall (1970).

We did not observe abnormally late breeding in either the hawk or owl populations that we studied. Seidensticker (1970*b*) reported that in 1967 many Red-tails hatched just as young ground squirrels (the most important prey species of nesting Red-tails) became available. Hence, breeding in the portion of Red-tailed Hawk population that successfully hatched eggs appeared to be synchronous with the food supply.

Our data indicate similar nest densities in the hawk and owl populations that we studied and in populations studied by Craighead and Craighead (1956) in Jackson Hole, Wyoming, in 1947.

The Great Horned Owl did not have the thin eggshells that were observed in declining raptor populations by Ratcliffe (1967), Hickey and Anderson (1968), and Fyfe et al. (1969). We did find thinning in Red-tailed Hawk eggshells. The eggs of some Red-tailed Hawks contained higher chlorinated hydrocarbon pesticide residues than the eggs of Great Horned Owls. This may have been the result of dissimilar non-breeding area exposure for the resident Great Horned Owl and the migratory Red-tailed Hawk. However, in 1967, clutch size and egg hatchability in nests that produced young appeared to be normal for both species, and we did not observe egg breakage or eating of eggs.

Nesting success in the Red-tailed Hawk population was below that considered necessary for the population to maintain itself. Most nests that failed did so before or during incubation. Some of the nest failures that occurred during this period could in reality have been failures to lay eggs which resulted from patho-physiological depressed hormone concentrations caused by chlorinated hydrocarbon pesticide residues (Peakall, 1970). But more direct, man-related causes are known to have been an important factor in some nesting failures.

Because individual hawks and owls in the populations we studied were not marked, we were not able to obtain renesting data.

Our data indicated that some nestling hawks died but the number of young fledged per successful nest was not below that reported in other studies. Chlorinated hydrocarbon pesticide residues were not high from an acute-toxicity point of view.

SUMMARY

We report on the nesting and reproductive performance of the Red-tailed Hawk and Great Horned Owl in south-central Montana during 1966 and 1967. Hawk and owl breeding seasons spanned 105 and 125 days respectively in 1967. Great Horned Owls wintered on the study area, but at least some Red-tailed Hawks winter south of the study area. Both hawks and owls nested primarily in cottonwood trees. The clutch size and number fledged from successful nests of Red-tailed Hawks averaged 2.9 and 1.7 respectively while Great Horned Owl clutch size and number fledged per successful nest averaged 2.2 and 1.8 respectively. The number of young fledged per recorded nesting attempt averaged 0.9 for the hawk and 1.2 for the owl. Nesting success for the hawk was 50 per cent and 64 per cent for the owl. All tissue and eggs contained measurable but relatively low levels of DDE, DDT, DDD, and dieldrin, and some samples contained heptachlor epoxide. The one hawk and one owl egg analyzed contained PCBs. The Great Horned Owl did not have thin eggshells but we did find thinning in Red-tailed Hawk eggshells.

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THE THREE-BIRD CHASE IN MOURNING DOVES

W. Reid Goforth

Our preliminary observations indicated some similarities between the multiple-bird flights of Mourning Doves (*Zenaidura macroura*) and those of waterfowl, but many differences seemed apparent. This paper attempts to analyze the function of this activity in Mourning Doves.

Multiple-bird chases in various waterfowl species, particularly the dabbling ducks, have been analyzed by workers interested in breeding behavior. Barclay (1970) reported on several types of multiple-bird flights that have been descriptively named. Hochbaum (1944) described these flights for several species of dabbling ducks, and indicated a relationship to territory establishment or, broadly interpreted, spacing or isolation of pairs. He indicated that chasing may result in spreading the ducks widely throughout available habitat. The Pintail (*Dafila acuta*) has been found to be an exception to the general pattern in that sexually active birds do not become isolated but rather seek out females to chase or other sexually active males to associate with (Smith, 1968). McKinney (1965) agreed that the primary function of three-bird flights was the dispersion of pairs, possibly serving to reduce the opportunity for predation at the nest site. Hori (1963) pointed out the need for care in differentiating pairing-display flights from sexual pursuits of mated females. It is the pursuit of mated females that most workers have dealt with in analyses of multiple-bird chases.

METHODS

Studies were conducted primarily at three sites of intense breeding activity: one site in southeastern Iowa, and two others in central Missouri. All sites contain shelterbelts of mixed evergreen and deciduous tree species, located in prairie–forest transition areas.

We recorded observations for any three-bird chase that could be sighted and followed for a minimum of 30–40 yards. Various means were used to identify the sex of individual birds participating in the chases. For some flights the sexes could be discerned by the behavioral or morphological characteristics observed before or after the actual flight. Behaviors useful in identifying sex included Perch-cooing by males and displays by males to females. On three occasions the role of the birds in nest-building activities was used to distinguish sex. Size differences were used to distinguish the sexes of birds that were paired and seen resting or feeding together. Occasionally, male coloration could be distinguished. On the Iowa area and one of the Missouri areas, many doves were marked for sexual identification by the use of a back tag modified from the type described by Blank and Ash (1956).

In cases where there was any doubt as to sex, the bird was recorded as "sex unknown."

TABLE 1

SEXES AND POSITIONS OF DOVES IN 135 CHASES

Number of chases	Last position	Middle	Lead
	Sexes of All 3 Birds Known		
10	Male	Male	Female
14	Male	Female	Male
3	Female	Male	Male
1	Male	Male	Male
	Sexes of 2 Birds Known		
9	Unknown	Male	Female
5	Male	Unknown	Female
15	Unknown	Female	Male
1	Male	Female	Unknown
2	Female	Male	Unknown
8	Male	Male	Unknown
6	Male	Unknown	Male
	Sex of 1 Bird Known		
14	Unknown	Unknown	Female
12	Unknown	Female	Unknown
2	Female	Unknown	Unknown
16	Male	Unknown	Unknown
9	Unknown	Male	Unknown
8	Unknown	Unknown	Male

RESULTS

Three hundred and twenty-one chases were recorded. Of these, all three doves were identified as to sex in 28 chases, two were of known sex in 46 chases, and one was of known sex in 61 chases. In the remaining 186 chases, none of the doves were identified as to sex.

Frequency and position of males and females in chases.—In all chases in which the sexes of two or all three of the birds were known, at least one male was involved (Table 1). In 42 of 75 chases with sexes of either two or three birds known, at least two males were involved.

Only one female was known to participate in any one chase, and in 15 chases in which the sex of two or more birds was known, no female was identified.

Birds of both sexes were identified in all positions in chases—lead, middle, and last. Males were tallied in the lead position 47 times vs. 38 times for females; in the middle position males and females were tallied 42 times each: and in the last position, males were seen 61 times vs. 7 times for females (Table 1).

Origin and termination of chases.—In the seven chases in which the female was identified as the last bird, the origin of the chase was seen. In these chases a pair of doves was observed (presumably in an established nesting territory) when another dove flew close by. In all cases the male of the pair chased the intruder and the female flew after her mate. Three of these chases were observed to termination and all three were short (less than 150 yards). These three chases terminated when the chasing male and his mate suddenly veered and returned to the starting area, while the intruding dove continued its flight. In another case the pair was seen to return to the area of origin of the chase within 3 minutes after the chase was initiated.

The origins of five chases with the female in the lead position were observed. In all of these chases, a female followed by a male flew close to the cooing perch of another male and the second male gave chase. In the only one of these cases in which the entire chase was observed the pair turned sharply and lit in a tree only a few seconds after the third dove left his perch to fly after them. The third dove then lit in the tree near them.

The origins of nine chases with the female in the middle position were observed. In eight of these chases, the origin was as described for those with the female in the lead position: a pair was pursued by a male near whose cooing perch they flew. In the one exception, two males and one female were picking up grit on a gravel site; when they all flew off, the female was in the middle position. In none of these nine cases was the termination of the chase observed.

Forty-one terminations of chases were observed, in addition to those described above. In three of these terminations, the two lead doves lit, and the last dove in the line (in two cases a known male) flew on. In these three cases. it was possible to identify the two doves that alighted as a leading male and a following female. One chase terminated when the three birds dispersed in three different directions. In this case the sex of none of the birds could be determined.

In 33 other cases where terminations were observed, the three birds alighted very near each other either in a field or in trees. The spacing of the three doves with respect to each other after alighting varied considerably.

The duration of chases could not be analyzed because entire chases were seen infrequently. It was common, however. for chases over a prairie area and a lake area to last for one minute or more. Many of these longer chases followed a criss-cross pattern over the same area.

TABLE 2

POSITION OF FEMALE RELATED TO FREQUENCY OF FLIGHT PATTERN

	Flight pattern	
Known position of female (87 chases)	Twisting	Straight
Lead	35	3
Middle	40	2
Last	0	6
Assumed position of female (14 chases where position of two males was known)		
Lead	7	1
Middle	6	0
Last	0	0

Flight patterns of three-bird chases.—There are two basic flight patterns for three-bird chases. I term one of these patterns "straight" and the other "twisting." In "straight" patterns, the birds fly with one directly behind the other, and with rather consistent spacing. The middle bird is commonly 1 or 2 feet behind the lead bird and the last bird is often 3 or 4 feet behind the middle bird. Occasionally the middle bird is spaced evenly between the other two. The flight paths are of varying altitude but are relatively level with few or no sharp turns to either side.

The "twisting" flight form is highly irregular with rapid changes in altitude and many sharp turns to the side. In this pattern, the spacing of the three birds is more irregular than in "straight" chases. Often the three birds are tightly grouped at one instant and spread wide the next. The birds continue to be aligned behind each other for the most part, but one may occasionally be offset from the direct line. Two of the three birds were seen flying side-by-side for a few seconds on only six different occasions. Of the 321 observed chases, 46 were classified as the "straight" form and 244 as "twisting." The remaining 31 chases could not be classified in this respect. Table 2 presents the frequency of flight form for those chases where the position of the female was known or could be reasonably assumed.

DISCUSSION

Of the several types of multiple-bird chases in ducks listed by Barclay (1970), the pursuit of transgressing pairs by a territorial male seems to be the type most comparable to the three-bird chases in Mourning Doves. However, Barclay's "territorial drake" is a drake of a mated pair. In doves the most common chases originate when an unmated male gives chase to a pair that flies close to him. This appears to be the defense of a territory by an unmated male. The term "three-bird-flight" is used to describe a flight pattern in ducks that includes a territorial drake in pursuit of the hen of a mated pair, with the hen's mate usually positioned last in the chase. In doves the female is always positioned next to her mate, either in front of or behind him.

The attempted rape flight in ducks was described by Barclay as being erratic in pattern and including several males following a hen. Many of the chases in doves are erratic (twisting), but in no case was attempted copulation observed.

The fact that the flight pattern is twisting when the female is in the lead or middle position suggests an effort on the part of the unmated male to gain the attention of the female participating in the chase. This common type of chase, i.e., a male chasing a pair that flew close to his cooing perch, could have the effect of preventing a pair from selecting a nest area close to an area already "claimed" by another male. This behavior, therefore, could cause nest dispersion, as has been suggested for ducks.

The straight flight pattern exhibited when the female occupies the last position may indicate a different function for this type of chase, with the unmated male simply fleeing from the pair.

SUMMARY

Observations were made of 321 three-bird chases of Mourning Doves. In 28 chases, the sexes of all birds were known; in 46 chases, the sexes of two birds were known; and in 61 chases, the sex of one bird was known. No more than one female was identified in any chase, and in one chase, all birds were known to be males. When a known pair was involved, the female was always positioned next to her mate in the chase, sometimes in front of him and sometimes behind him.

The most frequent cause of chase origin was when an unmated male pursued a pair that flew close to his perch.

Flight patterns were straight when the female was last in line of chase, and twisting when she was in the middle or lead position.

ACKNOWLEDGMENTS

I am indebted to Mr. Fred Shively and Mrs. Susan Duff for their help in trapping and tagging doves. I also wish to thank Dr. T. S. Baskett, Dr. Leigh H. Fredrickson, and Mr. Kenneth Sadler for helpful criticisms of the manuscript.

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MISSOURI COOPERATIVE WILDLIFE RESEARCH UNIT, UNIVERSITY OF MISSOURI, COLUMBIA, MISSOURI 65201. 25 MARCH 1971.

PROCEEDINGS OF THE FIFTY-SECOND ANNUAL MEETING
ERRATA

In the list of persons attending the Annual Meeting at Dauphin Island, Alabama (Wilson Bull., 83:339, 1971) the following names were inadvertently omitted:

From MINNESOTA: 10—*Duluth,* Joel K. Bronoel, Pershing B. Hofslund, Henry B. Roberts; *La Moille,* Violet Nagle, Pauline Wershofen: *Minneapolis,* Dorothy Breckenridge, W. J. Breckenridge, Isabel Daniels; *South St. Paul,* Mr. and Mrs. Thomas C. Savage.

The total registered attendance at the meeting was 255 rather than the 197 given.

FIELD CRITERIA FOR DETERMINING INCUBATION STAGE IN EGGS OF THE COMMON TERN

Helen Hays and Mary LeCroy

During the course of field work on Common (*Sterna hirundo*) and Roseate (*Sterna dougallii*) Terns on Great Gull Island, Suffolk County, New York, we submerged eggs of known age of the Common Tern in a beaker of water, then collected the embryos in order to correlate the period in incubation with the specific gravity and the stage of development. Westerkov (1950) describes a technique for determining stage of incubation of pheasant (*Phasianus colchicus*) and European partridge (*Perdix perdix*) eggs by immersing them in water. As the embryo develops the egg floats increasingly higher in the water, gradually rising to the surface over a period of days. More recently, Schreiber (1970) describes flotation characteristics for eggs of the Western Gull. Fant (1957) studied the development of pheasant emrbyos and published line drawings for embryos at different stages of incubation. Weller (1957) photographed embryos of the Redhead at various stages of development. Others have used similar techniques, particularly with game birds, but we find no such study for terns. Such information is potentially useful as a means of estimating approximate hatching dates in a tern colony infrequently visited or in studies involving egg transfer experiments. And as Schreiber (1970) suggests, if enough studies of this type are done, it may be possible to devise a flotation scale applicable to incubation periods of differing lengths.

METHODS

As part of a study of production each nest was marked the day the first egg was found. The nests then were examined daily for seven days and additional eggs were numbered until the clutch was complete. For our study we used only the third egg in 18 clutches of the Common Tern so marked. Each egg was floated in a beaker of fresh water. The embryo then was collected and preserved in 95 per cent alcohol. We used only the third egg as it is the egg that hatches most consistently in 20–21 days. Incubation times vary from 20–28 days, the longer periods probably being due to sporadic incubation prior to the laying of the second egg.

The series of embryos was examined for characterisites that the field worker can see with the naked eye or a hand lens. We could easily distinguish the differences in flotation and the gross differences in the embryos at 2-day intervals. (Fig. 1 and Fig. 2).

As the nests were checked only once a day, any egg could be as much as 24 hours old when marked (e.g., in Fig. 1, no. 2, which represents 3 to 4 days of incubation, the embryo could be as much as 5 days old). However, development of the embryos within our series appeared to be quite regular except in one embryo (11 days of incubation) which showed no more development than the embryo taken 24 hours earlier.

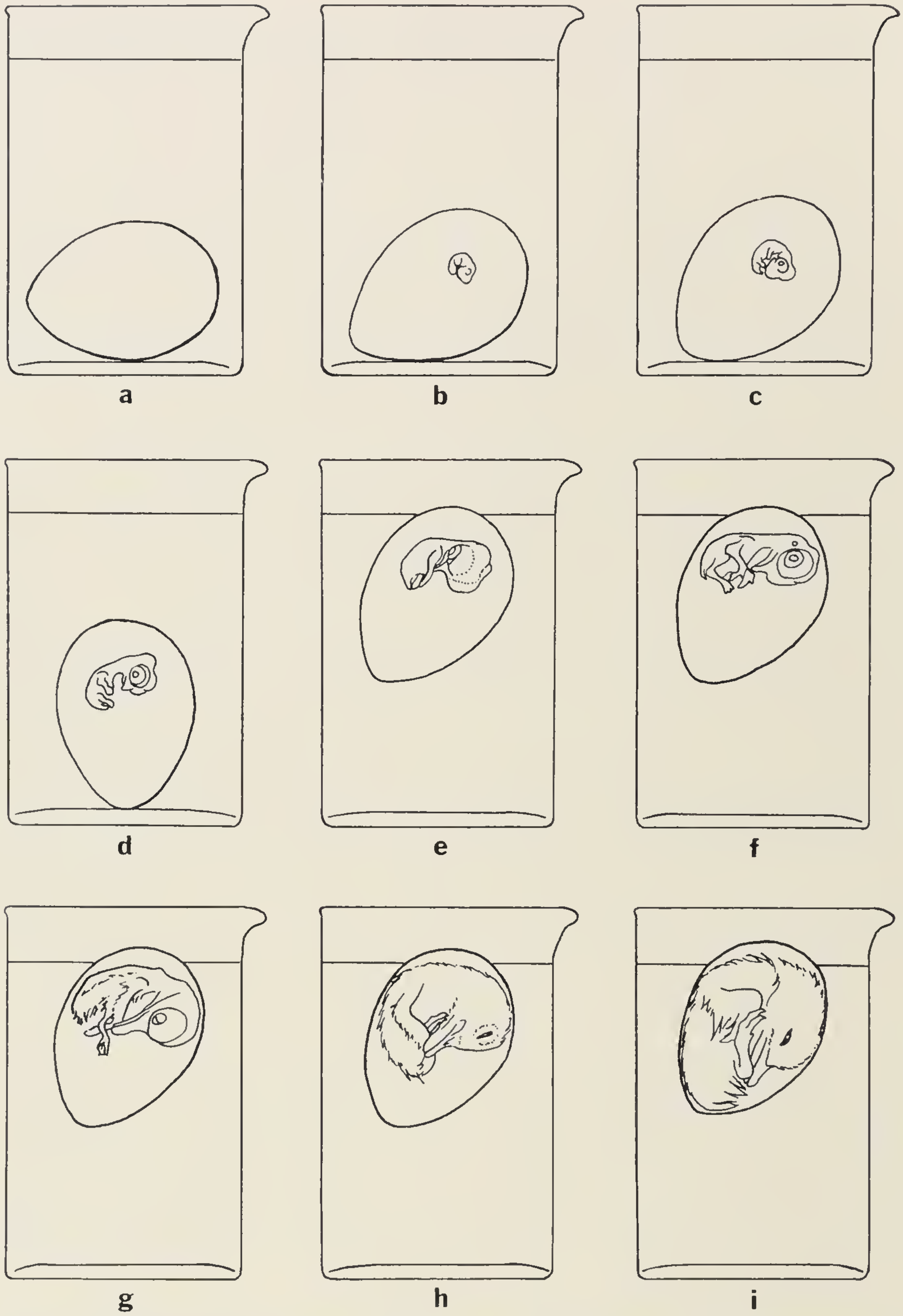

Fig. 1. Changes in egg flotation and embryo development with incubation in the Common Tern. a) 1–2 days incubation, b) 3–4 days, c) 5–6 days, d) 7–8 days, e) 9–10 days, f) 11–12 days, g) 13–14 days, h) 15–16 days, i) 17–18 days. Embryos ½ natural size.

FIG. 2. Embryos of the Common Tern. a) 3–4 days incubation, b) 5–6 days, c) 7–8 days, d) 9–10 days, e) 11–12 days, f) 13–14 days, g) 15–16 days, h) 17–18 days. Embryos 1½ natural size.

It is possible for a field worker using the following criteria as well as the illustrations to estimate the stage of incubation of eggs of the Common Tern within approximately 2 days. Roseate Terns seem similar in their developmental stages, although only a few eggs of this species were collected.

DESCRIPTION OF STAGES

1–2 days incubation—Egg lying on bottom of beaker with long axis parallel to bottom. Embryo visible as a white disk on yolk surface.

3–4 days incubation—Egg with small end on bottom of beaker and with long axis forming an angle of 30° with bottom. Embryo with midbrain prominent, eye prominent and slightly pigmented, bill not visible, limb buds separate from body.

5–6 days incubation—Egg with small end on bottom and with long axis forming angle of 45° with bottom. Embryo with upper mandible projecting from head and lower mandible visible and with wings and legs jointed.

7–8 days incubation—Egg stands vertically with small end on bottom. Embryo with eyelid, nictitating membrane and ear opening visible and with distinct grooves between digits.

9–10 days incubation—Egg floats at surface with diameter of exposed part of large end 15 mm. Embryo with egg tooth visible; with feather papillae visible along backbone and prominent around tail, and alula visible on wings; and with toes and webs distinct.

11–12 days incubation—Egg floats with exposed part of large end 17 mm in diameter. Embryo with down just breaking out of papillae along dorsal feather tract and around tail and with claws visible.

13–14 days incubation—Egg floats with exposed part of large end 20 mm in diameter. Embryo with eyelid beginning to close and with down breaking out of papillae in scapular area and on elbow and with down well grown on ventral surface.

15–16 days incubation—Egg floats with exposed part of large end 21 mm in diameter. Embryo with eye a slit and with body down-covered except for a bare area at base of bill.

17–18 days incubation—Egg floats with exposed part of large end 25 mm in diameter. Down-covered embryo fills egg; shell cracked but not pipped.

ACKNOWLEDGMENTS

We thank Dean Amadon for helpful comments on the manuscript, Grace Donaldson for help in collecting the embryos and floating the eggs, Christopher Pineo for making the drawings of the eggs and Arthur Singer for photographing the embryos.

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AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK, NEW YORK 10024, 27 MAY 1971.

REQUEST FOR INFORMATION

During the autumn migration of 1971, the Long Point Bird Observatory hopes to band and color-mark several hundred Sanderling at Long Point, Ontario. Information on the movement of these birds away from Long Point will facilitate research presently underway on the energy requirements of their migration. We would appreciate it if everyone sighting these birds would report their observations to:

Long Point Bird Observatory,
269 Beta Street,
Toronto 14, Ontario, Canada.

The following information would be appreciated: Date and time of observation; Location, including nearest city or town; Colors: note—birds will be colored on the breast; and the abdomen with two of the following colors: red, orange, pink, purple, yellow, green, blue, brown, black, and white (no color).

Leg that has been banded: this will tell if the bird is an adult or an immature.

SOME VIEWS ON EXOTIC WATERFOWL

Eric G. Bolen

Introductions of foreign species may be poor substitutes for ill-conceived or inadequate management of native game animals. Failure to meet the problems confronting endemic game populations must not be masked by furtive promise of future "successes" with exotic species.

The history of North America has fortunately not included serious attempts to establish wild populations of exotic waterfowl. Instead, gallinaceous birds were foremost in "experiments" with introductions. Now, however, the continuing enthusiasm and search for exotic sporting birds has indeed spread to waterfowl. Weller (1969) has thoughtfully reviewed the potential hazards that exotic waterfowl might bring to this continent. The spectre of direct interspecific competition between native and exotic species was among the prime considerations.

The regional focus for waterfowl introductions seems to lie mainly in the southeastern United States. This region, as much as any, is already well-stocked with an exotic biota of redoubtable proportions: nutria (*Myocastor coypus*), water hyacinth (*Eichornia crassipes*), the introduced fire ant (*Solenopsis saevissima richteri*), and, more recently, the walking catfish (*Clarias batrachus*) are compelling and instructive examples. The waterfowl taxa thought to make suitable additions include diving (Aythyini), puddling (Anatini), and perching (Cairinini) species. Within these groups are some species, most notably the perching ducks, which nest in natural tree cavities, and it is to the hole-nesting types that particular attention is drawn in this paper. Much concern has recently been expressed, for example, with the specialized habitat of the North American Wood Duck (*Aix sponsa*) by Jahn, Bellrose et al. (*in* Trefethen, 1966).

Wood Duck and Black-bellied Tree Duck.—The Wood Duck is a hole-nester naturally established in much of North America including the wooded portions of eastern Texas (Figure 1A). Recently, however, this species has been discovered nesting in southern Texas in a region broadly coincident with the northern breeding range of Black-bellied Tree Duck (*Dendrocygna autumnalis*) (Bolen and Cottam, 1967). This contact is apparently of recent origin and represents a range expansion for each species. Some measure of interspecific competition, although clearly speculative, already seems evident in this new, but natural, partial sympatry. Mixed clutches of Wood Duck and Black-bellied Tree Duck eggs have been recorded on at least two occasions in Live Oak County, Texas, (Bolen and Cain, 1968; Labuda, 1969). Male and female Black-bellied Tree Ducks alternately share incubation duties (Bolen, 1971), yet

Fig. 1. Range maps for (A) Wood Duck, (B) Black-bellied Tree Duck, and (C) Muscovy Duck. Wood Duck map adopted from Trefethen (1966), others from Delacour (1954; 1959). Arrows note direction of dispersal along the Gulf Coast; barriers are shown where there is presumably some environmental resistance to further dispersal. Note that Wood Duck range is apparently limited as it approaches semi-tropical regions whereas the Black-bellied Tree Duck range seems limited in the opposite direction by the advent of temperate areas. However, wild Muscovy Ducks introduced in the southeastern United States would instead be *approaching* favorable locales without an intervening barrier as they spread along the Gulf Coast.

the Wood Duck hens incubated the mixed clutches in both instances. One might have otherwise suspected that a Wood Duck hen, incubating alone, would have fared poorly in whatever amount of direct competition actually took place although there have been occasions when two Wood Duck hens simultaneously incubated a single set of eggs (cf. Fuller and Bolen, 1963). It is nonetheless surprising to find that Wood Duck hens dominated Black-bellied Tree Ducks at nest sites as they apparently did in the instances reported above.

Hence, there is now a biological interface in southern Texas where two native species sometimes meet and seek similar nesting sites. The contact is currently of small proportions, yet it seems that the Wood Duck may dominate a nesting site when tree ducks are also present. Presumably, the Wood Duck represents one of a variety of possible limitations to further range expansion of the Black-bellied Tree Duck into southeastern Texas. If so, this barrier is certainly a natural phenomenon and remains only of passing academic interest.

Muscovy Duck and Black-bellied Tree Duck.—We can now consider the impact that one or more additional hole-nesting species might bring to an area already served by two species with similar nesting requirements. It is well to emphasize that one of the exotic species under consideration is the Muscovy Duck (*Cairina moschata*), a tribal relative of the Wood Duck. Here again, there are limited observational data available to assess the behavior of Muscovy Ducks with Black-bellied Tree Ducks in southern Texas.

Throughout much of Central and South America the Black-bellied Tree Duck is sympatric with the Muscovy. There is little to suggest that interspecific competition in this extensive range is anything else but minimal. One may assume a priori that niche segregation in these species is well defined where they have long co-existed. Haverschmidt (1947), for example, noted Muscovy Ducks perched with Black-bellied Tree Ducks (here, the southern race *D. a. discolor*, however) in Surinam although this, in itself, is not evidence that competition has been entirely precluded in the tropical regions of sympatry. However, at the periphery (in Texas, the northern edge) of the tree duck's range (Figure 1B), one might reasonably assume that (a) environmental stresses on the tree ducks are greater than elsewhere and (b) that in the usual absence of other cavity-nesting waterfowl, the Black-bellied Tree Duck might adequately fill this niche without difficulty.

The evidence already presented, although scant, suggests that the Black-bellied Tree Duck is seemingly a poor competitor with the Wood Duck. However, the Wood Duck is a species of temperate environments and only infrequently meets with the tropically-adapted Black-bellied Tree Duck. A projection of these events with Muscovy Ducks, however, is markedly dissimilar. In this case, Muscovy Ducks introduced in the southeastern United States may well move south into the breeding area of the tree duck and would *not* be confronted with climatic adversity. Rather, Muscovy Ducks following the Gulf Coast southward would be moving directly into environmental conditions presumably of steadily increasing favorability (i.e. towards their native range, Figure 1C).

How then might we expect the northern Black-bellied Tree Duck population to fare if they should meet transplanted Muscovy Ducks on a common breeding ground in southern Texas? (One could well ask the same question regarding Wood Ducks and Muscovy Ducks in eastern Texas!). The observations now at hand suggest that Muscovy Ducks would dominate nest sites where tree ducks also attempt to nest. My records stem from Live Oak and San Patricio Counties, Texas, where feral Muscovy Ducks sometimes roam lake shores with Black-bellied Tree Ducks. The following nest histories, although necessarily abbreviated here, seem pertinent when considering potential interspecific competition:

1. A nest containing eight Black-bellied Tree Duck and four Muscovy eggs was incubated solely by the Muscovy hen.
2. A compound or "dump" nest containing the eggs of both species was intentionally robbed of, first, two Muscovy eggs and then eight additional Muscovy eggs, and finally, another six Muscovy eggs. Despite these "setbacks," a Muscovy hen assumed incubation of the entire clutch.
3. In still another nest, a Muscovy hen unsuccessfully incubated a clutch that contained tree duck eggs.
4. Finally, a Muscovy hen successfully invaded and broke up a Black-bellied Tree Duck nest already under incubation by tree ducks.

It seems clear that contact with Muscovy Ducks is not to the advantage of the Black-bellied Tree Ducks nesting in southern Texas. One can only speculate with distress as to the circumstances that might occur if Muscovy Ducks and other cavity-nesting exotics are placed into the environment now marking the northern periphery of the Black-bellied Tree Duck's range in the United States. The words of Delacour (1959:130) seem fully appropriate: "Wild Muscovy Ducks do well on pond and lakes, but the males are dangerous to other birds, mating with nearly all species and killing weaker birds. They should be isolated." Ornithologist and wildfowler alike should take ample heed of the potential problems posed by introductions of exotic waterfowl.

ACKNOWLEDGMENTS

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CORRIGENDA

Volume 83

Page 5, line 14 should read, "—96° 60′ W, lat. 17° 20′ E. . . ."

Page 7, Figure 1. The figure designations are transposed.

Page 10, Table 2. The % B.A. of *Quercus laurina* should read 0.7.

GENERAL NOTES

Further observations on use of the feet by foraging herons.—In two previous contributions (Meyerrieeks, Wilson Bull., 71:153–158, 1959; Auk, 83:471–472, 1966), I described how foraging herons use their feet in what is usually referred to as "foot-stirring" or "foot-raking" feeding behavior. To my knowledge, prior to 1970 this mode of foraging behavior was known for nine species of the Family Ardeidae: Snowy Egret (*Leucophoyx thula*); Reddish Egret (*Dichromanassa rufescens*); Louisiana Heron (*Hydranassa tricolor*); Reef Heron (*Demiegretta schistacea*); Little Egret (*Egretta garzetta*); Pied Heron (*Notophoyx picata*); White-faced Heron (*Notophoyx novaehollandiae*); Green Heron (*Butorides virescens*); and Black Heron (*Melanophoyx ardesiaca*) (see descriptions and contained references in Meyerriecks, op. cit.).

My purpose here is threefold: 1) to describe my observations of use of the feet while foraging by two additional species of herons, one using a "classical" method (foot-raking by the Little Blue Heron, *Florida caerulea*), and the other using the feet in a somewhat different manner in order to capture prey (Common Egret, *Casmerodius albus*); 2) to describe my observations of variations in this kind of behavior in species already known to use their feet while foraging (Louisiana Heron and Snowy Egret); and 3) to add an additional observation for the Green Heron.

All observations were made in the winter of 1969–70 at three localities in the Florida Keys: 1) a large slough on Little Duck Key, west of Marathon, Key Vaca; 2) the ocean side of Little Duck Key; and 3) the tidal shallows on the eastern side of Fiesta Key, located southwest of Islamorada, Upper Matecumbe Key. On many charts Fiesta Key is also known as Greyhound Key. Observations at Little Duck Key slough were made from blinds placed at the edge of the slough or directly from an open position alongside U.S. Highway 1. Those made on the ocean side of Little Duck Key and from Fiesta Key were from an open position at the edge of the tidal flats.

Little Blue Heron.—Two adults of this species were observed on 18 February 70 using their feet to forage in a manner somewhat reminiscent of both the Reddish Egret and the Green Heron, i.e., they would move forward using the "Wade Slowly" foraging technique (see details in Meyerriecks, Publ. Nuttall Ornith. Club, No. 2, 1960), occasionally stopping for a moment to extend one leg with toes widespread. Then they were seen to rake or scrape the substrate with a backward drag of the extended foot. At other times, the foraging heron would stop, peer down into the shallows, then extend a leg and foot-rake, afterwards peering intently at the raked area. The general stance of both birds and the peering down behavior were like those of the Reddish Egrets engaged in foot-raking. However, the raking motion of the spread toes was closer to that performed by Green Herons: unhurried, deliberate, a longer stroke than that of the Reddish Egret. Clearly, the use of the feet by these Little Blue Herons differed strikingly as compared with Snowy Egrets, the foot-stirrer *par excellence*.

One of the adults was seen to forage in Little Duck Key slough for two hours and 17 minutes; it foot-raked nine times during this period and was successful in capturing two small fish immediately after two separate foot-rakes. All of its raking appeared to be made in the soft mud covering the bottom of the slough. Water in the slough was clear and several inches deep. The other adult foraged in shallow pools left by the receding tide on the ocean side of Little Duck Key. This was a different individual because both birds were in view at the same time as seen from my position on the bordering road. This ocean-side adult raked only patches of turtle grass (*Thalassia*). The foraging bird would wade forward slowly, spy a patch of turtle grass, extend one leg and rake over the surface of the vegetation with a single, backward dragging motion, then peer intently at the raked patch. This adult was watched for 27 minutes and made 14 foot-rakes, only one of which led to the seizure of a small fish. Neither bird showed any aerial variant of this behavior, nor did I ever see an immature (white-plumaged) Little Blue Heron use its feet to foot-rake. Neither of the adults showed any preference for use of the right or left foot, but the brevity of the observations does not eliminate the possibility of "footedness" in this species.

On 16 March 70 I observed another adult Little Blue Heron use foot-raking twice during an observation period of 10 minutes at the Little Duck Key slough, but it made no strikes. It is not known if this was one of the two adults previously seen at or near the slough.

I was surprised to see this behavior in Little Blue Herons because I have watched this species forage for hundreds of hours and have not seen this feeding technique prior to these observations. No environmental variable such as weather, nature of the substrate, water condition, etc., seemed to differ strikingly from hundreds of other heron-foraging days I have recorded; hence, I believe that foot-raking may be a highly unusual foraging technique for this species. One is tempted to consider observational learning as a possible explanation for such rare occurrences in a few individuals. Seven or eight species of herons may be foraging in close approximation in sloughs and similar environments in the Florida Keys. Included in the group, typically, will be such frequent users of foot-stirring as Snowy Egrets, a species that not only engages in this behavior more often than any other North American heron, but also does so for longer periods and with greater success. Thus, ample opportunities are provided for other species to observe a proven method of prey capture.

Common Egret.—I made observations of use of the feet while foraging by two individuals of this species. The first was seen on the ocean side of Little Duck Key; the second was observed foraging in the shallows on the eastern side of Fiesta Key. The first bird was seen foraging at low tide among patches of turtle grass on 18 February 70. The foraging bird, using the wade slowly method of searching for prey, would approach a patch of vegetation, bend over and peer intently at it for several moments. a posture I had seen previously hundreds of times. Suddenly the bird extended its right leg with toes widespread, and then slowly raked the edge of the turtle grass patch with its toes. The motion was made deliberately, very slowly, a kind of *probing* of the vegetation. The foot was neither vibrated in the manner of the Snowy Egret nor was it used in the raking motion of the Reddish Egret. It was in fact a different way of disturbing prey from their hiding places. This egret foot-probed four times at four separate patches of grass and was successful in capturing fish after each probe. The bird probed twice with each foot. My observations were ended when a shell collector disturbed the egret.

The second individual was seen foraging among red mangrove (*Rhizophora mangle*) prop roots. On 15 March 70 this egret was seen first to use its feet directly in prey capture assistance when it struck at a fish which escaped by swimming into the cover of a nearby tangle of mangrove prop roots. Mangrove leaves and other debris at the base of the prop roots were covered by a few inches of very clear water. After the missed strike, the egret ran toward the mangroves, leaned over, and peered intently inside the prop root cover. Several times it swayed its neck from side to side, as if to gain a better view or perhaps to fixate its intended victim. Next, it extended its left leg, but the toes were held together. The bird then inserted its foot into the prop root cover and made a slow, deliberate raking motion twice over the debris on the substrate. It withdrew its foot and peered intently at the debris. I watched this individual forage for 70 minutes, and during this period the egret made seven strikes, two of which were successful. Of the missed strikes, three resulted in the egret running toward a prop root tangle and giving the performance just described. On its last use of foot-probing, the egret disturbed a fish which was promptly captured as it swam out from its protective cover.

As with the Little Blue Heron, I am prompted to consider this use of the feet by the Common Egret as exceptional behavior in view of the rarity of its occurrence, based on my own extended field observations. Several authors (cited in Meyerriecks, 1959) have noted the lack of foot-stirring in this species, although Bagg and Eliot (reference, op. cit.) described a different manner of prey capture involving use of the feet. In both my observations and those of Bagg and Eliot, the Common Egret used its feet in a manner quite different from that of "classical" foot-stirring or foot-raking.

Other heron species.—The smaller heron species (e.g., Louisiana Heron, Green Heron) normally do not forage among the densely packed pneumatophores of black mangroves (*Avicennia nitida*) but prefer to search for prey in the shallows at the edge of the pneumatophore zone or else among the less densely packed ones. However, on 13 January 70 at a slough in Layton, Long Key, I watched a single adult Snowy Egret foot-stir repeatedly in densely packed pneumatophores. The bird would vibrate its extended foot at the base of several pneumatophores in the classic style of this species. I watched this bird forage for nine minutes, and during this period it stirred the vegetation almost continuously, making 23 strikes. Seven attempts were successful in capturing very small fish. After one strike, during which the bird's head struck several pneumatophores, it closed its right eye repeatedly and shook its head a number of times. Perhaps general avoidance of the packed zone of pneumatophores is brought about by such annoyance or even injury to the eyes during a strike. Additionally, even though this egret made seven successful strikes in the dense zone, interference with a strike and subsequent loss of prey might stimulate a foraging bird to leave the pneumatophore area and seek more profitable foraging elsewhere.

An immature Green Heron, a bird of the year based on its plumage, was seen to foot-rake on 16 January 70 at the Layton slough. It did so five times, but the bird did not make any strikes after use of its feet. As pointed out previously (Meyerriecks, 1966, op. cit.), this is a very rare foraging method for this species.

In my 1959 paper I noted that I had never seen the Louisiana Heron use the scrape method of the Reddish Egret. Rather, its use of the feet closely resembled that of the Snowy Egret; that is, classic foot-stirring. On 19 February 70, however, I saw a lone adult Louisiana Heron use foot-scraping three times while foraging in the shallows east of Fiesta Key. The bird made one unsuccessful strike. The performance was very similar to that of the normal foot-scraping of the Reddish Egret.

Recently, Vanden Berge (Amer. Midl. Nat., 84: 289–364, 1970) has made a detailed study and analysis of ciconiiform appendicular musculature. He points out that "Four genera of the ardeids which were examined, namely, *Florida*, *Dichromanassa*, *Hydranassa*, and *Leucophoyx*, were remarkably consistent in the quantitative measurements and qualitative variations which were noted among all Ciconiiformes." He adds that "Of all the Ardeidae, these four 'day' herons show the most diversified locomotory activity during feeding." I could not agree more with respect to the last three genera, but this statement is misleading for *Florida*. The Little Blue Heron is a slow, deliberate forager and shows neither the active running techniques nor the more advanced wing-involved methods of the other three genera. Even in its rare foot-raking, as described here for the first time, this species again is slow and deliberate while foraging. Vanden Berge was unable to study the pelvic musculature of *Casmerodius albus*; it would be of the greatest interest to know if its musculature agreed with that of the four "day" heron genera studied by him. My field observations and the detailed anatomical investigations of Vanden Berge suggest that heron foraging behavior provides a fertile field for studies of the functional anatomy of heron musculature.—ANDREW J. MEYERRIECKS, *Department of Biology, University of South Florida, Tampa, Florida 33620, 28 January 1971.*

Size differences between Ross' and Snow Goose eggs at Karrak Lake, Northwest Territories in 1968.—In the central Canadian Arctic Ross' Geese (*Chen rossii*) and Snow Geese (*Chen caerulescens*) nest in mixed colonies on islands in shallow tundra lakes (Ryder. Auk, 86: 282–292, 1969). During nesting studies of the Ross' Goose at Karrak Lake, Northwest Territories (67°15′N 100°15′W) I occasionally found it difficult to determine visually whether temporarily unattended nests belonged to Ross' or Snow Geese. When I approached a nesting island during the egg-laying period, attending pairs would flush at a considerable distance (Ryder, Canadian Wildl. Serv. Rept. Ser. No. 3:27, 1967). One of the procedures used to obtain nest histories (i.e. follow the fate of nest and eggs from the day the first egg was laid to the hatching or disappearance of all eggs) was to mark all newly-started nests in a number of study areas at the colony. We temporarily assigned a species to each marked nest until the female was seen sitting on the nest. This method had one major drawback. On occasion marked nests were destroyed by predators (arctic fox, *Alopex lagopus*; Glaucous Gull, *Larus hyperboreus*; Herring Gull, *L. argentatus*) before laying was completed or just after completion. In such

TABLE 1

MEASUREMENTS OF SNOW GOOSE AND ROSS' GOOSE EGGS, KARRAK LAKE, NORTHWEST TERRITORIES, 1968

Snow Goose	Length (mm)	Width (mm)
N	50	50
upper	87.9	56.7
Range:		
lower	72.6	50.5
Average	80.5	53.8
S.D.	2.0	1.3
Ross' Goose	**Length (mm)**	**Width (mm)**
N	52	52
upper	80.2	51.4
Range:		
lower	67.2	44.7
Average	73.1	47.5
S.D.	2.5	1.5

Average lengths and widths are significantly different, $P < 0.01$.

instances attending females would desert before we had an opportunity to determine which species the nest belonged to.

I found from handling over 3000 Ross' and Snow Goose eggs that species determination of unattended nests was possible by the relative feel of egg widths. When an egg was held with the pointed end toward the thumb, there was a definite difference in the impression of size between eggs of the two species. To test this I classified, in 1968, by the above method, 52 Ross' and 50 Snow Goose eggs before measuring their lengths and widths. The eggs were given to me by my assistant who alone knew to which species the eggs belonged. In all cases I made correct identification. Lengths and widths of the eggs are presented in Table 1. Although the statistical tests presented are simple (they can be completed in the field) the data show that there is little overlap in the widths of the eggs between these two species.

This report may be useful to future investigators. Certainly the measurements of length and width are accurate, easily obtained and provide considerable confidence in correct identification of unattended goose nests in such mixed species populations.—JOHN P. RYDER, *Department of Biology, Lakehead University, Thunder Bay "P", Ontario, 25 January 1971.*

Cassin's Sparrow parasitized by cowbird.—On 16 May 1970 we camped in the Comanche National Grassland, 11 miles southeast of Campo, Baca Co., in extreme southeastern Colorado. We flushed a Cassin's Sparrow (*Aimophila cassinii*) from its nest in a sagebrush (*Artemisia filifolia*), about six inches above the ground. Inspection of the nest revealed three white eggs and one dull whitish egg blotched with brown. We believe the latter to have been an egg of the Brown-headed Cowbird (*Molothrus ater*). No bird of that species was observed at the site or in the vicinity.

The location is a vast sagebrush and grass prairie. A solitary tree is located approximately one mile from the site; while the nearest farm and associated grove of trees must be at least five miles from the site, although we have not measured the distance. Typical birds of the habitat are, besides *A. cassinii*; Western Meadowlark (*Sturnella neglecta*), Lark Bunting (*Calamospiza melanocorys*), Grasshopper Sparrow (*Ammodramus savannarum*), and Mockingbird (*Mimus polyglottos*). There are, in addition, Lesser Prairie Chicken (*Tympanuchus pallidicinctus*) in this portion of the Comanche National Grassland.

Friedmann (U.S. Natl. Mus. Bull. 233:159, 1963) states that "Cassin's sparrow appears to be an infrequent victim of the brown-headed cowbird." He lists eight records, all for the state of Texas with only two of these north of San Antonio. Sutton (Oklahoma Birds, 1967, p. 558) states that no parasitism of the Cassin's Sparrow has been reported in Oklahoma. Bailey and Niedrach (Birds of Colorado, 1965) and Ligon (New Mexico Birds, 1961) do not mention parasitism of *A. cassinii.* A search of the literature failed to reveal any references not included by Friedmann. Apparently, this is the first recorded instance of cowbird parasitism of the Cassin's Sparrow outside of the state of Texas.

The earliest date reported by Sutton (op. cit.: 616) for a nest with eggs in Oklahoma is 26 May. Normal clutch size judging from evidence he cites is four to five. We conclude that the nest we found was likely completed and represents an early date for this species. In addition, this is only the fourth report of a Cassin's Sparrow nest for Colorado, although this species is common in southeastern Colorado (Bailey and Niedrach, op. cit.: 809).—HUGH E. KINGERY AND PAUL R. JULIAN. *10 Emerson St., Denver, Colorado 80218 and 1269 Chinook Way, Boulder, Colorado 80303, 10 November 1970.*

Winter nesting attempts by Great-tailed Grackles.—Great-tailed Grackles (*Cassidix mexicanus*) normally begin nesting from mid-March to late April (Bent, U.S. Natl. Mus. Bull., 211, 1958; Selander and Giller, Condor, 63:29–96, 1961), however, an instance of autumnal nesting in this species has been recorded (Selander, Condor, 64:81–91, 1962). The present paper reports observations of winter nesting in Great-tailed Grackles.

During January and early February, 1971, we observed calling, displaying, and related courtship behavior in male Great-tailed Grackles an the Texas A&M campus. Great-tailed Grackles normally use the campus as a spring nesting area and build nests in the numerous live oak trees (*Quercus virginiana*). However, on 16 February, we observed eight newly constructed nests in a single live oak. Females were observed bringing grass and twigs to these nests. Although these females built nests, they failed to lay eggs and complete the breeding cycle.

Two adult male and two adult female Great-tailed Grackles were collected for examination. Ovaries measured 12 mm by 8 mm, with no individual ovum being larger than 1 mm by 1 mm; testes measured approximately 1 mm by 1 mm. These measurements are normal for this time of year.

Fall and winter (1970–71) precipitation levels for the College Station area were much lower than totals for the same periods in 1969–70 or 1968–69 (viz., 14.27 inches for the period June 1970–February 1971; and 28.51 inches and 39.53 inches during the same periods in 1969–70 and 1968–69, respectively). Temperatures ranged 37–85°F (Ave. = 63.0) during 34 of 42 (81 per cent) days prior to occurrence of nests. In the remaining eight days, three separate cold fronts moved through the area; and consequently, minima of 22–41° and maxima of 43–52° (Ave. = 39.6) were recorded for this eight-day period. An extended period of mild temperatures followed these three fronts and was in turn followed by a fourth cold front on the night of 21 February. Low temperatures were sustained for three days; and at this time, all nesting activities ceased.

We feel that the nest-building of these Great-tailed Grackles may have resulted from the abnormally high temperatures and/or dry winter weather. Apparently the threshhold for this portion of the reproductive cycle was lowered; however, the birds were not physiologically ready to continue this behavior sequence to fruition, i.e., egg-laying and incubation.

This is contribution no. TA 9046 from the Texas Agricultural Experiment Station.—Donald W. Coon, Robert F. Gotie, and Keith A. Arnold, *Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station 77843, 15 March 1971.*

Bluebirds successfully nesting in house under construction.—In forty years of studying Eastern Bluebirds (*Sialia sialis*), I have observed thousands of nests. Most of them were built in nest boxes, but some were built in mail boxes, tin newspaper cylinders, and cavities in tree trunks and fence posts. One nest was built in the cavity of a limestone rock used in a park entrance pillar, but was not successful.

A successful nesting observed in 1970 was most unusual. The nest was built in early August in one compartment of a concrete block placed next to a chimney located in the middle of the wooden section of a two story house under construction and about twenty feet from ground level. The house was being built in a small clearing in deciduous woods in the 140-acre tract owned by Mr. and Mrs. Alex Taylor in Leiper's Fork, Tennessee, twenty miles southwest of Nashville.

When the nest was built and the three eggs laid, the uprights were in place, but the outer walls were not boarded. While incubation was in progress, the walls were boarded, excepting the openings left for windows at front and back of this two-story and attic section. The pounding and activity of the workmen did not deter the nesting activities. The adults used the window openings at front and back for entrance and exit.

On 10 August, 3 eggs were being incubated which were not hatched on 23 August. The nest was not examined on 24 August, but the young were hatched by 25 August. On 4 September, I banded 3 well-developed young. They flew from the nest early on 11 September when about 17 days old.

In my experience, much human activity near the nest of Eastern Bluebirds usually causes desertion, therefore the faithfulness of this pair in this very unusual situation seems remarkable.—Amelia R. Laskey, *1521 Graybar Lane, Nashville, Tennessee 37215. 2 March 1971.*

Predation on snakes by Eastern Bluebird and Brown Thrasher.—At 08:00 on 9 September 1964 I watched a female Eastern Bluebird (*Sialia sialis*) as it devoured a snake about 8 inches long. This bird was one of a family group which frequented our home grounds and which had become accustomed to feeding on mealworms regularly provided during the nesting period and shortly thereafter. The bird was first noted as it flew to the roof of a low building about 5 feet high with a wriggling snake held in its bill. It beat the snake against the roof and thrashed it about for several minutes before beginning to swallow it. When the snake had half disappeared the bird paused, rested briefly with the remainder of the snake dangling from its bill, then resumed feeding until it was swallowed. I was unable to find any account in the literature of this species feeding on a snake.

On 21 September 1970 a Brown Thrasher (*Toxostoma rufum*) was observed attacking a live snake as it moved along the ground. For about 10 minutes the thrasher repeatedly picked up the snake and tossed it down again, after shaking it slightly, until it was dead. Then the bird fed upon the snake, hammering three or four times with its bill until a small piece was obtained which was swallowed. After feeding for about 5 minutes the bird drank from a small amount of water in some dried leaves on the ground nearby, resumed feeding briefly in the same manner, then drank again. After it flew away I retrieved the remainder of the snake, which was the tail section. It measured 8½ inches and I estimated the full length had been about 12 inches. The snake was an eastern milk snake or "barn" snake (*Lampropeltis doliata triangulum*), a species commonly found about our barn.—Annette B. Flanigan, *Smith Road, Waite Hill, Ohio 44094, 1 February 1971.*

Clicking in the egg-young of the Long-billed Curlew.—"Clicking," a sharp, metallic sound produced by a bird prior to hatching, has been observed in a number of precocial species (Driver, Nature, 208:315, 1965; summary in Driver, Ibis, 109:434–437, 1967). However, its origin and function are incompletely understood, and observations on additional species are needed.

From 24 to 26 May 1966 I observed and tape-recorded the hatching sounds of four Long-billed Curlew (*Numenius americanus*) egg-young taken from a nest west of Brigham City, Box Elder County, Utah. Clicking was heard in all pipped eggs from 21 to 9 hours prior to hatching. This is similar to the sequence reported by Vince (Anim. Behav., 14:34–40, 1966) in five species of galliforms. Driver (Nature, 208:315, 1965), however, stated that clicking continues for some hours after hatching. Structurally the clicks of *N. americanus* were brief sounds with frequencies ranging from 3 to 8 kc/sec (Fig. 1). Rates of 10–12 clicks per second were typical but considerable variation in the spacing

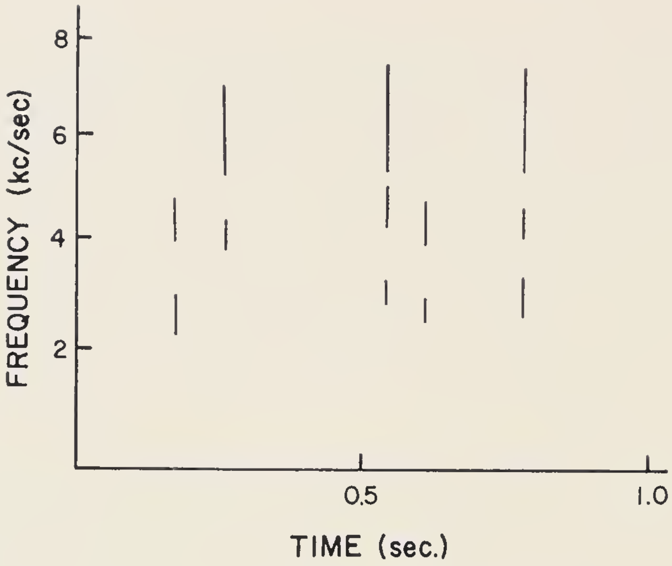

Fig. 1. Clicks given by Long-billed Curlew nine hours prior to hatching.

as well as the frequency of clicks was noted. The clicks of *N. americanus* were physically similar to those of the Gray Partridge (*Perdix perdix*) and the Painted Quail (*Excalfactoria chinensis*) studied by Vince (op. cit., plate II).

Suggested sources of the clicking sounds include bill-shell contact, bill-clapping, and respiratory movements (see Vince, op. cit., 39). My observations on the hatching curlew chicks showed that clicks were given with the bill open and were independent of bill-shell contact. Also clicks seemed to be associated with movements of the gular region which indicates an origin of clicking in the respiratory system, a view held by Driver (Ibis, 109:434–437, 1967). The clicks are probably produced by air passing over the syrinx during the period when the respiratory system becomes functional. My observations shed no light on the functional significance of clicking. Too little is known about the nesting biology of *N. americanus* to test Vince's hypothesis that clicking serves to synchronize hatching.

I am indebted to Drs. K. L. Dixon and P. M. Driver for suggestions concerning this note and to J. V. Forsythe, J. Woodson, and K. L. Shirley for assistance in the field. This study was completed while I was an NDEA predoctoral Fellow at Utah State University.—Dennis M. Forsythe, *Department of Biology, The Citadel, Charleston, South Carolina 29409, 1 February 1971.*

Flashes of white in the wings of other species elicit territorial behavior in a Mockingbird.—In the winter of 1969–1970 we first noted a Mockingbird (*Mimus polyglottos*) at our feeder on the morning of 23 January. On the afternoon of the following day the Mockingbird was first seen to attack other birds in the vicinity of the feeder. For the next six days we noted only chases directed to Red-bellied Woodpeckers (*Centurus carolinus*) and Evening Grosbeaks (*Hesperiphona vespertina*). Thereafter we also noted occasional attacks on Cardinals (*Richmondena cardinalis*) and Purple Finches (*Carpodacus purpureus*) and, less frequently, on White-throated Sparrows (*Zonotrichia albicollis*) and Downy Woodpeckers (*Dendrocopos pubescens*). We saw no attacks on Tufted Titmice (*Parus bicolor*), Carolina Chickadees (*P. carolinensis*), Pine Siskins (*Spinus pinus*), and American Goldfinches (*S. tristis*). Blue Jays (*Cyanocitta cristata*) drove off the

Mockingbird when attacked. Other species were seen too infrequently to comment on their relationships with the Mockingbird. The birds at our feeder apparently soon came to associate the arrival of the Mockingbird with a possible attack and birds would often flee to what appeared to be no more than the arrival of the Mockingbird. In many cases it was impossible to determine whether the fleeing of birds was caused by an attack or the mere arrival of the Mockingbird. We comment here only on what we considered to be actual attacks. Evening Grosbeaks and Red-bellied Woodpeckers were invariably attacked when they approached within 100 feet or more of the feeder; other species were chased only within a few feet of the feeder, and occasionally were not attacked even when on the feeder. The Mockingbird often chased Evening Grosbeaks and Red-bellied Woodpeckers for 100 feet or more. Chases of other species never exceeded a few feet. The Red-bellied Woodpeckers soon stopped visiting the feeder and were not seen again until 6 March, four days after the Mockingbird disappeared. The other species continued to visit the feeder although the Evening Grosbeaks rarely had an opportunity to feed.

We find it interesting that Evening Grosbeaks and Red-bellied Woodpeckers were the first species attacked and that the attacks on these two species were considerably more virulent and elicited at greater distances from the feeder than with other species. Of the birds commonly occurring at our feeder, only the Evening Grosbeak and the Red-bellied Woodpecker exhibit flashes of white in the wings while in flight, a characteristic they share with the Mockingbird. We regard these observations as a natural experiment indicating that the white markings in the wings of the Mockingbird function importantly as a "releaser" for aggressive or territorial behavior.—Helmut C. Mueller, *Department of Zoology, University of North Carolina, Chapel Hill,* and Nancy S. Mueller, *Departments of Zoology and Poultry Science, North Carolina State University, Raleigh, North Carolina, 15 March 1971.*

Robins night-roosting in open fields.—On 4 April 1966 between 20:00 and 21:00, we observed 20–23 Robins (*Turdus migratorius*) roosting on the ground in open hayfields. The Robins were found while we were capturing Ring-necked Pheasants (*Phasianus colchicus*) by nightlighting (Labisky, Illinois Nat. Hist. Surv. Biol. Notes, 62, 1968) in southeastern Livingston County, east-central Illinois. About 95 per cent of the land area in this portion of Illinois is under cultivation: corn and soybeans are the principal crops. Eight of the Robins were found in a 40-acre field that contained a mixture of oat stubble and clovers and was bordered on three sides by a mature multiflora rose (*Rosa multiflora*) hedge. The other 12–15 Robins were found in a 23-acre field that had been planted to a variety of grasses and legumes and was bordered on one end by a row of mature osage orange (*Maclura pomifera*) trees. Vegetation in both fields was about 6 inches high. These two fields, 6 miles apart, were the only fields in which we nightlighted on this particular night. Although we have nightlighted in east-central Illinois for more than 10 years and in all months except May and June, this is the only instance in which we observed Robins.

The Robins usually flushed and flew in a nearly vertical ascent when we approached in the nightlighting truck to a distance of 25 to 50 feet. However, we approached to within 10 feet of two Robins before they flushed. The Robins were roosting in small groups (2–7 birds), the individual birds being 2 to several feet apart. In addition to the Robins and Pheasants, the only other birds observed in the fields were a few Meadowlarks (*Sturnella* spp.) and an occasional passerine of undetermined species.

We speculate that the field-roosting Robins were migrants that had abruptly terminated their daily flight because of unfavorable weather: (1) the temperature was 35° F, the wind was from the northwest at 12–15 mph, the sky was overcast, and intermittent snow flurries were occurring; (2) the peak of Robin migration in east-central Illinois occurs between 20 March and 10 April (Graber et al., Illinois Nat. Hist. Surv. Biol. Notes (In press), 1971); and (3) at least some arboreal species—i.e., *Hylocichla* thrushes—do not select their typical diurnal habitat when landing in darkness (Cochran et al., Living Bird, 6:224, 1967). To our knowledge, this is the first recorded instance of Robins night-roosting in open fields.—William L. Anderson, Stanley L. Etter, and G. Blair Joselyn, *Illinois Natural History Survey, Urbana, Illinois 61801, 8 February 1971.*

Further notes on the juvenal plumage of the Spotted Rail (*Rallus maculatus*).—Dickerman and Parkes (Wilson Bull. 81:207–209, 1969) described three sooty plumaged juvenile Spotted Rails (*Rallus maculatus*) from Mexico that differed strikingly from three juveniles from Trinidad and southern South America. The difference was suggested as the most diagnostic character of *R. m. insolitis*, the subspecies of Mexico and Central America. Haverschmidt found among his series of eight specimens of nominate *R. m. maculatus* from Surinam, now deposited in the Leiden Museum, a male in juvenal plumage collected 29 January 1966 at Marienburg, without black and white barring on its underparts (as mentioned in his "Birds of Surinam," 1968), which appeared identical to the Mexican specimen illustrated by Dickerman and Parkes (ibid.). A second specimen from his collection, a female collected at Paramaribo, 28 December 1966, is late in the first prebasic (postjuvenal) molt, but retains juvenal feathers on the throat, lower breast and abdomen. These feathers are distinctly barred with white. Thus two juveniles from Surinam exhibit the differences described by Dickerman and Parkes for the juveniles *R. m. insolitis* and *R. m. maculatus.*

These two juveniles and three adults from Surinam in Haverschmidt's collection were sent to the American Museum of Natural History where Dickerman was able to compare them with the three Mexican juveniles and ten other juvenile *R. m. maculatus*, including two very small flightless birds, one previously illustrated taken 23 September 1950 in the Caroni Swamp of Trinidad, and one taken 7 November 1961 at Concepcion, Corrientes Prov., Argentina. It appears that there are three distinct patterns and varying intermediate patterns of juvenal plumage. In all three phases the feathers of the lower belly and flanks are more strongly barred than are those of the breast and upper belly.

1. *Dark phase*—ventral feathers sooty, tipped with darker, lacking white barring (Fig. 1: see also illustration in Dickerman and Parkes, ibid). Specimens examined: Mexico 3 (1 Veracruz, 2 Oaxaca); Surinam 1 (Marienburg); Brazil 2 (São Paulo). The latter specimens while dusky below, have feathers more strongly barred with pale buff, and thus are intermediate between the dark phase and the barred phase.
2. *Pale phase*—feathers of throat and breast pale grayish brown, the latter *weakly barred* with white. Specimens examined: Brazil 2 (São Paulo), Argentina 1 (Barrancas al Sud); Trinidad 1. The Argentine specimen is in late first prebasic molt and may be faded, but is more similar to the pale than to the barred phase. From the description in Dickerman and Parkes the juvenile from Paraguay (Field Museum Natural History) is also apparently of this color phase. The Trinidad specimen was illustrated in Dickerman and Parkes.
3. *Barred phase*—throat gray, feathers of breast and belly sharply barred with white, throat feathers spotted with white (see illustration Dickerman and Parkes, ibid). Species examined: Argentina 2 (Barrancas al Sud and Concepcion); Brazil 2 (São Paulo); Surinam 1 (Paramaribo). The Surinam specimen is somewhat more

FIG. 1. Ventral view of three color phases of juvenal plumage of the Spotted Rail (*Rallus maculatus*); pale phase, left (Brazil, São Paulo) barred phase, center (Argentina, Concepcion). and dark phase, right (Surinam). Strongly contrasting feathers of pale phase bird are first basic plumage.

extensively gray below, but the ventral feathers are sharply barred with white. The two Brazilian specimens, intermediate between the pale and barred phase, are less barred on the breast than the illustrated specimen but have similar spotting on the throat.

Unfortunately there are apparently no specimens of juvenile *R. m. inoptatus* available (Watson, Wilson Bull. 83:349–356, 1962) for comparison with the series of juvenile *R. m. maculatus* and *R. m. insolitis.* Although the dusky phase that had been considered to be characteristic of *insolitis* is now known to be found in juveniles of the nominate form, there is one character of the juvenal plumage that permits separation of all specimens into their respective populations. As noted previously by Dickerman and Parkes the undertail coverts of juvenile *maculatus* are dusky gray or white broadly tipped with buff, whereas in the three juvenile *insolitis* these feathers virtually lack any suggestion of buff, their white undertail coverts being tipped with sooty gray.

The eight adult *insolitis* (2 Costa Rica and 6 Mexico) now available uniformly differ from adult *maculatus* in having white spots instead of streaks dorsally. The dorsal spots in *insolitis* (and streaks in the case of *maculatus*) are smaller in the first basic plumage than in latter "adult" plumages as indicated by comparisons of birds in late first prebasic molt with adult birds taken in the breeding season. In contrast to the juvenal plumage the shorter dusky undertail coverts of the adults of both *insolitis* and *maculatus* may be tipped with buff. As noted by Watson (ibid.) there is some variation in the depth of color of the feather edgings of the back and wings. In *insolitis* these were described as being chocolate brown in contrast to paler edgings in *maculatus.* While individual birds may be matched in either series, *insolitis* averages considerably darker, and no *maculatus* specimen can match the darkest *insolitis.*

Mexican specimens were collected under permit from the Departmento de Conservacion de la Fauna Silvestre, Secretaria de Agricultura y Ganaderia. We thank the curators of the Leiden Museum, the Peabody Museum, Yale University, and the Carnegie Museum for permission to examine specimens in their care.—Robert W. Dickerman, *Department of Microbiology, Cornell University Medical College, New York, New York 10021,* and F. Haverschmidt, *Wolfskuilstraat 16, Ommen, Holland, 19 June 1971 (Originally received 19 November 1970).*

LOUIS AGASSIZ FUERTES AND MARGARET MORSE NICE AWARDS

Fuertes Awards are devoted to the encouragement and stimulation of young ornithologists. One particular desire is the development of research interests among amateur ornithologists. Any kind of ornithological research may be aided. Recipients of grants need not be associated with academic organizations. Each proposal is considered primarily on the basis of possible contributions to ornithological knowledge. Although grantees are not required to publish their studies in *The Wilson Bulletin*, it is hoped that they will submit their manuscripts to the editor of *The Bulletin* for consideration.

Most of the statements applicable to the Fuertes Awards are also applicable to the Nice Award. However, the Nice Award is limited to persons not affiliated with a college or university.

In some years two Fuertes Awards have been made, in some years one. Amounts have been between $200 and $100. One Nice Award is made annually, in the amount of $100.

Interested persons may write to Val Nolan Jr., Department of Zoology, Indiana University, Bloomington, Indiana 47401. Completed applications must be received by 1 May 1972. Final decisions will be made by the Council at the annual meeting of the Society on June 13–16, 1972.

ORNITHOLOGICAL NEWS

The year 1971 marked the 50th year of membership in the Wilson Society for: Margarette E. Morse, Margaret M. Nice, Wendell P. Smith, Edward S. Thomas, and Edward von Siebold Dingle.

On 23 October 1971 the Cornell Laboratory of Ornithology awarded the Fifth Annual Arthur A. Allen Award to Peter Scott.

The personal library of the late James L. Baillie, one of the finest private ornithological collections in North America, has been acquired by the University of Toronto, and will be known as the James L. Baillie Ornithological Library. Mr. Baillie's field journals, personal diaries, and correspondence with other naturalists are also included in the collection. By agreement with Mrs. Baillie the University will grant free access to anyone interested in consulting this collection, currently housed in the temporary Rare Book Room of the University Library.

Members who know students that are interested in ornithology should send nominations to the Student Membership Committee addressed to Douglas James, Department of Zoology, University of Arkansas, Fayetteville, Arkansas 72701. The nominees will be invited by the committee to apply for membership in the Wilson Ornithological Society.

The color plate in this issue was subsidized by a generous member of the Society. Members are reminded that the Bulletin maintains a "Colorplate Fund." Contributions in any amount to this fund will be welcomed, and should be sent directly to the Treasurer, designated for the Fund. We ultimately would like to be able to include a color plate in each issue of *The Bulletin.*

At the close of another volume and another year it is again my good fortune and pleasure to extend personal thanks to all those many members of the Society who have contributed to the success of *The Bulletin.* As usual special thanks go to the members of the Editorial Board and other ornithologists who reviewed papers submitted for publication. The exacting job of preparing the index for this volume was skillfully and rapidly done by Bonnie Rose McBride who merits special thanks.

After several years during which we had a large backlog of papers, and experienced long delays in publication we now find ourselves in the position to publish papers with a minimum delay after acceptance.—G.A.H.

ORNITHOLOGICAL LITERATURE

The Hamlyn Guide to Birds of Britain and Europe. By Bertel Bruun. Illustrated by Arthur Singer. Consultant Editor, Bruce Campbell. The Hamlyn Publishing Group Ltd., New York, 1970: 4½ × 7½ in., 319 pp., 516 birds illustrated in color. 25/- (= $3.00).

Having had the pleasure of reviewing "Birds of North America" for this journal (Wilson Bull., 79:251–254, 1967), I looked forward eagerly to reviewing its natural companion, a European guide by two of the same authors, Bruun and Singer. In general, I was not disappointed. The same charm of Arthur Singer's illustrations is maintained throughout, and his meticulous attention to detail makes this an identification book *par excellence.* Every bird is pictured in color, and there is the same abundance of illustrations. Special treatment is given to difficult groups, and much space is devoted to immatures, seasonal plumages, flight pictures, and silhouettes. Immature and female buntings have a two-page spread, for example, and Bonelli's Eagle has five illustrations—an adult and an immature standing and an adult, a first-year bird, and a second-year bird in flight. It is this wealth of color illustrations that distinguishes a really fine field guide such as this from the host of mediocre publications masquerading under that name. The publishers are to be complimented for not trying to cut corners and illustrating some birds by line drawings, as is so often done.

The general format is the same as that followed in Birds of North America: the text is on one page and the illustration of the bird on the opposite page. This time-saving feature is universally praised whenever I hear this book or its predecessor being discussed, and has undoubtedly contributed greatly to their success. A field guide is for use in the field, and the less time it takes you to look up a bird, the better. Individual species are given five to ten lines of text, exceptionally 15; brief note is made of habitat and sometimes behavior, if significant for identification purposes, but the text is mainly concerned with field identification. Range is shown by a map beside the text, an excellent feature. The maps are small but adequate, and in addition to showing summer and winter ranges they also indicate with arrows the principal routes taken by migrants. Sonagrams of bird songs, which were one of the less successful features of Birds of North America, have wisely been omitted in the present volume, their place being taken by written descriptions.

At the end of each species description a symbol has been added to indicate the status of the bird in Britain, i.e. R (= resident), S(ummer), W(inter), P(assage), and V(agrant). A given bird may belong to several categories—the Grey Heron, for instance, is RWP, but since the category "V" by definition excludes all other categories, the unfortunate result is that no bird can be RSVP! If the book is translated into other languages, it would be appropriate to change the symbols to fit the bird's status in the country involved.

In addition to the individual species treatment, there is a general introduction of 5–10 lines to each family and major subfamilial and generic grouping, giving the salient points of life history and anatomy. This is a first-rate idea, especially for the beginner interested in the broad distinctions between the major groups. These familial accounts are often charmingly illustrated with representative species, as in the waterfowl (pp. 42–43) and the warblers (pp. 222–223).

The area covered by the book extends eastward to include the Ural Mountains, Caspian Sea, and the Caucasus and thus introduces the reader to a number of species not illustrated or even described in other European bird books, e.g. Pallas' Sea Eagle, Siberian White

Crane, Oriental Cuckoo, Citrine Wagtail, and Menetries' Warbler. The book includes all birds that have occurred in Europe at least five times in this century; accidentals not meeting this requirement are not described but listed separately at the back of the book. Also included are introduced and escaped species "well established in a feral state." While not quarrelling with this principle, it would have been interesting to know more precisely what guidelines were used; this is a perennial problem for checklist compilers.

The major fault of the book is one that concerns the publishers, not the authors. The book is so cheaply put together that it literally falls apart with even minimal use. The pages are stuck in with glue, and my review copy came apart right on my desk by the mere act of turning the pages; I can imagine what would happen to the book in the field. The same complaint has been heard to a lesser degree about Birds of North America, and one would have thought that a lesson might have been learned, but apparently not, since the European guide is even worse in this respect. Those who would like to give this book a lot of use (which it certainly deserves) might seriously consider taking it to their local bookbinder for a proper cover.

The other faults of the book, though numerous, should be seen in their proper perspective. When a new book comes out on such well-covered areas as Europe or North America I think a reviewer has a duty to be extra-critical of it because readers want to know why they should buy this book rather than any of the other books on the subject. Some parts of the world are still not covered by any popular bird book, and in these cases it is worth buying almost anything that comes out, and reviewers tend to be more lenient. But Europe has a multiplicity of bird books, and the following complaints should be seen in this light.

First, the book badly needs the attention of a competent taxonomist. Taxonomic order is disregarded without comment in many places. Bustards are placed between cranes and rails, a novel approach even in so controversial an order as the Gruiformes. The owls are in a mess; the Barn Owl is sandwiched between other owls and the Tawny Owl has been separated from the other members of the genus *Strix. Acrocephalus agricola* comes in the middle of *Locustella*, and the *Cisticola* in the middle of *Acrocephalus.* None of these arrangements appear to have any advantages for identification purposes, in contrast to the cases of the Snow Finch and the Bearded Tit, which have been taken out of their correct order and placed next to similar-looking birds for identification purposes, and the fact is so mentioned in the text.

Not only the order is at fault. In cases of controversial genera, the authors decided that the fairest course would be to give equal time to all classifications. Thus we find the shearwaters on page 26 in the following order: *Puffinus puffinus*, *Procellaria baroli*, *Puffinus gravis*, *Procellaria diomedea*, and *Puffinus griseus.* Similarly with the small thrushes on pages 256–258, the Bluethroat is in *Luscinia*, followed by the Robin in *Erithacus*, the Red-flanked Bluetail in *Tarsiger*, and back to *Luscinia* with the Nightingale. King Solomon himself could have given no more fair a judgement.

The authors are apparently unaware that the "Rufous Warbler," placed between *Sylvia* and *Phylloscopus*, is in fact a thrush, the genus *Cercotrichas* being widespread in Africa where the birds are known popularly as Scrub Robins. And a final taxonomic point—the group treatment in the Turdinae needs to be revised. After the Muscicapinae, instead of a discussion of Turdinae we come to a major heading "WHEATEARS" (a new subfamily, Oenanthinae?); after the Wheatears we proceed without major heading change through various genera of small thrushes, such as *Saxicola* and *Phoenicurus* (which are now presumably in Oenanthinae), until finally at the genus *Turdus* we come to the heading "THRUSHES." This needs to be tightened up.

Turning to the text, I am afraid I found the game of "spot the error," popular with reviewers, to be a very rewarding one in this book. Many of these errors stem from the fact that the description of the bird does not correspond with its picture; author and artist did not get together enough here. There is only space for me to mention the principal errors here.

The labels of the immature Dalamatian Pelican and White Pelican have been transposed (p. 30). The Squacco Heron (p. 36) is said to be told from the Cattle Egret by its red bill in breeding season—but it is the Cattle Egret that has the red bill in the breeding season; the Squacco's bill is dark green and black, as illustrated. The painting of the Common Scoter (p. 62) is correctly of the European race *nigra*, but the text describes the American race *americana*. The account of the Common Crane (p. 102) contains the statement "On the ground the tail looks very bushy." This is a classic blooper (the "tail" being the elongated secondaries which droop over the tail of a standing bird.) Under Glaucous Gull (p. 142) we are told to "note in flight the transluscent (*sic*) windows at base of primaries" but these are not shown in the flight illustration.

Calls are poorly described in a number of birds, and practically no use is made of the time-honored device of reducing them to a memorable phrase, nor even are they written out in full. The Woodpigeon call is inadequately rendered as "Cooing consists of five syllables, emphasis on the first." This is in any case wrong, as the emphasis is on the second syllable. The dove calls are all poor and so are the owls, to which special emphasis should have been given. All that is said of the Little Owl (p. 172) is "calls are shrill and sharp," which is completely useless—the Blackbird has some shrill and sharp calls, as do a couple of hundred other European birds.

Lastly, something has gone wrong on the Nuthatch page (p. 272). Kruper's Nuthatch has been omitted entirely from both text and illustrations, yet the map opposite Corsican Nuthatch, confined to Corsica, shows a range in Asia Minor which is about right for Kruper's Nuthatch—??

In conclusion, I may say that the above remarks show only that there has been some sloppy editorial work and some sloppy writing; they do not really detract from the overall quality of the book. With the proviso that you do something about having the book properly bound, I heartily recommend its purchase.—STUART KEITH.

ORNITHOLOGY IN LABORATORY AND FIELD, 4th Edition. By Olin Sewall Pettingill, Jr. Burgess Publishing Co., Minneapolis, 1970: 7½ × 10 in., xvii + 524 pp., col. frontispiece and 30 pl. (2 in color), many bl. and wh. figures and illustrations. $11.95.

Since the spiral-bound first edition of 1939, Pettingill's manual has introduced a generation of college students to laboratory and field aspects of ornithology. Updating of the 1956 edition is welcome indeed.

The fourth edition is longer than its predecessor by 143 pages. There are additional black and white plates and, for the first time, colored illustrations are present. An agreeable profusion of Walter J. Breckenridge's pen and ink sketches enlivens the pages. Information-filled appendices now total 88 pages. A number of significant topics, untreated in earlier editions, has been added.

Outstanding in this edition is the revision of "Feathers and Feather Tracts" overseen by Peter Stettenheim and superbly illustrated by Robert P. Ewing. "Anatomy and Physiology" is enhanced by Berger's contribution on myology. An 18 page discussion of behavior, a section on "Ancestry, Evolution, and Decrease of Birds," and an introduction, "Birds and Ornithology," are among the added topics which give new dimensions to this work.

It is obvious that much more than updating of a laboratory-field manual has been achieved. Pettingill states (p. vii) that while no pretense has been made to cover the entire field of ornithology, added material is "possibly enough to supplant the need of an extra textbook." It would certainly seem that the broadened scope of this edition is designed to fit the work into the category of a general text. Presentation of the text's 20 sections as "more or less independent units" and the extensive lists of references with each section will allow an instructor versatility in use of the volume in a wide spectrum of approaches to teaching ornithology.

It is evident that much care has gone into all stages of preparation of this edition. The comments and few criticisms I offer are, by and large, more in anticipation of a fifth edition than in derogation of the present.

I count a total of 41 pages that require fill-ins (labels, data, migration routes, etc.) by the student. The book is not inexpensive. Some students may not elect to retain it. What of its resale value? Who would wish to purchase a used copy? I question the appropriateness of having workbook pages bound into a text.

In my opinion the colored illustrations of the digestive and urogenital systems (plates 24 and 25) contribute little except possibly added expense. Carefully executed black and white drawings can convey impressions as distinct, if not more so, than these. Furthermore, why should these (and certain other) illustrations not have labels? The student should not expend effort identifying structures in a drawing which is designed to aid him in locating these structures in the specimen itself.

Kinesis of the upper jaw, disappointingly, receives the briefest mention. In my experience students have much curiosity about this. The mechanism of upper jaw movement, then, can afford interesting introduction to many aspects of the skull.

It would be a welcome departure from traditional directions for identification and dissection if—with at least a part of the myology—emphasis were placed upon functional aspects of a muscle system such as that of the wing, leg, or jaw. Memorizing listed information about individual muscles would then be subordinated to something more meaningful to college students.

In a book remarkably free of inappropriate phraseology it is unfortunate that the following could not have been eliminated. (Italics in this paragraph are mine.) Birds "have radiated widely in form and action *in order to live in particular environments*"—(p. 3). Winter visitants come from northern nesting grounds "*to pass the winter in less rigorous climate*"—(p. 207). Rather than the "*Functions* of Territory"—(p. 313)—might it not have been more precise to say the "*Significance* of Territory?" The Connecticut Warbler "migrates in an eccentric manner"—(p. 285); a route eccentric in outline? Reviewers can be overly critical. But, after all, instruction is the primary purpose of this volume and the more precise the statement the more effective.

The brief review of ectoparasites (Appendix I) is excellent. A concise introduction to endoparasites of birds would be of much use to the student.

It would be convenient if all the families of the birds of the world were listed (pp.: 142–144). The Pycnonotidae, incidentally, might well have been included in the list of North American families; the Red-whiskered Bulbul has been established in the Miami area for more than ten years.

With respect to the list (p. 191) of birds known to molt remiges simultaneously, I suggest that anhingas and flamingos are "notable" too.

Polychromatism is discussed (p. 193). Might not the subject of polymorphism have been introduced?

Although the Dodo may be the first species of bird which at present is surely known to have been exterminated by man (p. 421), there is increasing indication that at much earlier times Moas, as well as other species, may have been eliminated by man—see, e.g., P. S. Martin and H. E. Wright, Jr. (Pleistocene Extinctions, 1967).

"So far there is no evidence that the Cattle Egret has had any harmful effects on other herons. . ."—(p. 202). Lowe-McConnell (Ibis, 109:168–179, 1967) and Dusi (Alabama Birdlife, 16:4–6, 1968) have indicated otherwise.

Finally, with reference to the map of North America (p. 210), could not the southern one-third of the Florida peninsula have been indicated as something other than grassland or glacier!

Usefulness of this long-established and well-liked work has been much enhanced for both field and laboratory study by updating and by the new features it contains. Important topics added to this edition have opened new avenues for its use in the teaching of Ornithology. Students of birds, at whatever level, will find the volume an indispensable one for their shelves.—OSCAR T. OWRE.

THE HAWKS OF NEW JERSEY. By Donald S. Heintzelman. New Jersey State Museum, Trenton, N.J., Bulletin 13, December 1970: 6 × 9 in., 104 pp., 2 maps, 4 tables, 39 halftones, 47 drawings. $2.00.

The first half of this small volume is a general ornithological introduction to hawks and falcons, with an account of the fossil record, a general ecological discussion of predation and food chains, an account of autumn hawk flights at Cape May, at the Montclair Hawk Lookout Sanctuary and along the Kittatinny Ridge. In a section on endangered species, particular attention is paid to the accumulation of pesticides in food chains leading to drastic poisoning and reproductive failure in the Peregrine Falcon, Bald Eagle and Osprey. There is also an account of habitat destruction and hawk shooting as contributory factors in the decline of hawk populations.

The systematic section covers 19 species, each accompanied by a half-tone photograph and a food habits diagram. The species accounts are brief but seem adequate for the purpose of an introduction to the life history of each, including names, field marks, range in New Jersey, nest, eggs and general comments. The incubation periods for many species seem much too short (compare Brown and Amadon, 1968) and seemingly are cited without heed to the critique published by Nice. Finally a ten page section on hawk identification includes drawings of hawks in flight, an account of hawk-watching stations, and a brief key to the species described. The diagrams of the tail shapes of Sharp-shinned and Cooper's Hawks are incorrectly drawn, while the Austing photographs show the "square" versus rounded tails nicely. It is not often noted that the square tail of the Sharp-shin is due to the prominence of the fifth tail feathers on each side, not the sixth, which is distinctly shorter, as nicely figured by George M. Sutton in *The Wilson Bulletin* several decades ago.

Easily the best part of the book is the account of hawk flights and migration points, a field in which Mr. Heintzelman has had long experience. The account of food-chain poisoning and pesticide accumulation is brief and to the point, easily read, and this book presents this information where it can be easily found and digested by people with little background or opportunity for serious study. All in all, I think this is a worthwhile addition to the general ornithological library and one that even the experienced hawk-watcher will want to have.—WALTER R. SPOFFORD

MATING SYSTEMS, SEXUAL DIMORPHISM, AND THE ROLE OF MALE NORTH AMERICAN PASSERINE BIRDS IN THE NESTING CYCLE. By Jared Verner and Mary F. Willson. The American Ornithologists' Union Ornithological Monographs, No. 9, 1969: 6¾ × 10 in., 76 pp., 4 tables. $2.50.

Prompted by their interest in the mating systems of North American passerines, Verner and Willson have searched the books and periodicals of four of the largest American university libraries for material describing passerine parental behavior and the degree of male participation in the rearing of the young. The present work consists primarily of a long table which 1) classifies 291 species from the region north of Mexico as being either sexually monomorphic or dimorphie, 2) indicates what is known about their mating systems, and 3) reports the roles of the male during the several stages of reproduction from nest-building through the period of dependence. For each species about which there is information there are citations to the 1,585 items that constitute the bibliography, with the result that this work is an exremely useful reference to virtually all the American literature (since about 1880) pertaining to the subjects mentioned above. Also important, the table is a rough but quick indicator of the state of knowledge about each species. I counted 57 for which there is no more than one bibliographic entry, and the authors regard only 48 species as "reasonably well known" (page 31).

Other tables summarize the frequencies of sexual di- and monomorphism and of the various mating systems according to family and also analyze male participation and nonparticipation in the care of the young according both to mating system and to the extent of sexual variation. On the basis of these summaries possible associations between the variables under consideration, for example, between polygyny and male behavior, are tested statistically and discussed very briefly.

This monograph will be an important reference for years to come, not only to those interested in the evolution of avian mating systems and in sexual dimorphism but also to anyone seeking life-history information on North American passerines.—VAL NOLAN JR.

BIRDS OF ROCKY MOUNTAIN NATIONAL PARK. Museum Pictorial No. 18. By Allegra Collister. Denver Museum of Natural History, 1970: 6 × 9 in., paper covered, 64 pp., many photos. $1.00.

This booklet is an annotated check-list of the 256 species of birds that have been found in the Park, in Shadow Mountain Recreation Area, and the immediate vicinity. Observations of unusual occurrence are cited. Photographs by Alfred M. Bailey, Robert J. Niedrach, Patricia Bailey Witherspoon, and others enhance the publication.—PETER STETTENHEIM.

THE WILSON ORNITHOLOGICAL SOCIETY

INDEX TO VOLUME 83, 1971

By Bonnie Rose McBride

This index includes, in addition to the names of genera, species, and authors, references to the following topics: Anatomy, aviculture, behavior, breeding, clutch size, distribution, ecology, eggs, embryology, food habits, fossils, growth and development, habitat, hatching, hybridization, incubation, measurements, migration, molts and plumages, mortality, nesting, nesting success, nests, parasitism, pesticides, physiology, populations, predation, roosting, sex ratios, taxonomy, territory, voice and vocalizations, weather, and winds. Also included are references of biological significance to reptiles and mammals.

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